

# UC Berkeley

## McCown Archaeobotany Laboratory Reports

### Title

Compilation of Phytolith and Starch Images of Taxa Relevant to the Contemporary Caribbean

### Permalink

<https://escholarship.org/uc/item/4gg9m8rg>

### Authors

Fernández-Pérez, Natasha A.  
Hastorf, Christine A.

### Publication Date

2018-09-12

### Copyright Information

This work is made available under the terms of a Creative Commons Attribution-ShareAlike License, available at <https://creativecommons.org/licenses/by-sa/4.0/>

# UC Berkeley Archaeobotany Laboratory Report #86: Compilation of Phytolith and Starch Images of Taxa Relevant to the Contemporary Caribbean

Natasha A. Fernández-Pérez and Christine A. Hastorf

Fall 2018

Date: September 12, 2018

## Background:

In Spring 2018, Natasha A. Fernández-Pérez approached Christine A. Hastorf because she wanted to do a Directed Reading on phytolith and starch applications to archaeology. Since she wanted to work on the Historical/Contemporary Caribbean, where the plantscape has been affected by colonialism, imperialism and globalization, the readings ranged from all over the Neotropics and included few relevant plants from the Old World (e.g. rice, bananas and Near Eastern cereals). To organize the information and morphotypes presented in these readings by plant taxa, and following professor Hastorf's advice, she created a file where the images were arranged in alphabetical order by family, genus and specie, with their respective references. In total, 81 families were included:

Acanthaceae	Cucurbitaceae	Menispermaceae
Amaranthaceae	Cyatheaceae	Moraceae
Anacardiaceae	Cyperaceae	Musaceae
Annonaceae	Dasypogonaceae	Myristicaceae
Apiaceae	Dichapetalaceae	Myrtaceae
Araceae	Dilleniaceae	Orchidaceae
Arecaceae	Dioscoreaceae	Oxalidaceae
Asteraceae	Ebenaceae	Piperaceae
Barringtoniaceae	Elaeocarpaceae	Poaceae
Basellaceae	Ericaceae	Pteridaceae
Bataceae	Erithroxelaceae	Restionaceae
Bignoniaceae	Euphorbiaceae	Simaroubaceae
Bixaceae	Fabaceae	Smilacaceae
Bombacaceae	Fagaceae	Solanaceae
Boraginaceae	Flacourtiaceae	Sterculiaceae
Brassicaceae	Haemodoraceae	Strelitziaceae
Bromeliaceae	Heliconiaceae	Thelypteridaceae
Burmanniaceae	Hernandiaceae	Thurniaceae
Burseraceae	Humiriaceae	Tropeolaceae
Cactaceae	Hymenophyllaceae	Ulmaceae
Cannabaceae	Juglandaceae	Urticaceae
Cannaceae	Juncaceae	Zamiaceae
Chloranthaceae	Lauraceae	Zingiberaceae
Chrysobalanaceae	Loranthaceae	
Clusiaceae	Lowiaceae	
Combretaceae	Lygodiaceae	
Commelinaceae	Magnoliaceae	
Convulvulaceae	Malvaceae	
Costaceae	Marantaceae	

## References Included:

### McCown Archaeobotany Laboratory Collections:

- Australian Museum
- Korstanje and Babot

Abramiuk, Marc A., Peter S. Dunham, Linda Scott Cummings, Chad Yost, and Todd J. Pesek. 2011. Linking Past and Present: A Preliminary Paleoethnobotanical Study of Maya Nutritional and Medicinal Plant Use and Sustainable Cultivation in the Southern Maya Mountains, Belize. *Ethnobotany Research and Applications* 9:257–73.

Babot, María del Pilar. 2003. Starch Grain Damage as an Indicator of Food Processing. In *Phytolith and Starch Research in the Australian-Pacific-Asian Regions: The State of the Art*.

Ball, Terry B., L. Vrydaghs, I. Van Den Hauwe, J. Manwaring, and E. De Langhe. 2006. Differentiating Banana Phytoliths: Wild and Edible *Musa Acuminata* and *Musa Balbisiana*. *Journal of Archaeological Science* 33 (9):1228–36.

Ball, Terry B., Karol Chandler-Ezell, Ruth Dickau, Neil Duncan, Thomas C. Hart, José Iriarte, Carol Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <http://dx.doi.org/10.1016/j.jas.2015.08.010>.

Chandler-Ezell, Karol, Deborah Marie Pearsall, and James A. Zeidler. 2006. Root and Tuber Phytoliths and Starch Grains Document Manioc (*Manihot Esculenta*), Arrowroot (*Maranta Arundinacea*), and Llerén (*Calathea* Sp.) at the Real Alto Site, Ecuador. *Economic Botany* 60 (2):103–20. [http://www.bioone.org/doi/abs/10.1663/0013-0001\(2006\)60%5B103:RATPAS%5D2.0.CO%3B2](http://www.bioone.org/doi/abs/10.1663/0013-0001(2006)60%5B103:RATPAS%5D2.0.CO%3B2).

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

Dickau, Ruth, Anthony J. Ranere, and Richard G. Cooke. 2007. Starch Grain Evidence for the Preceramic Dispersals of Maize and Root Crops into Tropical Dry and Humid Forests of Panama. *Proceedings of the National Academy of Sciences of the United States of America* 104 (9):3651–56.

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

Gu, Yansheng, Zhijun Zhao, and Deborah Marie Pearsall. 2013. Phytolith Morphology Research on Wild and Domesticated Rice Species in East Asia. *Quaternary International* 287. Elsevier Ltd and INQUA:141–48. <http://dx.doi.org/10.1016/j.quaint.2012.02.013>.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

Holst, Irene, J Enrique Moreno, and Dolores R. Piperno. 2007. Identification of Teosinte, Maize, and Tripsacum in Mesoamerica by Using Pollen, Starch Grains, and Phytoliths. *Proceedings of the National Academy of Sciences of the United States of America* 104 (45):17608–13. <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2077075&tool=pmcentrez&rendertype=abstract>.

Horrocks, Mark, Matthew Campbell, and Warren Gumbley. 2007. A Short Note on Starch and Xylem of Ipomoea Batatas (Sweet Potato) in Archaeological Deposits from Northern New Zealand. *Journal of Archaeological Science* 34 (9):1441–48.

Horrocks, Mark, and Robert B. Rechtman. 2009. Sweet Potato (Ipomoea Batatas) and Banana (Musa Sp.) Microfossils in Deposits from the Kona Field System, Island of Hawaii. *Journal of Archaeological Science* 36 (5). Elsevier Ltd:1115–26. <http://dx.doi.org/10.1016/j.jas.2008.12.014>.

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannahs. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

Itzstein-Davey, Freea, David Taylor, John Dodson, Pia Atahan, and Hongbo Zheng. 2007. Wild and Domesticated Forms of Rice (Oryza Sp.) in Early Agriculture at Qingpu, Lower Yangtze, China: Evidence from Phytoliths. *Journal of Archaeological Science* 34 (12):2101–8.

Lentfer, Carol J. 2009. Tracing Domestication and Cultivation of Bananas from Phytoliths: An Update from Papua New Guinea. *Ethnobotany Research and Applications* 7:247–70.

Logan, Amanda L., Christine A. Hastorf, and Deborah Marie Pearsall. 2012. “Let’s Drink Together”: Early Ceremonial Use of Maize in the Titicaca Basin. *Latin American Antiquity* 23 (3):235–58.

Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

Musaubach, María Gabriela, Anabela Plos, and María Del Pilar Babot. 2013. Differentiation of Archaeological Maize (*Zea Mays* L.) from Native Wild Grasses Based on Starch Grain Morphology. Cases from the Central Pampas of Argentina. *Journal of Archaeological Science* 40 (2). Elsevier Ltd:1186–93. <http://dx.doi.org/10.1016/j.jas.2012.09.026>.

Pagán-Jiménez, Jaime R. 2007. *De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas*. Vol. 1067. Oxford: British Archaeological Reports Limited.

Pagán-Jiménez, Jaime R., and Lisabeth A. Carlson. 2014. Recent Archaeobotanical Findings of the Hallucinogenic Snuff Cojoba (*Anadenanthera Peregrina* (L.) Speg.) in Precolonial Puerto Rico. *Latin American Antiquity* 25 (1):101–16.

Pagán-Jiménez, Jaime R., Reniel Rodríguez-Ramos, Basil A. Reid, Martijn van den Bel, and Corinne L. Hofman. 2015. Early Dispersals of Maize and Other Food Plants into the Southern Caribbean and Northeastern South America. *Quaternary Science Reviews* 123:231–46. <http://www.sciencedirect.com/science/article/pii/S0277379115300445>.

Pasqua, Alessandro, Liovando Marciano da Costa, and Ervan Garrison. 2017. Phytolith Evidence of Historical Rice Cultivation at Wormsloe Historic Site, Georgia, USA. *Journal of Archaeological Science: Reports* 14 (June). Elsevier:557–74. <http://linkinghub.elsevier.com/retrieve/pii/S2352409X17300159>.

Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

Pearsall, Deborah Marie. 1993. Contributions of Phytolith Analysis for Reconstructing Subsistence: Examples from Research in Ecuador. *Current Research in Phytolith Analysis: Applications in Archaeology and Paleoecology*. MASCA.

Pearsall, Deborah Marie. 2002. "Maize Is Still Ancient in Prehistoric Ecuador: The View from Real Alto, with Comments on Staller and Thompson." *Journal of Archaeological Science* 29: 51–55. doi:10.1006/jasc.2001.0736.

Pearsall, Deborah Marie, Karol Chandler-Ezell, and Alex Chandler-Ezell. 2003. "Identifying Maize in Neotropical Sediments and Soils Using Cob Phytoliths." *Journal of Archaeological Science* 30 (5): 611–27. doi:10.1016/S0305-4403(02)00237-6.

Pearsall, Deborah Marie, Karol Chandler-Ezell, and Alex Chandler-Ezell. 2004. "Maize Can Still Be Identified Using Phytoliths: Response to Rovner." *Journal of Archaeological Science* 31 (7): 1029–38. doi:10.1016/j.jas.2003.11.007.

Pearsall, Deborah Marie, Karol Chandler-Ezell, and James A. Zeidler. 2004. Maize in Ancient Ecuador: Results of Residue Analysis of Stone Tools from the Real Alto Site. *Journal of Archaeological Science* 31:423–42.

Pearsall, Deborah Marie, Dolores R. Piperno, Elizabeth H. Dinan, Marcelle Umlauf, Zhijun Zhao, and Robert A. Benfer. 1995. Distinguishing Rice (*Oryza Sativa* Poaceae) from Wild *Oryza* Species through Phytolith Analysis: Results of Preliminary Research. *Economic Botany* 49 (2):183–96.

Perry, Linda. 2002. Starch Analyses Reveal Multiple Functions of quartz “manioc” Grater Flakes from the Orinoco Basin, Venezuela. *Interciencia* 27 (11):635–39.

Perry, Linda. 2002. Starch Granule Size and the Domestication of Manioc (*Manihot Esculenta*) and Sweet Potato (*Ipomoea Batatas*). *Economic Botany* 56 (4):335–49.

Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449. <http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

Piperno, Dolores R. 2006. *Phytoliths: A Comprehensive Guide for Archaeologists and Paleoecologists*. Oxford: AltaMira Press.

Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in Cucurbita and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.

Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

Piperno, Dolores R., Anthony J. Ranere, Irene Holst, and Patricia Hansell. 2000. Starch Grains Reveal Early Root Crop Horticulture in the Panamanian Tropical Forest. *Nature* 407:894–97.

Pohl, Mary E. D., Dolores R. Piperno, Kevin O. Pope, and John Glendon Jones. 2007. Microfossil Evidence for Pre-Columbian Maize Dispersals in the Neotropics from San Andres, Tabasco, Mexico. *Proceedings of the National Academy of Sciences* 104 (16):6870–75. <http://www.pnas.org/cgi/doi/10.1073/pnas.0701425104>.

Poveda-Díaz, Nataly, Maria Eugenia Morales-Puentes, and Gregory Vaughan. 2016. Phytoliths Produced by Common Bean (*Phaseolus Vulgaris* L.), Achira (*Canna Indica* L.), and Squash (*Cucurbita Ficifolia* Bouché), Crop Species from Boyacá, Colombia. *Revista de La Academia Colombiana de Ciencias Exactas, Físicas y Naturales* 40 (154):137–46.

Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

Twiss, Page C., Erwin Suess, and Robert M. Smith. 1969. “Morphological Classification of Grass Phytoliths.” In *Soil Science of America Proceedings*, 33:109–15. Madison, Wisconsin. doi:10.1007/s00702-011-0732-4.

Vrydaghs, L., Terry B. Ball, H. Volckaert, I. Van Den Houwe, J. Manwaring, and E. De Langhe. 2009. Differentiating the Volcaniform Phytoliths of Bananas: *Musa Acuminata*. *Ethnobotany Research and Applications* 7:239–46.

Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

Wu, Yan, Leping Jiang, Yunfei Zheng, Changsui Wang, and Zhijun Zhao. 2014. Morphological Trend Analysis of Rice Phytolith during the Early Neolithic in the Lower Yangtze. *Journal of Archaeological Science* 49 (1). Elsevier Ltd:326–31. <http://dx.doi.org/10.1016/j.jas.2014.06.001>.

ACANTHACEAE



# Justicia pringlei

## Phytolith

2. Segmented hairs from *Justicia pringlei* with tapered shafts and small, rounded apices. The hair on the left is broken near the base (156 x).

3. Right, a cystolith from *Justicia pringlei* showing the tuberculate surface decoration. On the left is a completely silicified segmented hair attached to a hair base (156 x).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Mendoncia spp.

## Phytolith

Fig. 5. Genus-specific phytolith from the seeds of *Mendoncia* spp. recovered from modern soils underneath tropical montane forest in Panama.

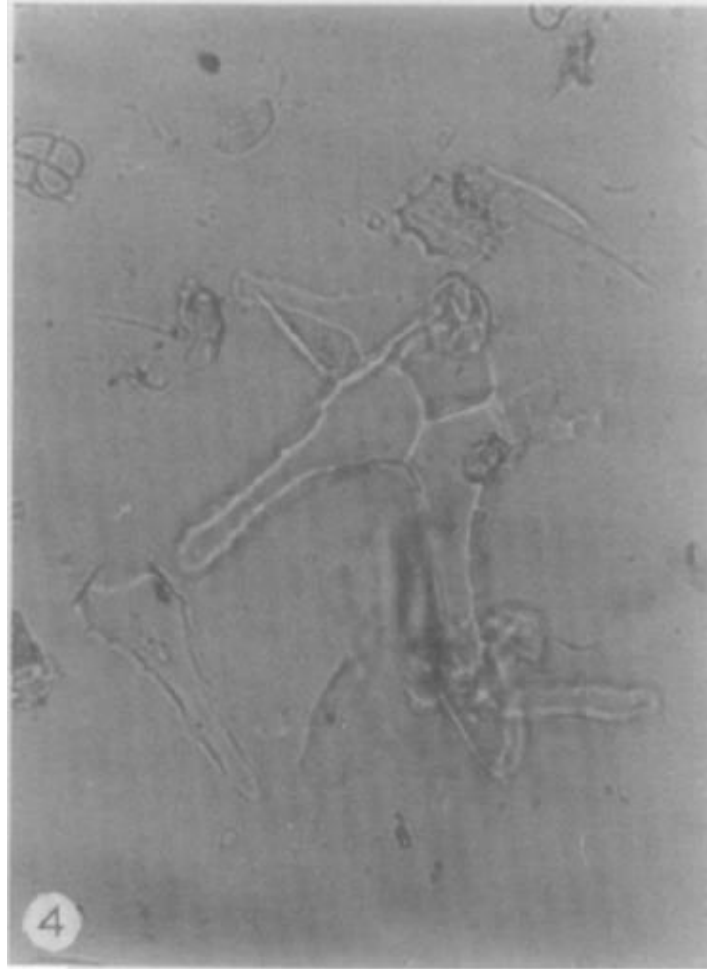


Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449.  
<http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Mendoncia coccinea

## Phytolith

4. Non-segmented club-shaped hairs from *Mendoncia coccinea* (156 x).

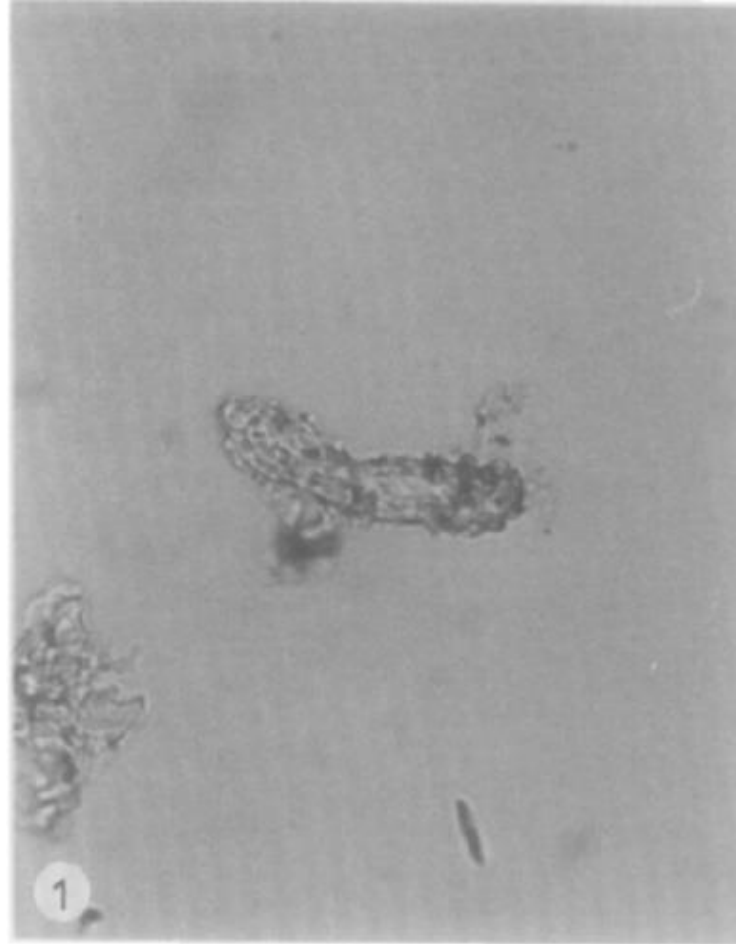


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Odontonema bracteolata

## Phytolith

1. An elongate cystolith from *Odontonema bracteolata*. The tuberculate surface pattern is developed only on the right end of the cystolith (156 x)



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Pseuderanthemum davei

## Phytolith

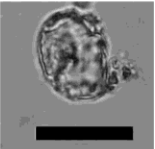
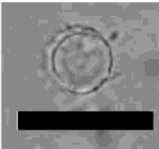

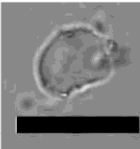
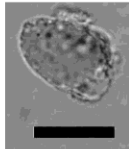
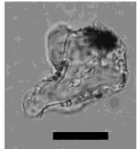
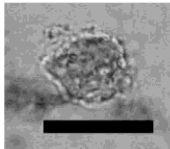
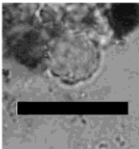

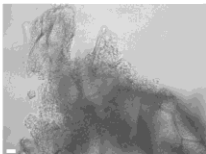
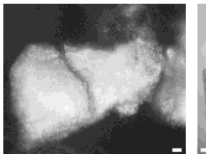
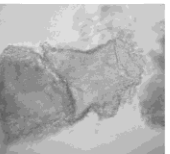
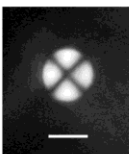
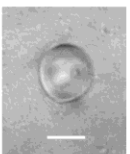
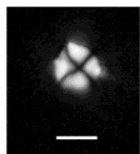
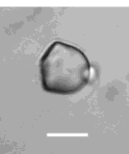
2. Cystoliths from  
Pseuderanthemum davei (250x).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

AMARANTHACEAE

# Amaranthus caudatus

Amaranthaceae <i>Amaranthus caudatus</i> "amaranto, coimi or quiwicha"	
<b>Phytolith assemblage characterization</b>	
flower and seed	<p>Non diagnostic phytoliths (*):</p> <p>a) Flat round scrobiculate margin silica phytolith. Rare.</p>  
	<p>b) Asymmetrical bilobate (saddle) silica short cell. Rare.</p>  <p>c) Conical scrobiculate silica phytolith. Rare.</p>   <p>d) Asymmetrical silica phytolith. Rare.</p>  <p><b>References:</b> Reported as not present in Piperno 1988:30 for <i>Amaranthus</i> sp.</p>
stem	<p>Non diagnostic phytoliths (*):</p> <p>a) Sub-spherical globose silica phytolith. Rare.</p>  <p><b>References:</b> Reported as not present in Piperno 1988:30 for <i>Amaranthus</i> sp.</p>
leaf	<p>Non diagnostic phytoliths (*):</p> <p>a) Spherical globose silica phytolith. Rare.</p>  <p><b>References:</b> Reported as not present in Piperno 1988:30 for <i>Amaranthus</i> sp.</p>
<b>Starch assemblage characterization</b>	
flower and seed	<p>a) Mainly semi-compound grains called "starch chunks", compounded by single grains compactly disposed and filling the whole cell. Granula spherical and polyhedral; ranging in size from 1,5µm to 5µm long length; not visible hilum and lamella; distinct cross.</p>    
	<p>b) Also, single grains, spherical and bell-shaped with facets; variable in size from 11µm to 75µm; visible hilum as a dot; not visible lamella; distinct centric cross, with four arms visible. May occur in aggregates.</p>     <p><b>References:</b> Partially based on Bello Perez et al. 1998; Cortella and Pochettino 1990 and 1994; Wilhelm et al. 1998.</p>

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Amaranthus mantegazzianus

Amaranthaceae *Amaranthus mantegazzianus* "amaranto, chaclión or chaquillón"

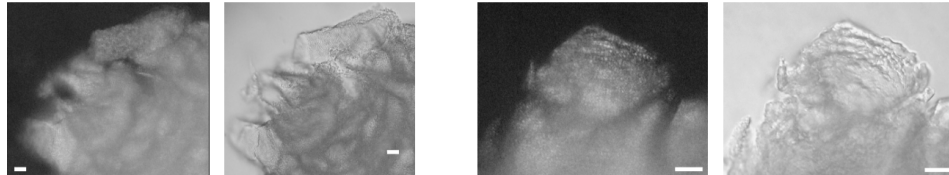
## Phytolith assemblage characterization

flower and seed

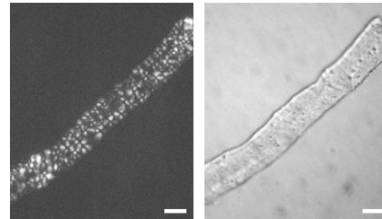
**References:** Reported as not present in Piperno 1988:30 for *Amaranthus* sp.

## Starch assemblage characterization

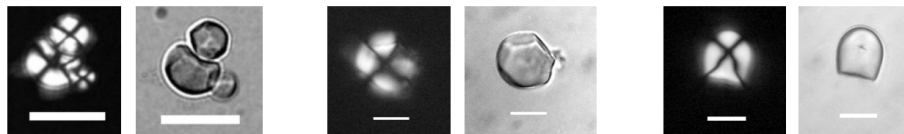
a) Mainly semi-compound grains called "starch chunks", compounded by single grains compactly disposed and filling the whole cell. Single grains, spherical or polyhedral; ranging in size from 0,5µm to 3µm long length; not visible hilum and lamella; sometimes indistinct cross.



b) Another compound grains, fiber-like, with a single external package; variable in size and number of granula. Granula; uncertain shaped; distinct centric hilum as a dot; distinct centric cross, with four arms visible.



c) Also, single grains, polyhedral, spherical, irregular and bell-shaped, with facets; variable in size from 5µm to 75µm long length; visible hilum as a dot; not visible lamella; distinct centric cross, with four arms visible. May occur in aggregates.



**References:** Partially based on Cortella and Pochettino 1990 and 1994.

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection



# Amaranthus mantegazzianus

## Starch

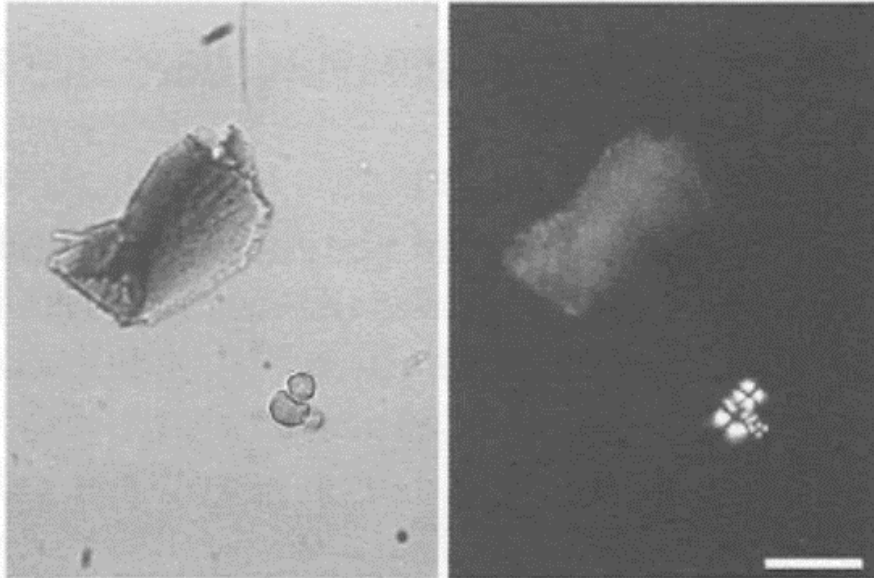


Figure 2. Amaranth (*Amaranthus mantegazzianus*) non-processed perispermatic cells compactly filled with starch grains and medium-sized grains. Views with normal (left) and polarised light (right). Scale bar = 40 $\mu$ m.

Babot, María del Pilar. 2003. Starch Grain Damage as an Indicator of Food Processing. In *Phytolith and Starch Research in the Australian-Pacific-Asian Regions: The State of the Art*.

# Chenopodium quinoa

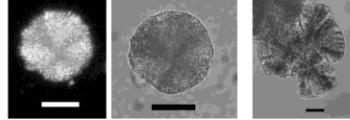
**Chenopodiaceae *Chenopodium quinoa* "quinua or quinoa"**

**Phytolith assemblage characterization**

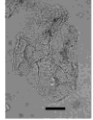
**leaf**

Non diagnostic phytoliths (\*):

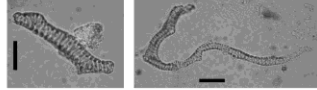
a) Flat sub-circular granulate calcium oxalate phytoliths. Common.



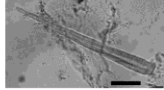
b) Articulate epidermal silica tissue. Rare.



c) Silica tracheids. Common.



d) Acute dorsal sulcate silica hair. Rare.



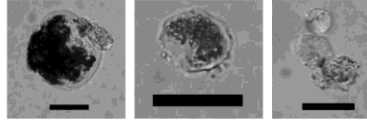
**References:** Reported as not present in Piperno 1988:34.

---

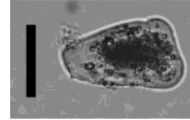
**seed**

Non diagnostic phytoliths (\*):

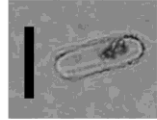
a) Flat round with different surface ornamentation silica phytolith. Common.



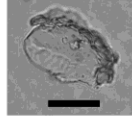
b) Polyhedral irregular granulate silica phytolith. Rare.



c) Oval dorsal aculeate silica phytolith. Rare.



d) Polyhedral irregular silica phytolith. Rare.



**References:** Reported as not present in Piperno 1988:34.

---

**stem**

No phytoliths.

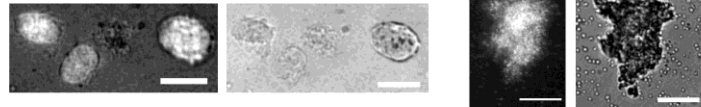
**References:** Reported as not present in Piperno 1988:34.

---

**Starch assemblage characterization**

**seed**

a) Mainly compound grains, with indefinite number of granula -as many as 14000-; ellipsoidal, ovoid or spherical, well rounded; ranging in size from 15µm to 31µm long length; with a single external packing. Granula polyhedral; ranging in size from 0,5µm to 3µm long length; not-visible hilum and lamella; indistinct centric or eccentric cross, with one, two, three or four arms visible.



**References:** Partially based on Cortella and Pochettino 1990 and 1994, Prado et al. 1996, Varriano-Marston and DeFrancisco 1984, Wilhelm et al. 1998.

b) Single grains, polyhedral, six-sided; ranging in size from 5µm to 40µm long length; not-visible hilum and lamella; distinct centric or eccentric cross, with one, two, three or four arms visible. May occur as compound grains, compounded by a definite number of granula.

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Chenopodium quinoa

## Starch

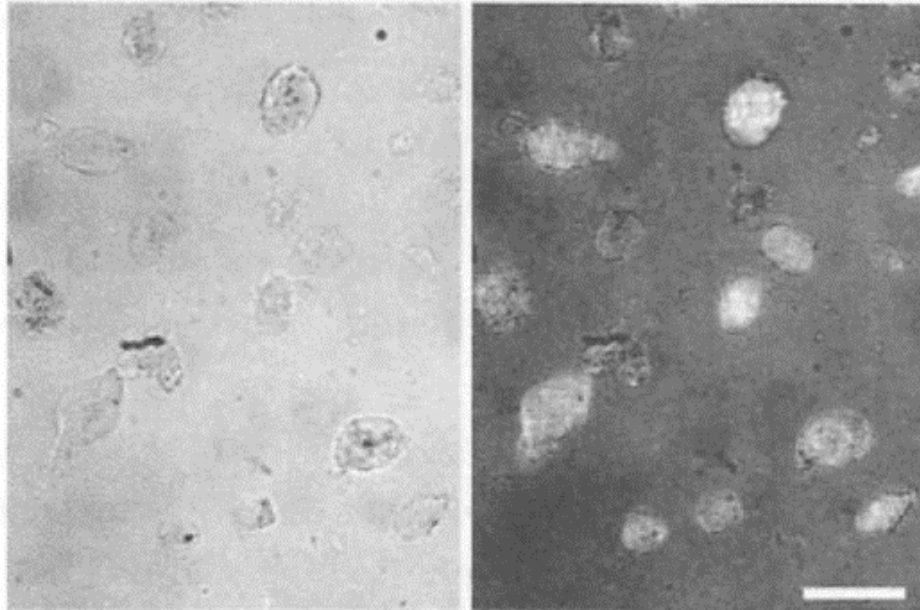


Figure 3. Quinoa non-processed compounded starch grains. Views with normal (left) and polarised light (right). Scale bar = 40µm.

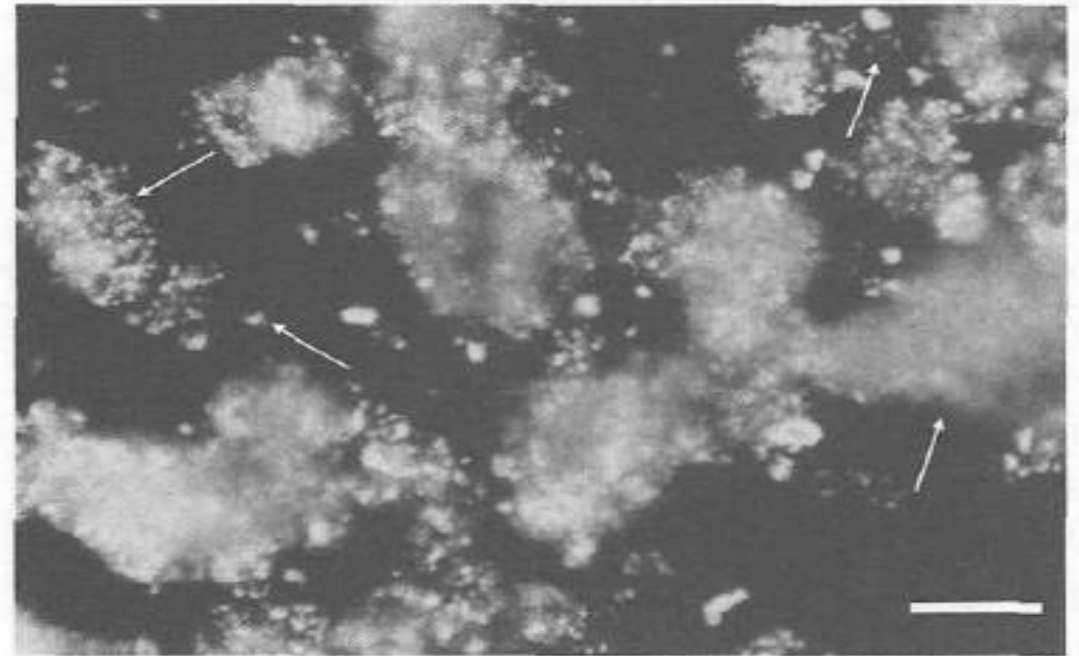


Figure 7. Starch of quinoa *llipta* showing charring effects. Clustered grains in the process of disjoining, a disjoined individual granule, a medium-sized grain with low birefringence and clumps of gelatinised grains are marked with arrows. View with polarised light. Scale bar = 40µm.

# Chenopodium quinoa

## Starch

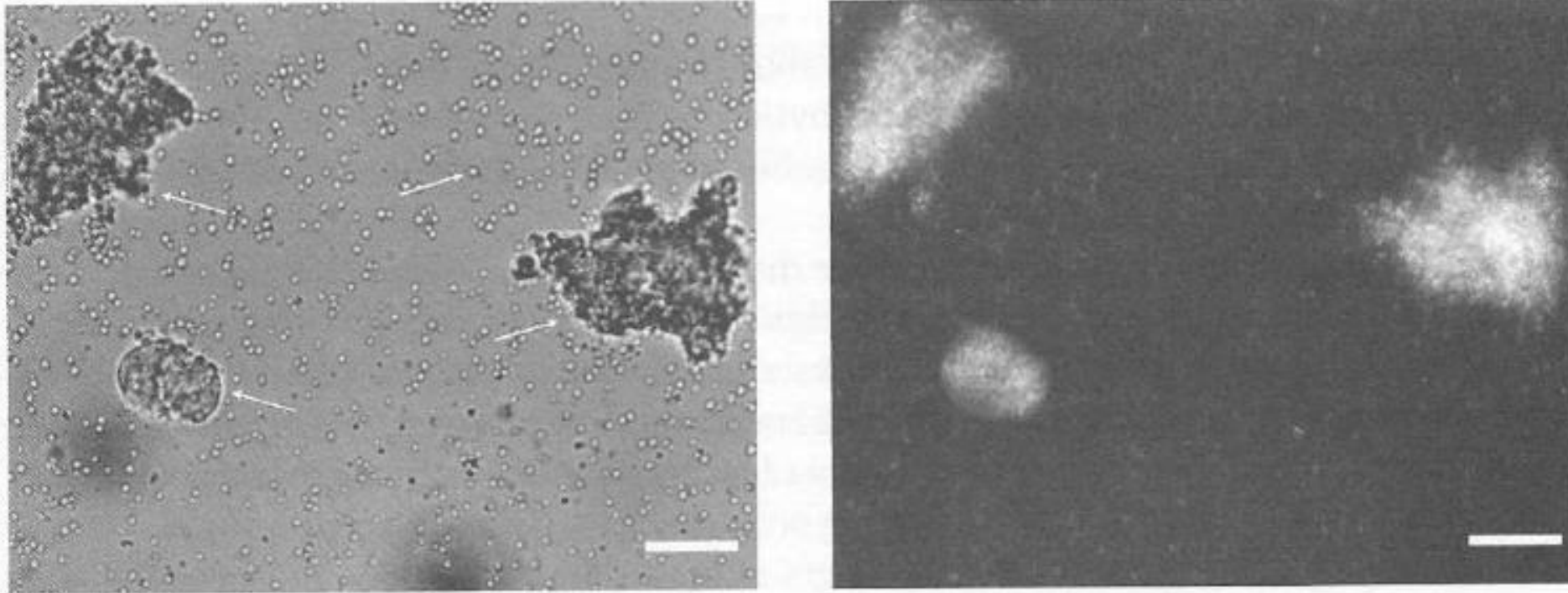


Figure 12. Starch of quinoa flour showing milling effects. (a) Compounded grains in different stages of disjoining and a disjoined individual grain are marked with arrows. View with normal light (left). (b) View with polarised light (right). Scale bar = 20 $\mu$ m.

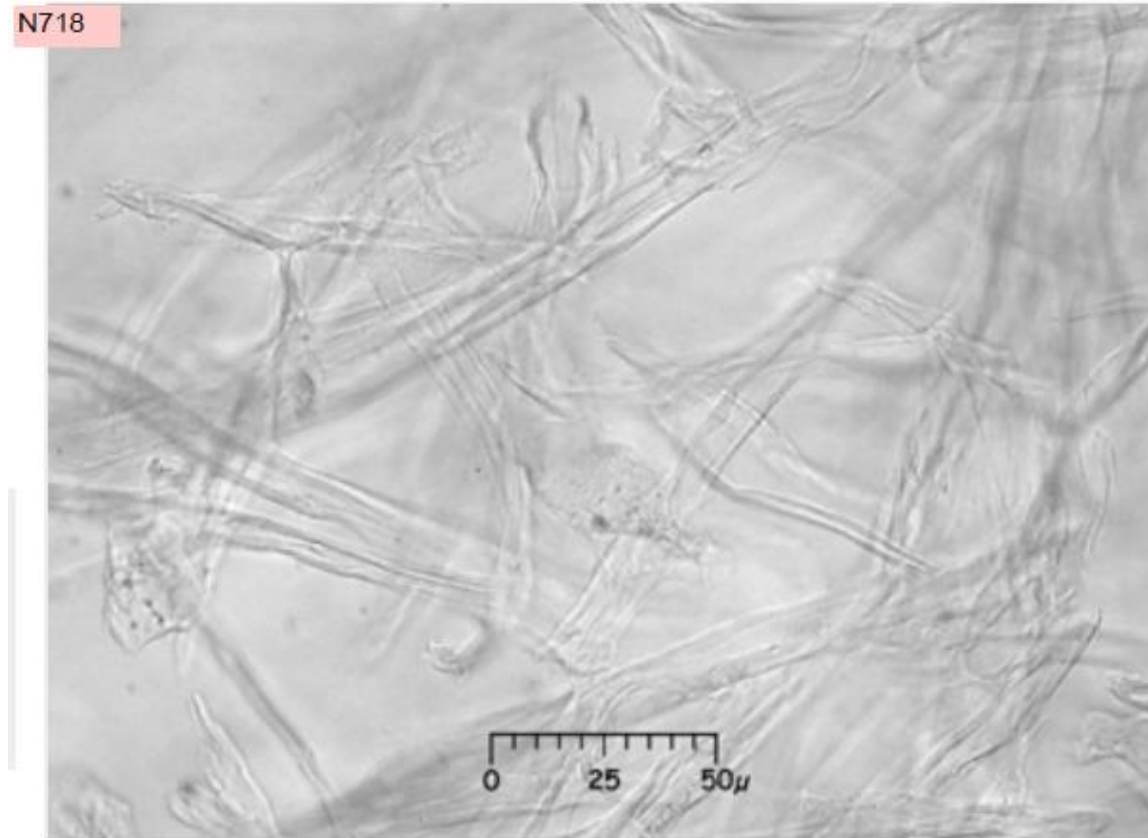
Babot, María del Pilar. 2003. Starch Grain Damage as an Indicator of Food Processing. In *Phytolith and Starch Research in the Australian-Pacific-Asian Regions: The State of the Art*.

ANACARDIACEAE

# Spondias purpurea

## Phytolith

Type established by Karol  
Chandler- Ezell, 2004  
Diagnostic level: fruit/seed



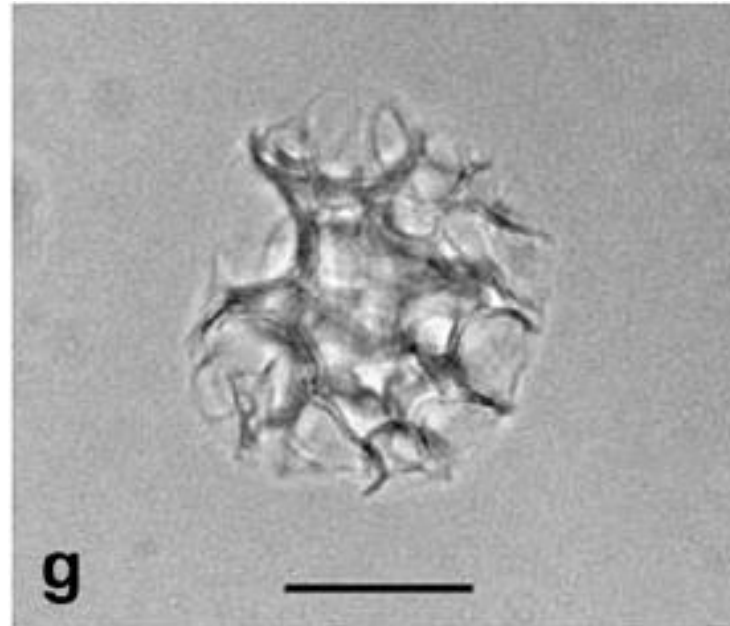
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

ANNONACEAE

# Annona glabra

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. g) Hair base from *Annona glabra* leaf



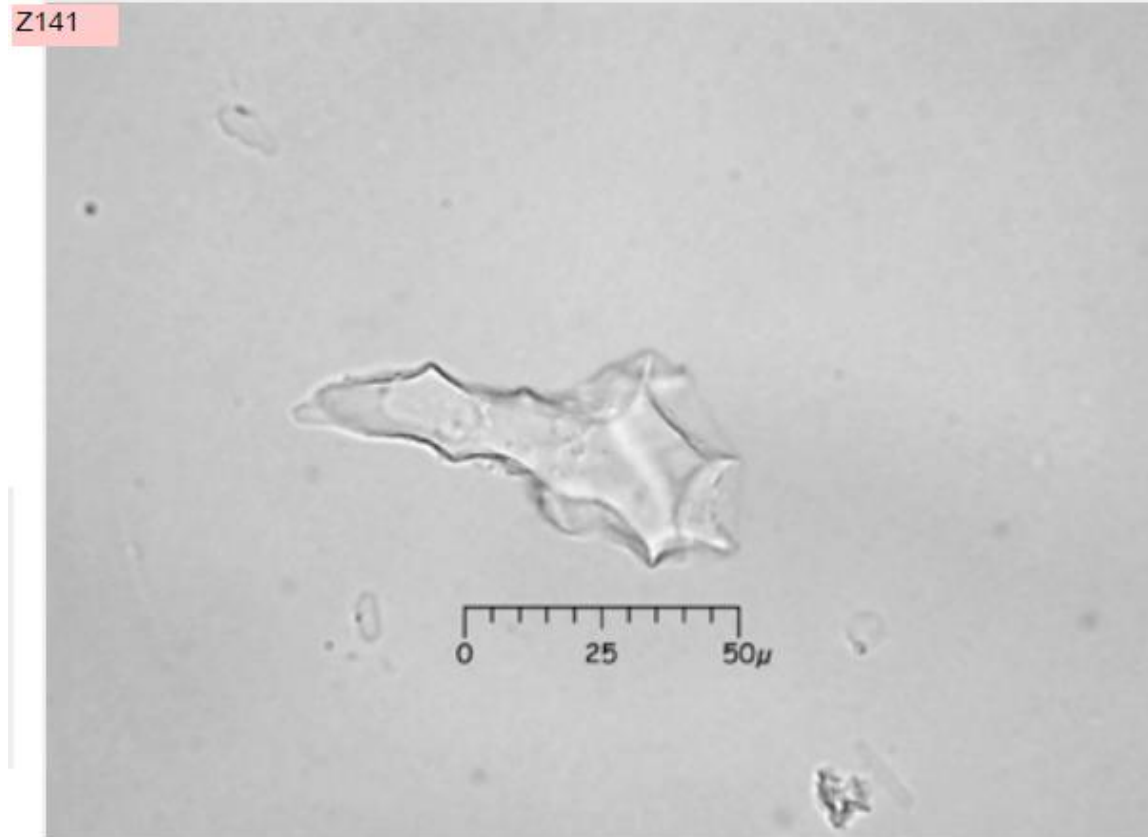
Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.



# Duguetia sp.

## Phytolith

Facets and overall shape both irregular, often with concave surfaces. NOT a regular, symmetrical sphere.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Goniothalamus marcani

## Phytolith

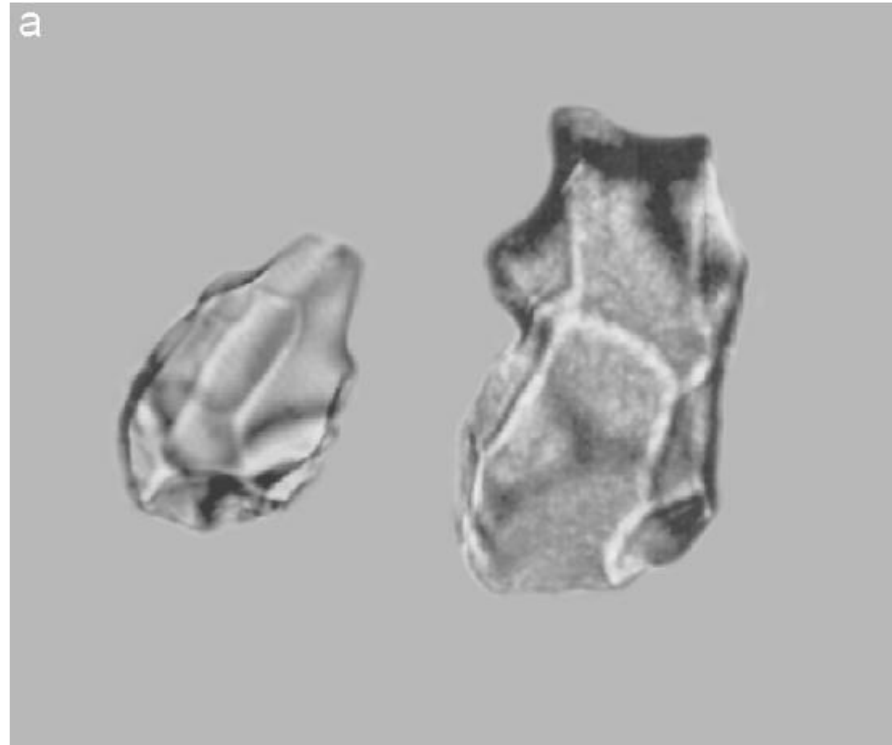


Fig. 3. (a) Facetate phytoliths from Asian Fagaceae (*Lithocarpus acuminatissima*), left, and Annonaceae (*Goniothalamus marcani*), right. Reprinted from Kealhofer and Piperno, 1998. Reprinted from Piperno (2006a), Copyright AltaMira Press.

Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

# Guatteria dumetorum

## Phytolith

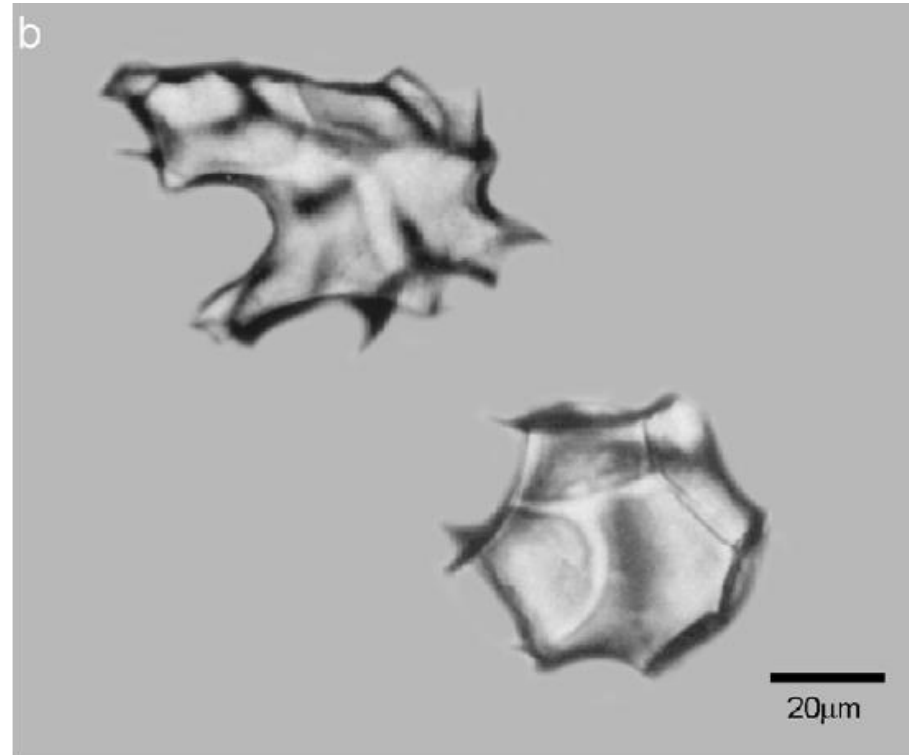


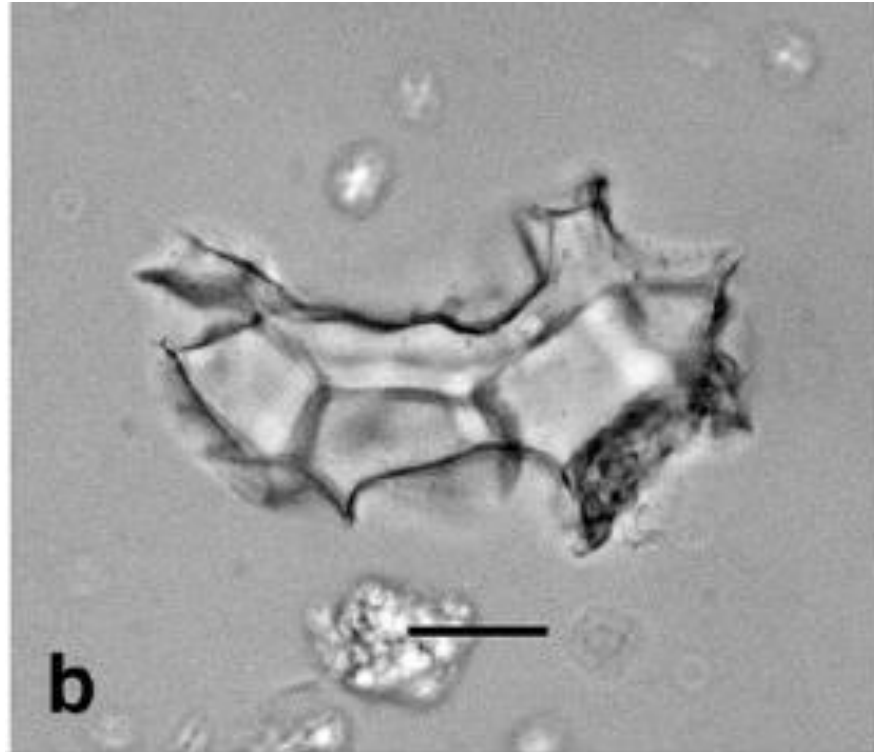
Fig. 3. (b) Spherical facetate, right (*Unonopsis pittieri*), and irregular facetate phytoliths, left (*Guatteria dumetorum*) from tropical American Annonaceae. Reprinted from Piperno (2006a), Copyright AltaMira Press.

Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

# Guatteria guianensis

## Phytolith

Fig. 5. Phytoliths from dicotyledons.  
b) Irregular multi-faceted phytolith  
from *Guatteria guianensis* leaf



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Unonopsis pittieri

## Phytolith

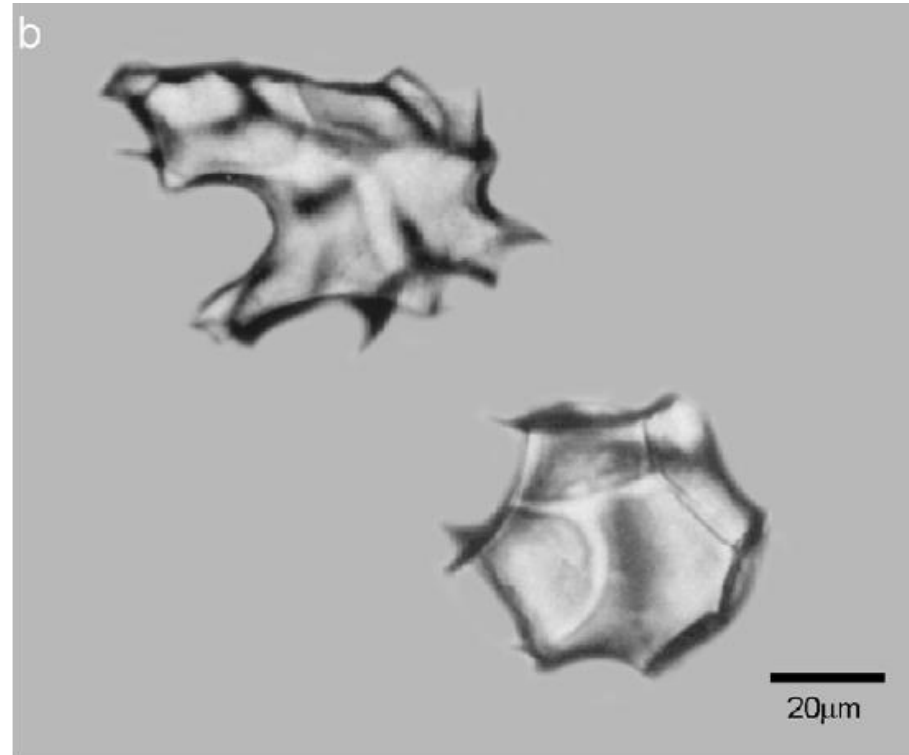


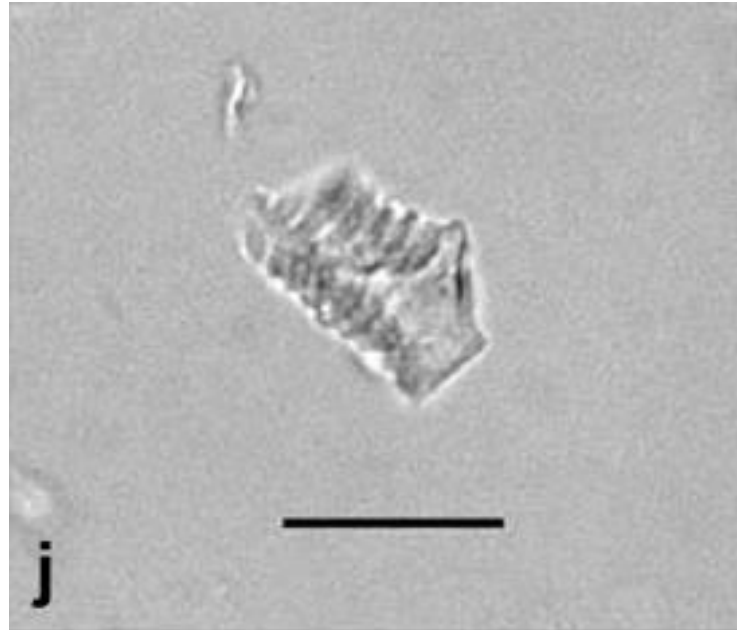
Fig. 3. (b) Spherical facetate, right (*Unonopsis pittieri*), and irregular facetate phytoliths, left (*Guatteria dumetorum*) from tropical American Annonaceae. Reprinted from Piperno (2006a), Copyright AltaMira Press.

Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

# Unonopsis stipitata

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. j) Tracheid from *Unonopsis stipitata*

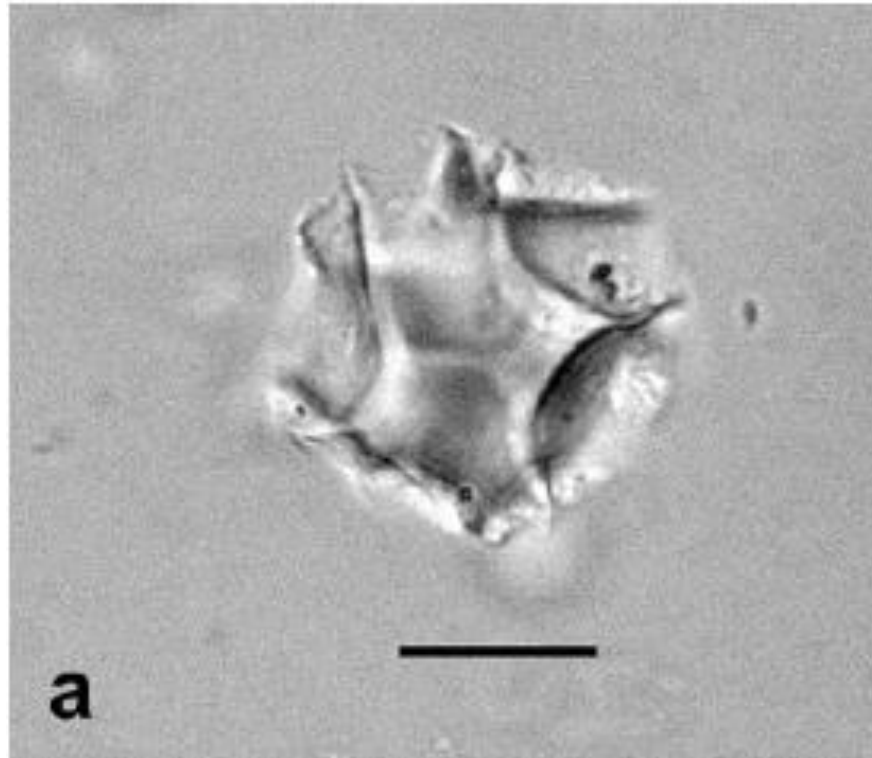


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Unonopsis stipitata

## Phytolith

Fig. 5. Phytoliths from dicotyledons.  
a) Spherical multi-faceted phytolith  
from *Unonopsis stipitata*



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

APIACEAE



# Arracacia xanthorriza

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

Apiaceae *Arracacia xanthorriza* "arracacha"

Phytolith assemblage characterization

tuber

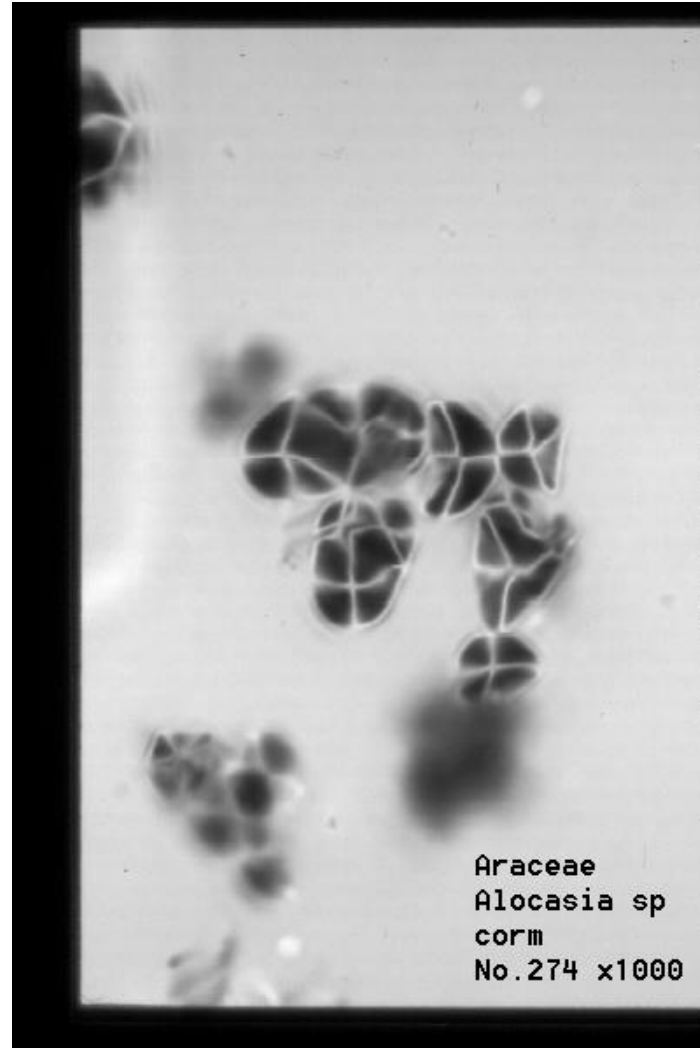
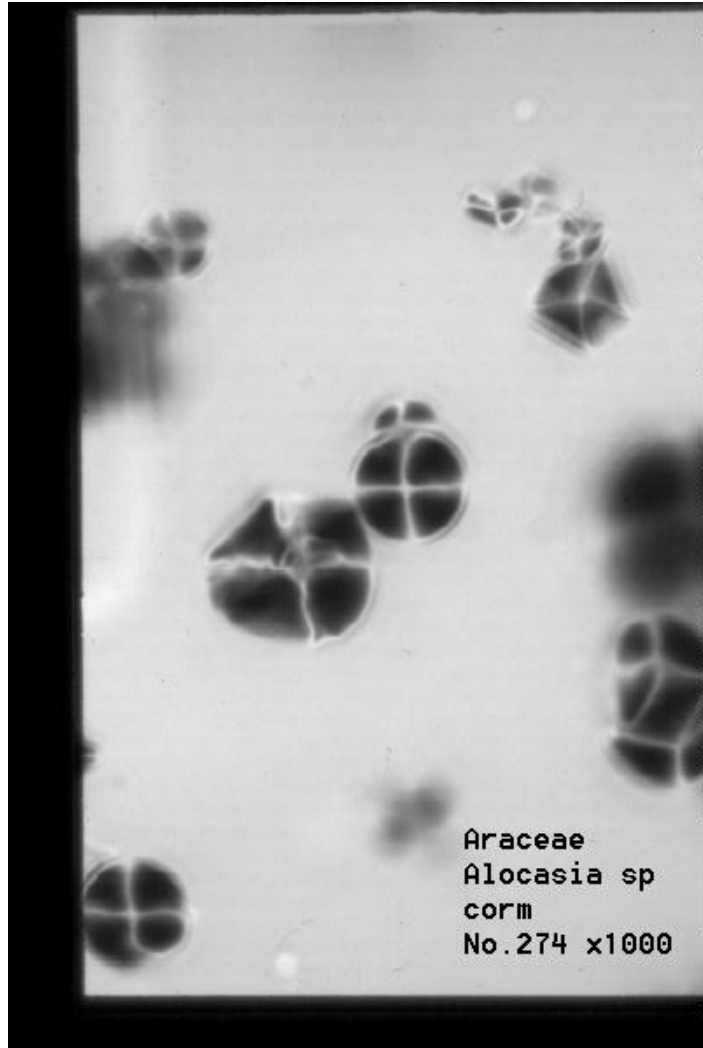
**References:** Reported as a family where phytoliths have been found to be not present, rare or not taxonomically significant in Pearsall 2000:371.

Scale bar = 20µm.

ARACEAE

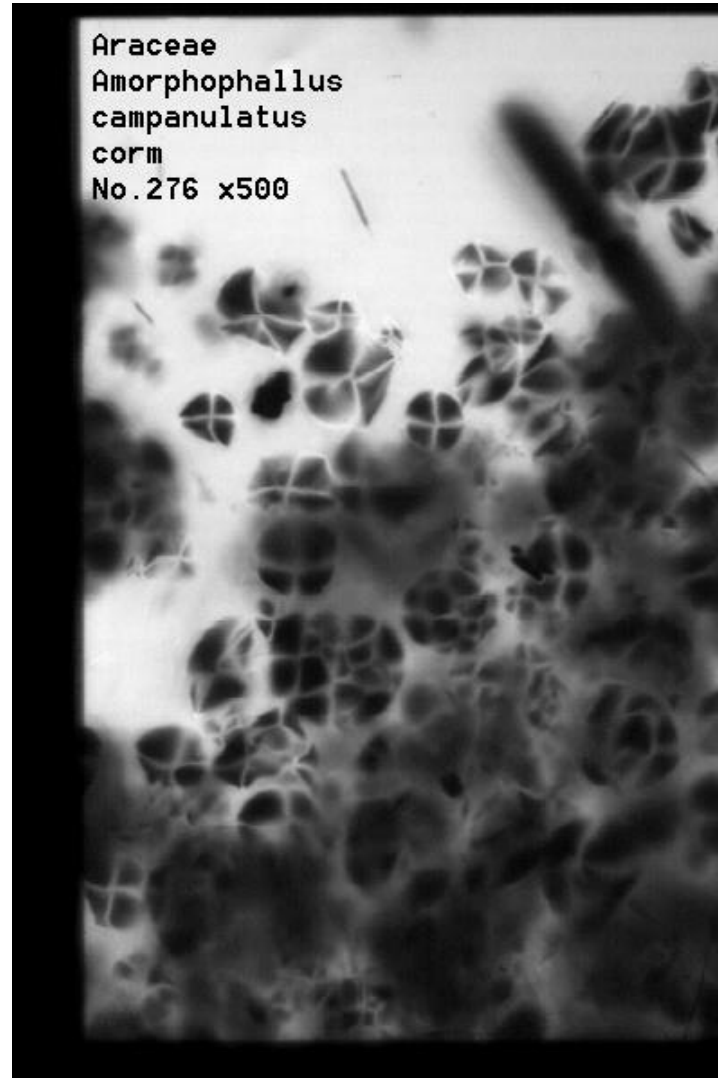
# Alocasia sp.

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



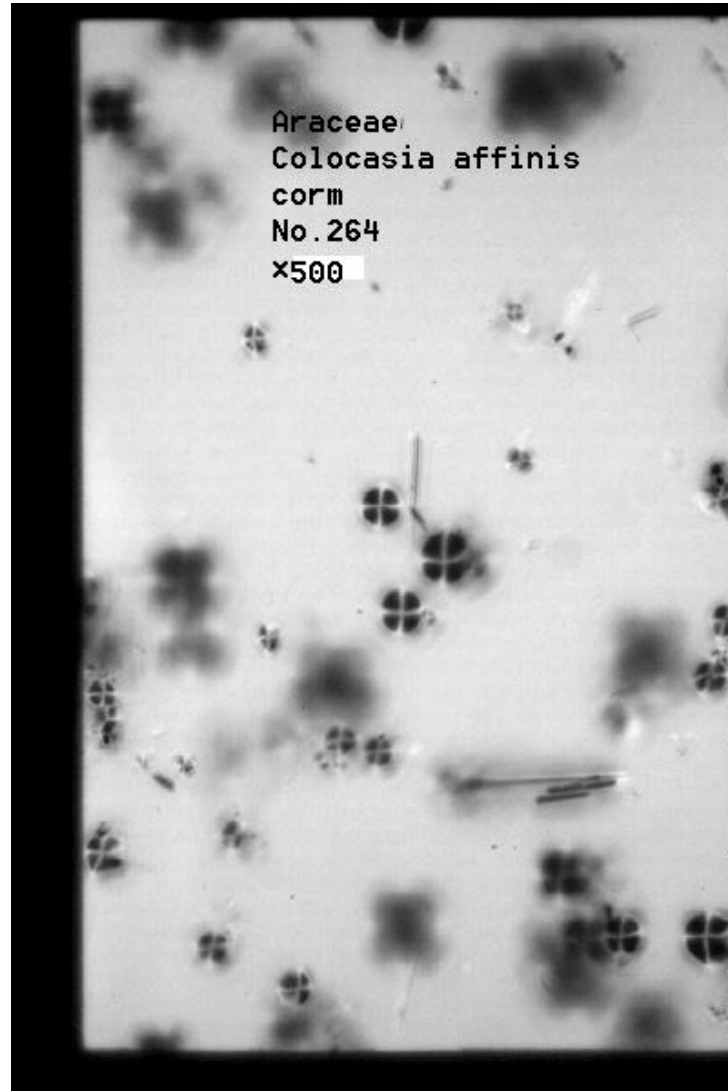
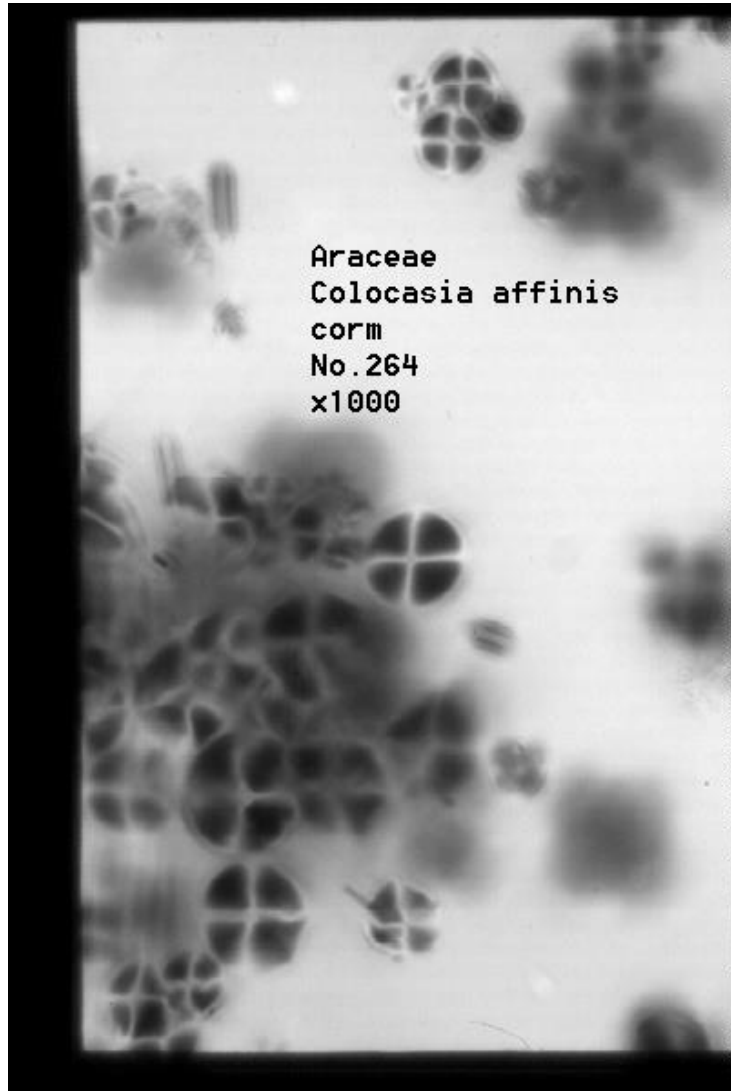
# Amorphophallus campanulatus

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



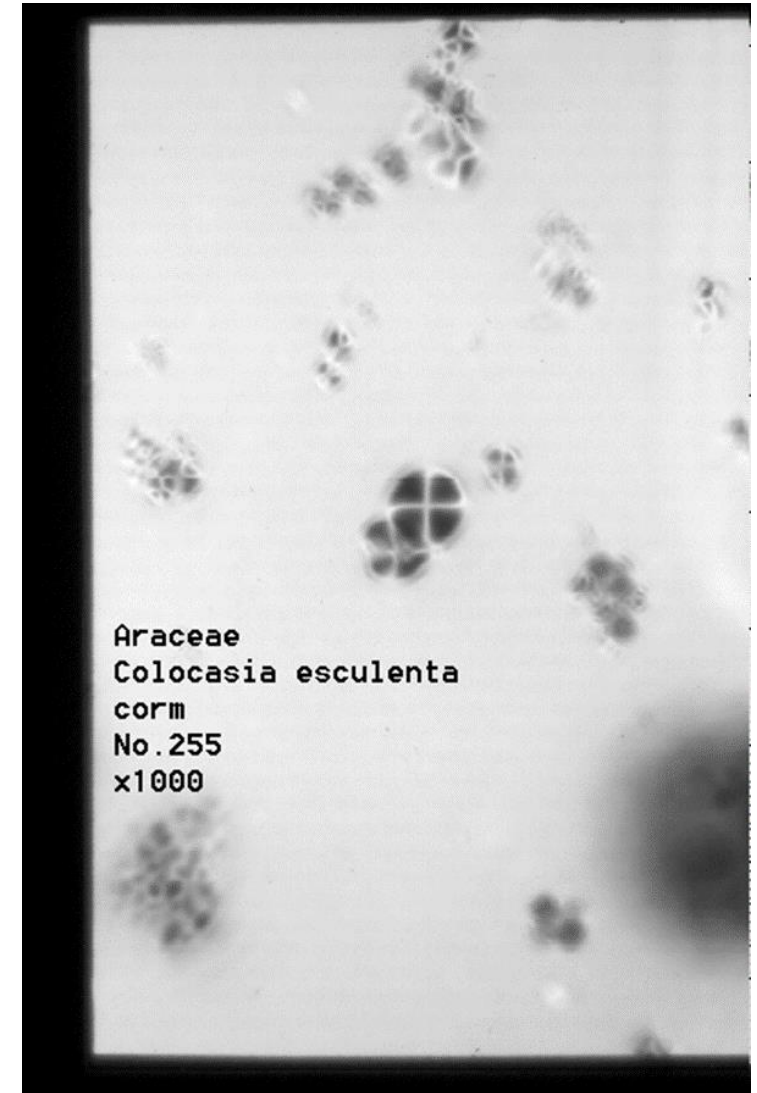
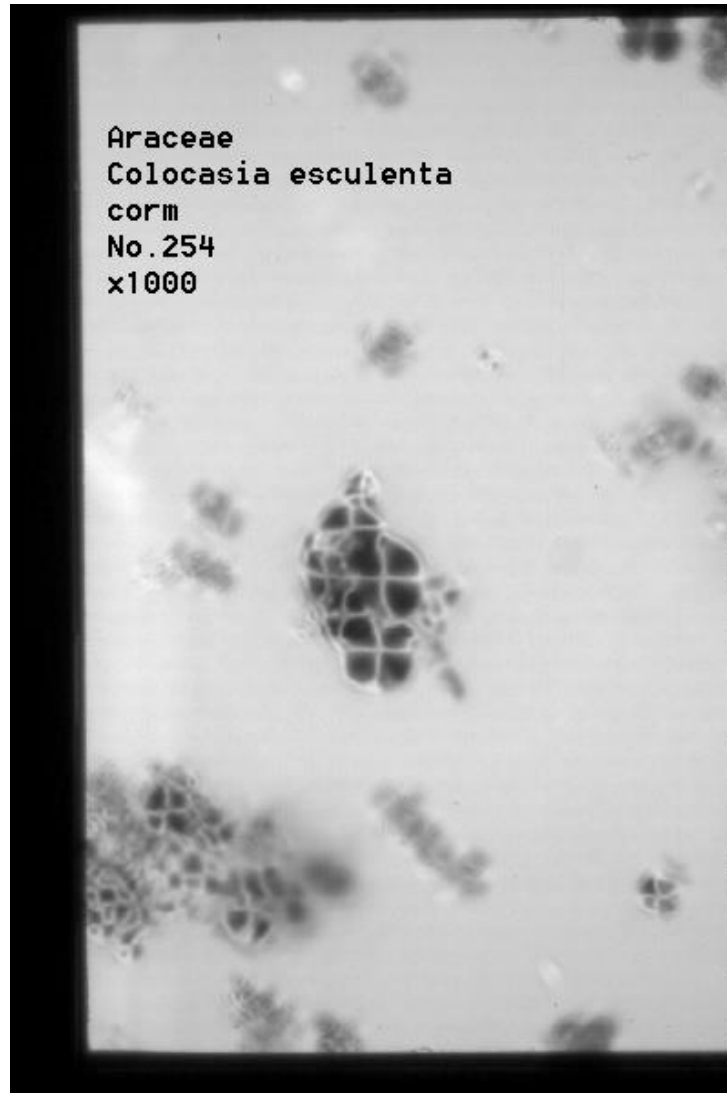
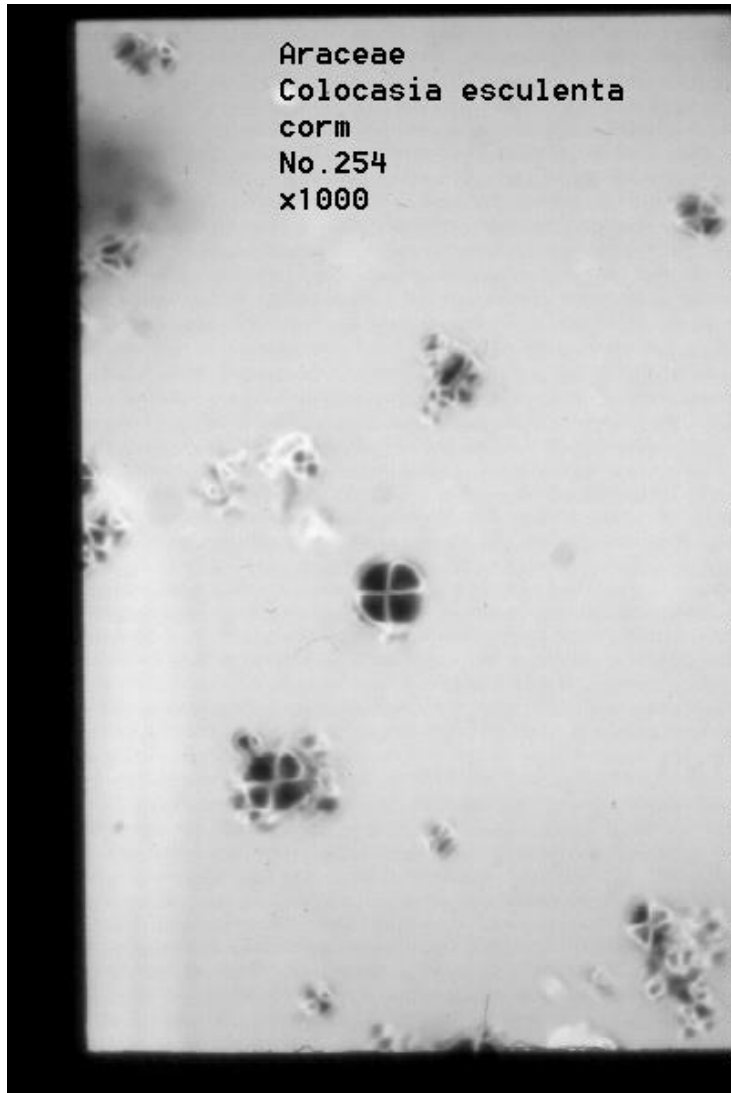
# Colocasia affinis

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



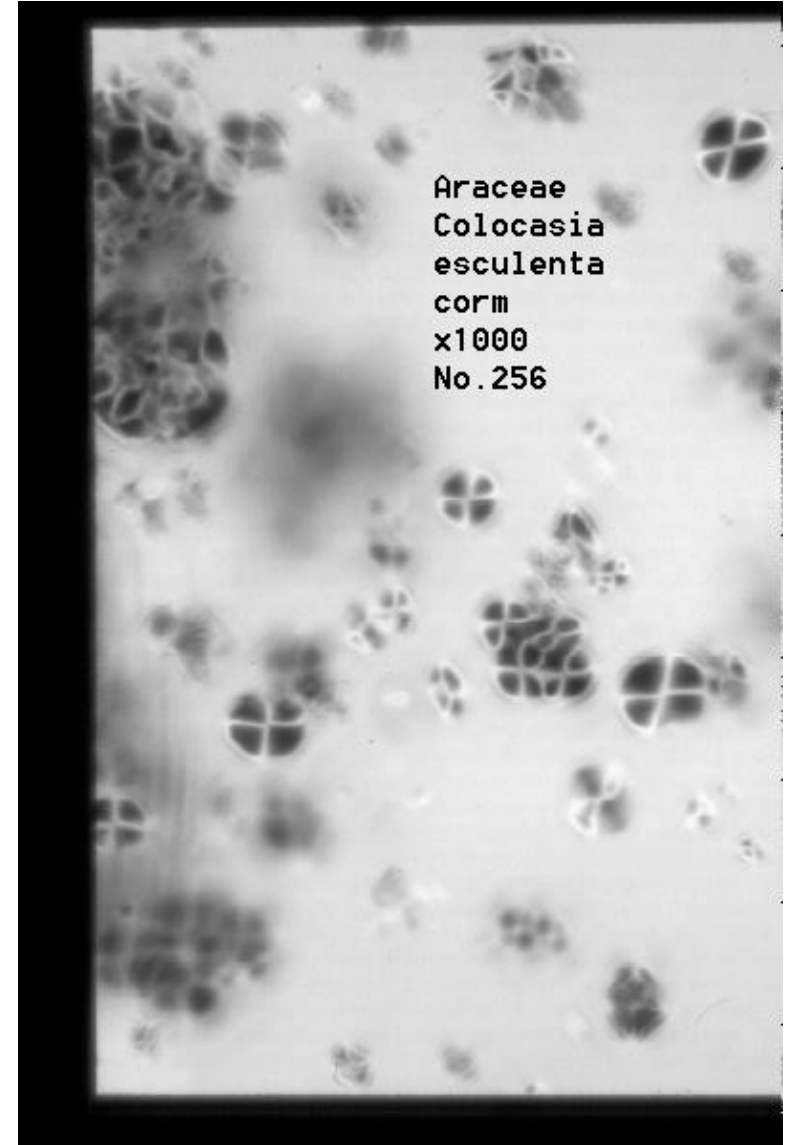
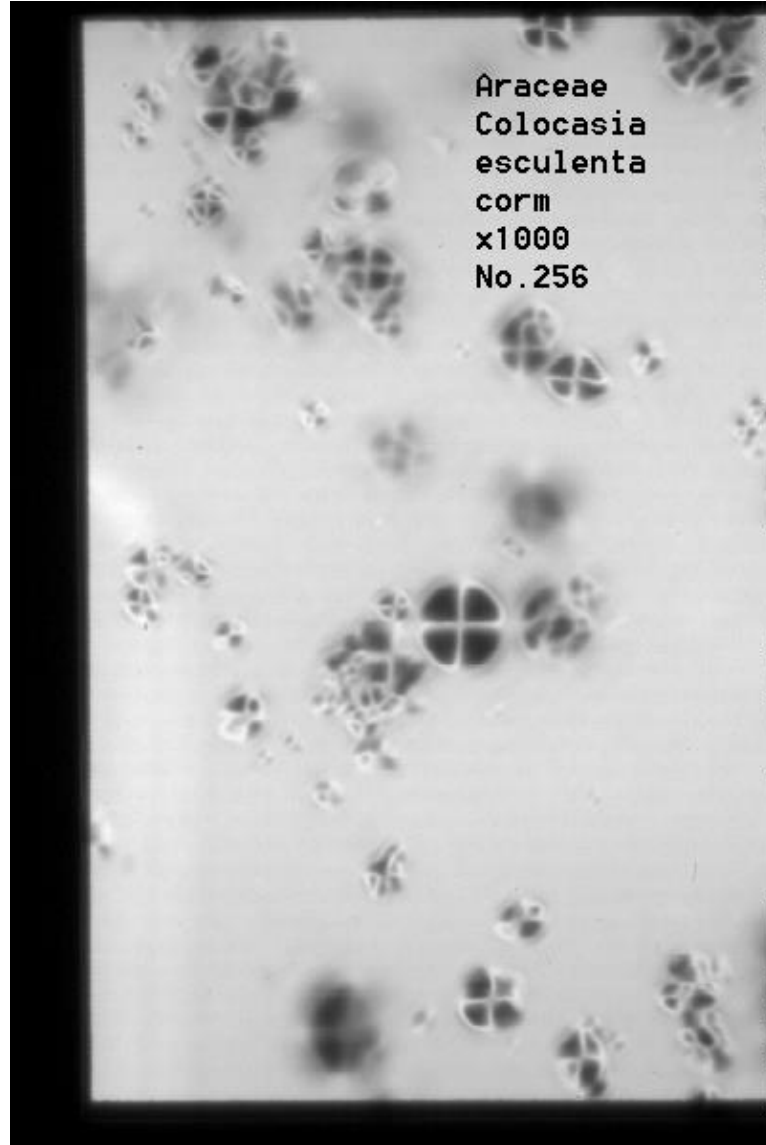
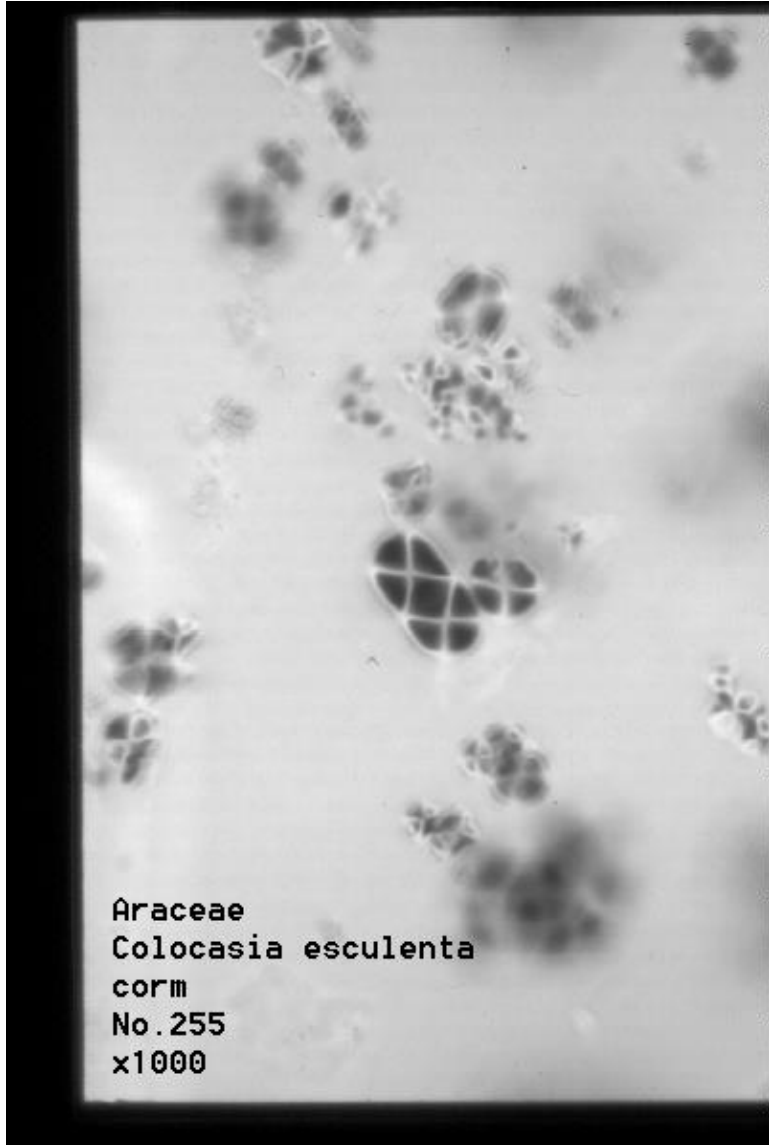
# Colocasia esculenta

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



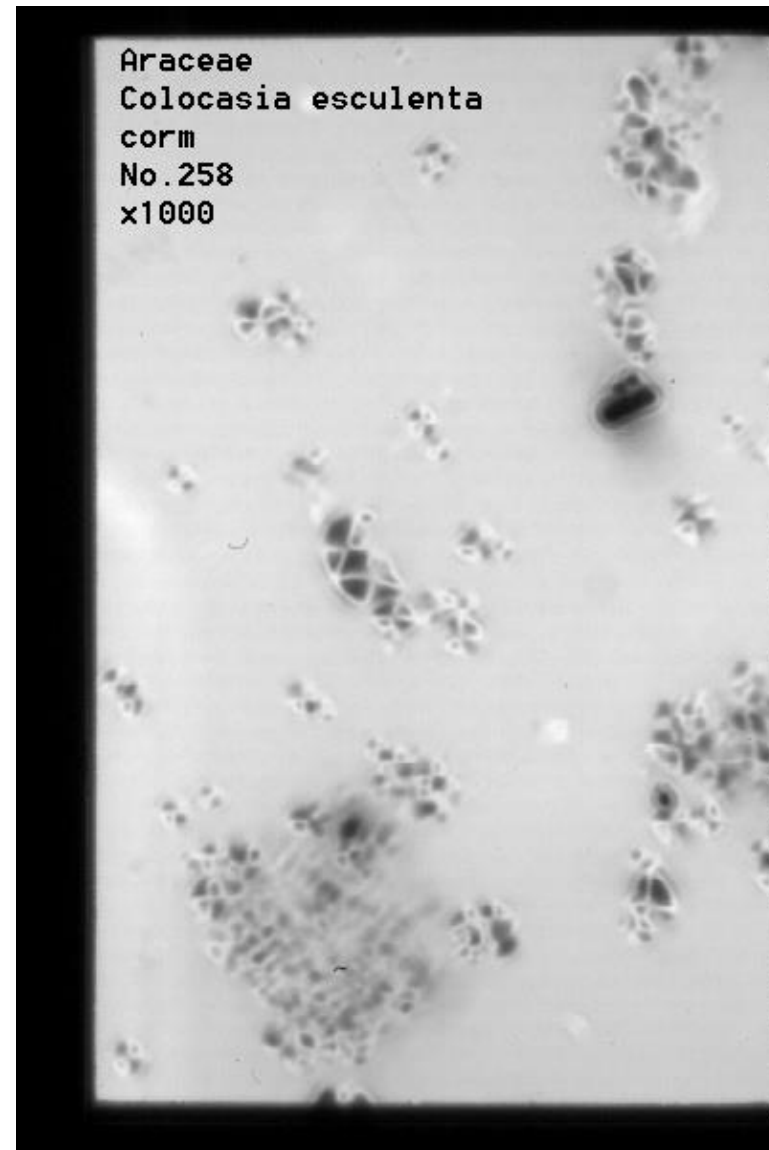
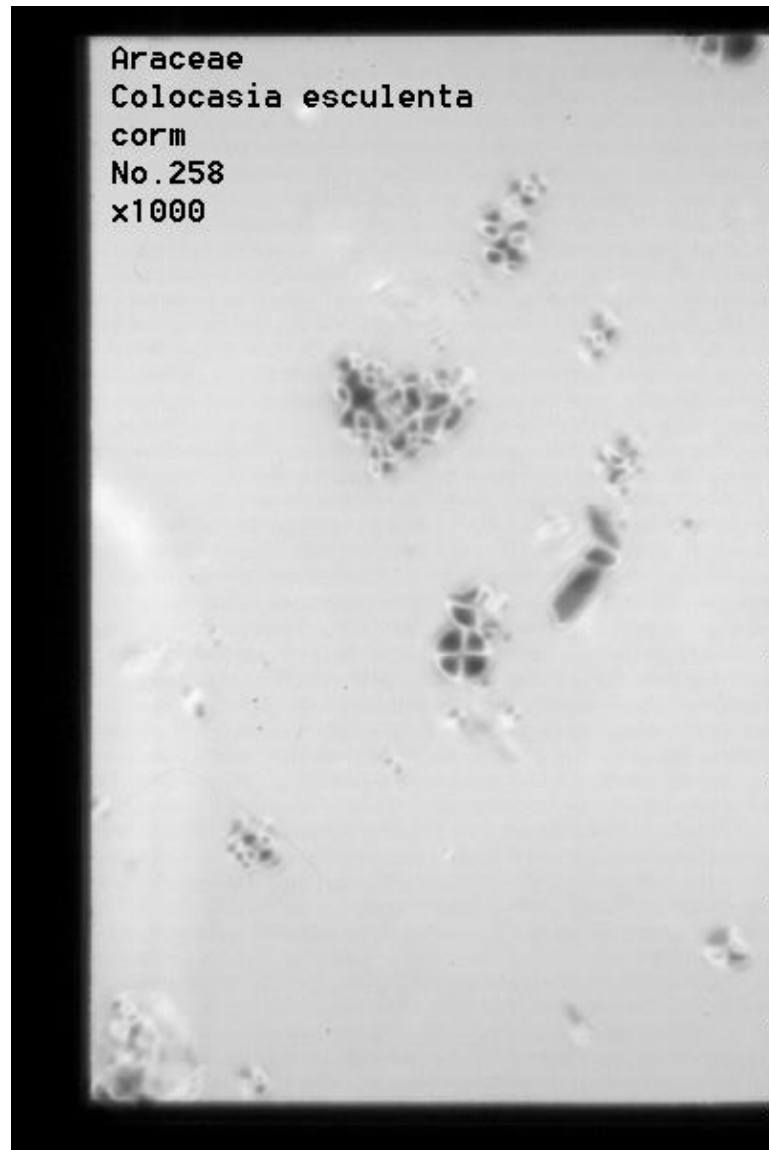
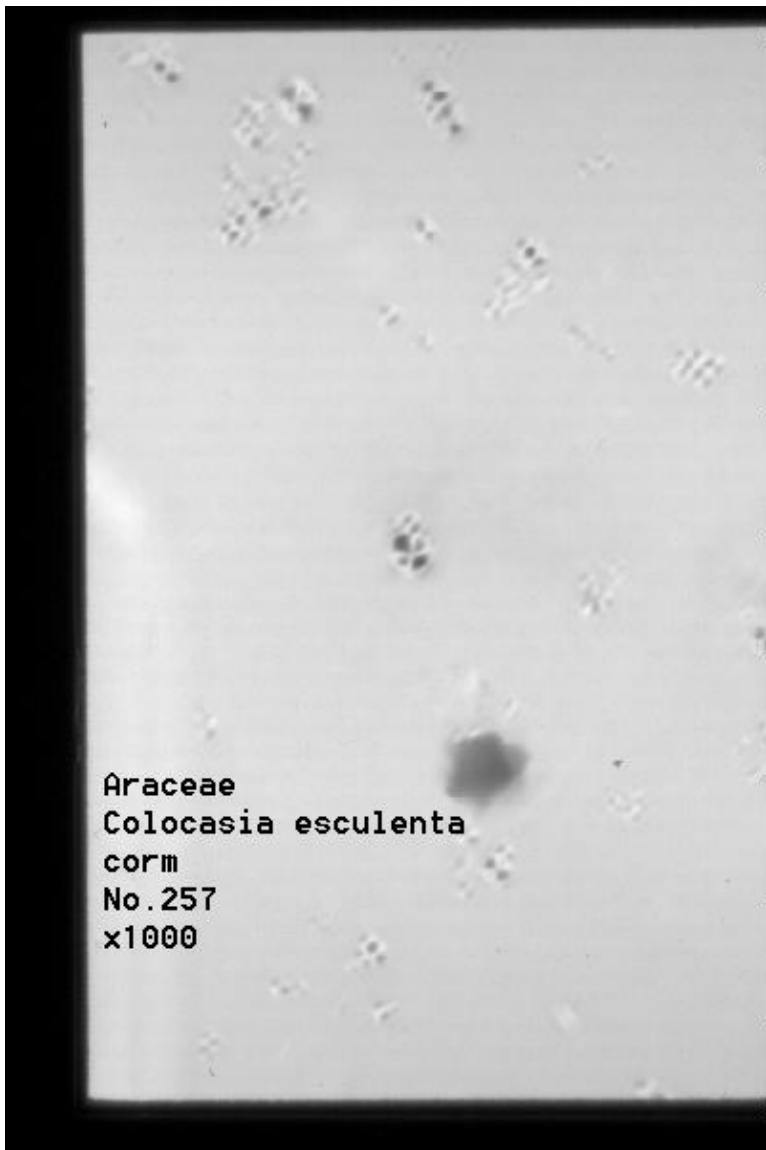
# Colocasia esculenta

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Colocasia esculenta

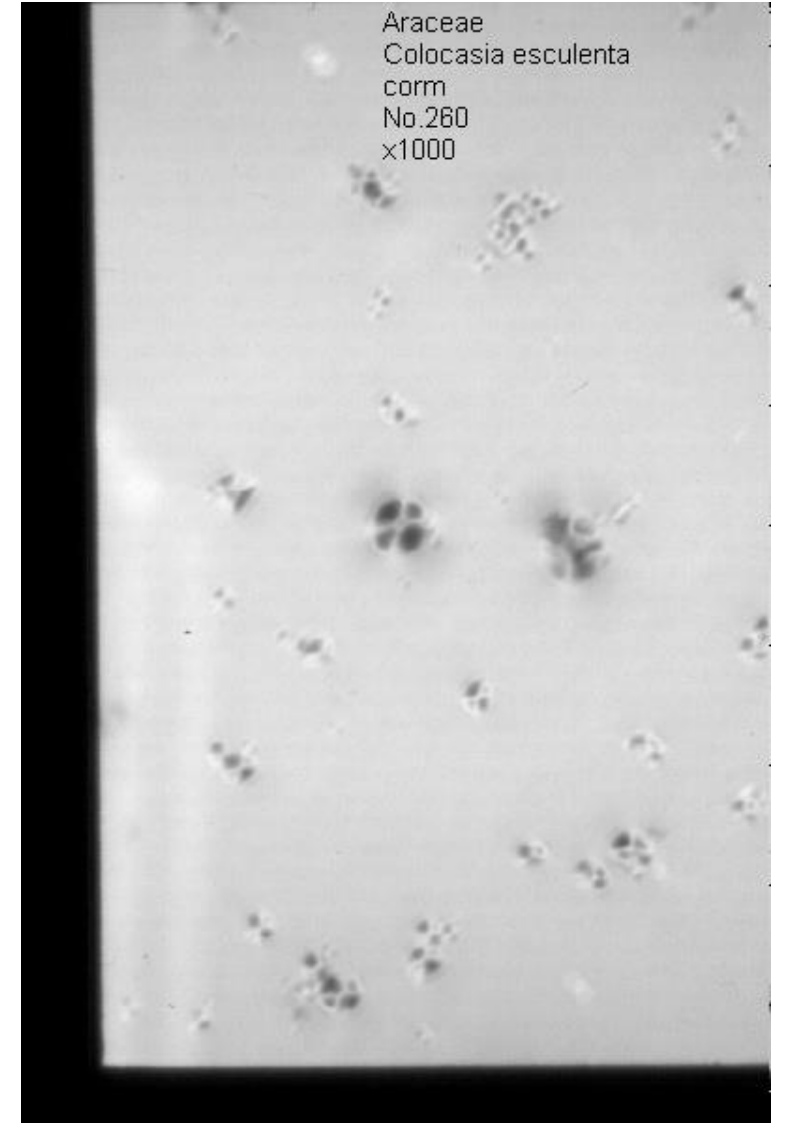
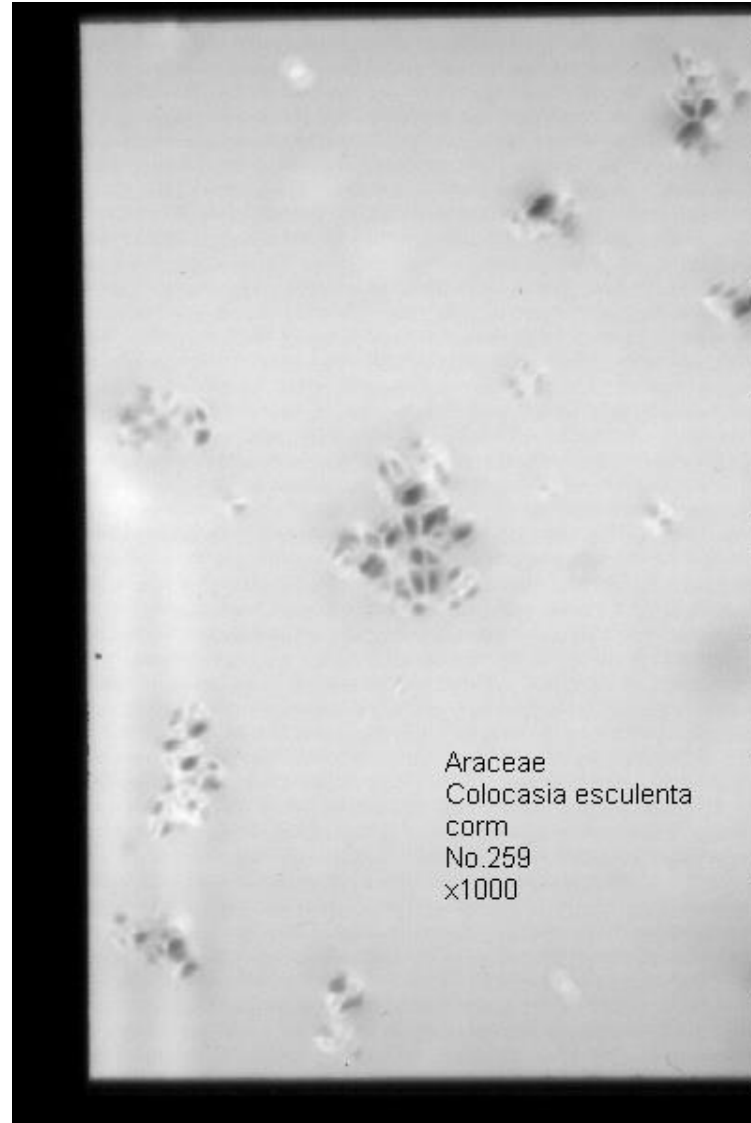
Australian Museum,  
McCown Archaeobotany  
Laboratory Collection





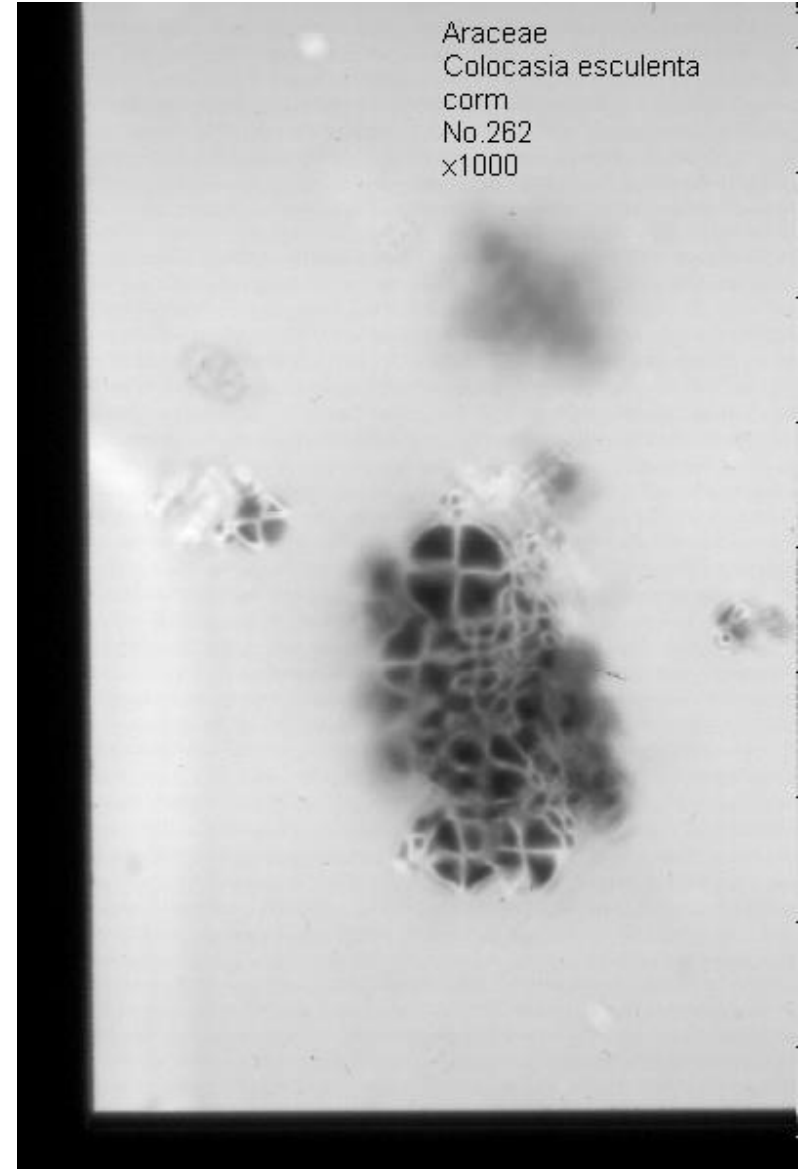
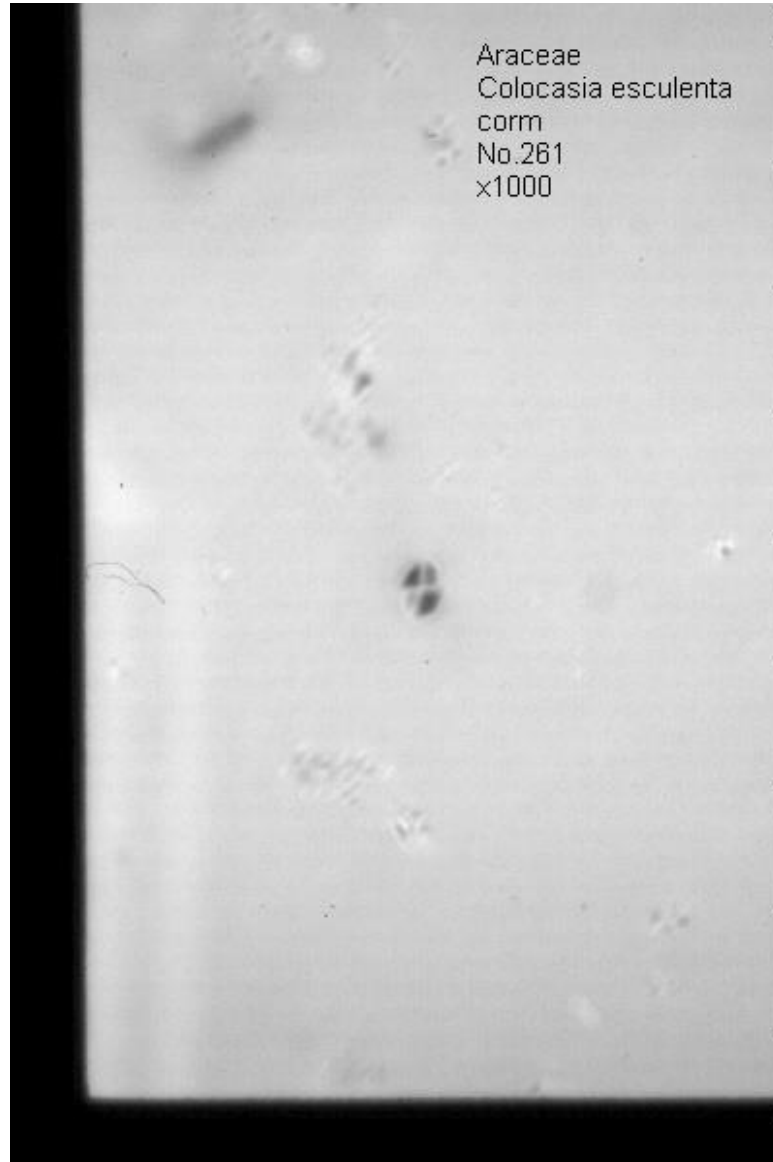
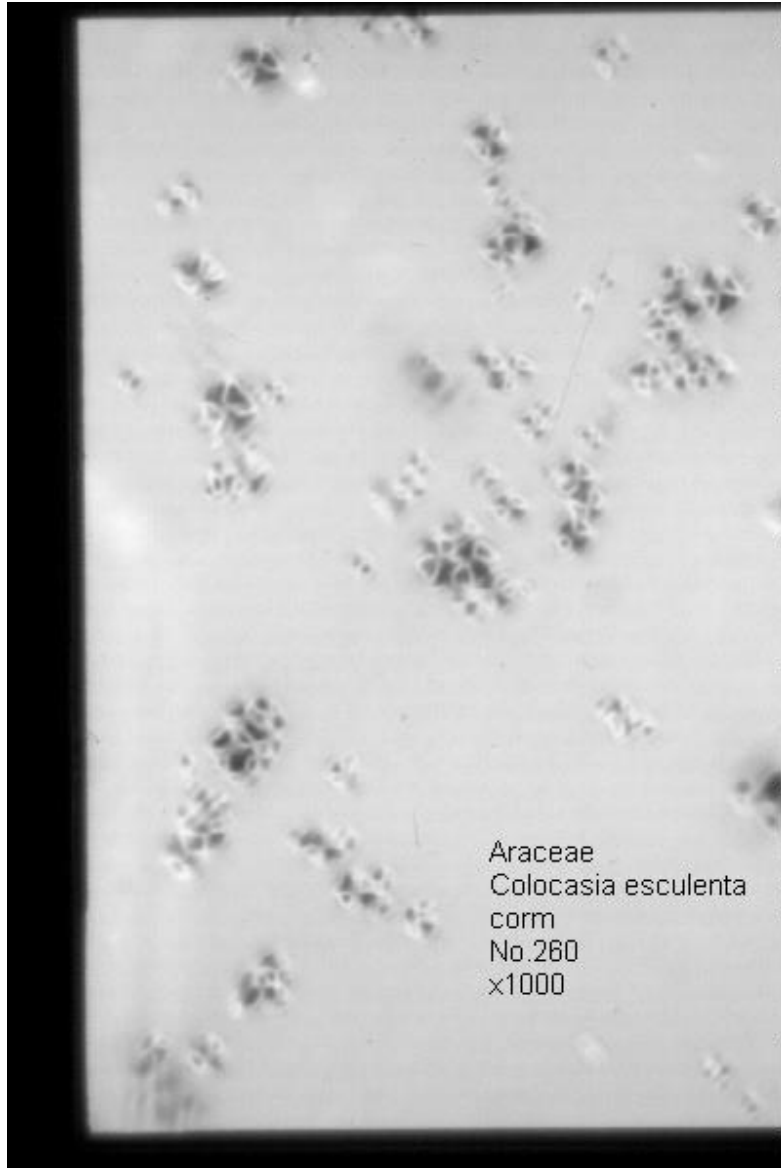
# Colocasia esculenta

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



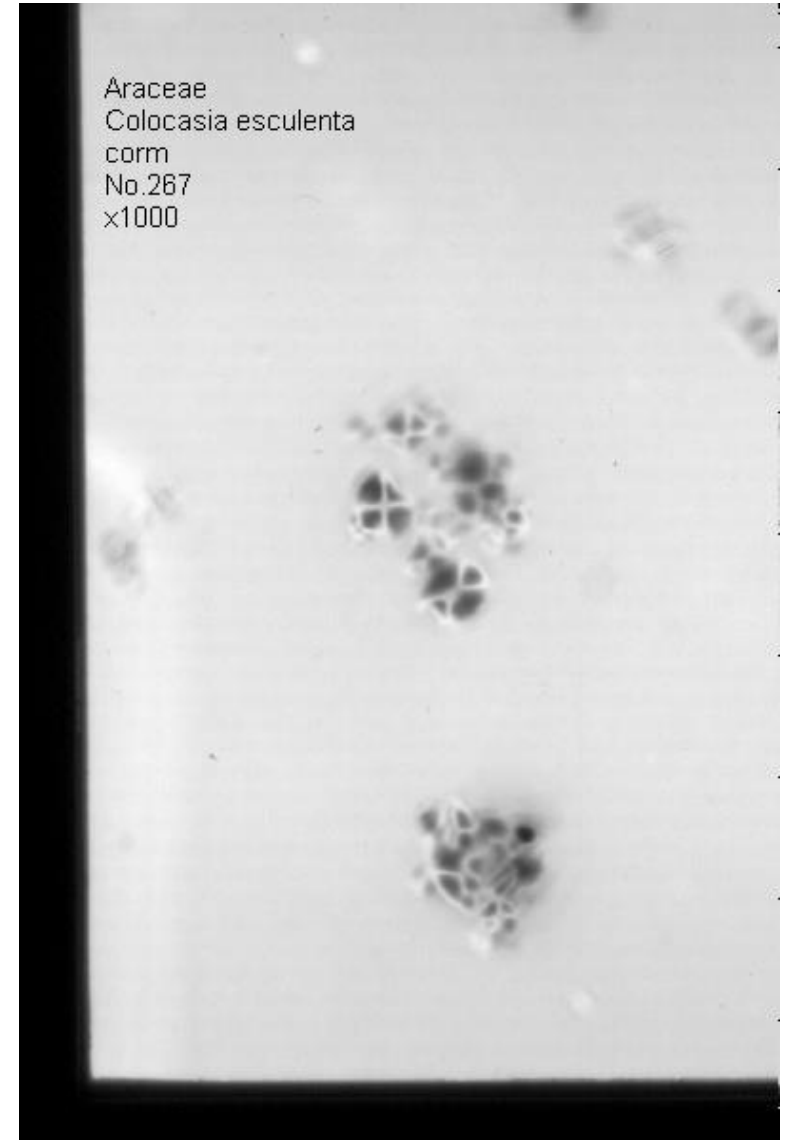
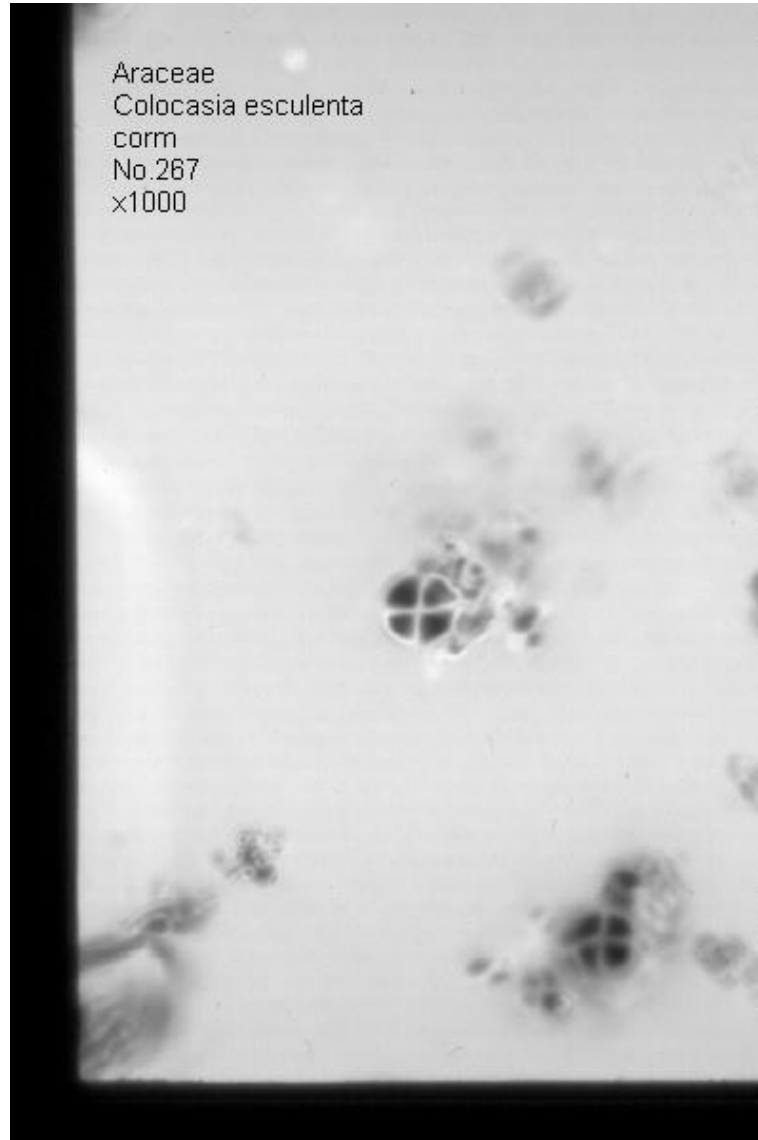
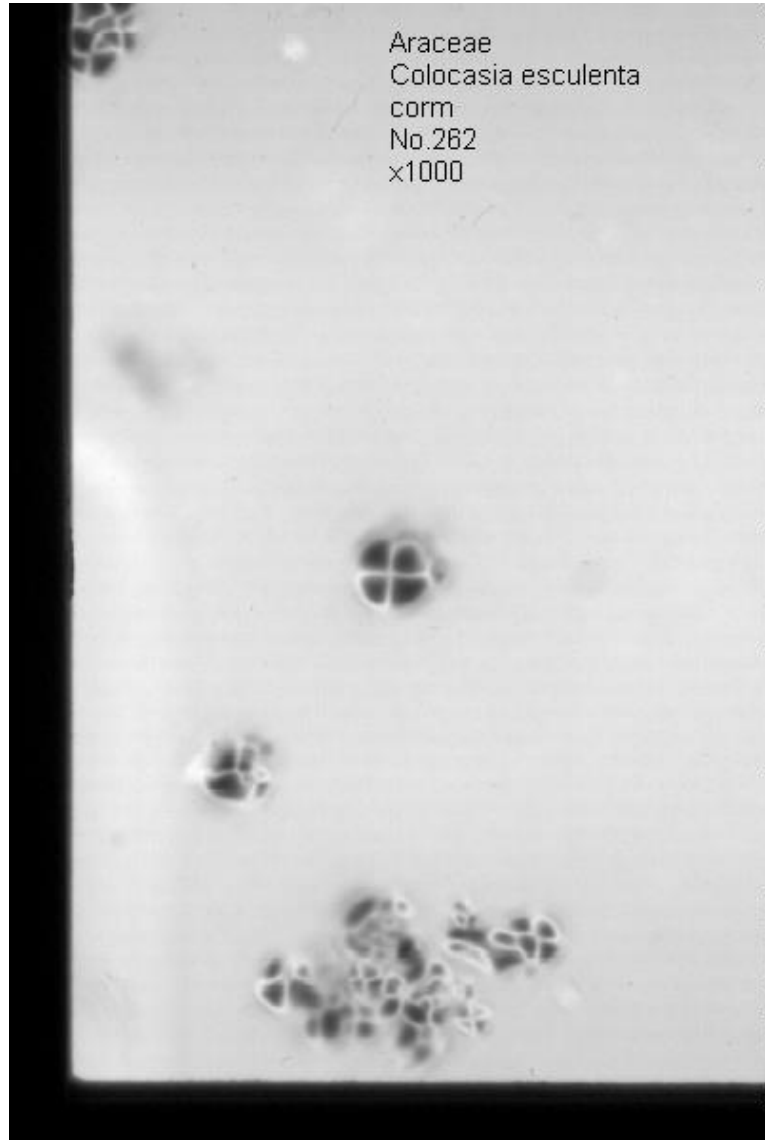
# Colocasia esculenta

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



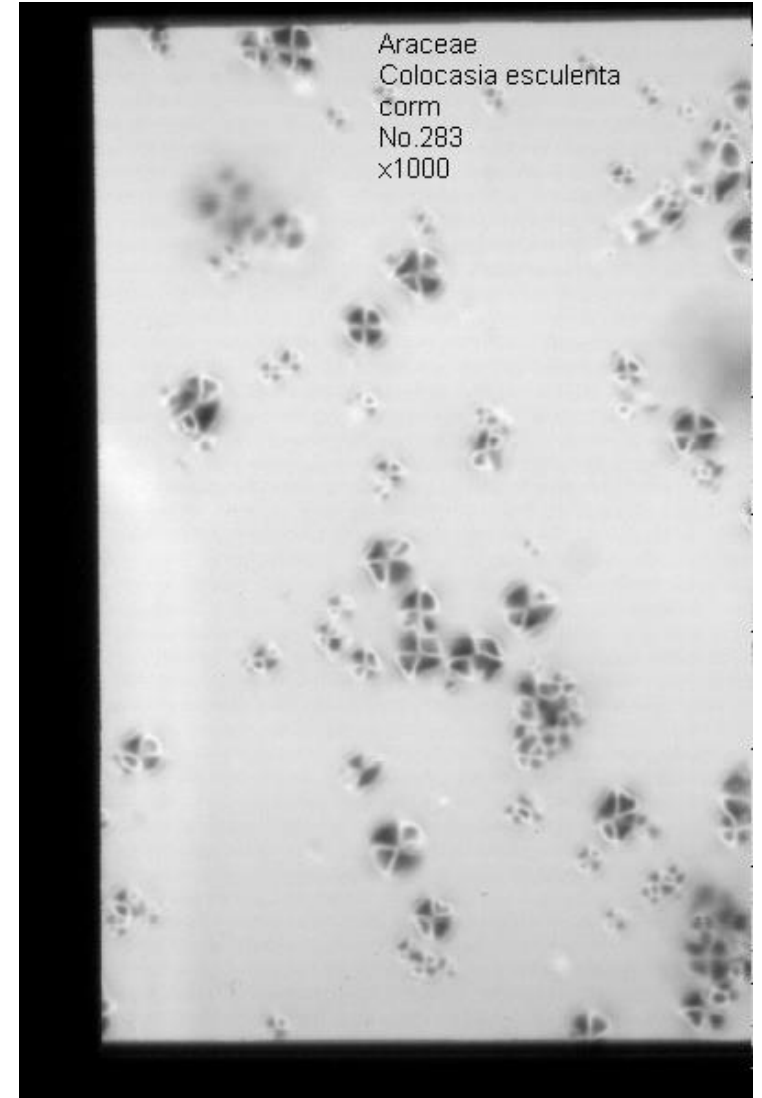
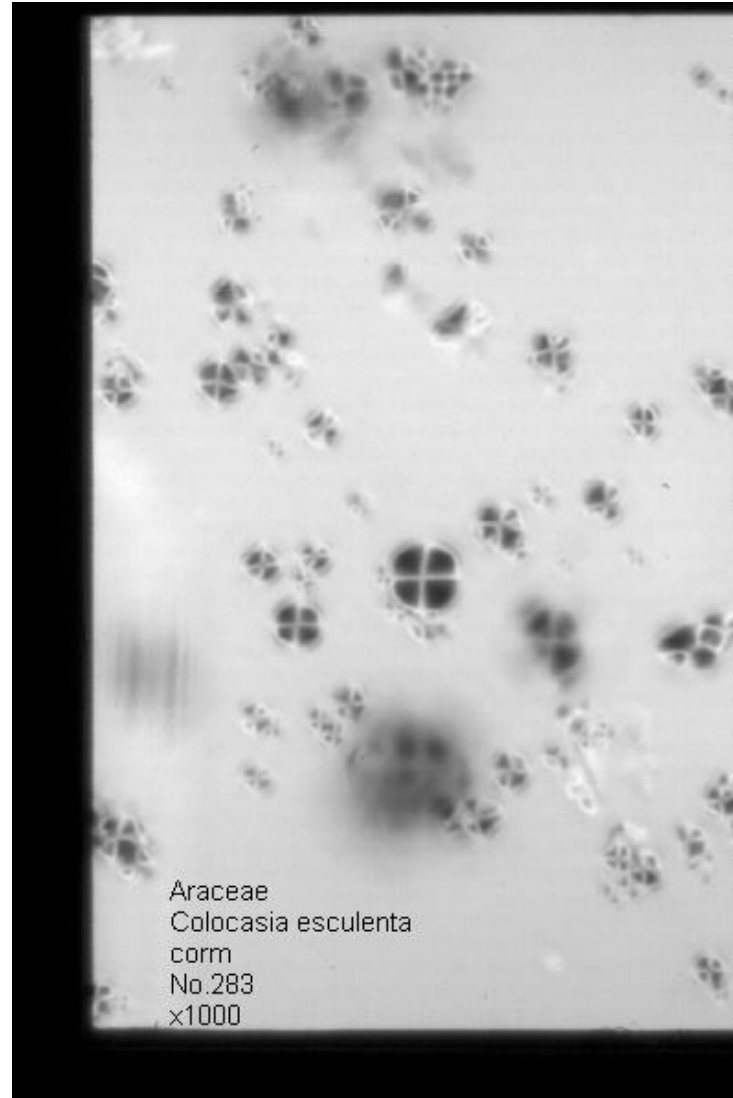
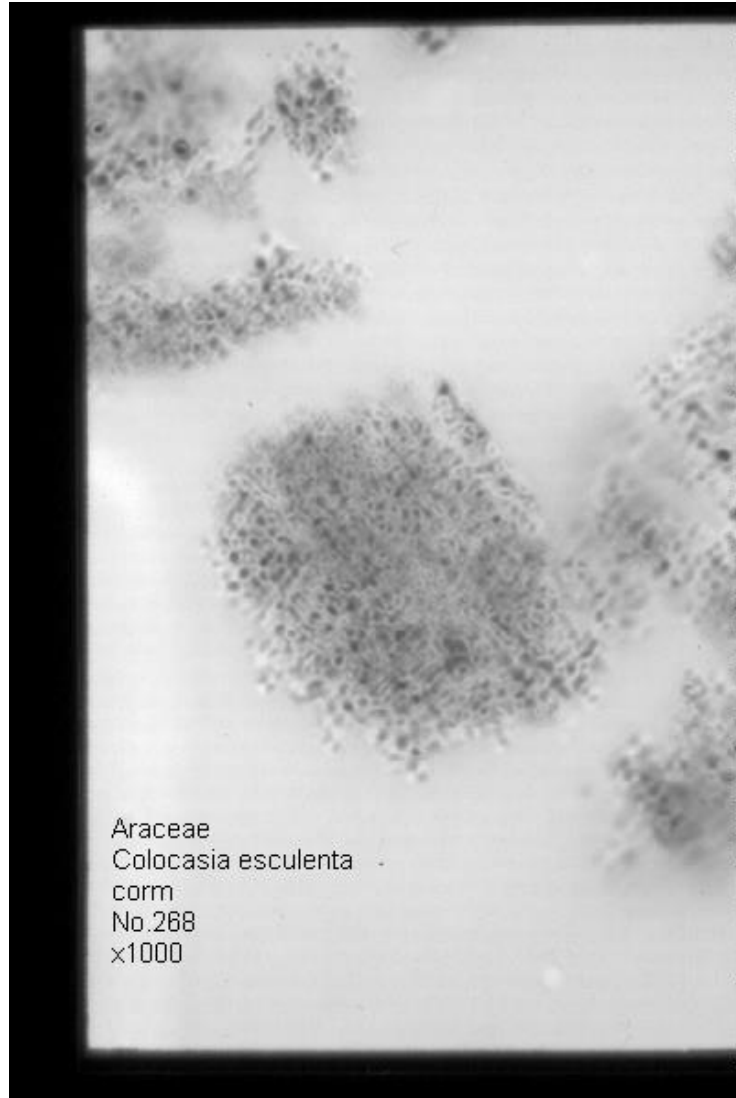
# Colocasia esculenta

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Colocasia esculenta

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Colocasia esculenta

## Phytolith

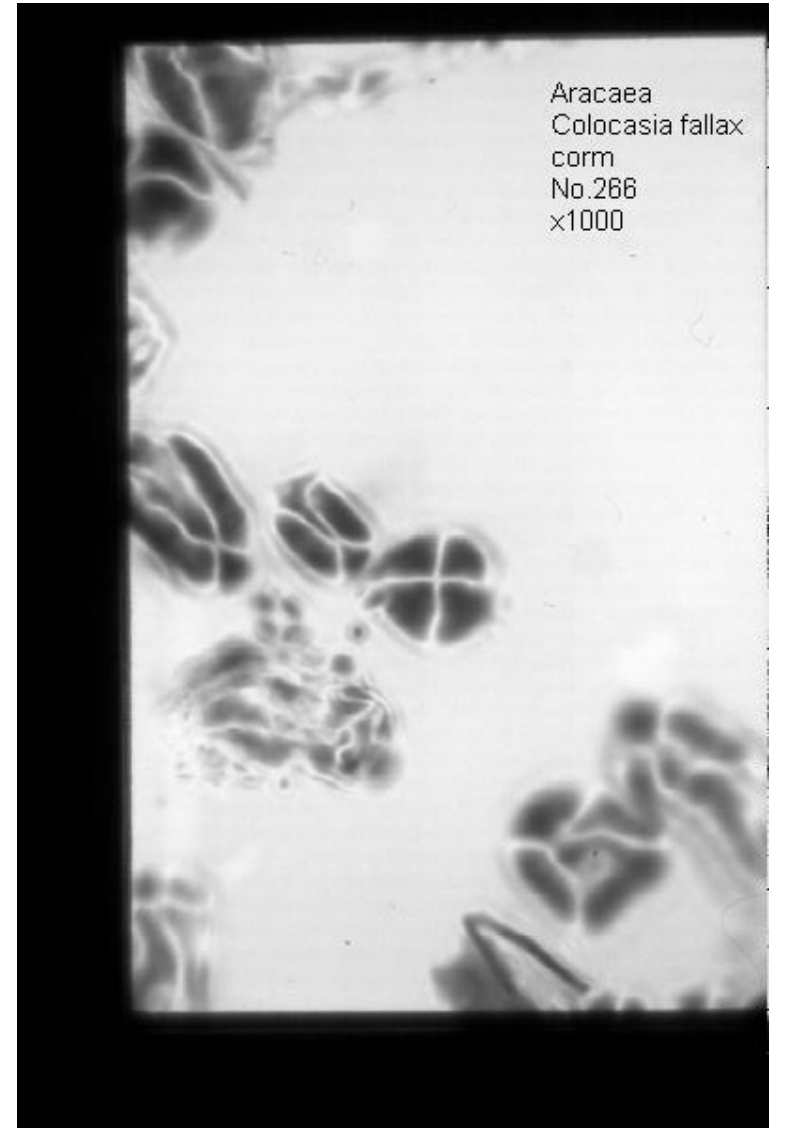
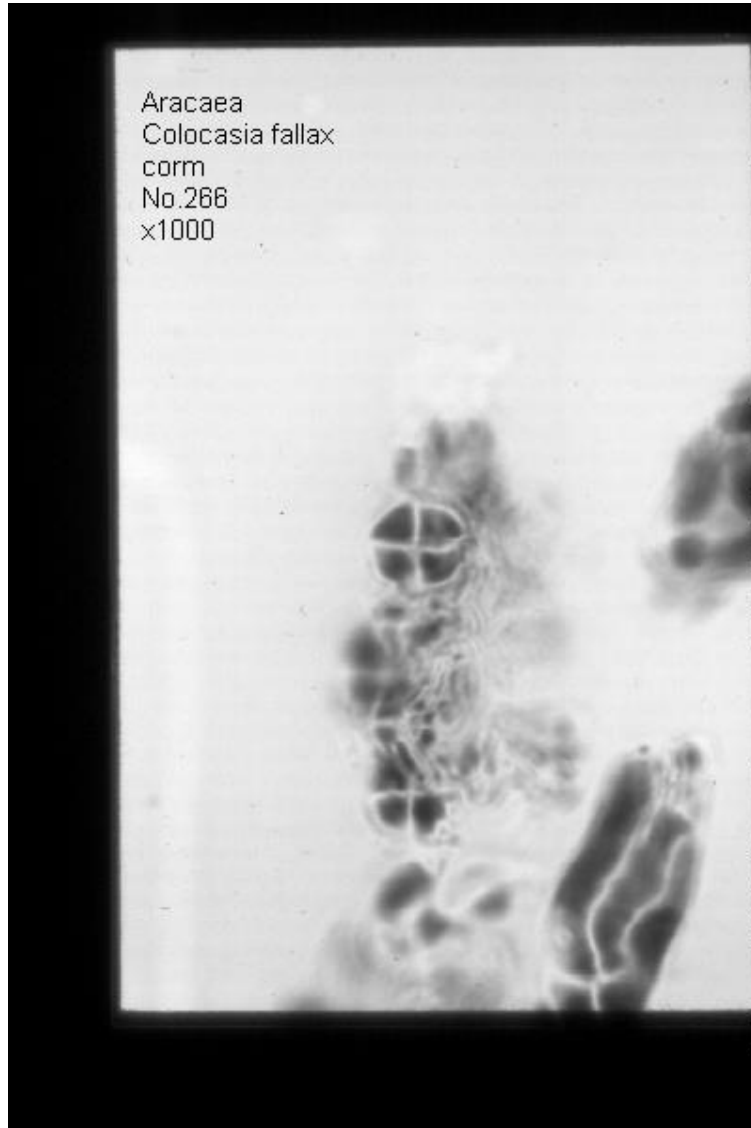
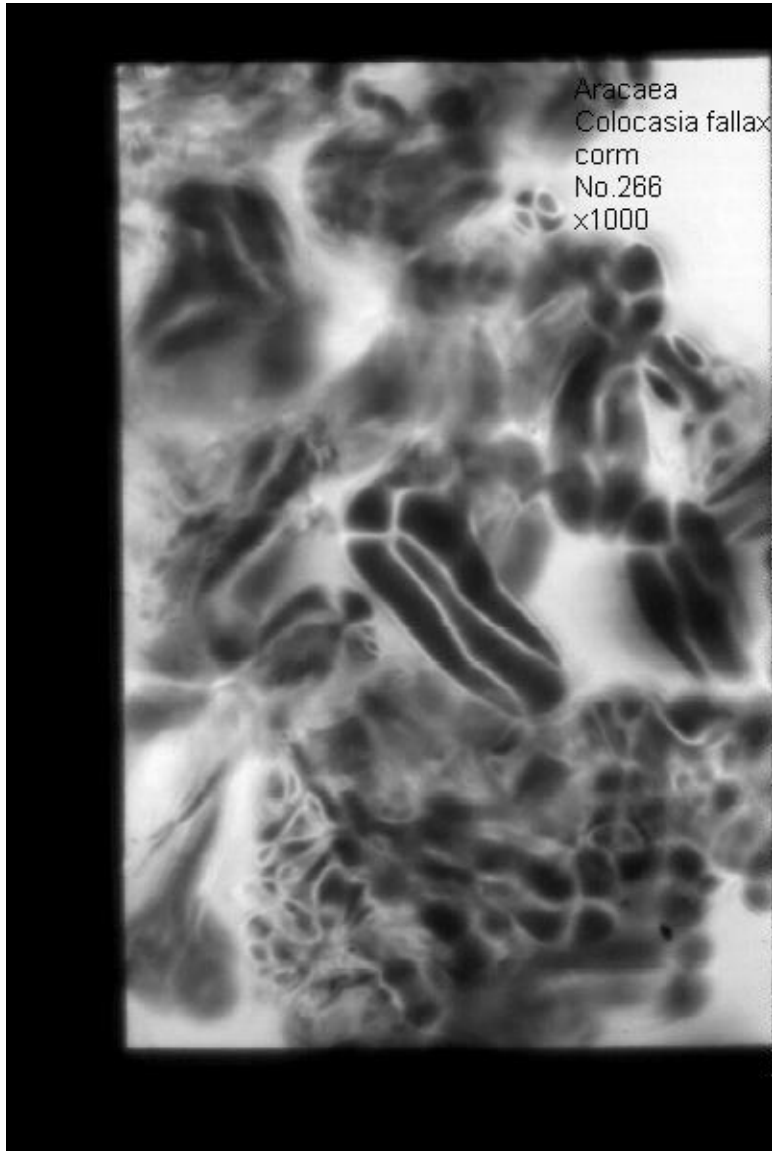
Type established by Karol  
Chandler- Ezell, 2004.  
Cultivated tuber. Diagnostic  
level: undetermined



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

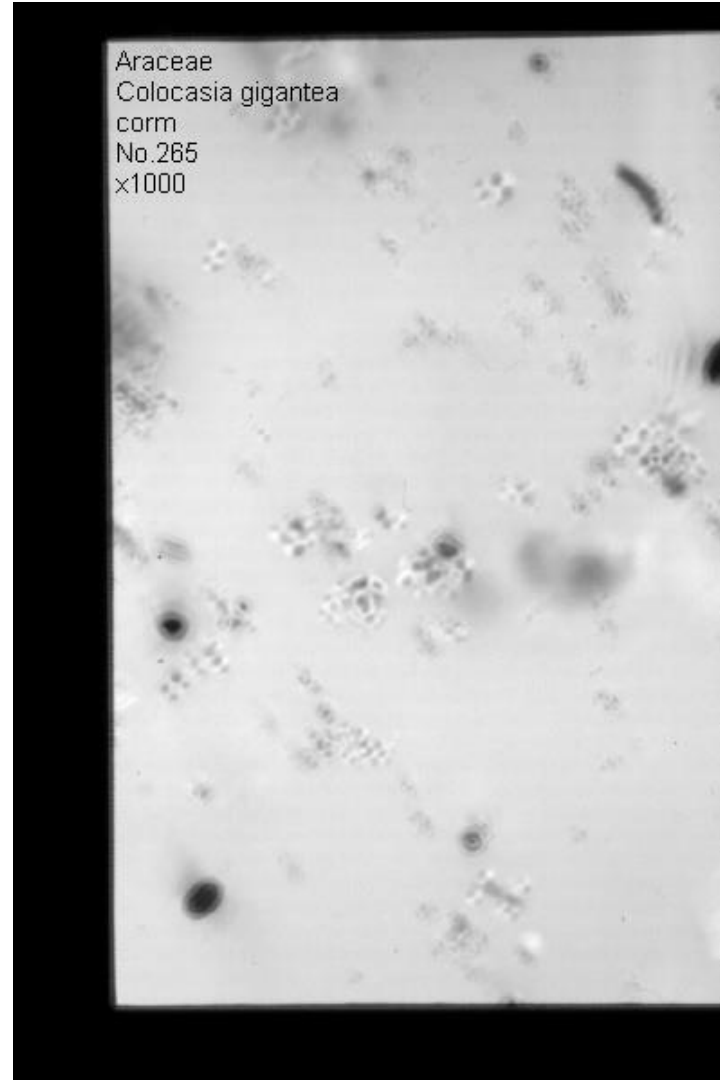
# Colocasia fallax

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection

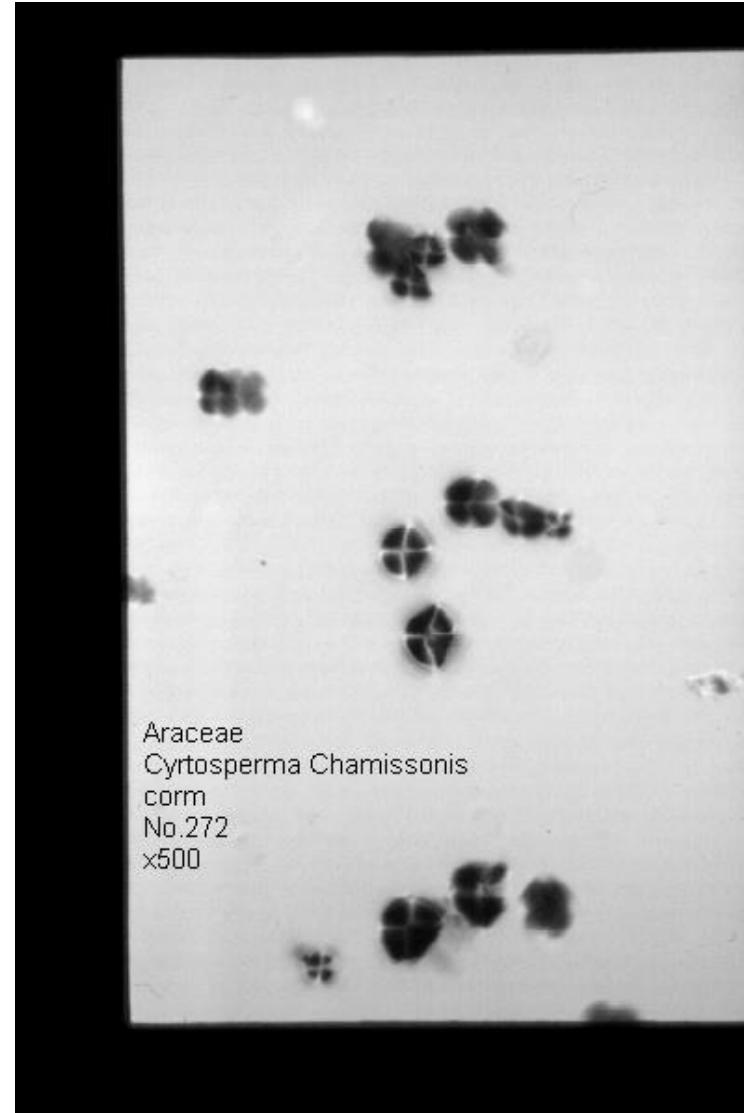
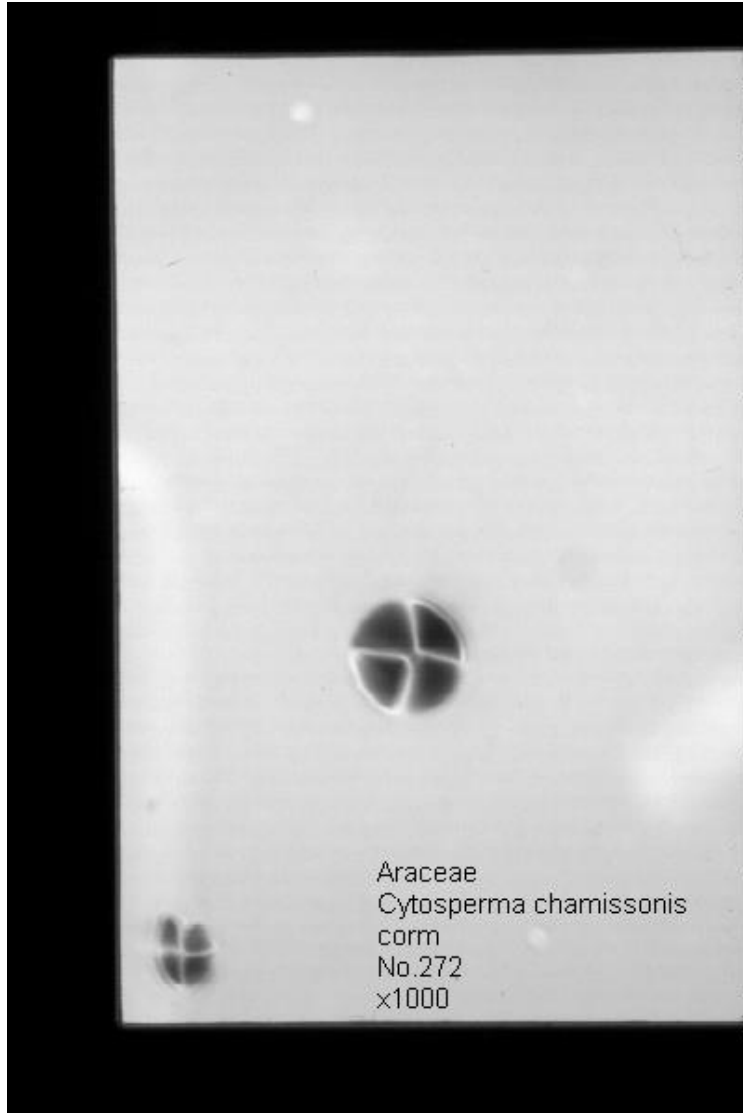


# Colocasia gigantea

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



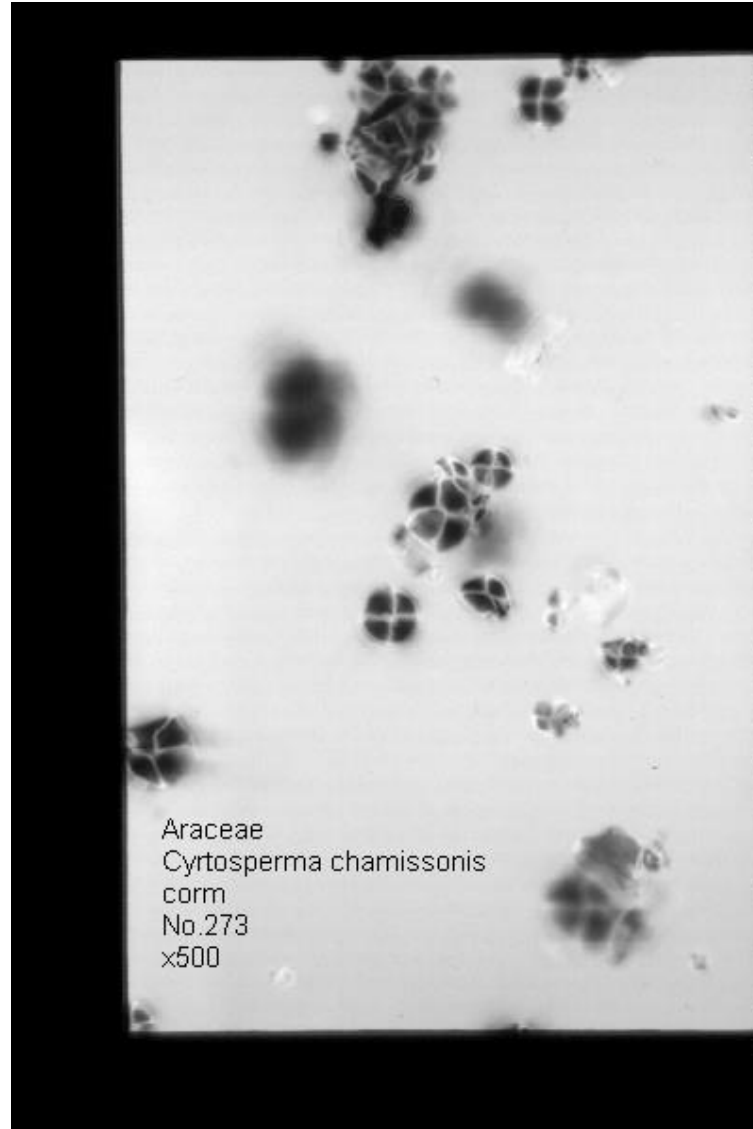
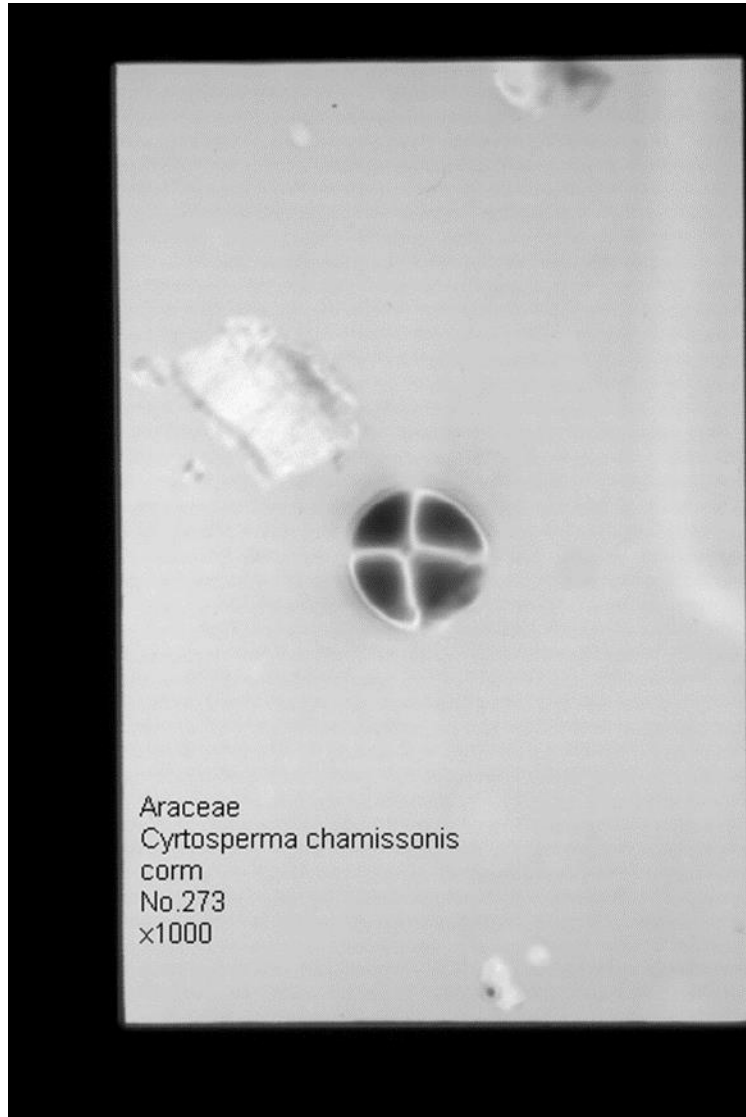
# Cyrtosperma chamissonis



Australian Museum,  
McCown Archaeobotany  
Laboratory Collection

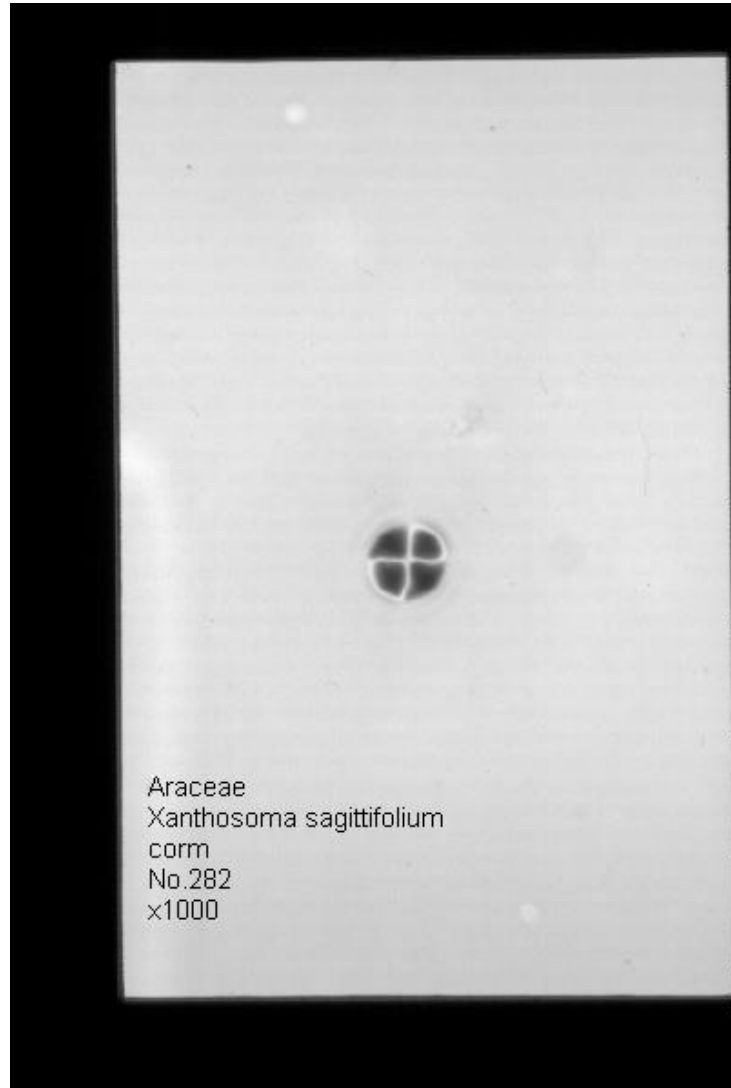


# Cyrtosperma chamissonis



Australian Museum,  
McCown Archaeobotany  
Laboratory Collection

# Xanthosoma sagittifolium



Australian Museum,  
McCown Archaeobotany  
Laboratory Collection

# Xanthosoma sagittifolium

## Starch

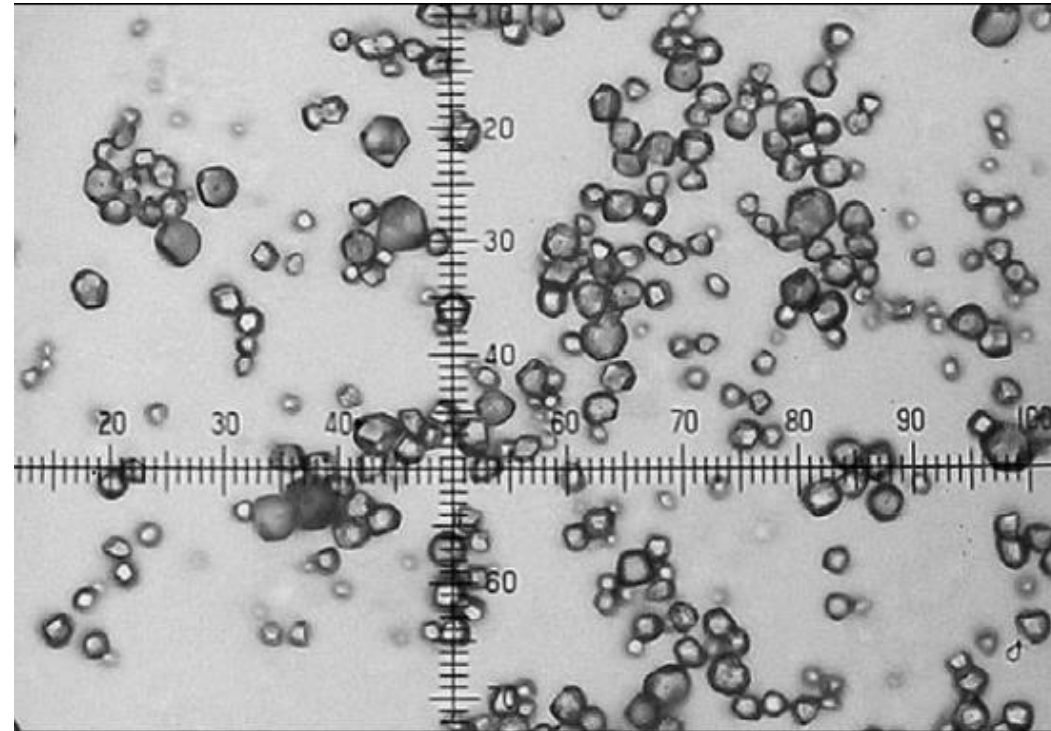
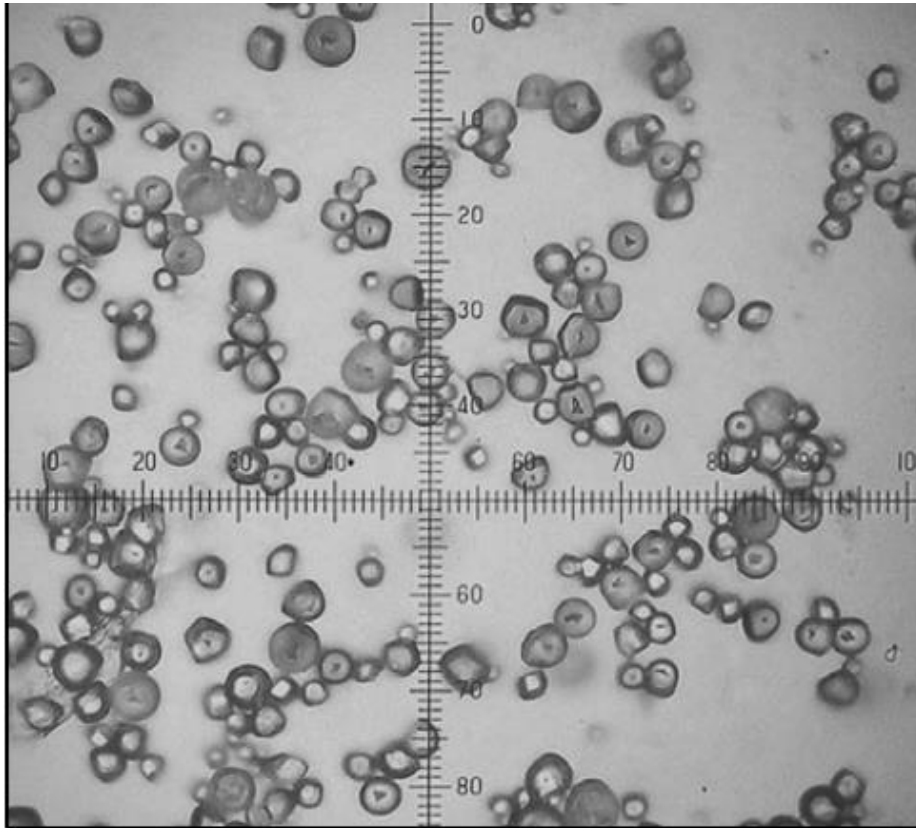
### APPENDIX:

Xanthosoma sagittifolium (yautia, malanga). Compound grains, not laminated often without a fissure. Very defined pressure facets with conspicuous edges. Size: 2–16 microns long

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Xanthosoma sagittifolium

## Starch

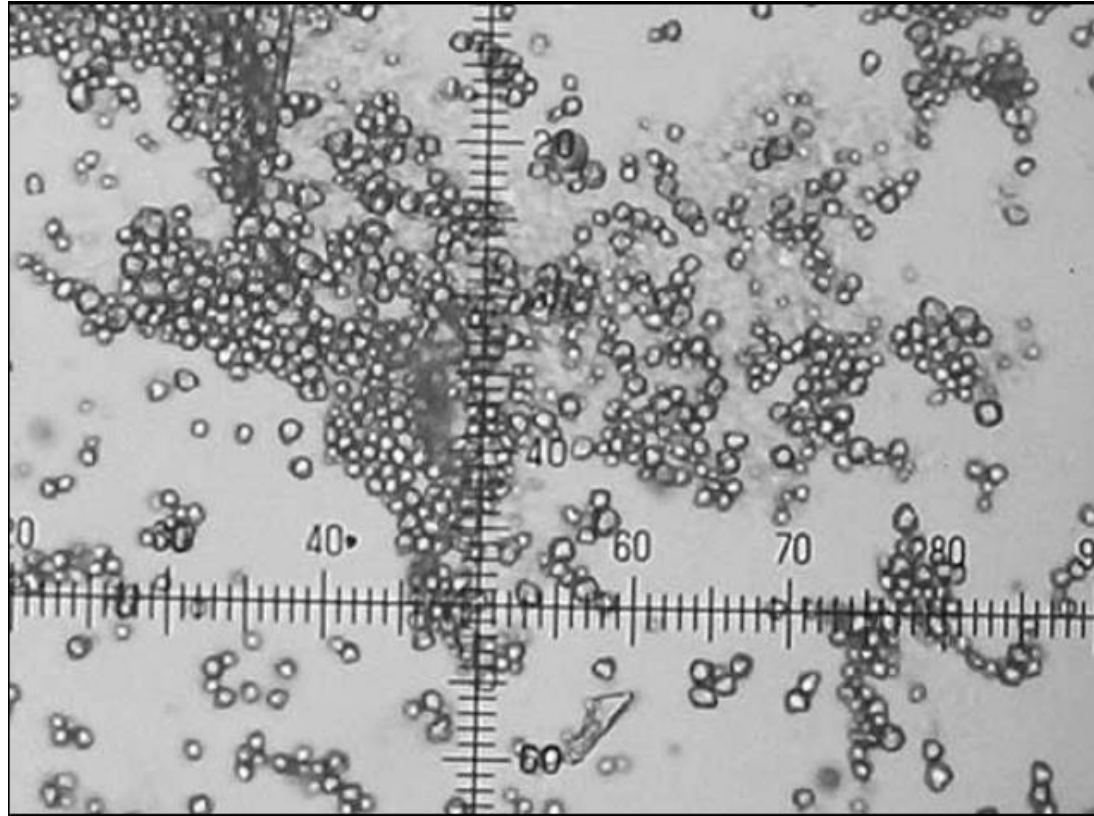


cf.

Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Xanthosoma undipes

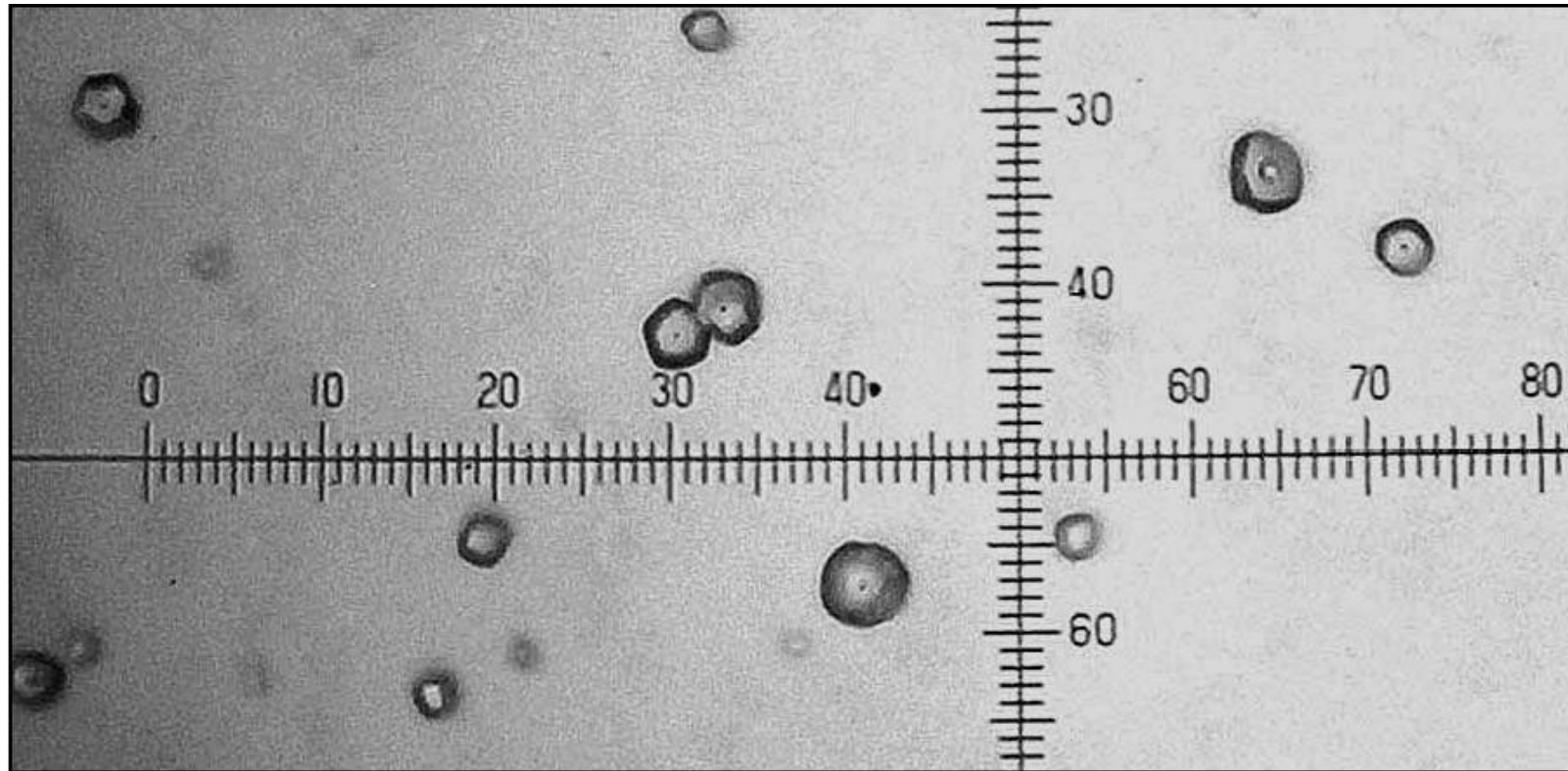
Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Xanthosoma violaceum

## Starch

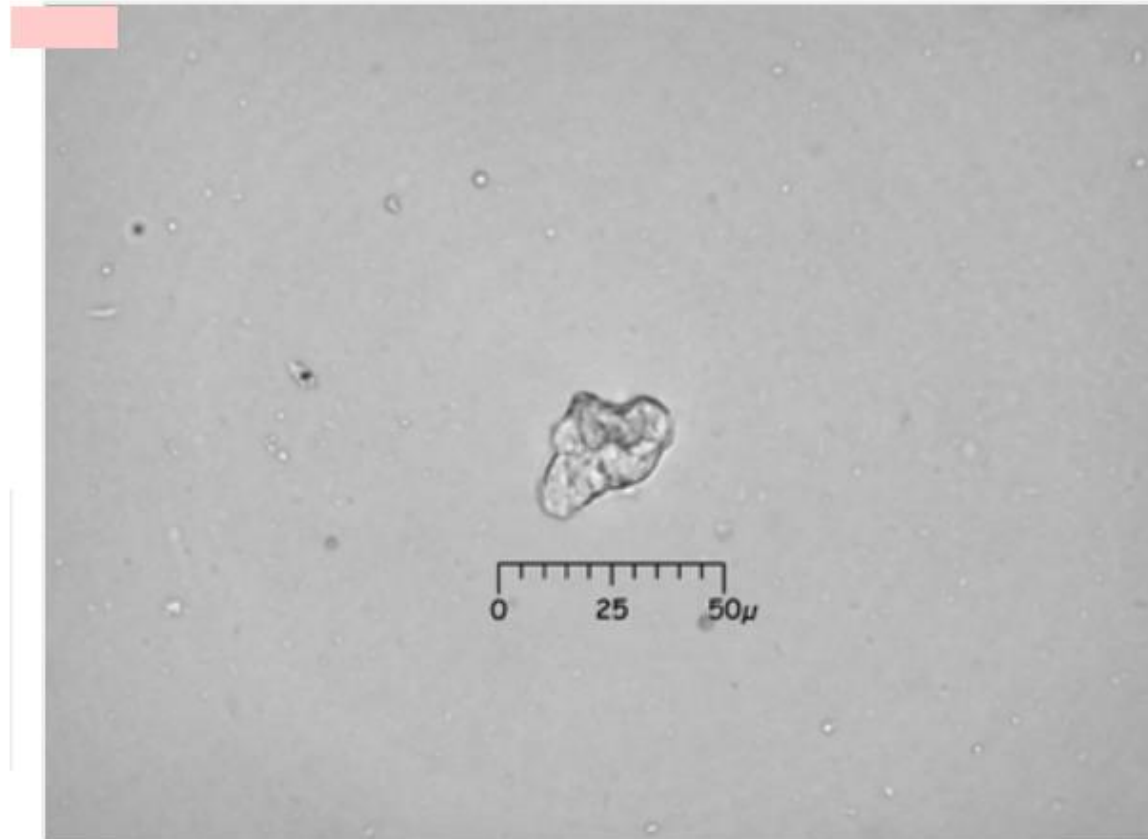


Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Xanthosoma sp.

## Phytolith

Type established by Karol  
Chandler- Ezell, 2004  
Diagnostic level: not  
determined



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

ARECACEAE



# Arecaceae

## Phytolith



a. Globular echinate diagnostic of the Arecaceae

Abramiuk, Marc A., Peter S. Dunham, Linda Scott Cummings, Chad Yost, and Todd J. Pesek. 2011. Linking Past and Present: A Preliminary Paleoethnobotanical Study of Maya Nutritional and Medicinal Plant Use and Sustainable Cultivation in the Southern Maya Mountains, Belize. *Ethnobotany Research and Applications* 9:257–73.

# Arecaceae

## Phytolith

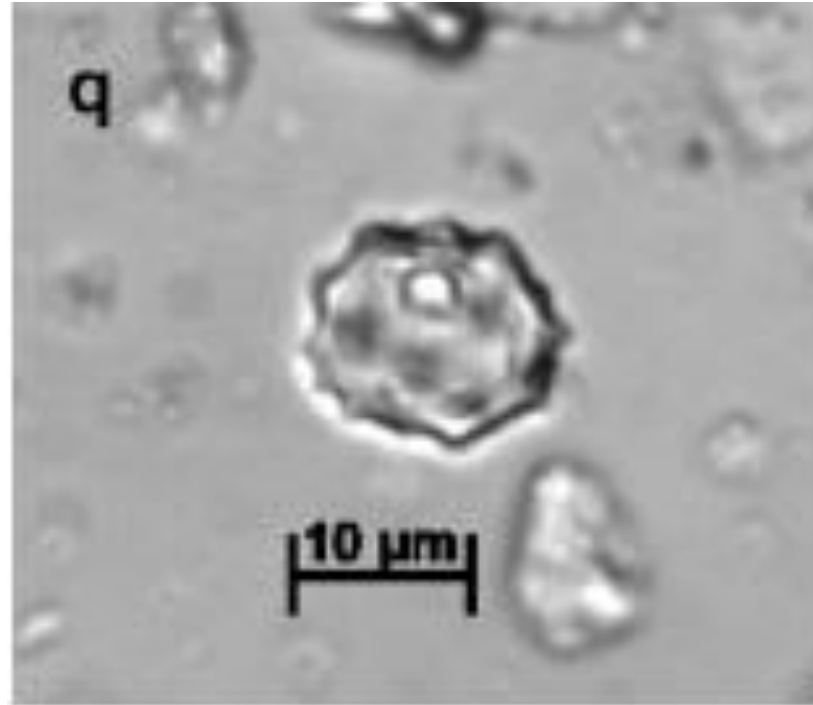


Fig. 5. Selected microbotanical remains. Phytoliths: q) Arecaceae globular echinate (Sed. Sample 3)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Acrocomia sp.

Palmae *Acrocomia* sp. "chonta"

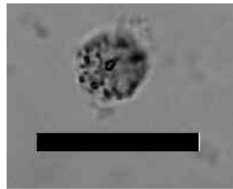
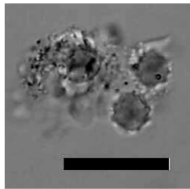
## Phytolith assemblage characterization

Diagnostic phytoliths:

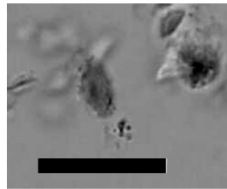
a) Conical echinate silica phytoliths. Very common.

leaf

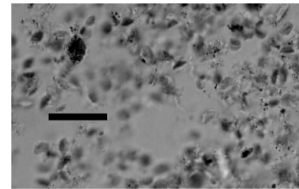
Plane view.



Lateral view.



Assemblage.

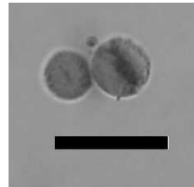


**References:** Reported in  
Piperno 1988:24 from  
Tomlinson 1961.

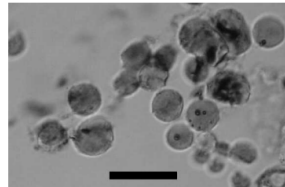
Diagnostic phytoliths (\*):

a) Round psilate silica phytolith. Very common.

leaf trunk



Assemblage.

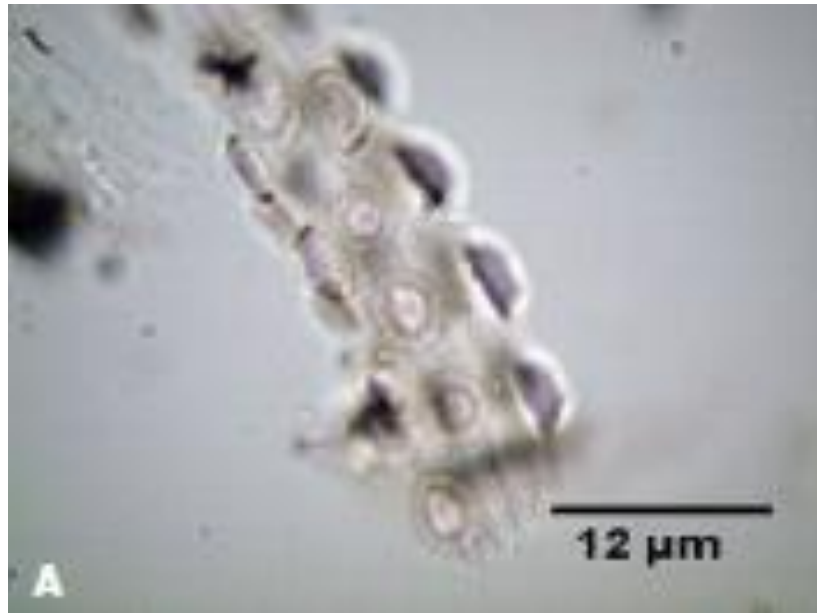


Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Acrocomia aculeata

## Phytolith

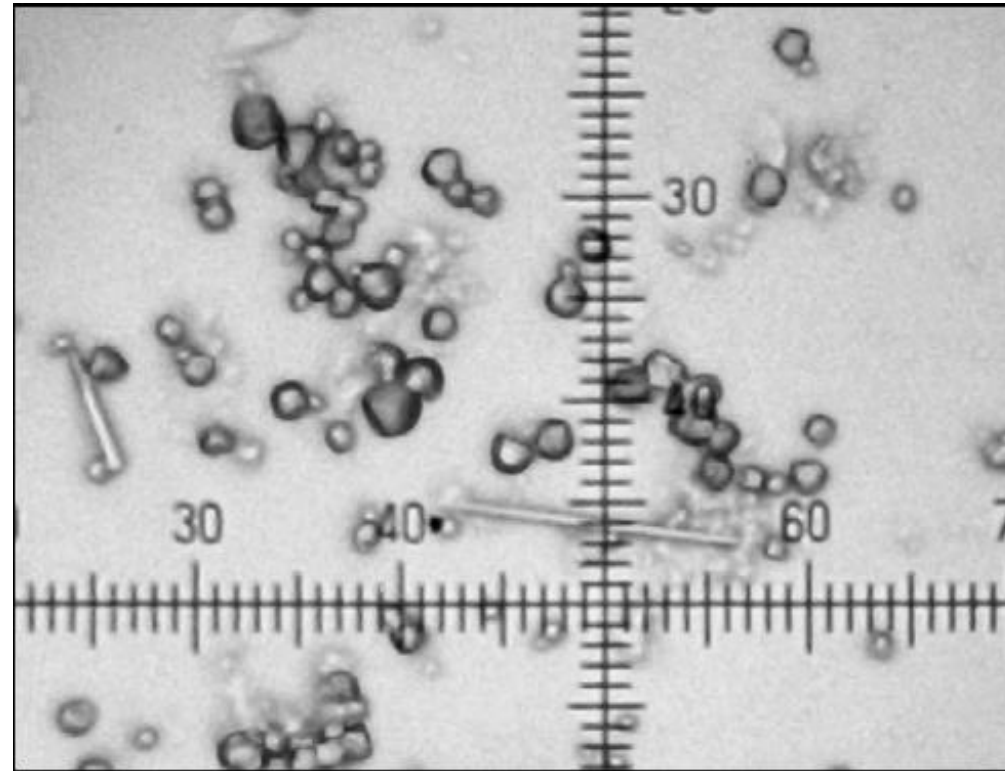


A. Silicified cells of *Acrocomia aculeata*. ICN 0842.

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Acrocomia media

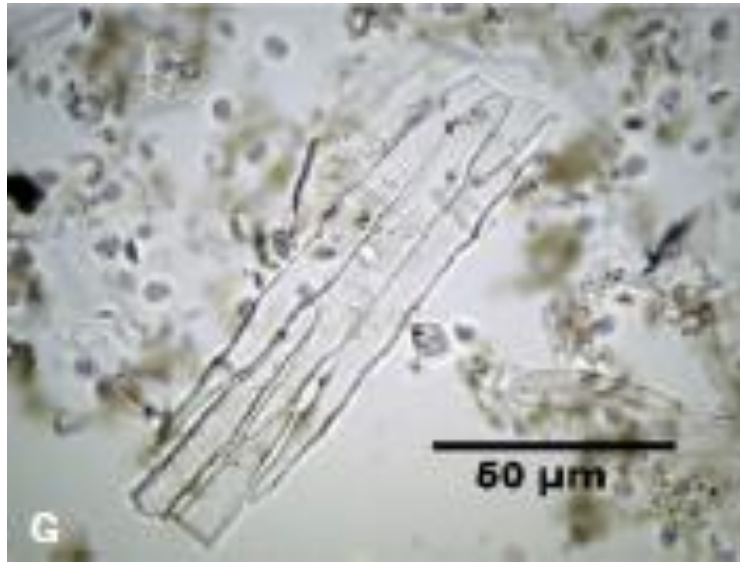
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Aiphanes deltoidea

## Phytolith

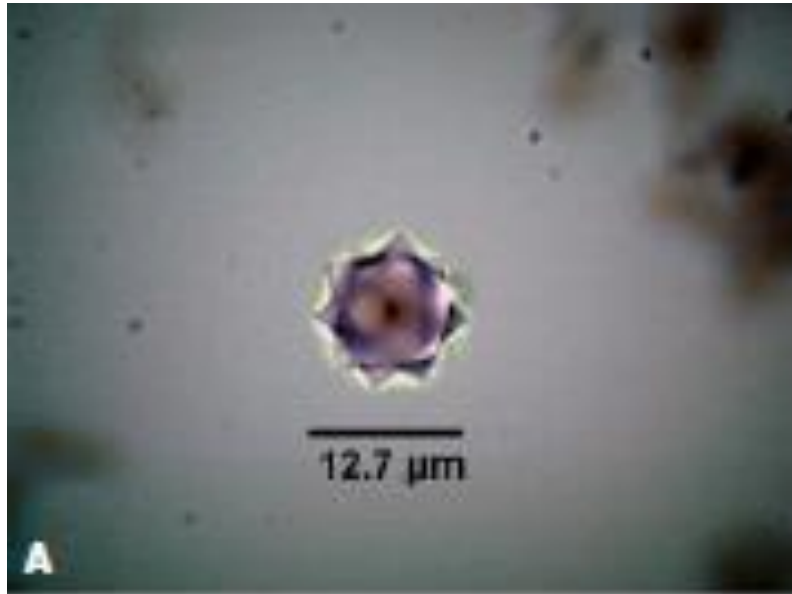


G. Silicified cells of *Aiphanes deltoidea*. ICN 0242.

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Ammandra decasperma

## Phytolith



A. globular echinate symmetrical (Ammandra decasperma. ICN 0244).

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Astrocaryum acaule

## Phytolith



H. Silicified cells of *Astrocaryum acaule*. ICN 0245.

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.



# Astrocaryum chambira

## Phytolith



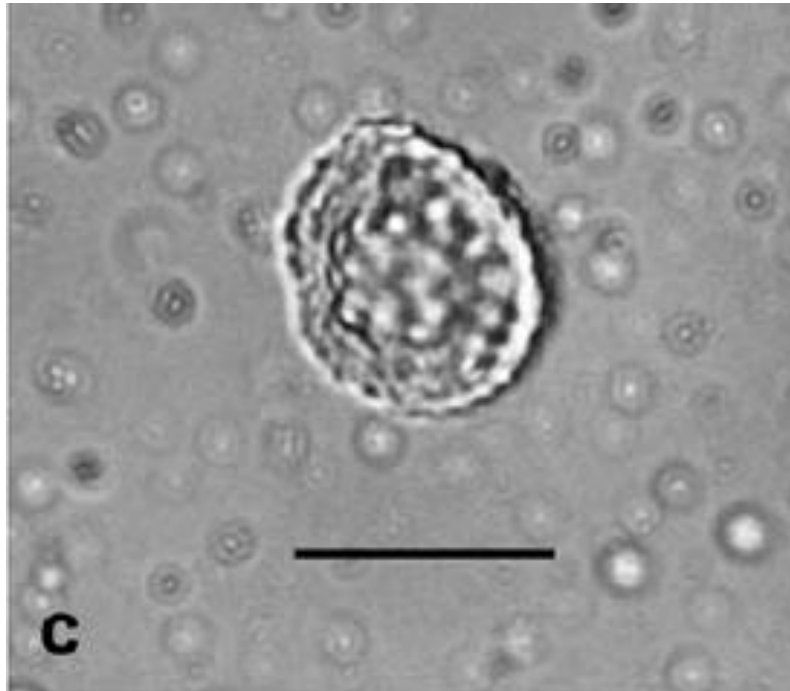
B. Silicified cells of *Astrocaryum chambira*. ICN 0249.

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Astrocaryum murumuru

## Phytolith

Fig. 3. Phytoliths from non-grass monocots. c) Conical body from *Astrocaryum murumuru*



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Attalea butyracea

## Phytolith



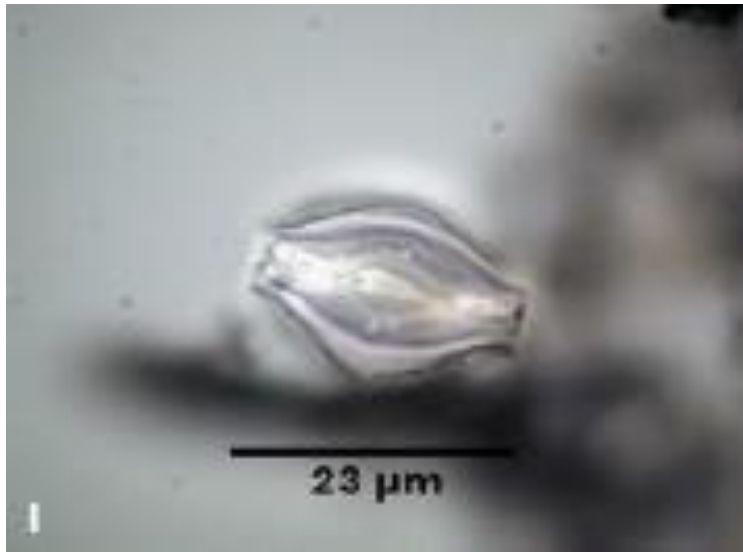
B. globular echinate (*Attalea butyracea*. ICN 0255).

C. globular echinate elongate (*Attalea butyracea*. ICN 0254).

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Attalea maripa

## Phytolith

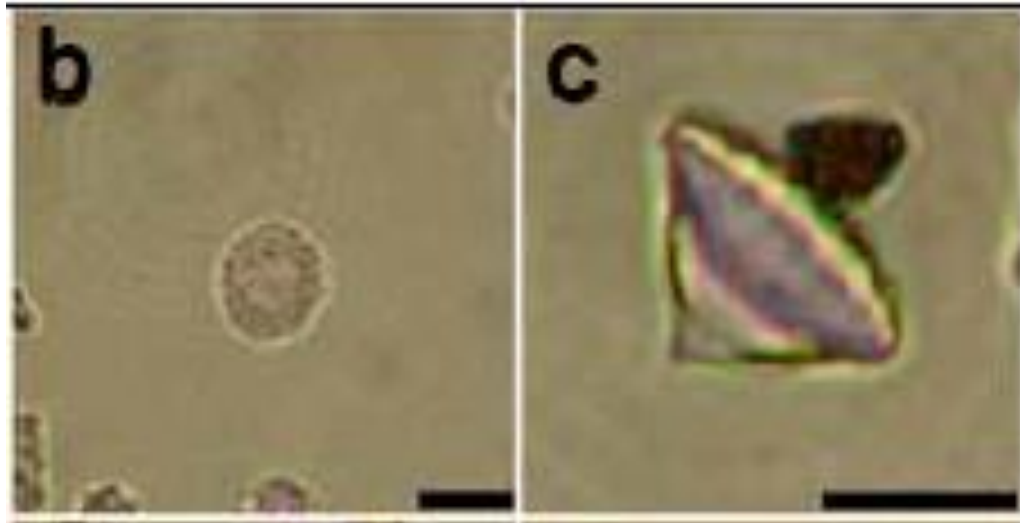


I. Silicified cells of *Attalea maripa*. ICN 0263.

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Bactris-type

## Phytolith



b. *Bactris*-type spinulose conical body diagnostic of the Arecaceae, but may be distinctive of certain palm genera such as *Bactris*, *Geonoma*, *Caryota*, and *Chamaedorea*.

c. *Bactris*-type in side-view.

Abramiuk, Marc A., Peter S. Dunham, Linda Scott Cummings, Chad Yost, and Todd J. Pesek. 2011. Linking Past and Present: A Preliminary Paleoethnobotanical Study of Maya Nutritional and Medicinal Plant Use and Sustainable Cultivation in the Southern Maya Mountains, Belize. *Ethnobotany Research and Applications* 9:257–73.

# Bactris sp.

## Phytolith

Side view of body shows profile of two projections on top, smooth bottom surface. Diagnostic level: family

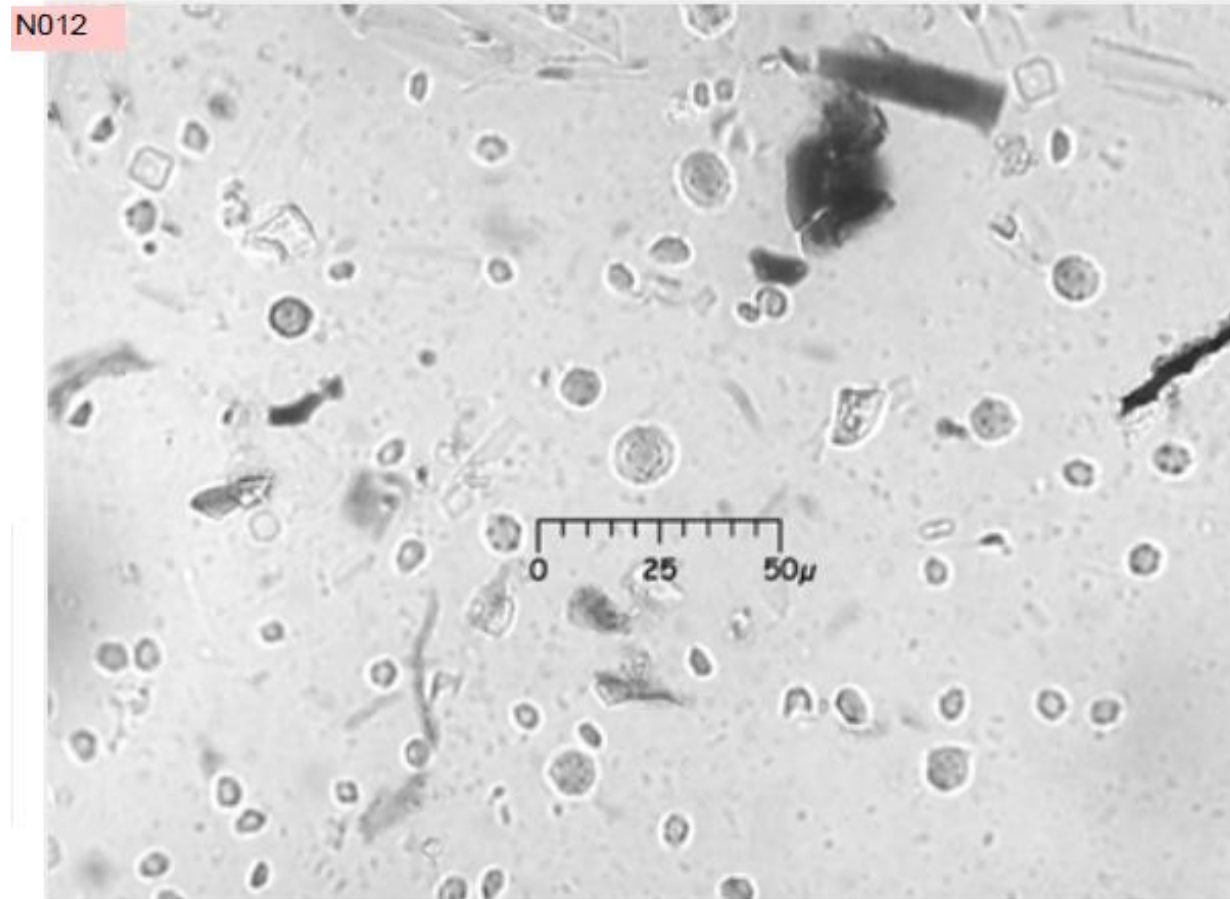


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Bactris sp.

## Phytolith

There are several small spinulose spheres and other conical bodies in the background of this image.  
Diagnostic level: family

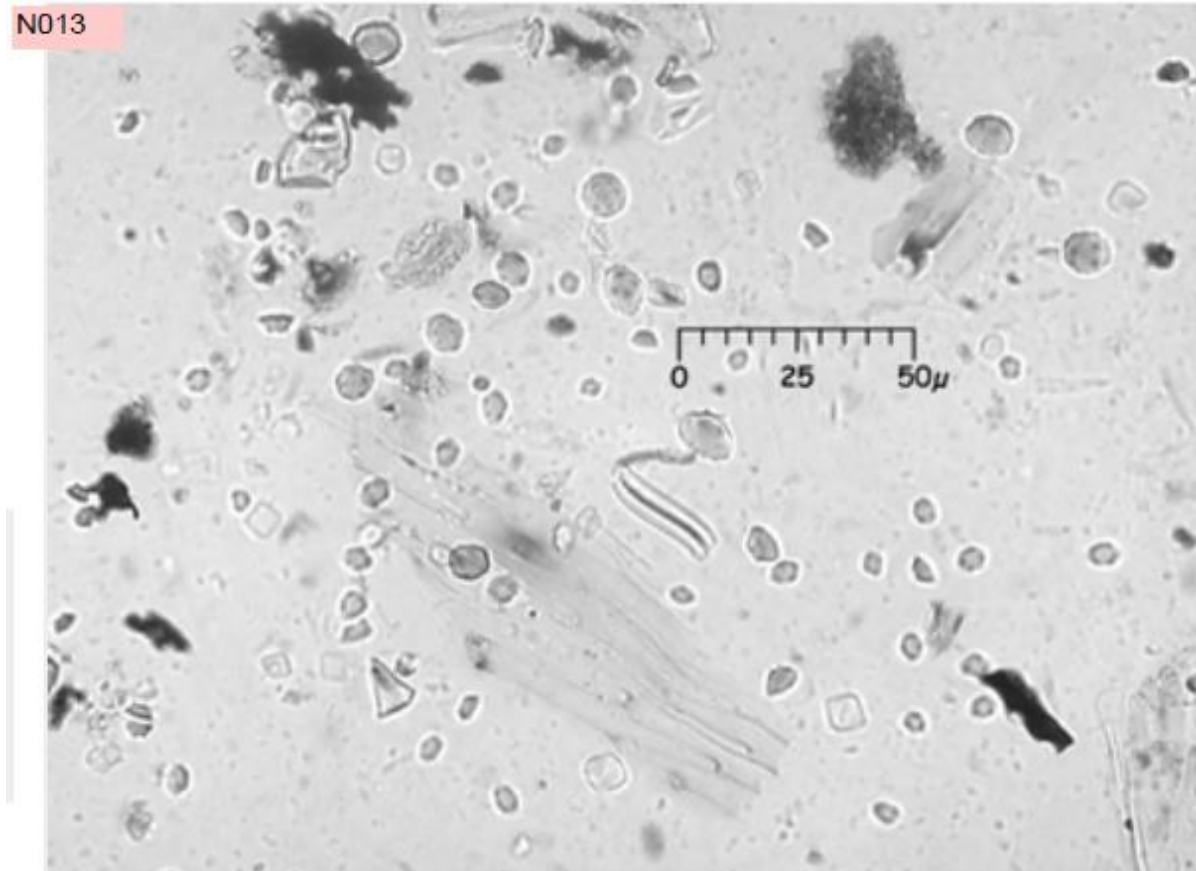


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Bactris sp.

## Phytolith

You can spot several spinulose spheres and other conical bodies in the background of this image.  
Diagnostic level: family



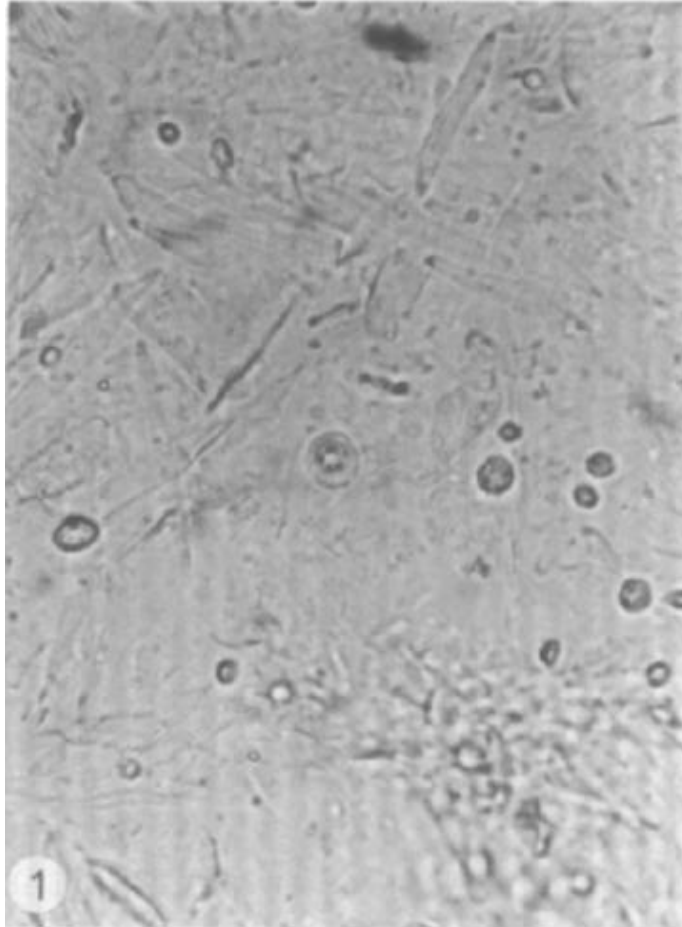
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Bactris sp.

## Phytolith

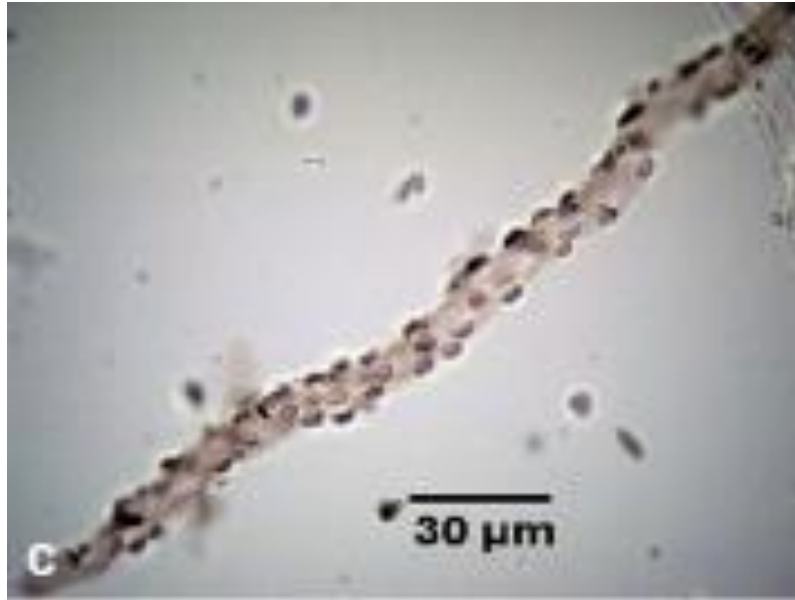
1. Hat-shaped silica bodies from Bactris (400 × ).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Bactris gasipaes var. gasipaes

## Phytolith



C. Silicified cells of *Bactris gasipaes* var. *gasipaes*. ICN 0855

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Bactris gasipaes

## Starch

### APPENDIX:

Bactris gasipaes (pejibaye, peach palm). Mostly simple grains, rarely compound, with slight depressions. Size: 4–14 microns long. Most palms contain few starch grains, which are unremarkable in shape, and very small. Size: 1–2 microns

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Bactris killipii

## Phytolith

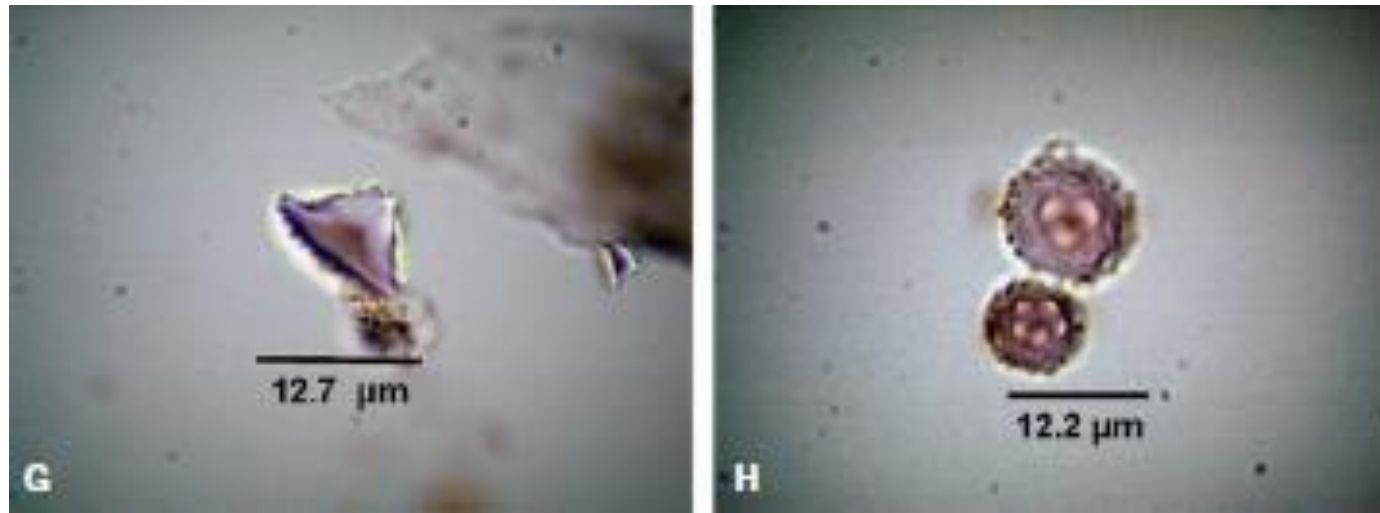


F. Silicified cells of *Bactris killipii*. ICN 0858.

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Bactris sphaerocarpa

## Phytolith



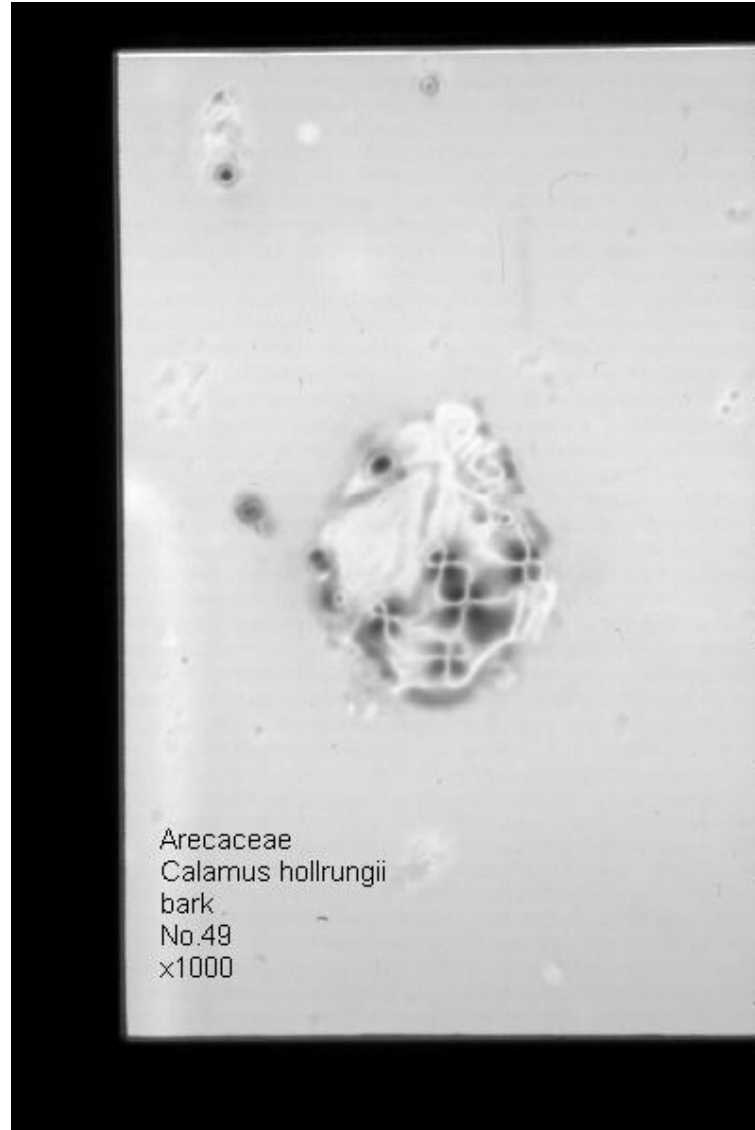
G. conical (front view) (*Bactris sphaerocarpa*. ICN 0299).

H. conical (top view) (*Bactris sphaerocarpa*. ICN 0299).

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

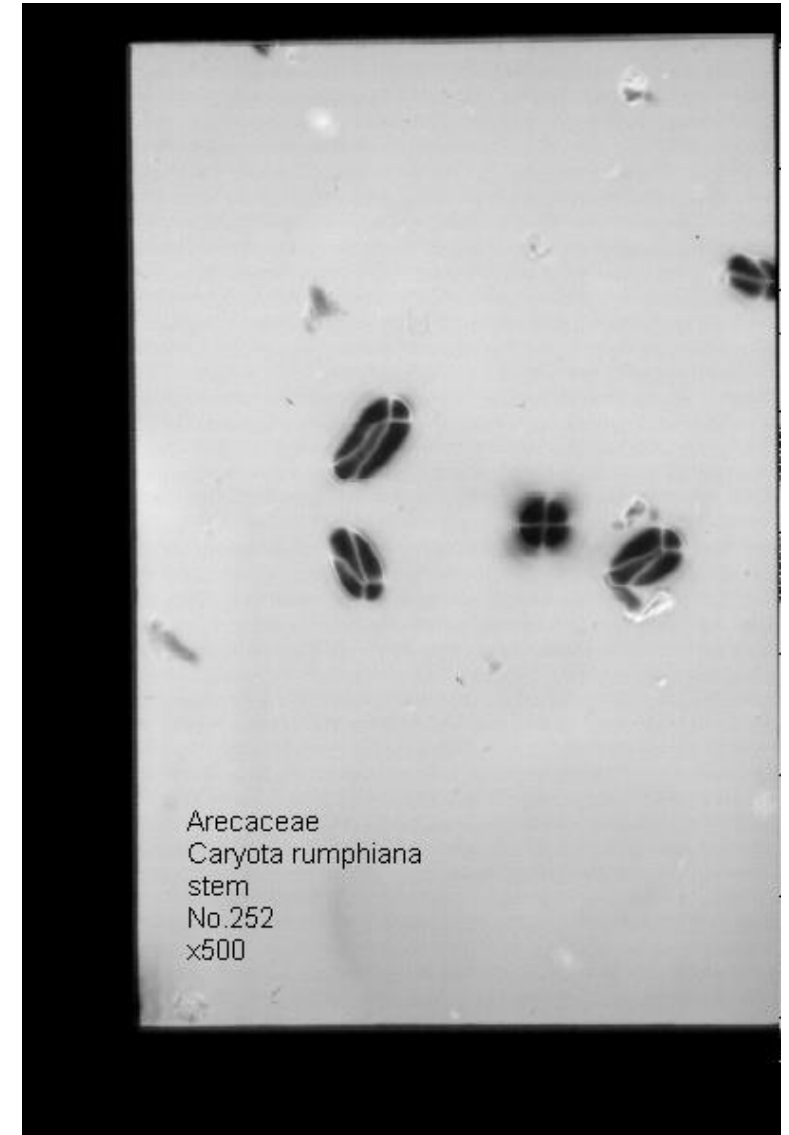
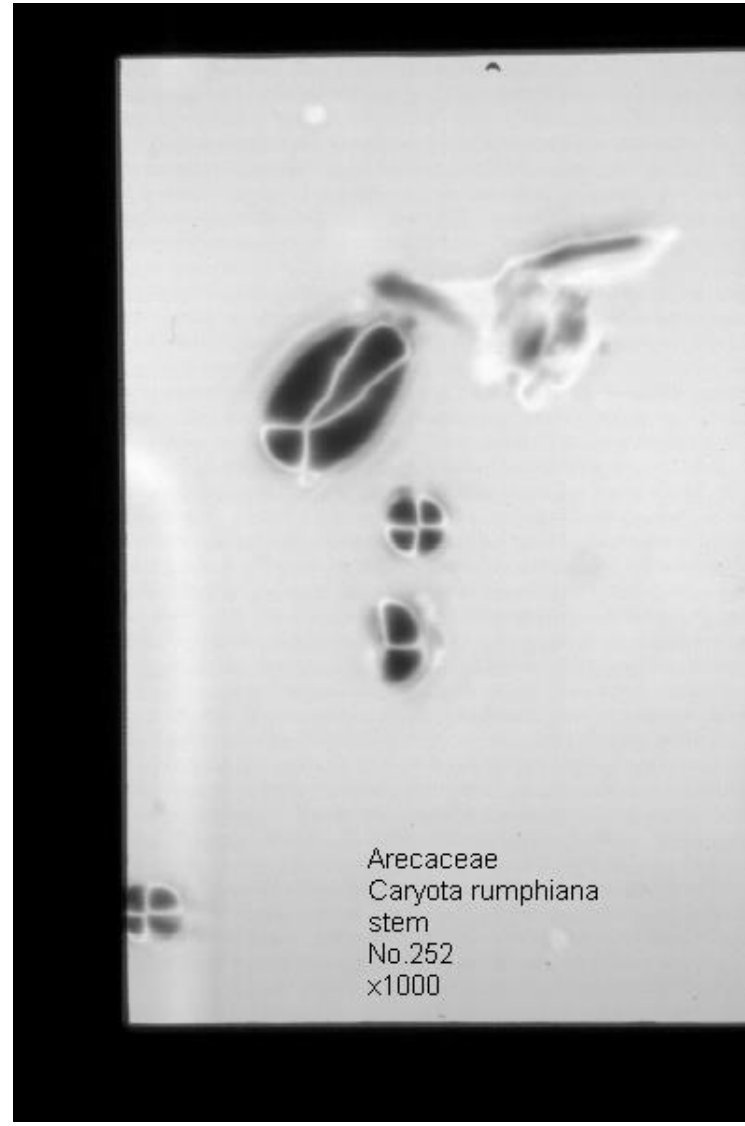
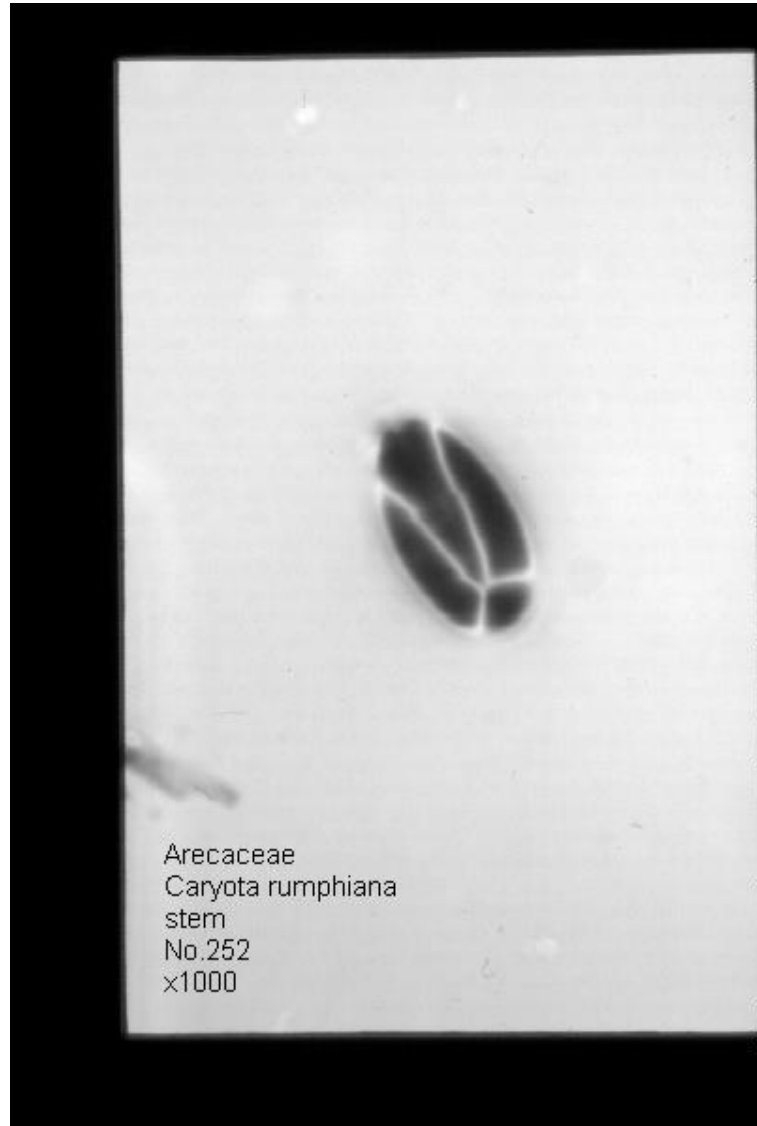
# Callamus hoorungii

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Caryota rumphiana

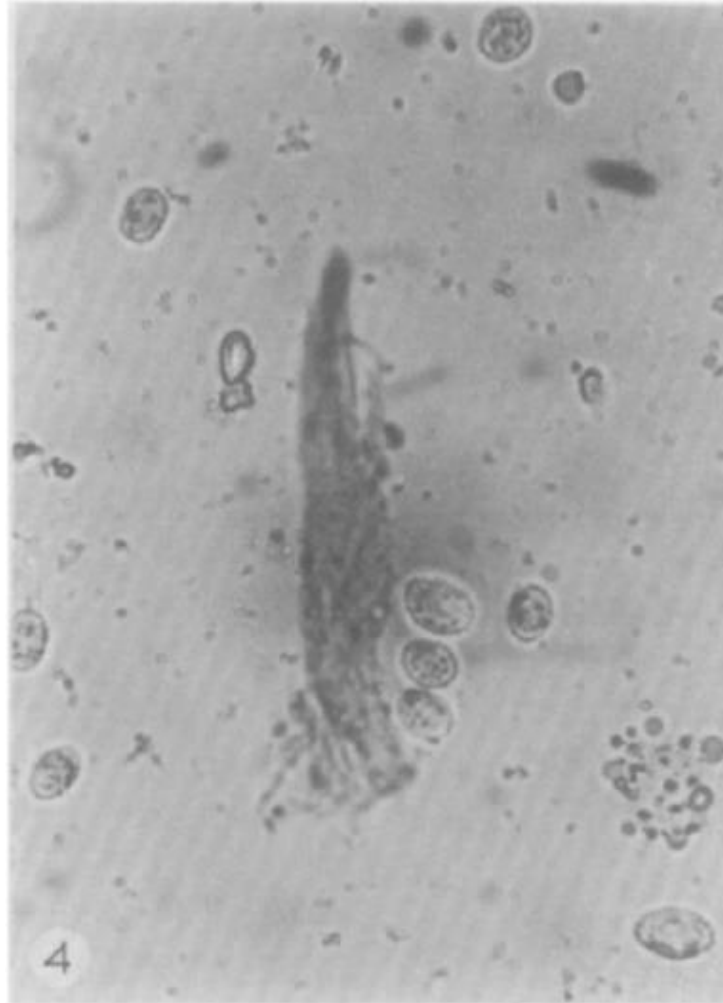
Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Chamaedorea sp.

## Phytolith

4. Hat-shaped silica bodies from Chamaedorea (400 × ).

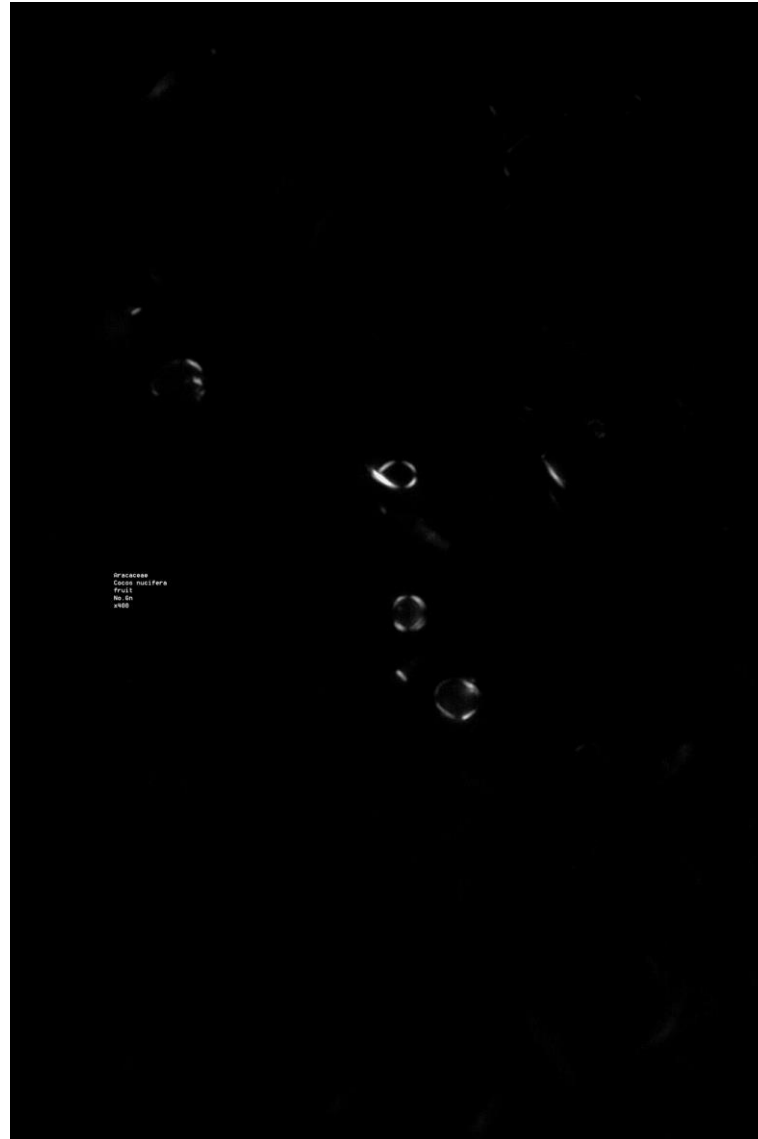
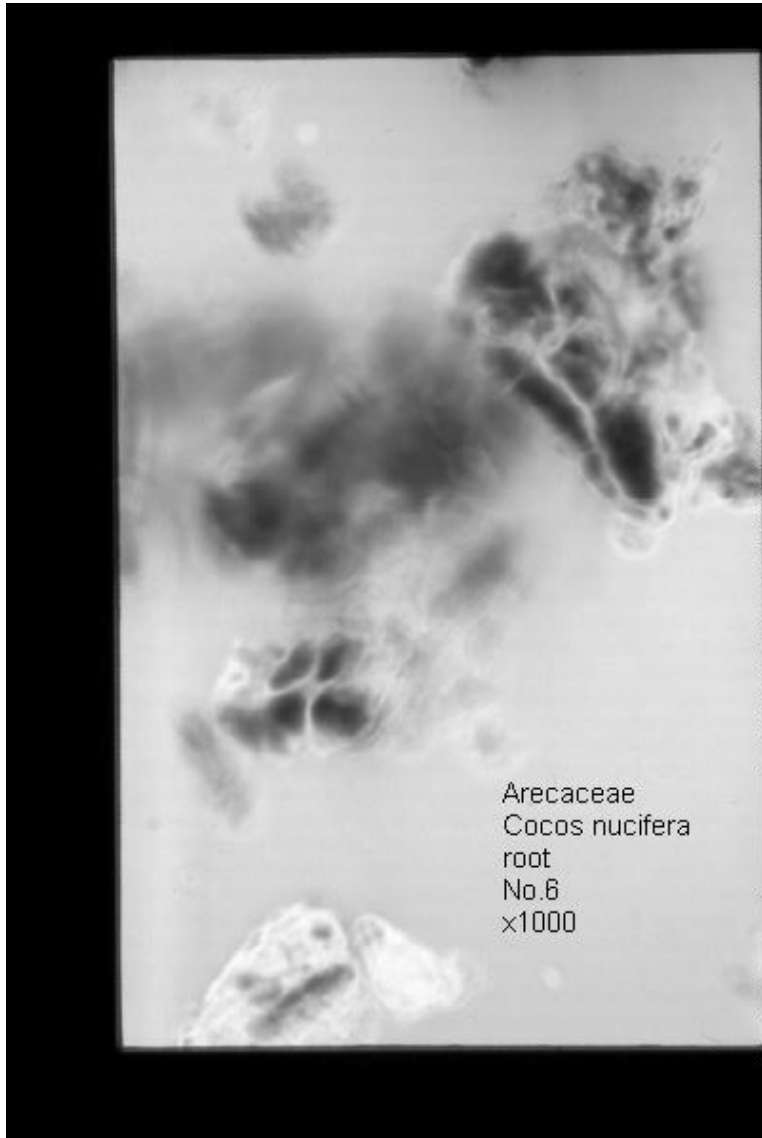


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.



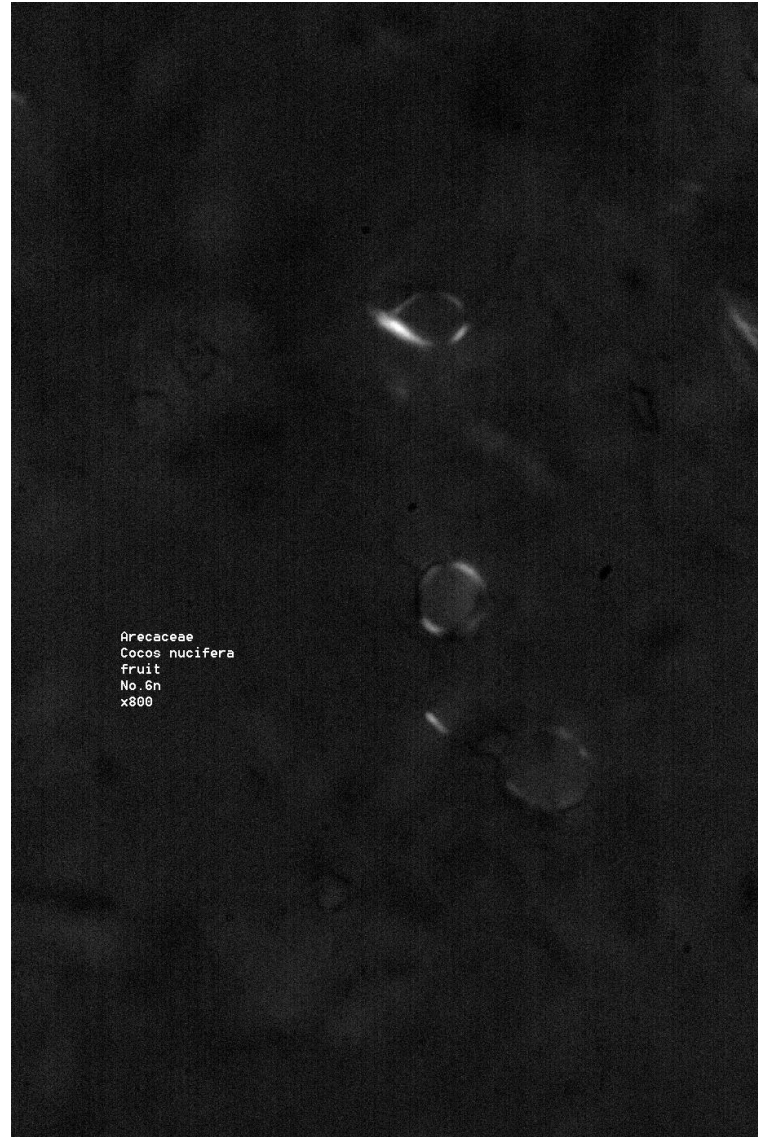
# Cocos nucifera

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Cocos nucifera

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



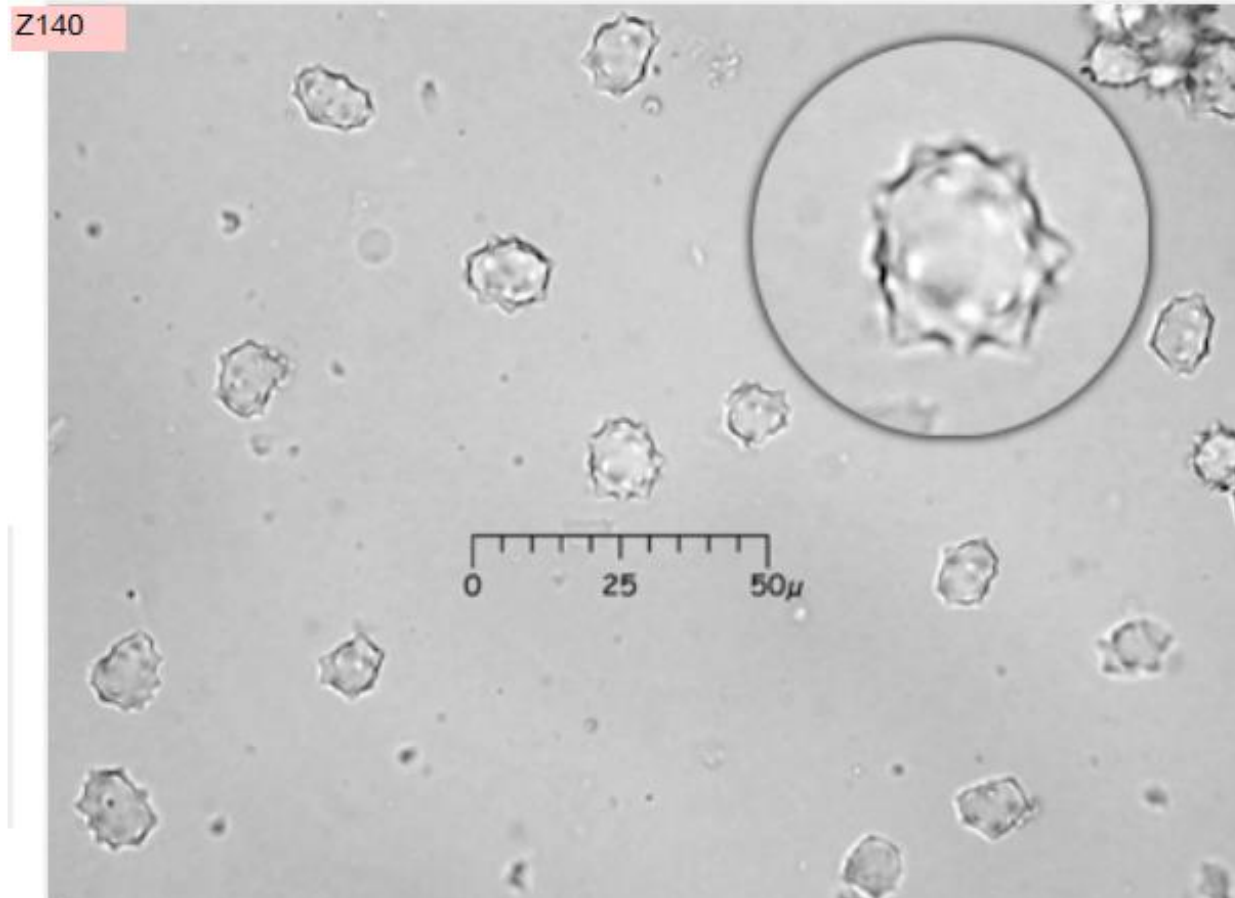
# Cocos nucifera

## Phytolith

Spinulose spheres.

Be sure to rotate to determine whether body is a sphere or conical body with spinulose projections.

Diagnostic level: family, Arecaceae

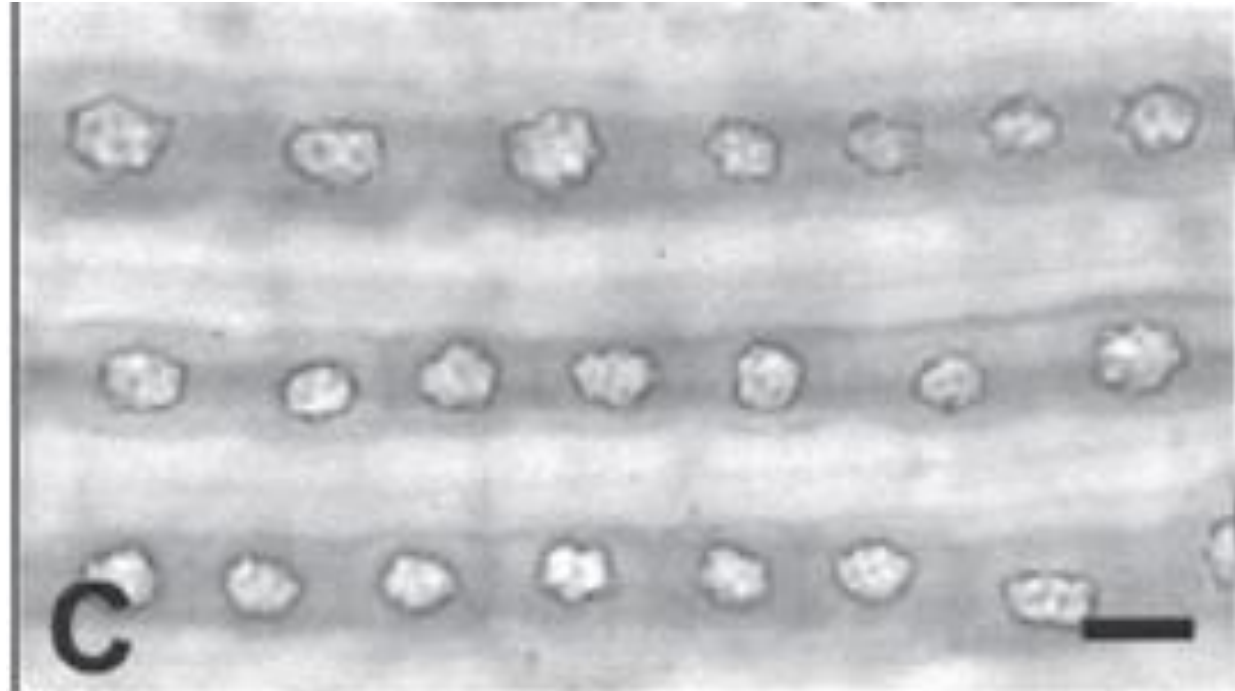


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Drymophloeus beguinii

## Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. C. *Drymophloeus beguinii* (Arecaceae), irregularly spherical bodies in vascular bundle-sheath cells (bar = 10  $\mu\text{m}$ ).

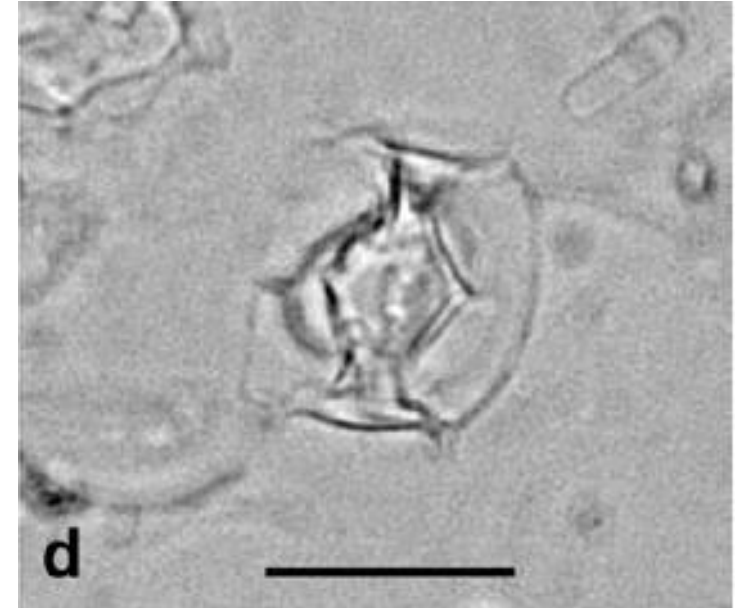
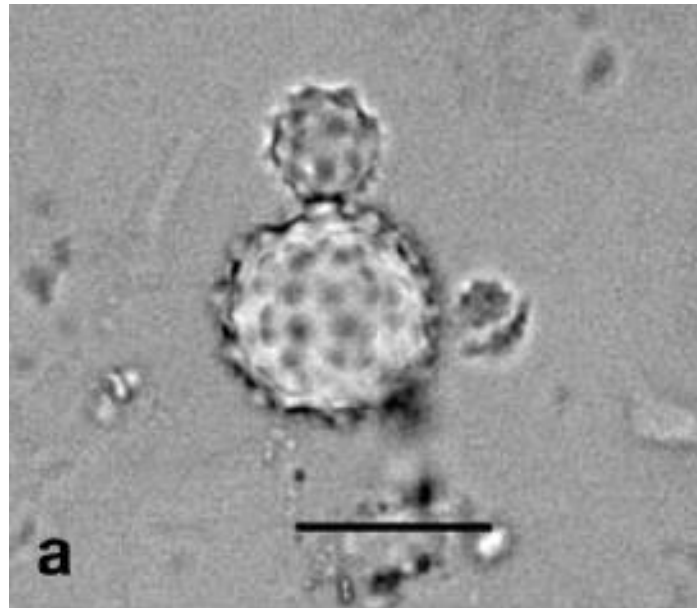


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Euterpe oleracea

## Phytolith

Fig. 3. Phytoliths from non-grass monocots. a) Globular echinate phytoliths from *Euterpe oleracea*, d) Stomata from *E. oleracea* leaf



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Euterpe precatoria

## Phytolith

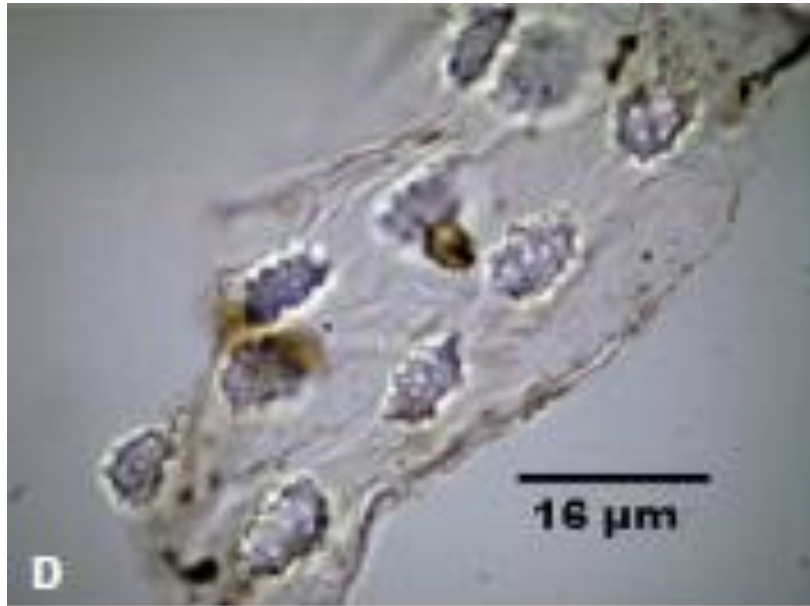


E. Silicified cells of *Euterpe precatoria*. ICN 0865.

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Geonoma atrovirens

## Phytolith



D. Silicified cells of *Geonoma atrovirens*. ICN 0320.

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Geonoma camana

## Phytolith



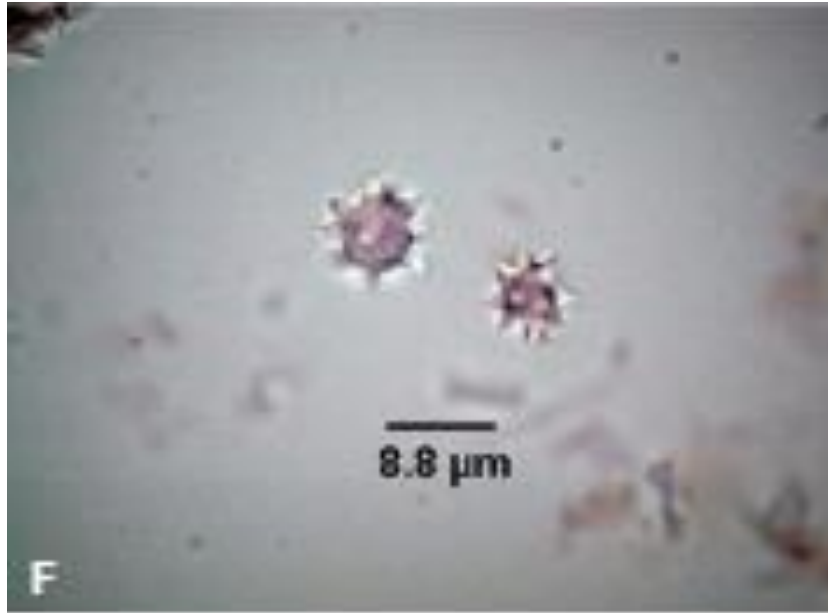
i. globular echinate symmetric (Geonoma camana. ICN 0323).

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.



# Geonoma orbignyana

## Phytolith



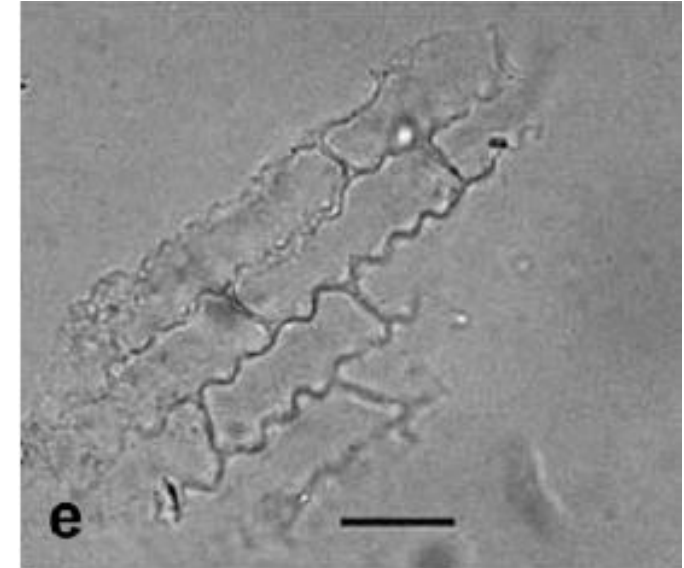
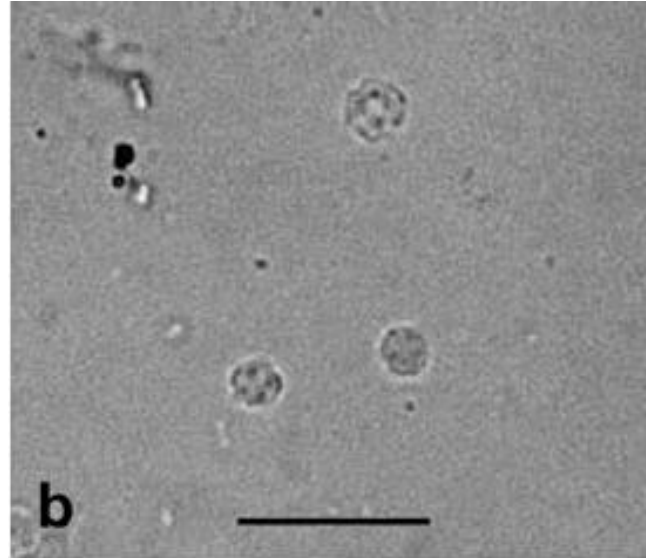
F. globular echinate with long acute projections (*Geonoma orbignyana*. ICN 0341).

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Mauritia flexuosa

## Phytolith

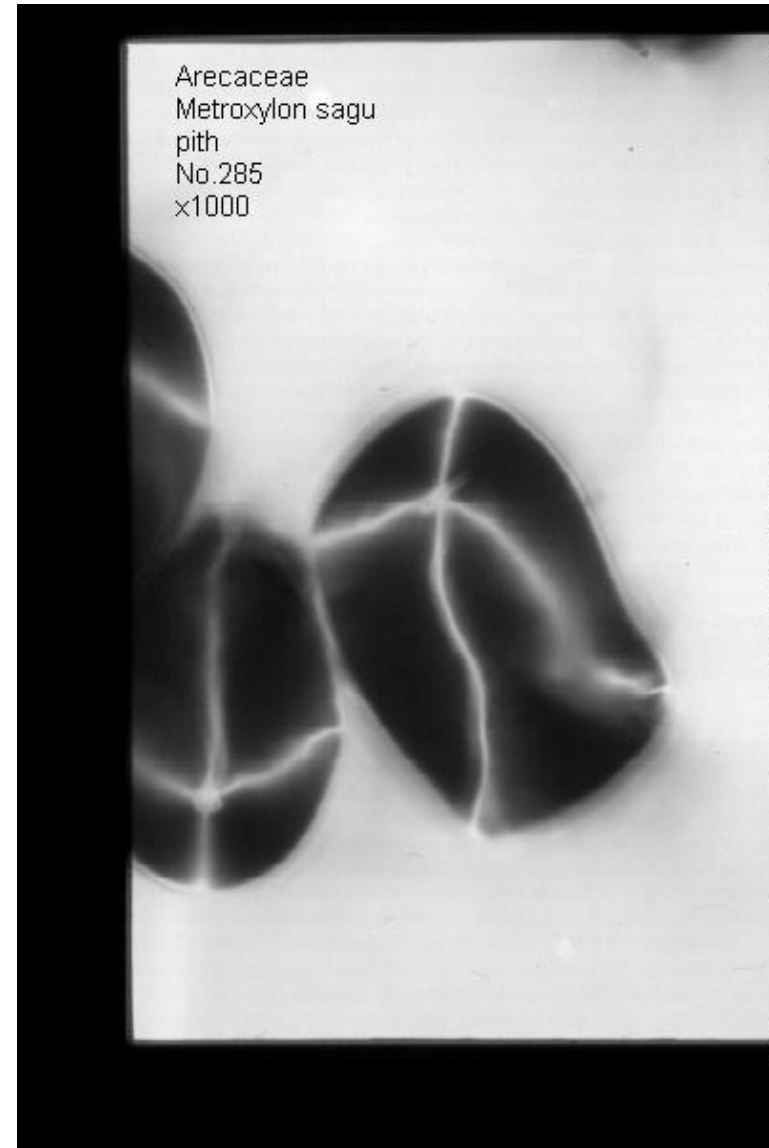
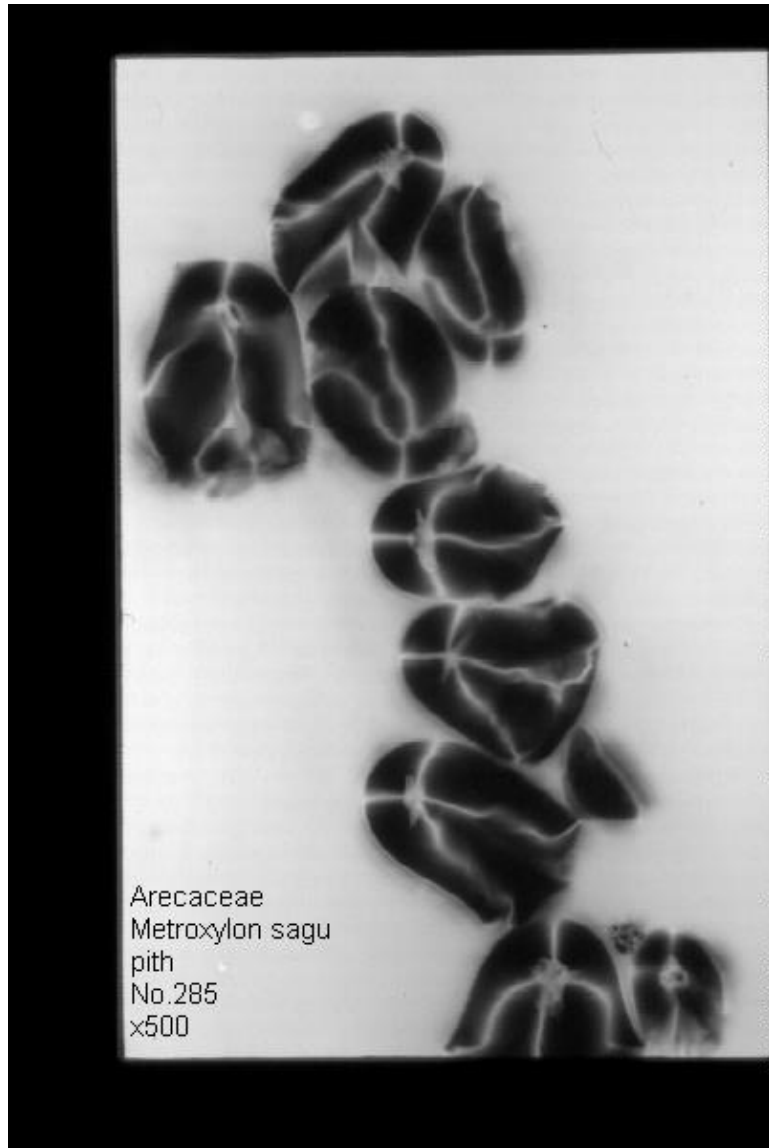
Fig. 3. Phytoliths from non-grass monocots. b) Globular echinate phytoliths from *Mauritia flexuosa*, e) Adaxial epidermis from *M. flexuosa* leaf



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

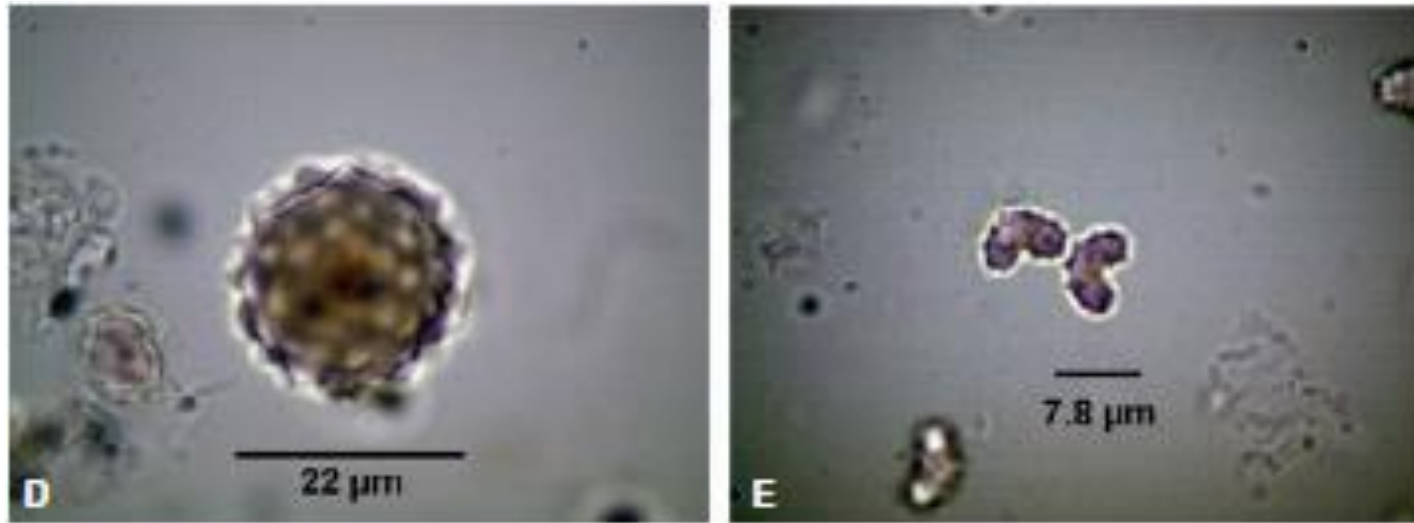
# Metroxylon sagu

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Oenocarpus bataua

## Phytolith



D. globular echinate with short acute projections (Oenocarpus bataua. ICN 0878).

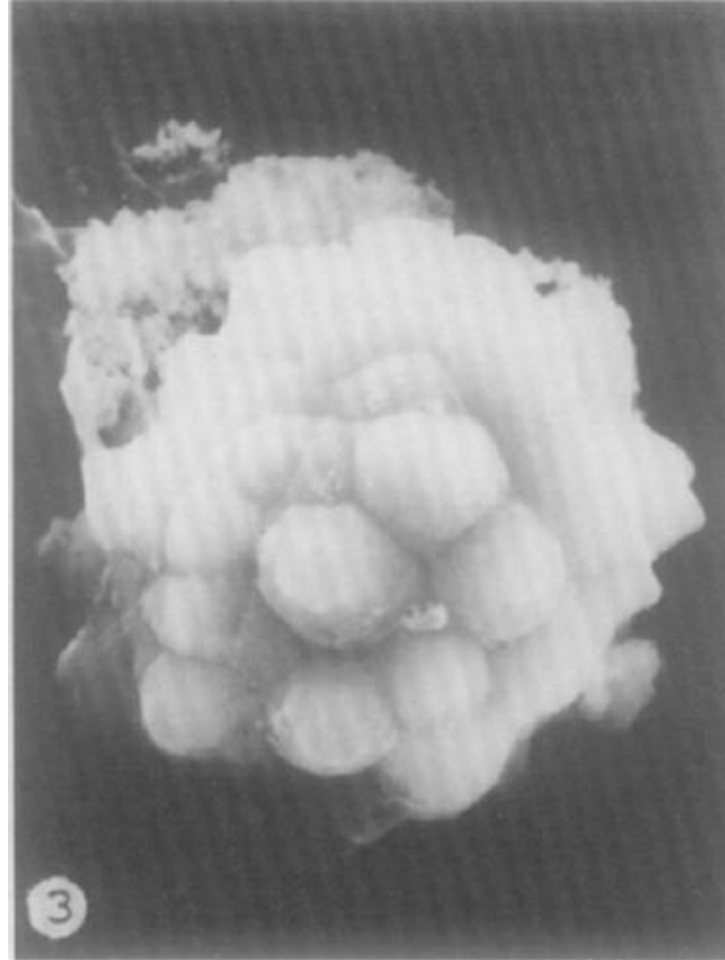
E. reniform echinate (Oenocarpus bataua. ICN 0878).

Morcote-Ríos, Gaspar, Rodrigo Bernal, and Lauren Raz. 2016. Phytoliths as a Tool for Archaeobotanical, Palaeobotanical and Palaeoecological Studies in Amazonian Palms. *Botanical Journal of the Linnean Society* 182:348–60.

# Sabal minor

## Phytolith

3. SEM photograph of a spherical, spinulose phytolith from *Sabal minor* (5000 x )

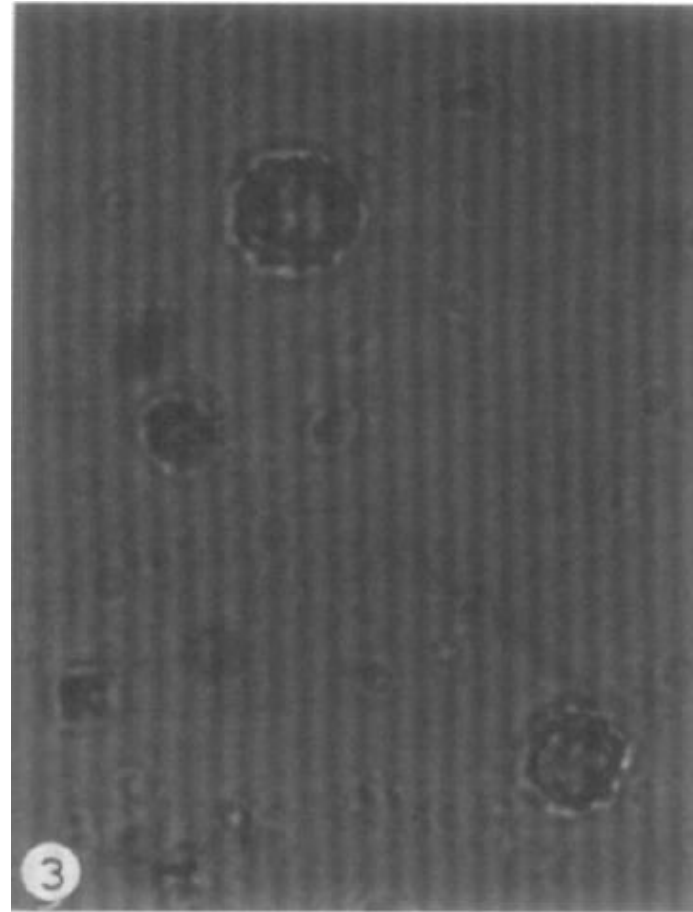


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Sabal minor

## Phytolith

3. Spherical, spinulose  
phytoliths from *Sabal minor*  
(650 x ).

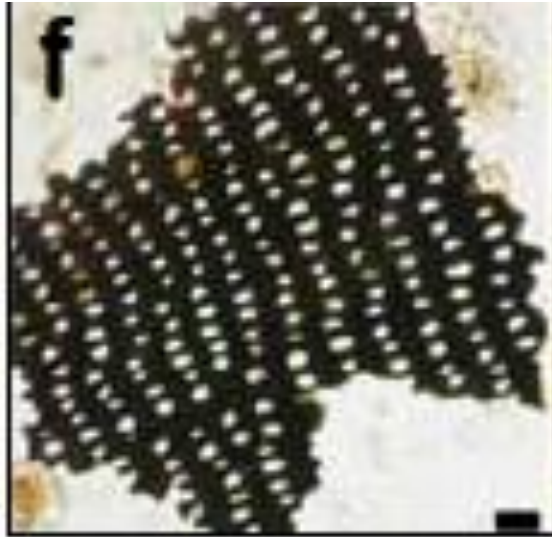


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

ASTERACEAE

# Asteraceae

## Phytolith



f. Opaque perforated platelet diagnostic of an Asteraceae inflorescence.

Abramiuk, Marc A., Peter S. Dunham, Linda Scott Cummings, Chad Yost, and Todd J. Pesek. 2011. Linking Past and Present: A Preliminary Paleoethnobotanical Study of Maya Nutritional and Medicinal Plant Use and Sustainable Cultivation in the Southern Maya Mountains, Belize. *Ethnobotany Research and Applications* 9:257–73.



# Asteraceae

## Phytolith

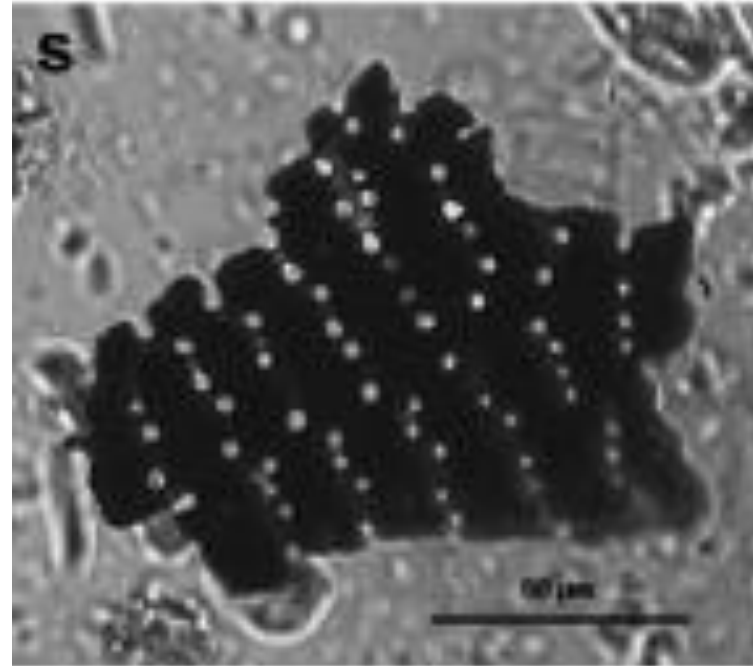


Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. s) Asteraceae opaque perforated platelets (GM Profile 4 0-10 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Asteraceae

## Phytolith

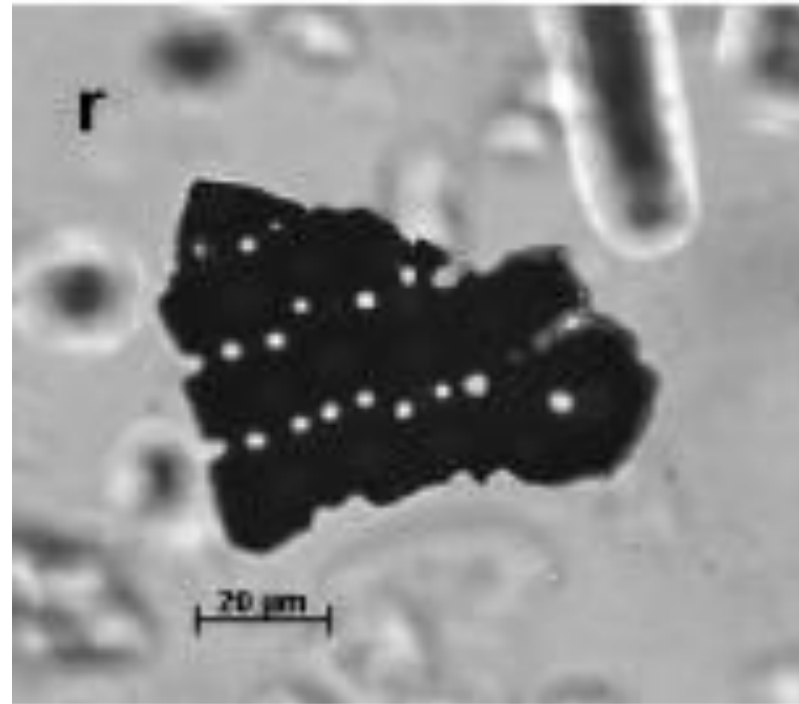


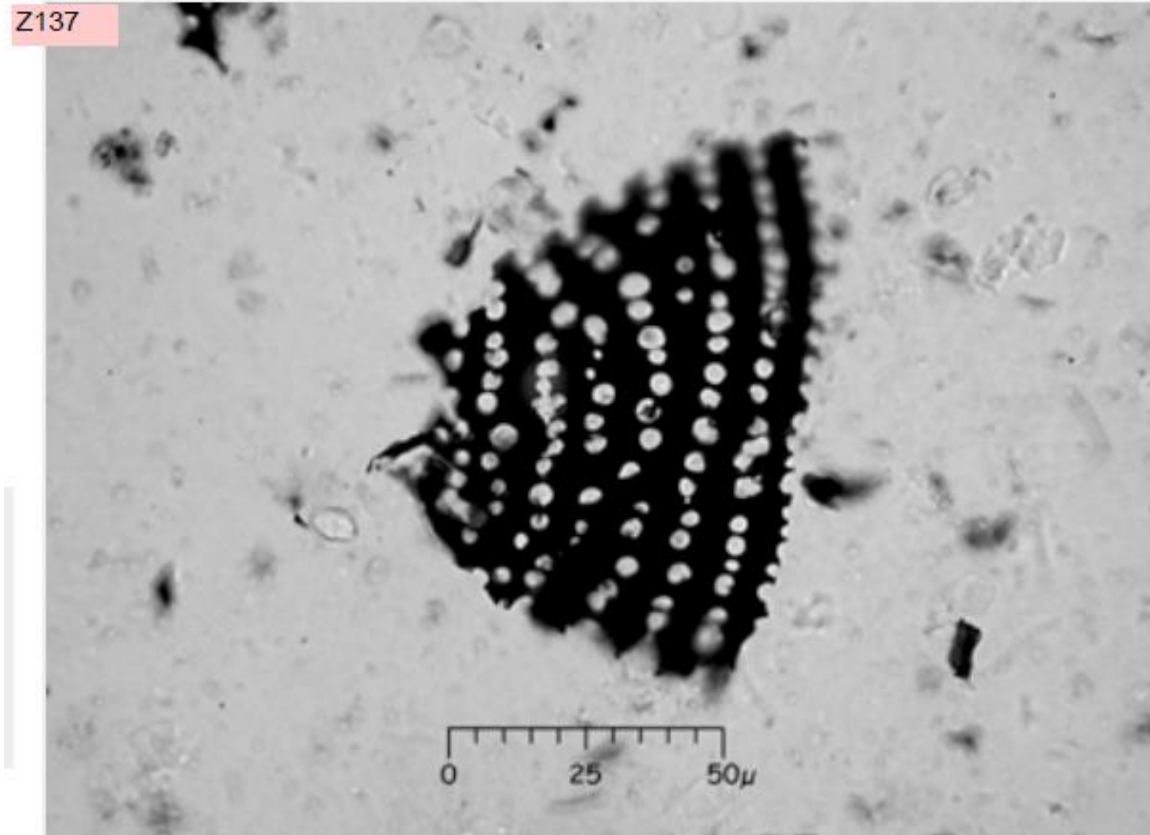
Fig. 5. Selected microbotanical remains. Phytoliths: r) Asteraceae opaque perforated plate (Sed. Sample 3)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Asteraceae

## Phytolith

Be sure sheet is occluded and flat. Three dimensional, irregularly surfaced sheets are another type. Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Bidens sp.

## Phytolith

4. A segmented hair with squarish segments and thick cell walls from *Bidens* (400 x ).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Calea urticifolia

## Phytolith

1. A segmented hair from *Calea urticifolia* with a spherical base and thick cell walls (250 × ).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Eclipta alba

## Phytolith

1. An armed segmented hair with an unarmed apex and base from *Eclipta alba*. The apex is not shown (400 X).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Elephantopus mollis

## Phytolith

4. Non-segmented threadlike hairs from *Elephantopus mollis*. They have small, circular bases (125 x).

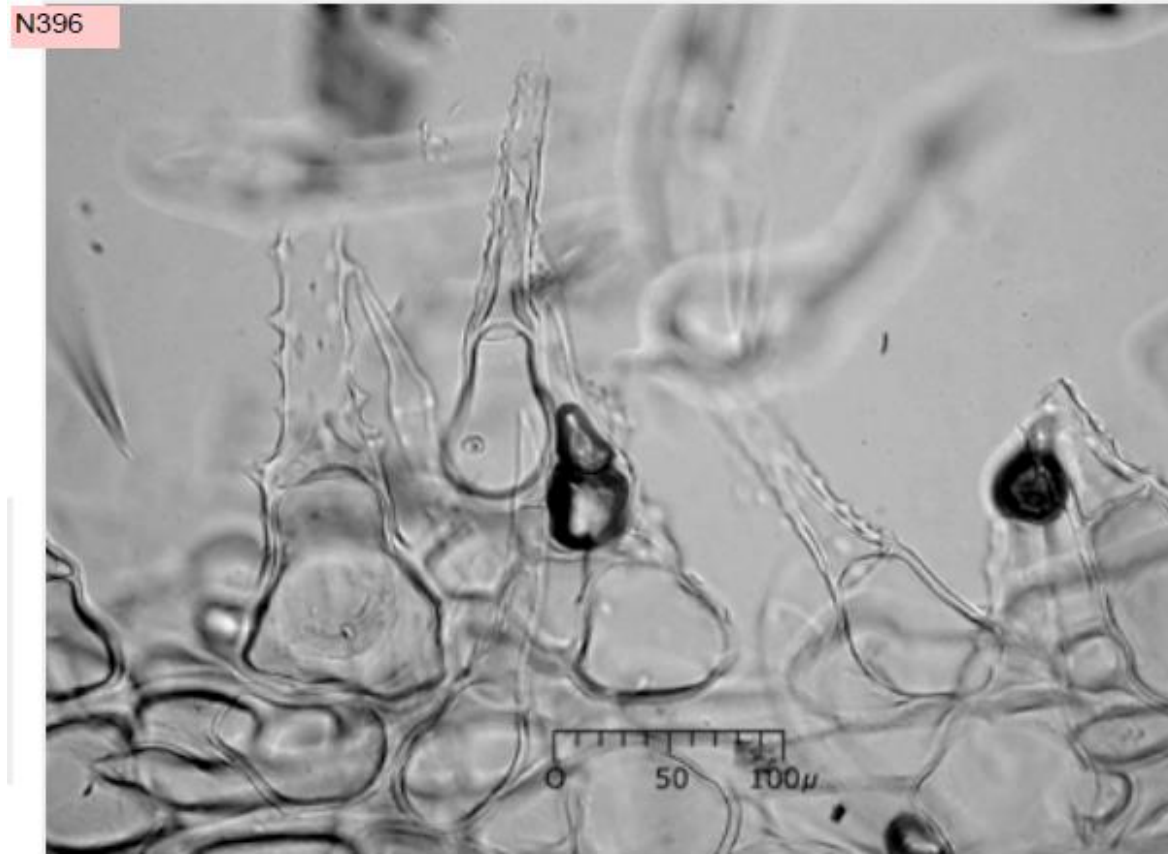


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Lipochaeta sp.

## Phytolith

Asteraceae hairs tend to be armed. Compare to 40IIIBa201 Cucurbitaceae/Asteraceae hair and 40IIIBa202 Croton fraseri (Euphorbiaceae) hair.  
Diagnostic level: family



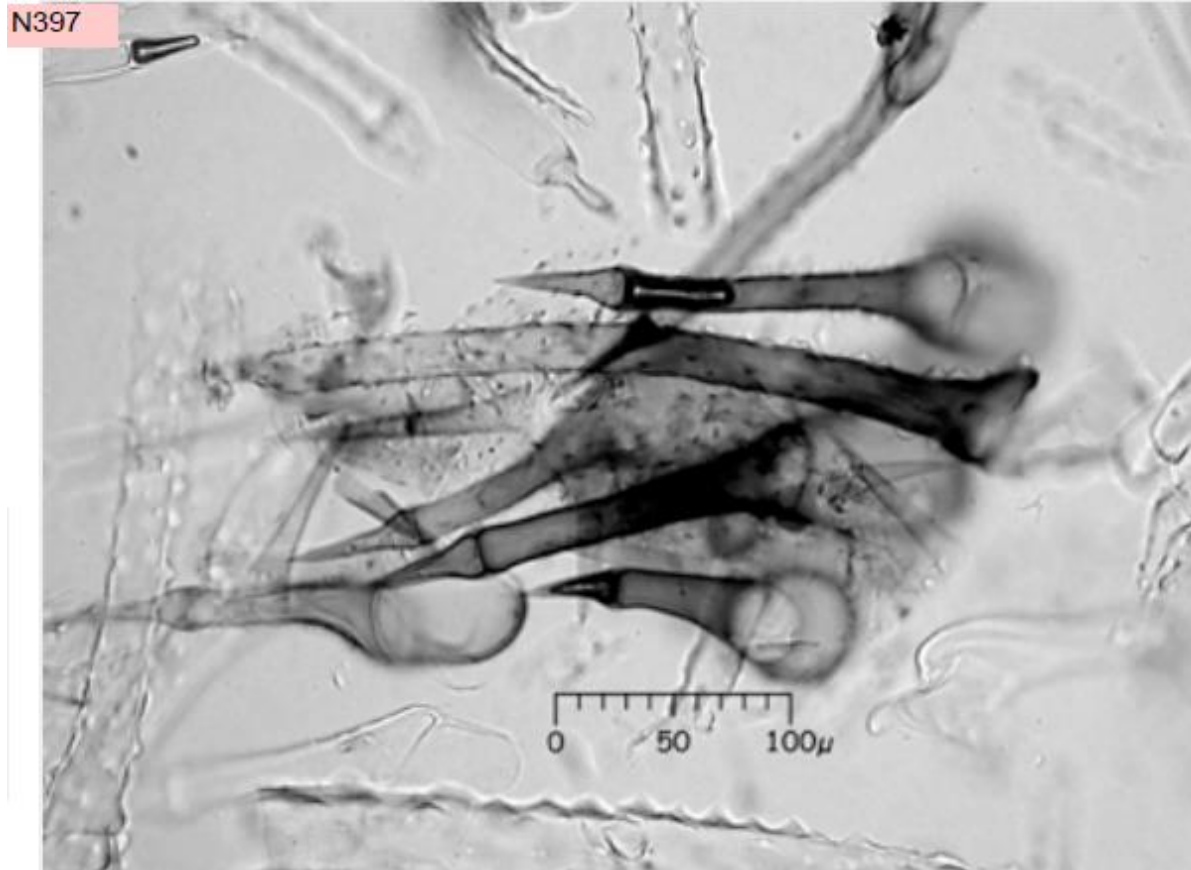
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Lipochaeta sp.

## Phytolith

Asteraceae hairs tend to be armed. Compare to 40III Ba201 Cucurbitaceae/Asteraceae hair and 40III Ba202 Croton fraseri (Euphorbiaceae) hair. May occur with some hairs segmented and unarmed: type 40III Ba201 (see lower right) Sometimes occluded as shown, or blackened.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lipochaeta sp.

## Phytolith

Be careful of confusion with other Asteraceae multicellular hair types such as armed hairs (40III Ba1) and 40III Ba202, *Croton fraseri* (Euphorbiaceae) hair. Diagnostic level: Asteraceae/Cucurbitaceae



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lipochaeta sp.

## Phytolith

Asteraceae hairs tend to be armed. Compare to 40III Ba201 Cucurbitaceae/Asteraceae hair and 40III Ba202 Croton fraseri (Euphorbiaceae) hair. Diagnostic level: family

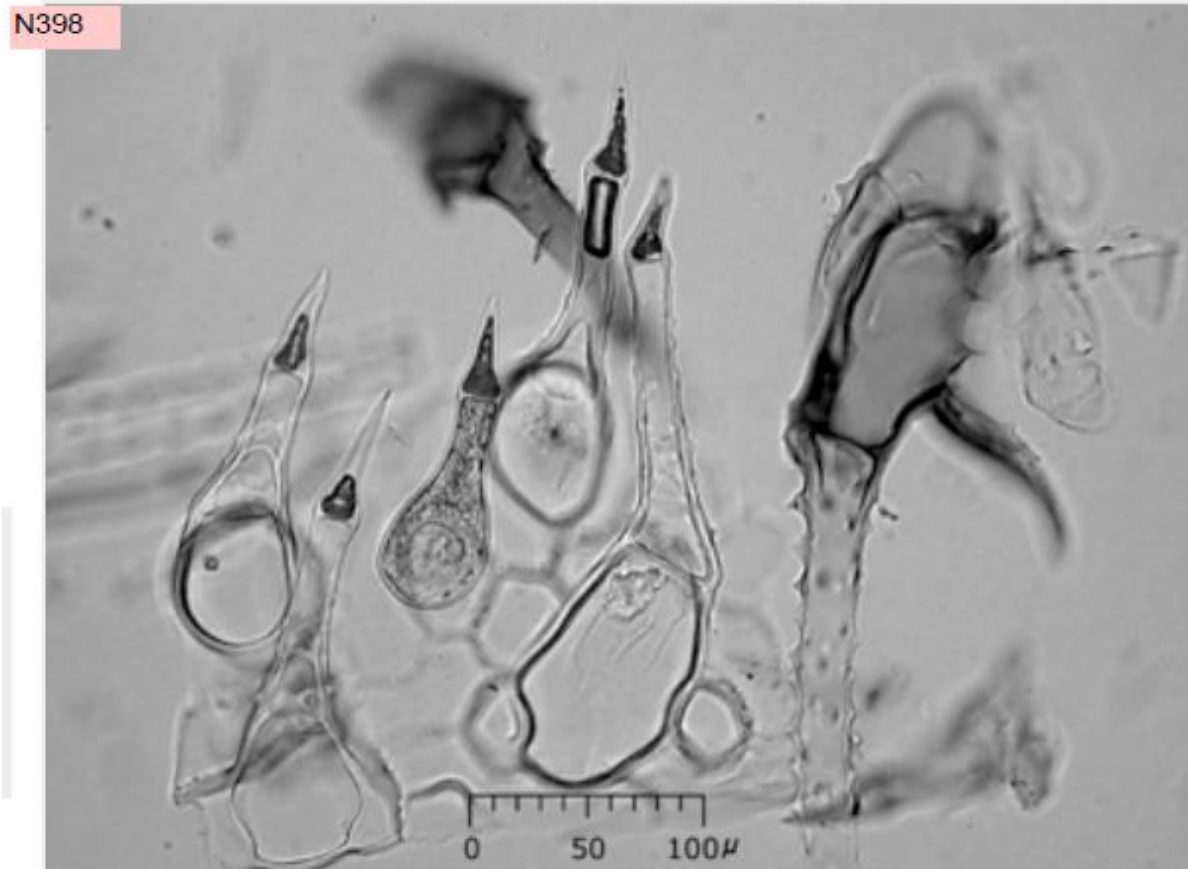


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lipochaeta sp.

## Phytolith

Asteraceae hairs tend to be armed. Compare to 40III Ba201 Cucurbitaceae/Asteraceae hair and 40III Ba202 Croton fraseri (Euphorbiaceae) hair. Diagnostic level: family

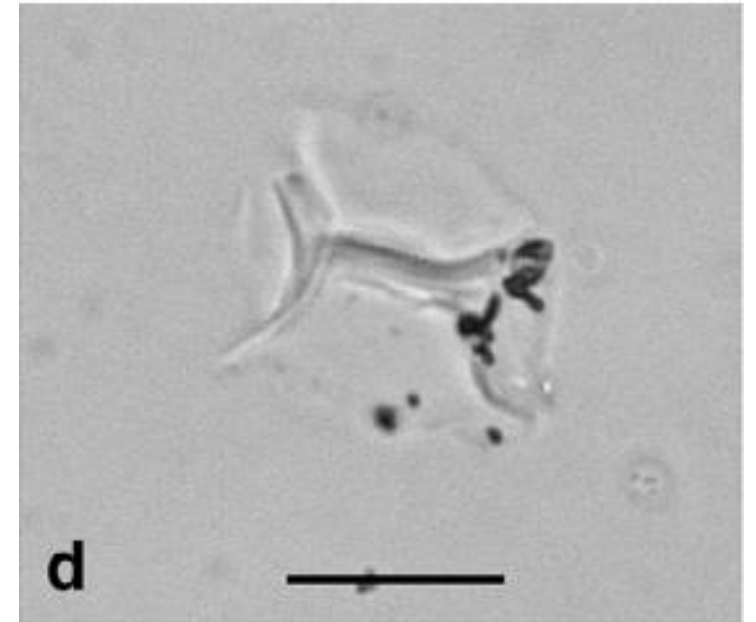
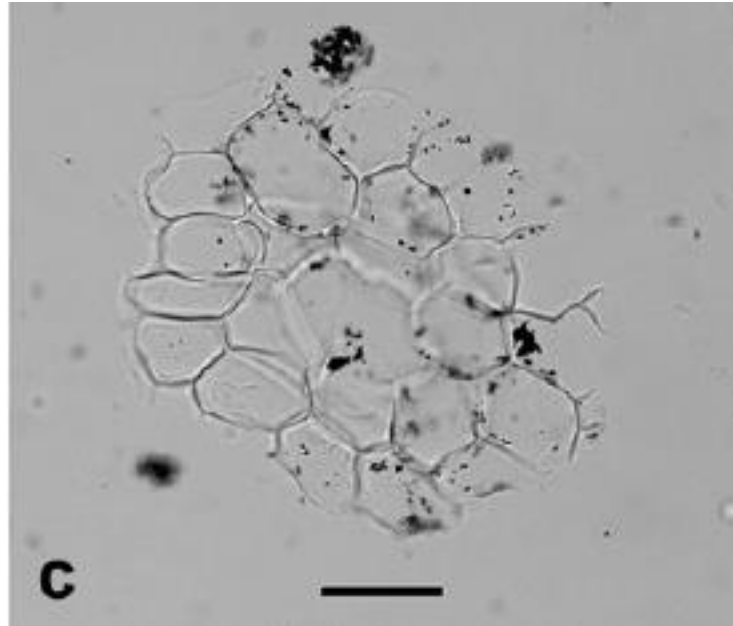


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Melampodium camphoratum

## Phytolith

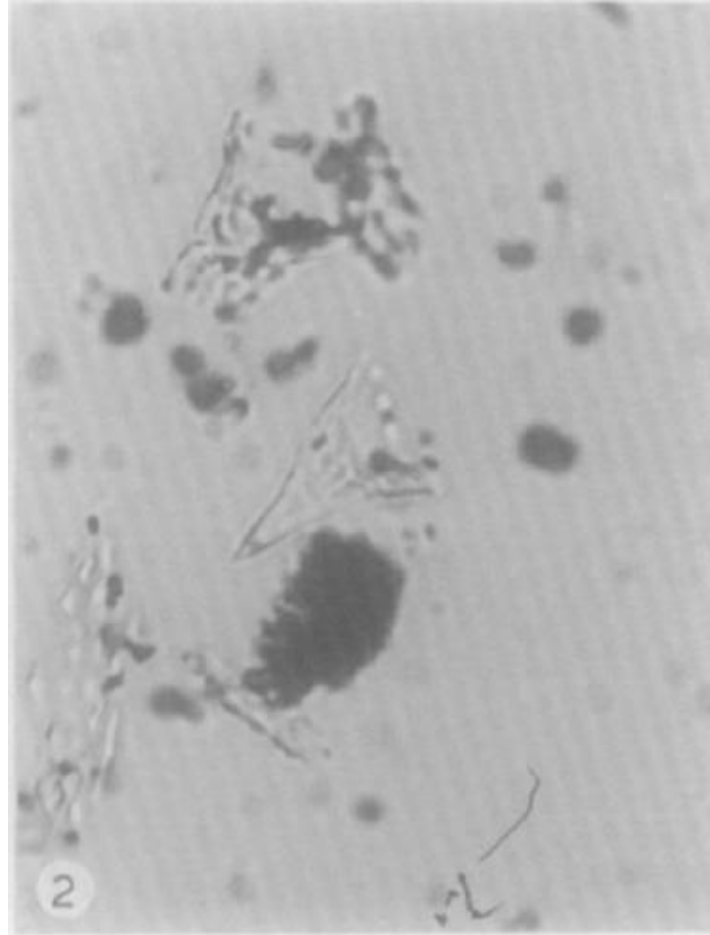
Fig. 5. Phytoliths from dicotyledons.  
c) Hairbase from *Melampodium camphoratum*, d) Blocky polyhedrals from *M. camphoratum*



# Melanthera hastata

## Phytolith

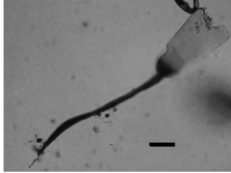
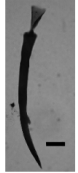

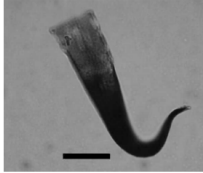

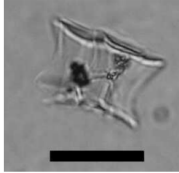
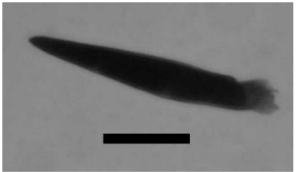
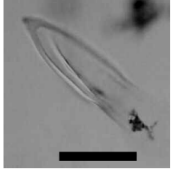

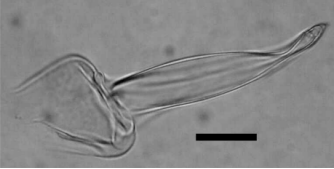
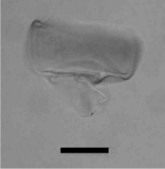
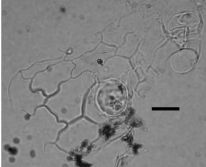
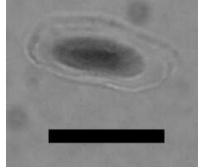
2. An armed segmented hair with an unarmed apex from *Melanthera hastata* (250 x).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Smallanthus sonchifolius

Asteraceae *Smallanthus sonchifolius* “yacón”

Phytolith assemblage characterization	
tuber	Non diagnostic twisted hairs. Segmented hairs, platelets and other (*).  stem No opal phytoliths (*).
leaf	<p>Diagnostic hairs (*):</p> <p>a) Acute opaque silica hair. Different terminal bases. Very common.</p>    <p>b) Unciform opaque silica hair. Not common.</p>  <p>c) Segmented translucent silica hairs. Not common.</p>  <p>d) Roundel concave in lateral margins. Rare.</p> 
flower	<p>Non diagnostic phytoliths (*):</p> <p>a) Acute opaque silica hair. Different terminal bases. Rare.</p>  <p>b) Acute translucent silica hairs. Rare.</p>  <p>c) Acute translucent silica hair. Different terminal bases. Not common.</p>    <p>d) Translucent stoma and epidermal silica cells. Rare.</p>  

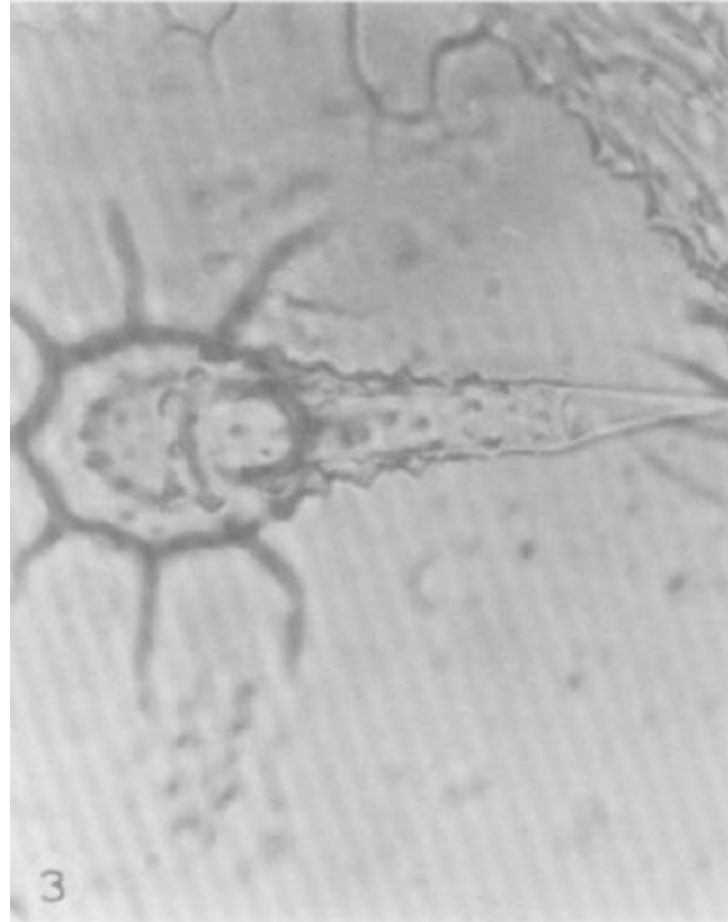
Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Wulffia baccata

## Phytolith

3. An armed segmented hair with an unarmed apex from *Wulffia baccata* (400 x). It is attached to the hair base.



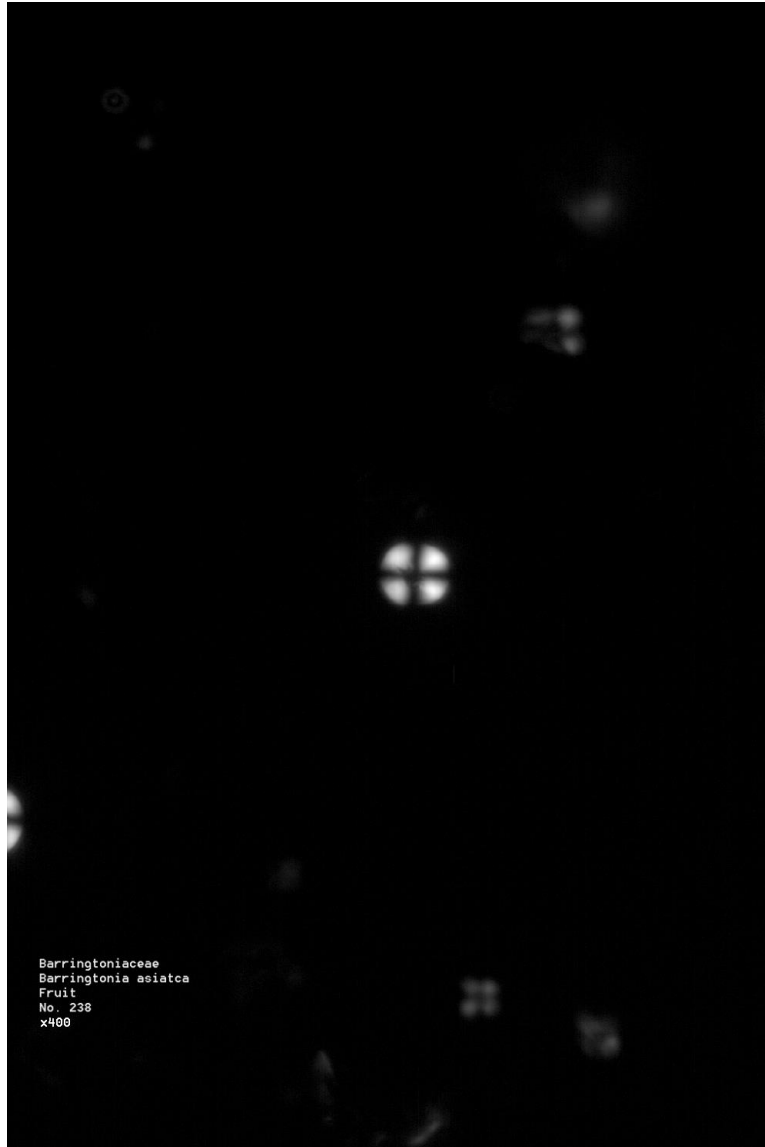
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.



BARRINGTONIACEAE

# Barringtonia asiatica

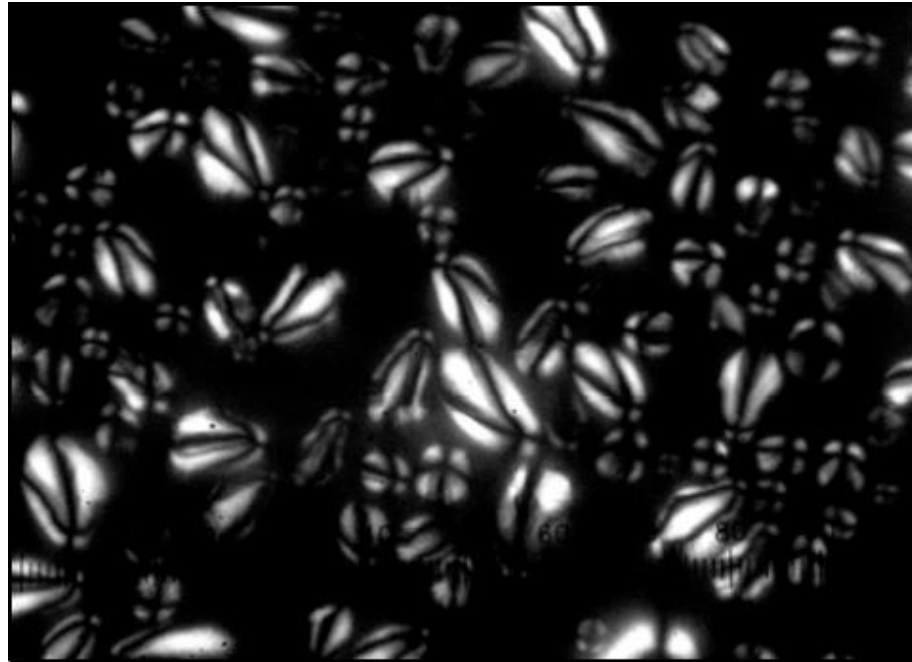
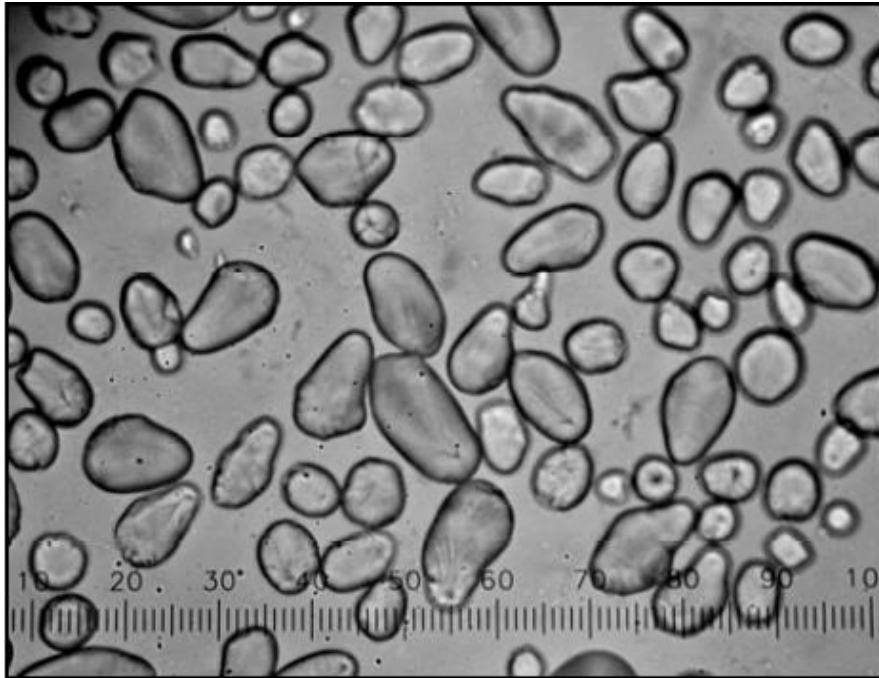
Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



BASELLACEAE

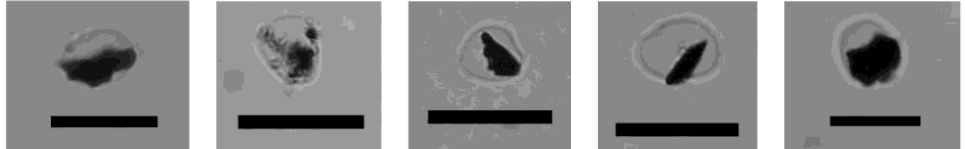
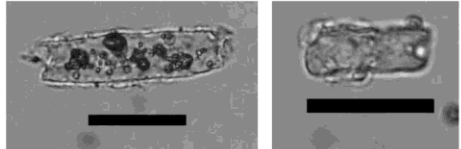
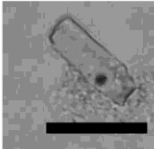
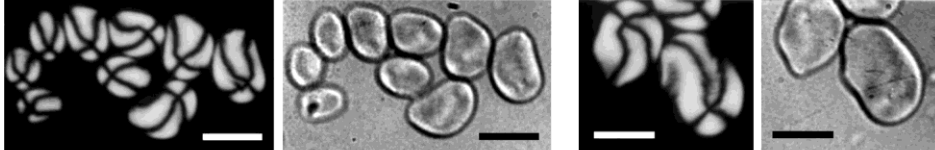
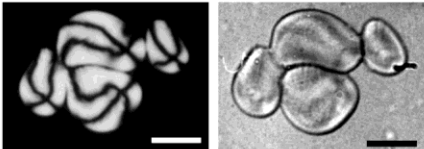
# Anredera vesicaria

## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Ullucus tuberosus

Basellaceae <i>Ullucus tuberosus</i> "ulluco"	
<b>Phytolith assemblage characterization</b>	
leaf	<p>Diagnostic phytoliths (*):</p> <p>a) Round to sub-round silica phytoliths with charcoal spots. Common.</p> 
tuber	<p>Non diagnostic phytoliths (*):</p> <p>a) Rectangular irregularly cavate silica phytolith. Rare.</p>  <p>b) Rectangular psilate silica phytolith. Rare.</p>  <p>c) Sub-spherical irregularly cavate silica phytolith. Rare.</p>
<b>Starch assemblage characterization</b>	
tuber	<p>a) Single grains, globular or subglobular; less than 7µm.</p> <p>b) Single grains, generally asymmetrical, variable in shape, irregular, prismatic, oval, pear-, bow- and bell-shaped, sometimes with one or more rounded projections and/or truncations in different parts; from 10µm to 30µm long length; highly eccentric distinct hilum as a circle or line; very distinct lamella; radiating lines from the hilum to the border of the grain; distinct eccentric cross to the rounded end, with sinuous, non-well definite dark arms intersecting at one point, fibrous appearance. May occur in aggregates.</p>  <p>c) Compound grains compounded by two-five granula. Granula generally unequal, with at less a symmetry axis.</p> 
<p><b>References:</b> Partially based on Cortella and Pochettino 1995.</p>	

Scale bar = 20µm.

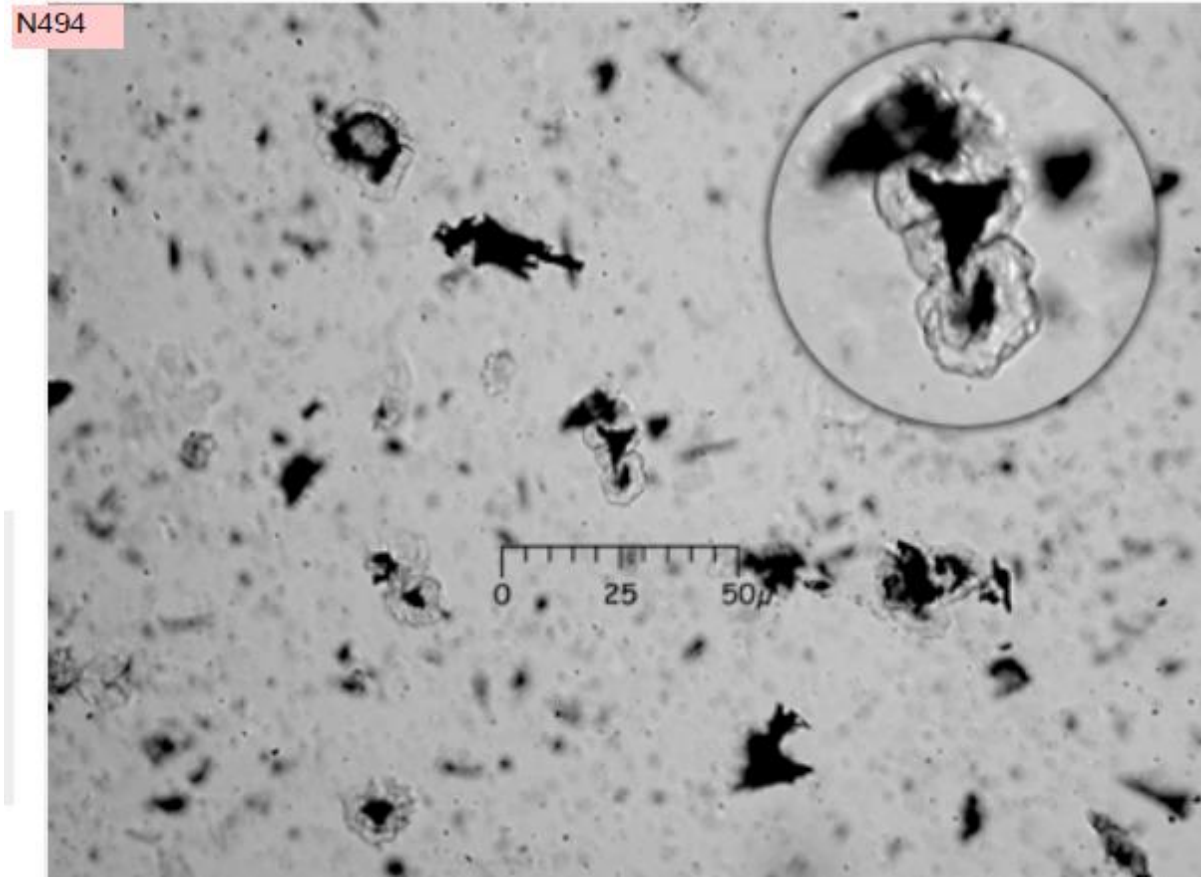
Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

BATACEAE

# Batis maritima

## Phytolith

Unknown origin in tissue.  
Perhaps a cystolith with occluded  
fragments in interior.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

BIGNONIACEAE

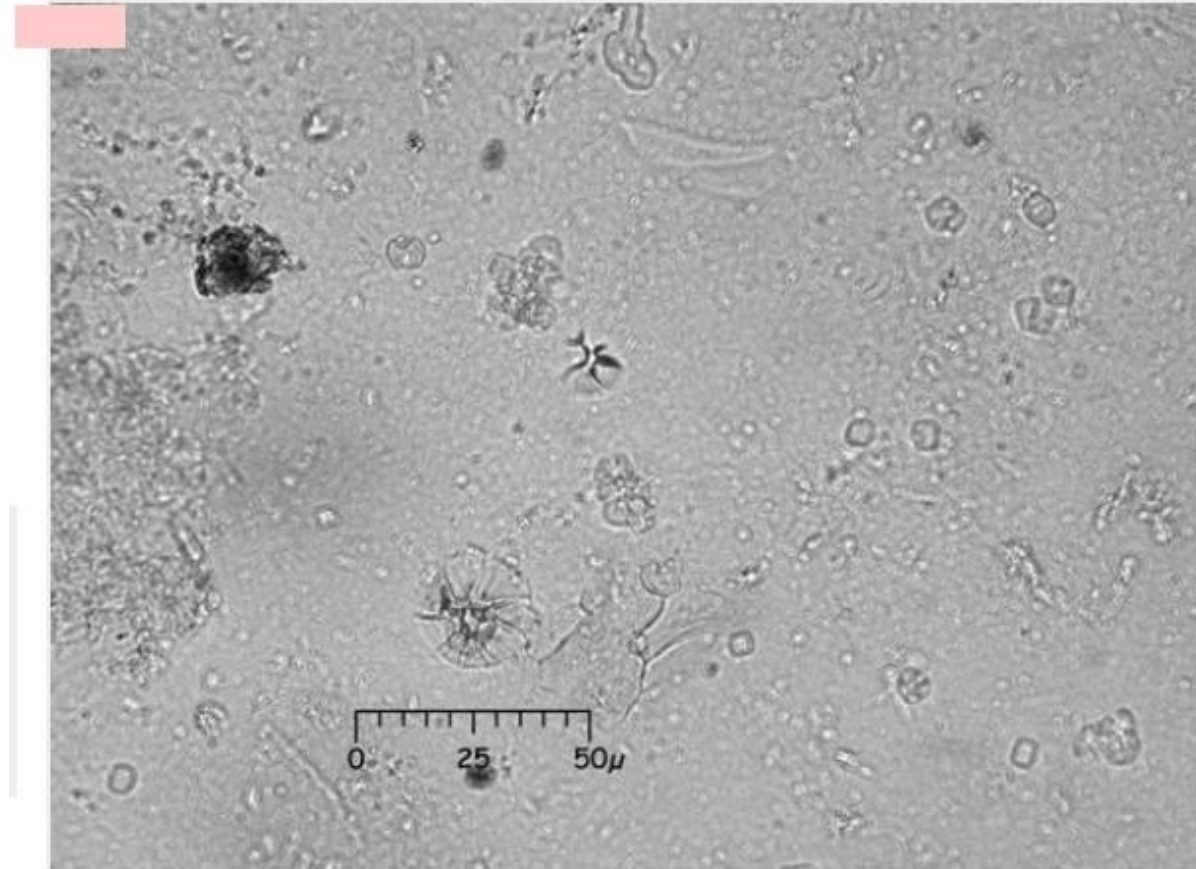


# Tecoma gandichiandi

## Phytolith

Slide E101.

Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

BIXACEAE

# Bixa orellana

Bixaceae *Bixa orellana* "urucú or achiote"

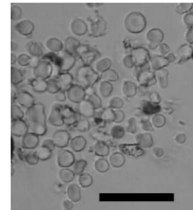
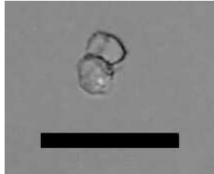
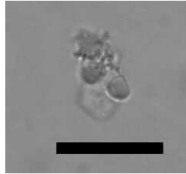
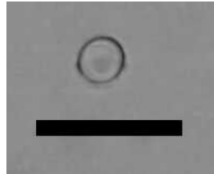
## Phytolith assemblage characterization

Diagnostic phytoliths (\*):

a) Round to sub-round planar psilate silica phytolith. Very common.

Assemblage view.

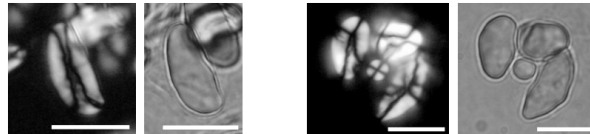
seed



**References:** Reported as not present in Piperno 1988:35 (it does not say which part of the plant was sampled).

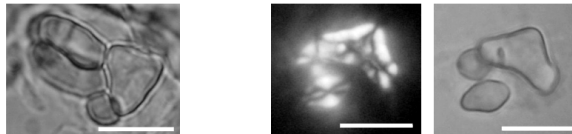
## Starch assemblage characterization

a) Single grains, oval, subspherical, ellipsoidal, sausage-, and pear-shaped, sometimes with one or two truncations and a well rounded opposite end; variable in size from 5µm to 37µm long length; sometimes distinct hilum; not visible lamella; mainly centric, but also eccentric cross, with four arms visible, intersecting at the center or meeting two by two.



seed

b) Commonly compound grains, generally boomerang-shaped but also oval, without an external unique packing, compounded by two granula. Granula, variable in size and shape, typically bell-, bowl-shaped, and subquadrangular oblique, with a wavy or concave truncation at broader end; from 15µm to 37µm long length; distinct eccentric cross. Some compound grains, compounded by two sausage-shaped granula. Aggregates.

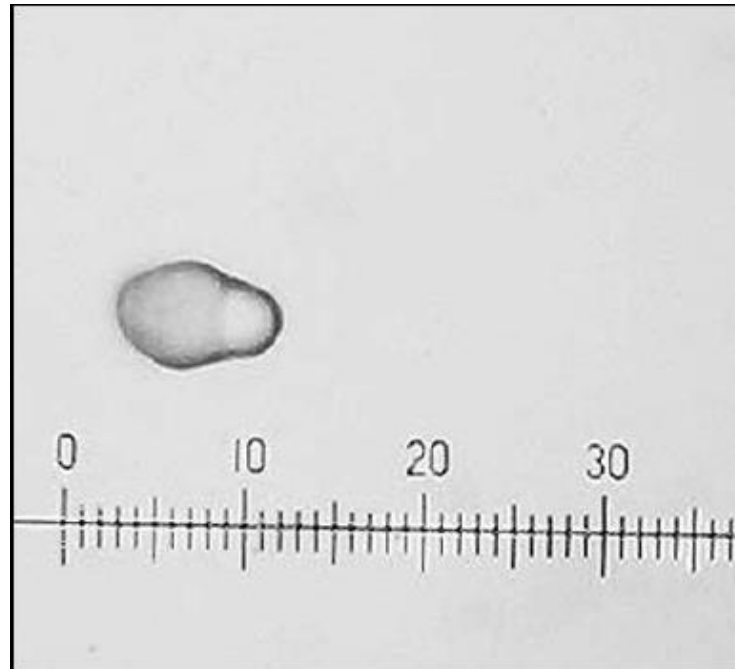
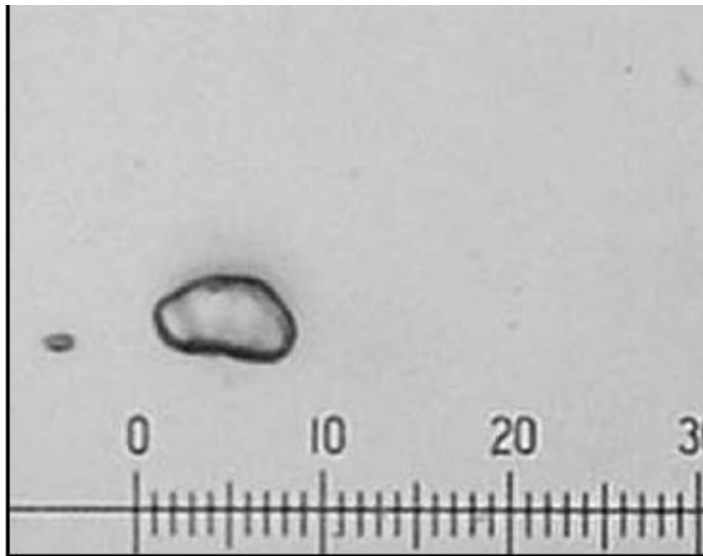


Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Bixa orellana

## Starch

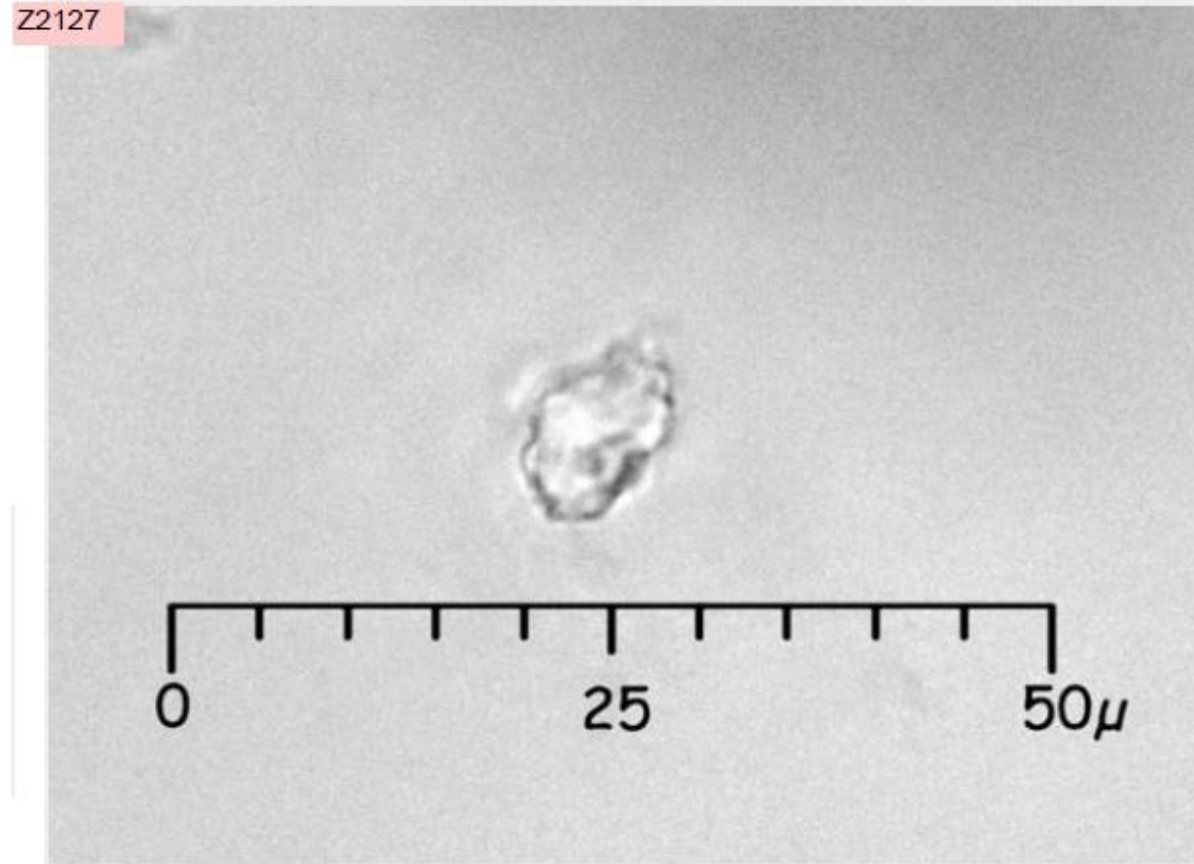


Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Bixa orellana

## Phytolith

Diagnostic level under investigation. Observed in *Bixa orellana* (PC1691).

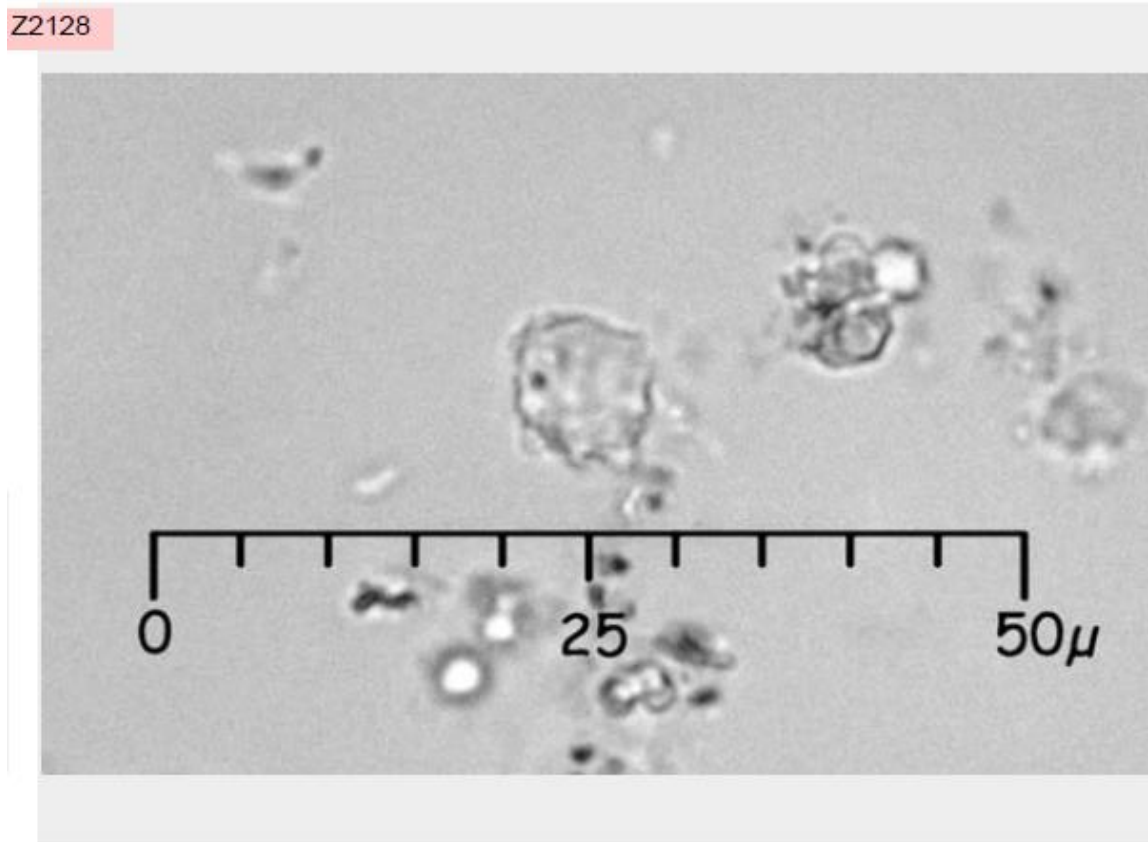


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Bixa orellana

## Phytolith

Diagnostic level under investigation. Observed in *Bixa orellana* (PC1691)



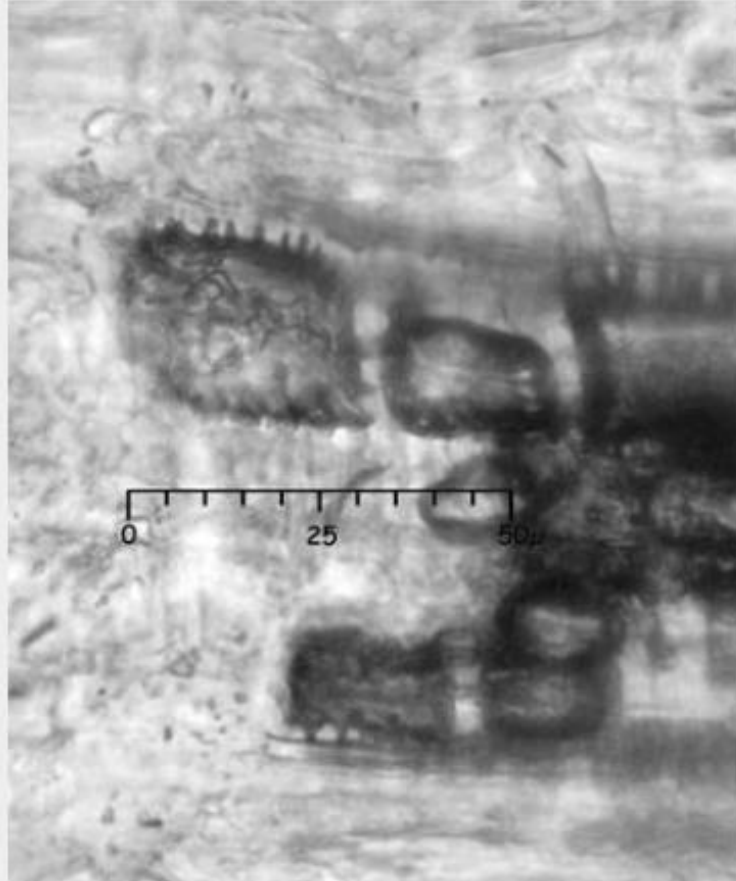
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Bixa orellana

## Phytolith

Projections are not speculate,  
ie, not 22VIII.  
Not diagnostic

Z2139

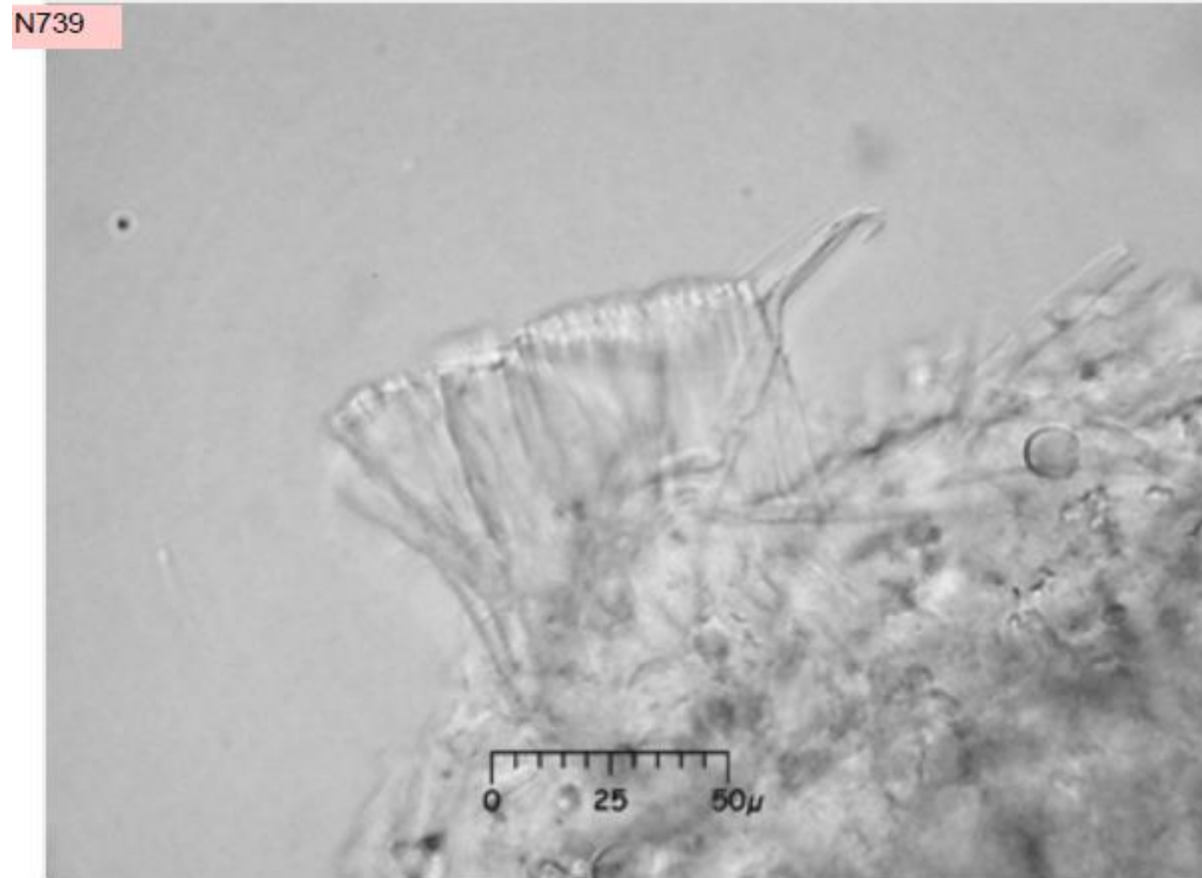


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Bixa orellana

## Phytolith

Type established by Karol  
Chandler- Ezell, 2004  
Diagnostic level: fruit/seed



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

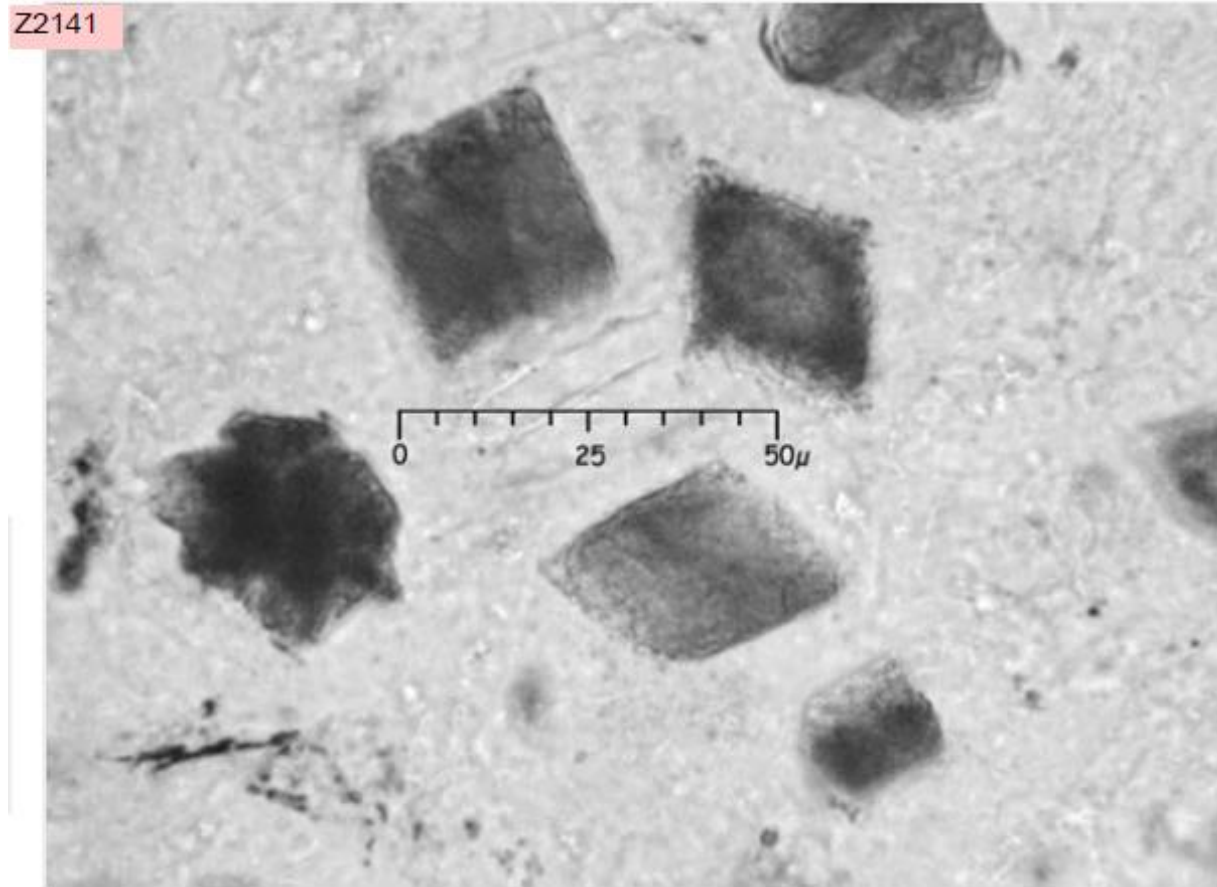


BOMBACACEAE

# Ceiba sp.

## Phytolith

PC2866, wood specimen  
Diagnostic level: under study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Huberodendron patinoi

## Phytolith

See top view (Record #155) of  
this body .  
Not diagnostic

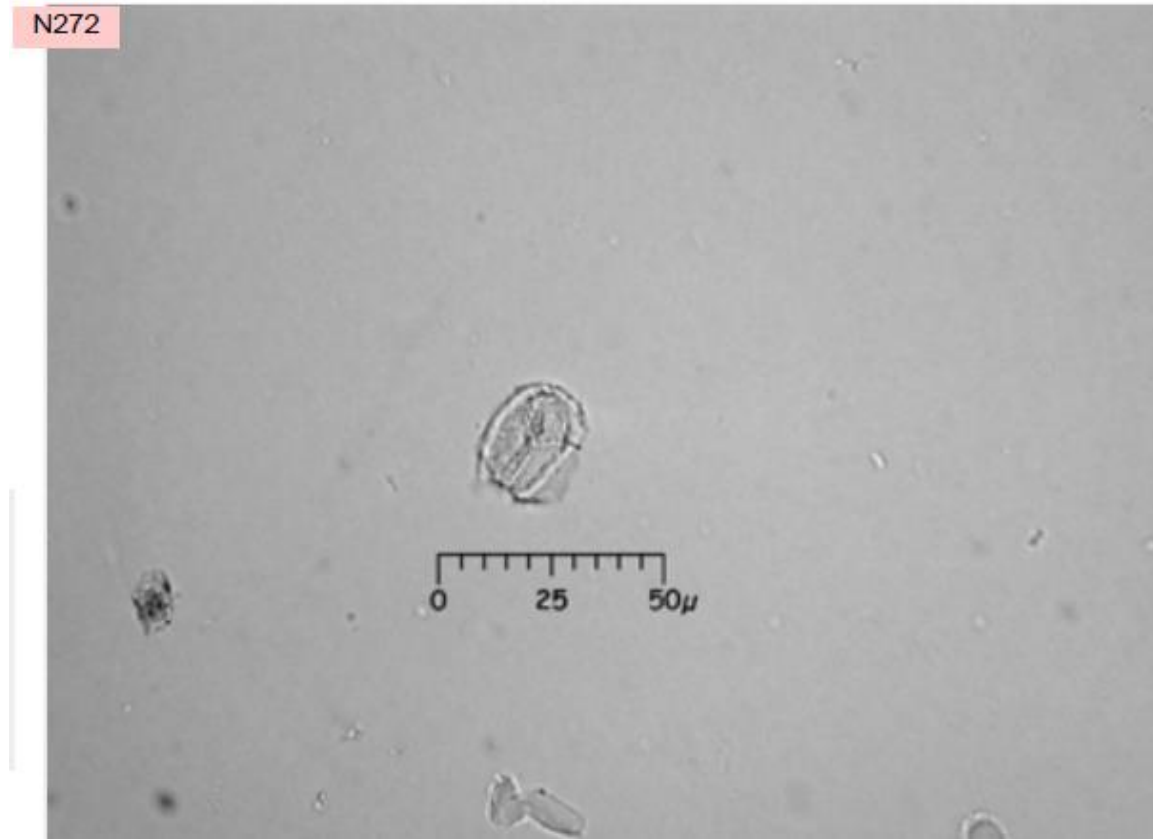


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Huberodendron patinoi

## Phytolith

See side view (Record #154) of  
this body.  
Not diagnostic



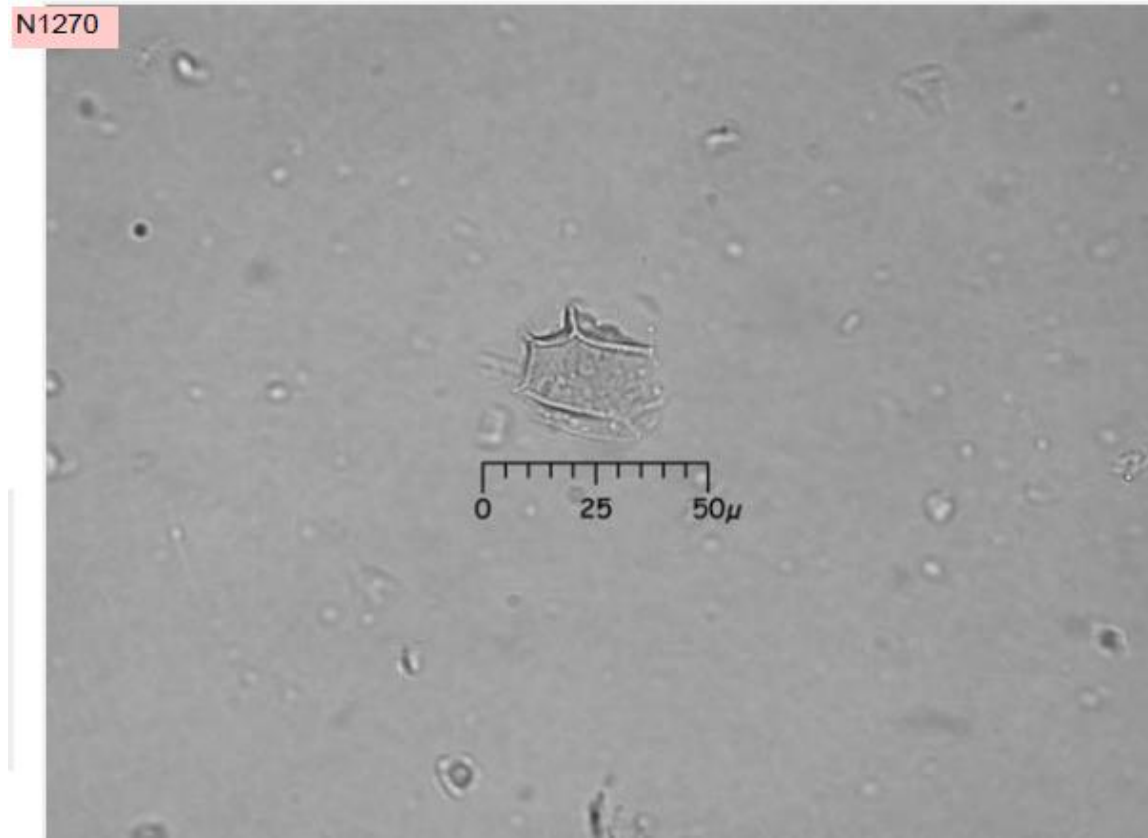
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Huberodendron patinoi

## Phytolith

Slide 1372a.

Diagnostic level: genus



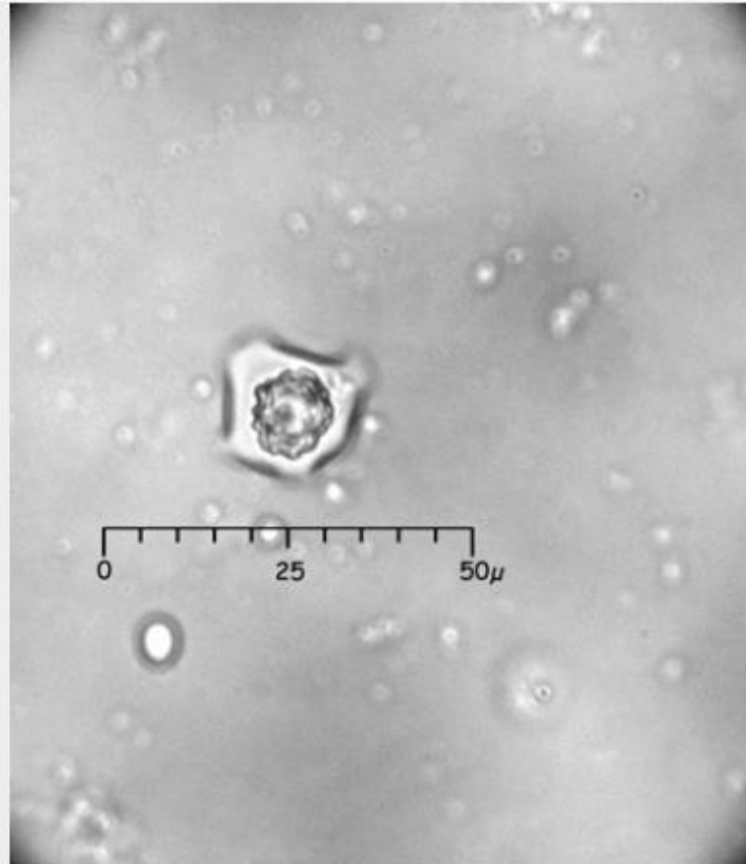
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maltisia cf. alata

## Phytolith

Nodular spheres occur in moderate levels in Maltisia cf. alata. Size range: 8 -22 microns. Overlaps with Marantaceae nodular spheres. Marantaceae/Bombacaceae mixed type

Z4270

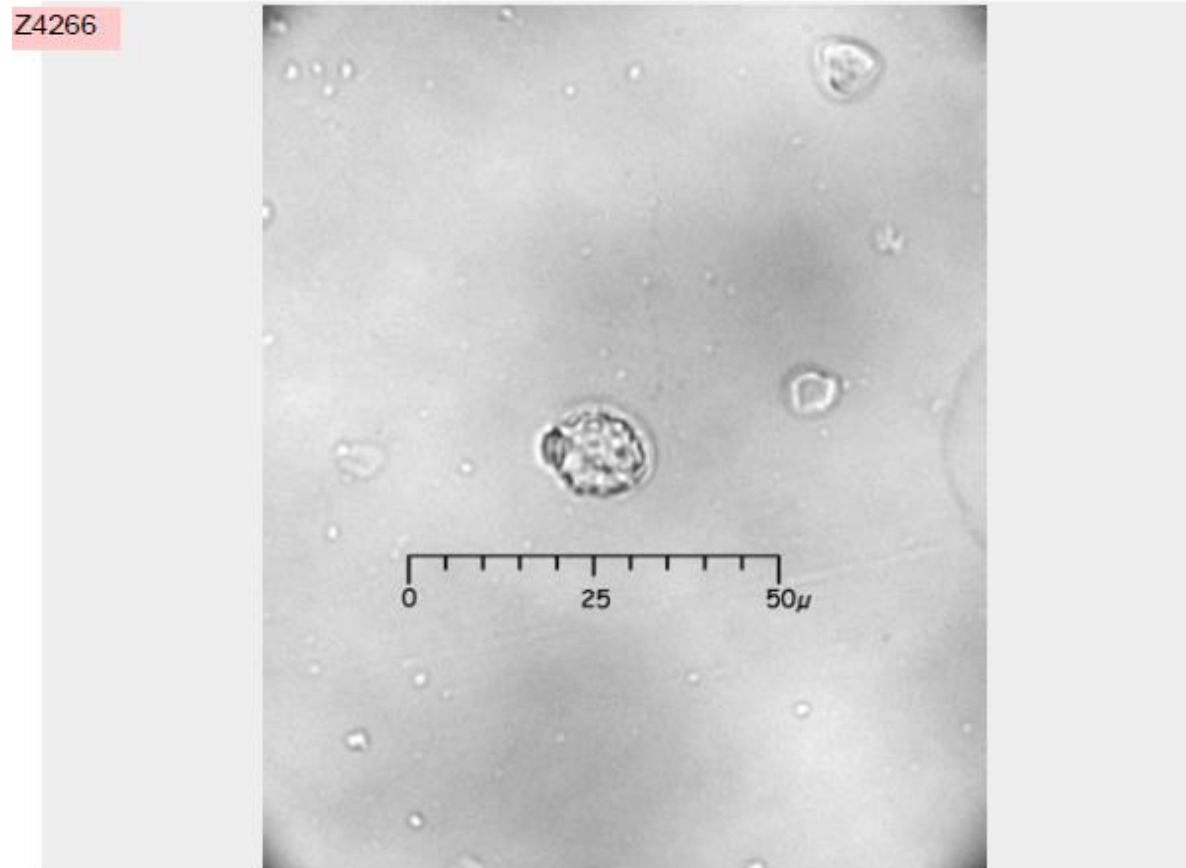


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maltisia cf. alata

## Phytolith

Nodular spheres occur in moderate levels in Maltisia cf. alata. Size range: 8 -22 microns. Overlaps with Marantaceae nodular spheres. Marantaceae/Bombacaceae mixed type

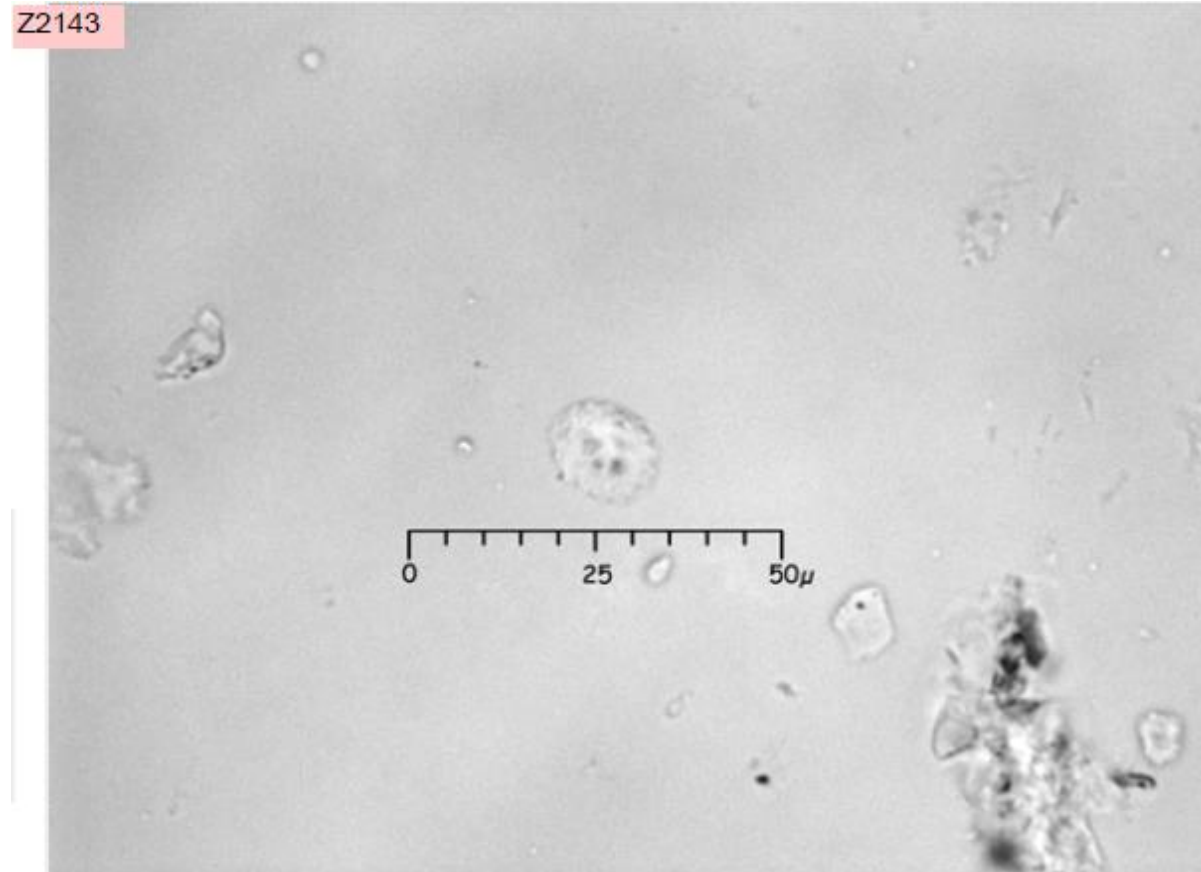


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maltisia cordata

## Phytolith

80IIIB has been considered is a Marantaceae family diagnostic. Occurs rarely in PC2127, Maltisia cordata, Bombacaceae. Marantaceae/Bombacaceae mixed type



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

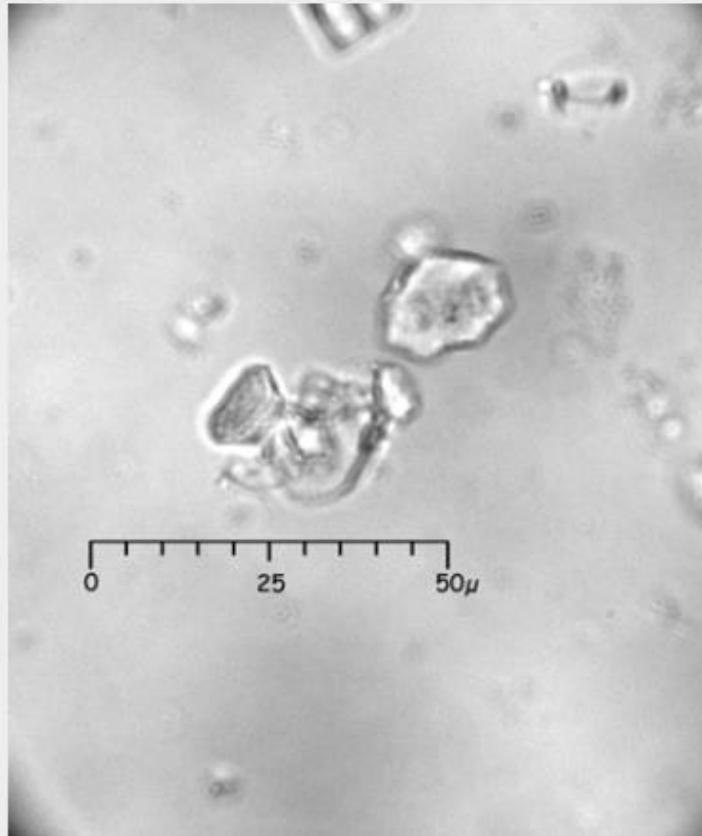


# Maltisia cordata

## Phytolith

80IIIB has been considered is a Marantaceae family diagnostic. Occurs rarely in PC2127, Maltisia cordata, Bombacaceae. This image shows the rugulose bottom. Marantaceae/Cannaceae/Bombacaceae mixed type

Z2143



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maltisia longipes

## Phytolith

Stomate.

Diagnostic level: family

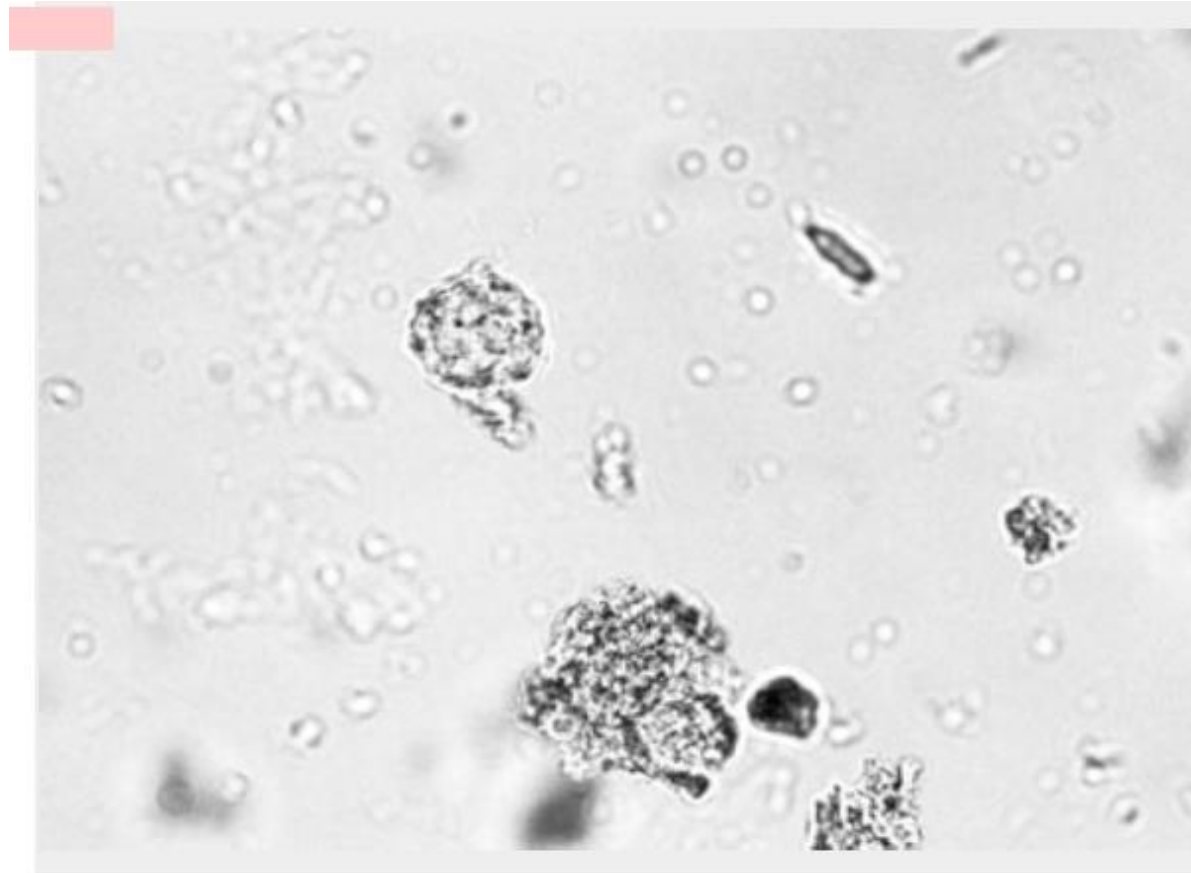


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maltisia longipes

## Phytolith

Cystolith with stalk  
Diagnostic level: generalized  
arboreal indicator



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maltisia longipes

## Phytolith

Note flat tip of hair. Occur rarely.  
Slide 1366.  
Diagnostic level: species



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maltisia longipes

## Phytolith

Slide 1366 leaf.

Diagnostic level: species

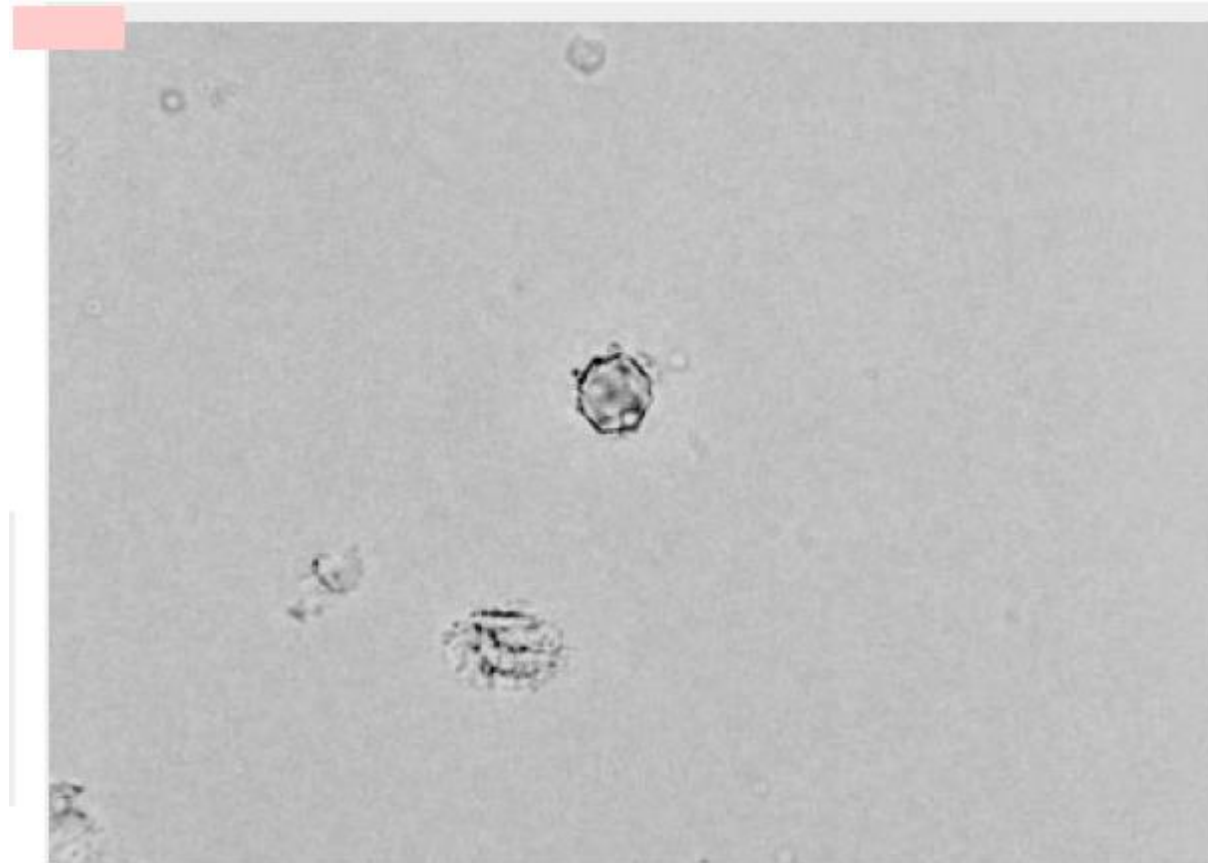


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Ochroma pyramidalis

## Phytolith

Category currently overlaps with  
Marantaceae nodular spheres.  
Diagnostic level:  
Marantaceae/Bombacaceae



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Ochroma pyramidalis

## Phytolith

Category currently overlaps with  
Marantaceae nodular spheres.  
Diagnostic level:  
Marantaceae/Bombacaceae



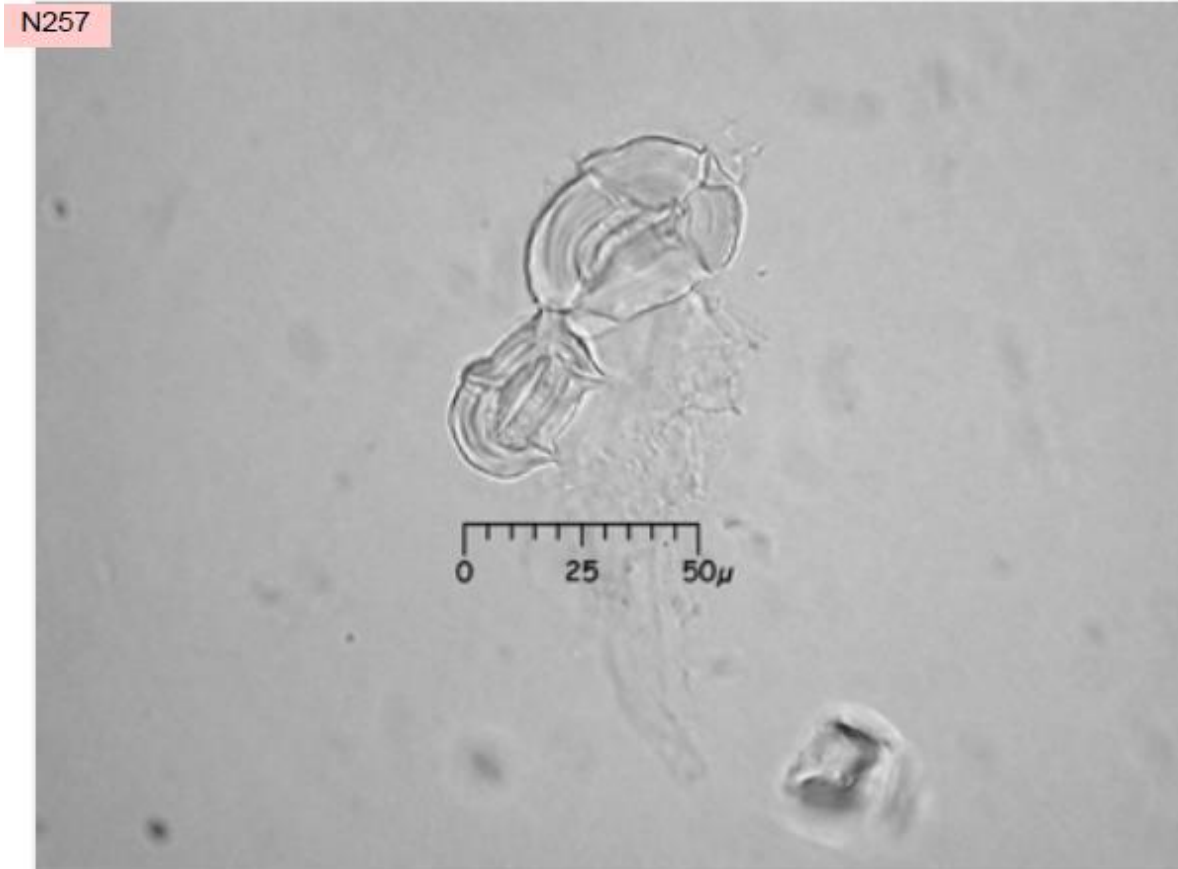
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pachira aquatica

## Phytolith

Diagnostic level: family

Note the “corners” of the body, where angular structure cups rounded interior. When broken, forms 20VD See also Record #147, 148 and 149. Note angular structure. From the bottom, it forms one stripe across length of back and two crossing body from side to side. In this top view, they appear as angular bands crossing



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



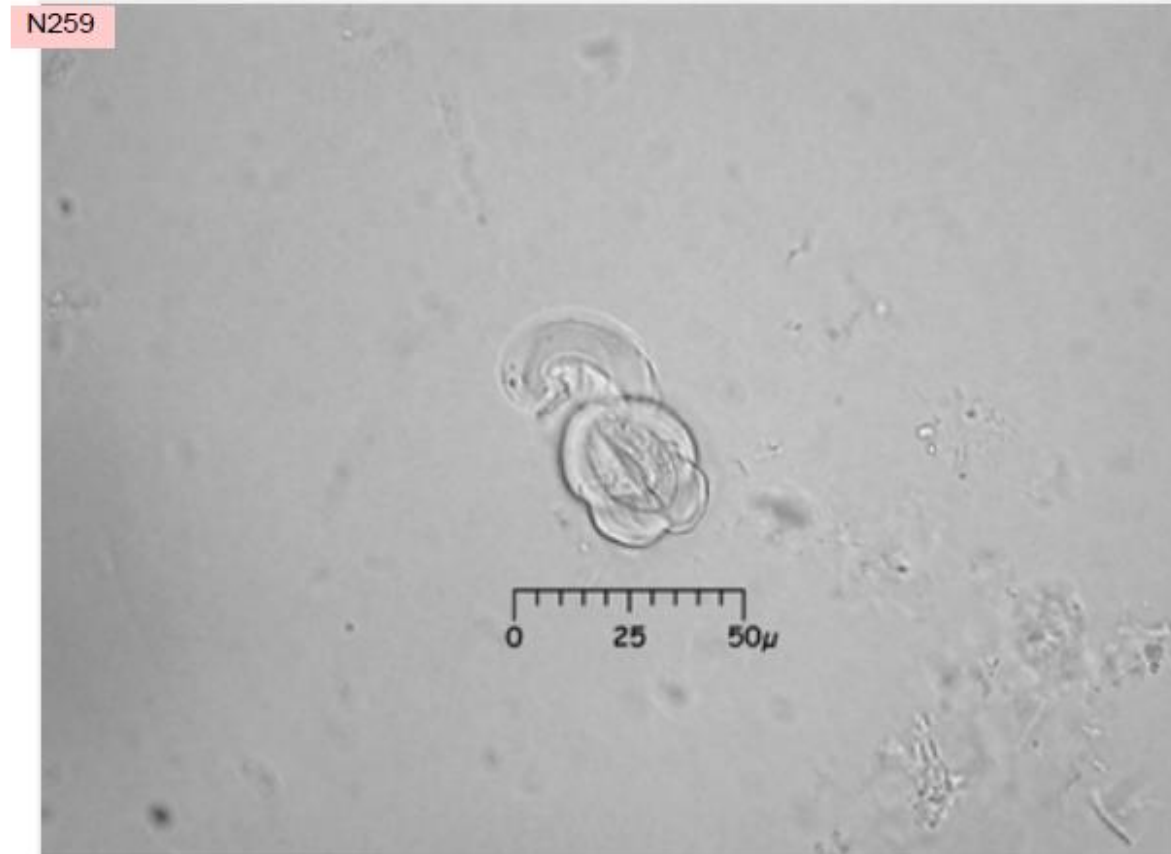
# Pachira aquatica

## Phytolith

Top view. Note attached filament. See also Record #146, 148 and 149.

Angular structure that forms one stripe across length of back and two crossing body from side to side is not in focus in this view.

Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pachira aquatica

## Phytolith

Side view.

See also Record #146,147 and 149.

Diagnostic level: family

Note angular structure that forms one stripe across length of back and two crossing body from side to side. These appear in "top" of body as angular bands crossing subsidiary cells. In this side view they appear as angular



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pachira aquatica

## Phytolith

Note the “corners” of the body, where angular structure cups rounded interior. When broken, forms 20VD.

Bottom view.

See also Record #146,147 and 148.

Note angular structure that forms one stripe across length of back and two crossing body from side to side. These are visible from “top” of body as angular

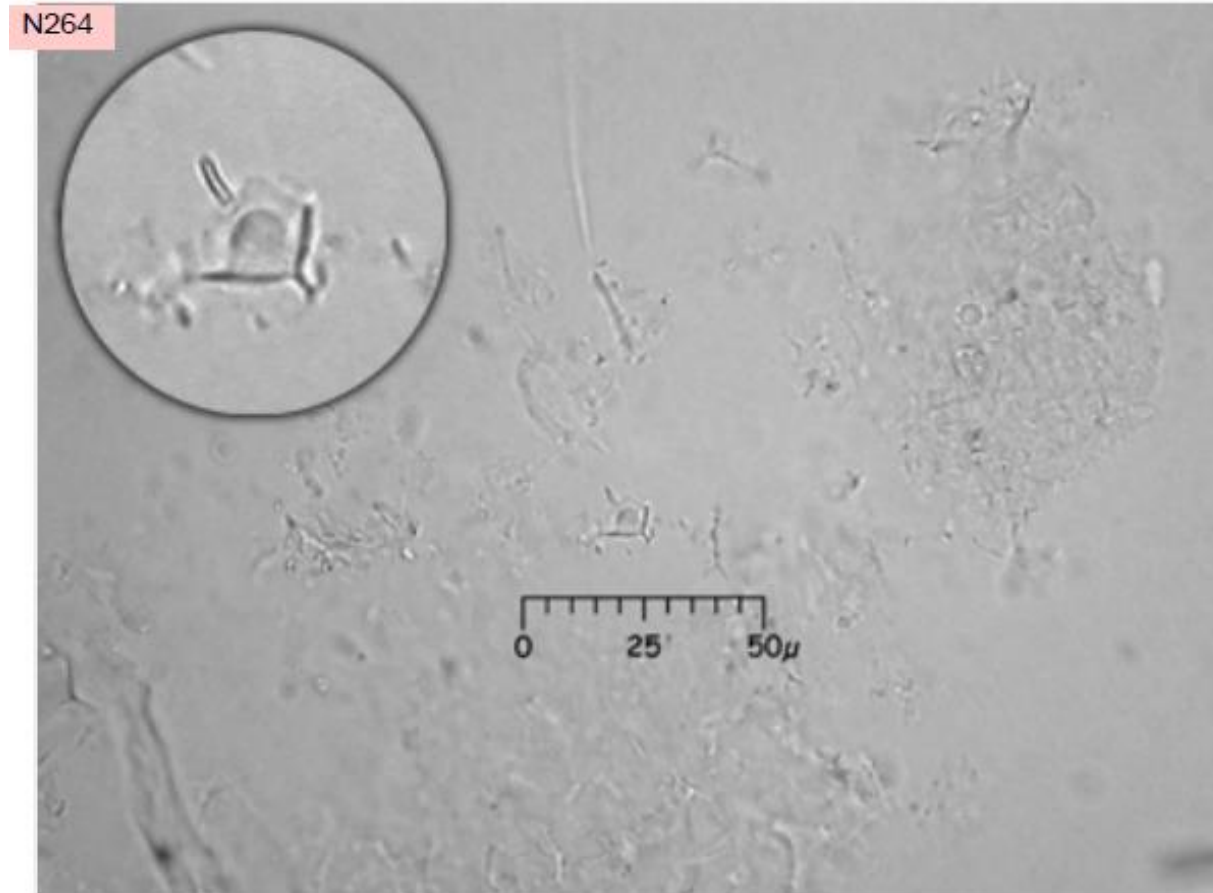


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pachira aquatica

## Phytolith

Body is very faint. Notice y-shaped triangular cup around interior rounded part of body.  
Diagnostic level: family



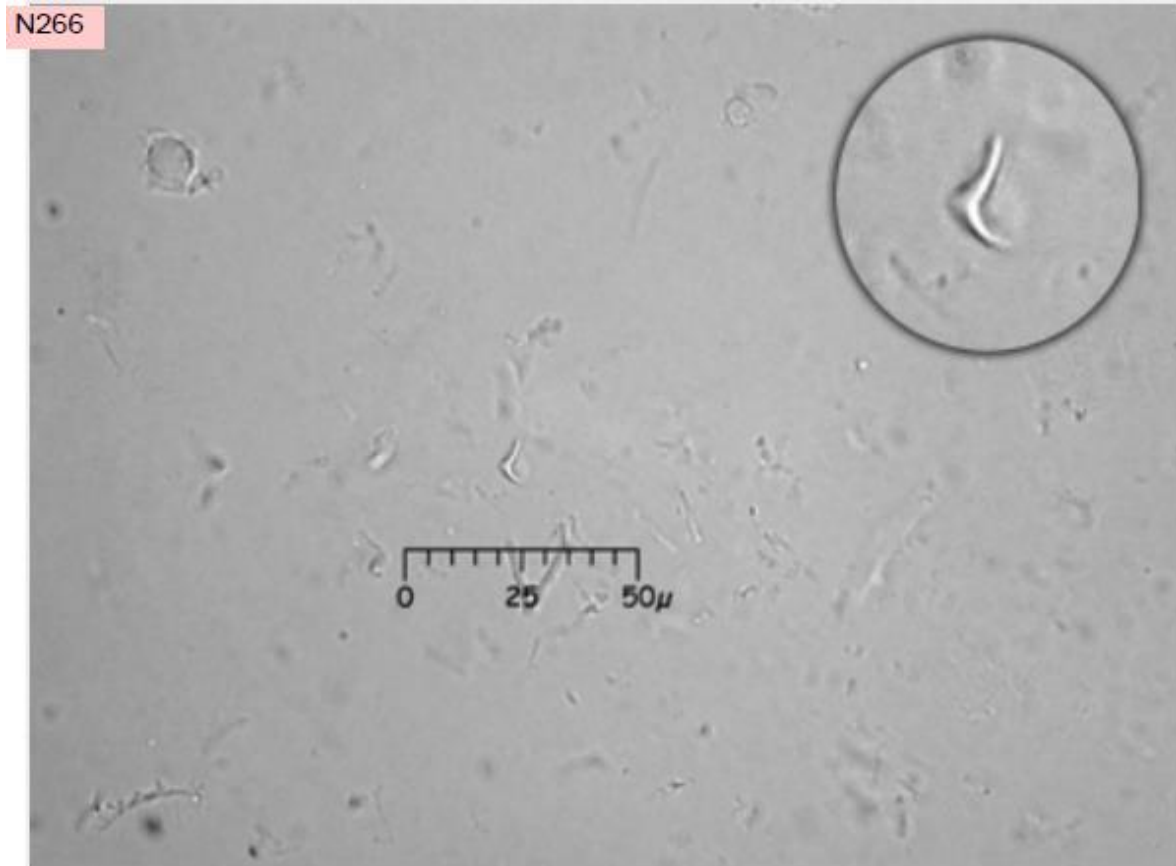
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pachira aquatica

## Phytolith

Body is very faint. This view shows the triangular rim.

Diagnostic level: family

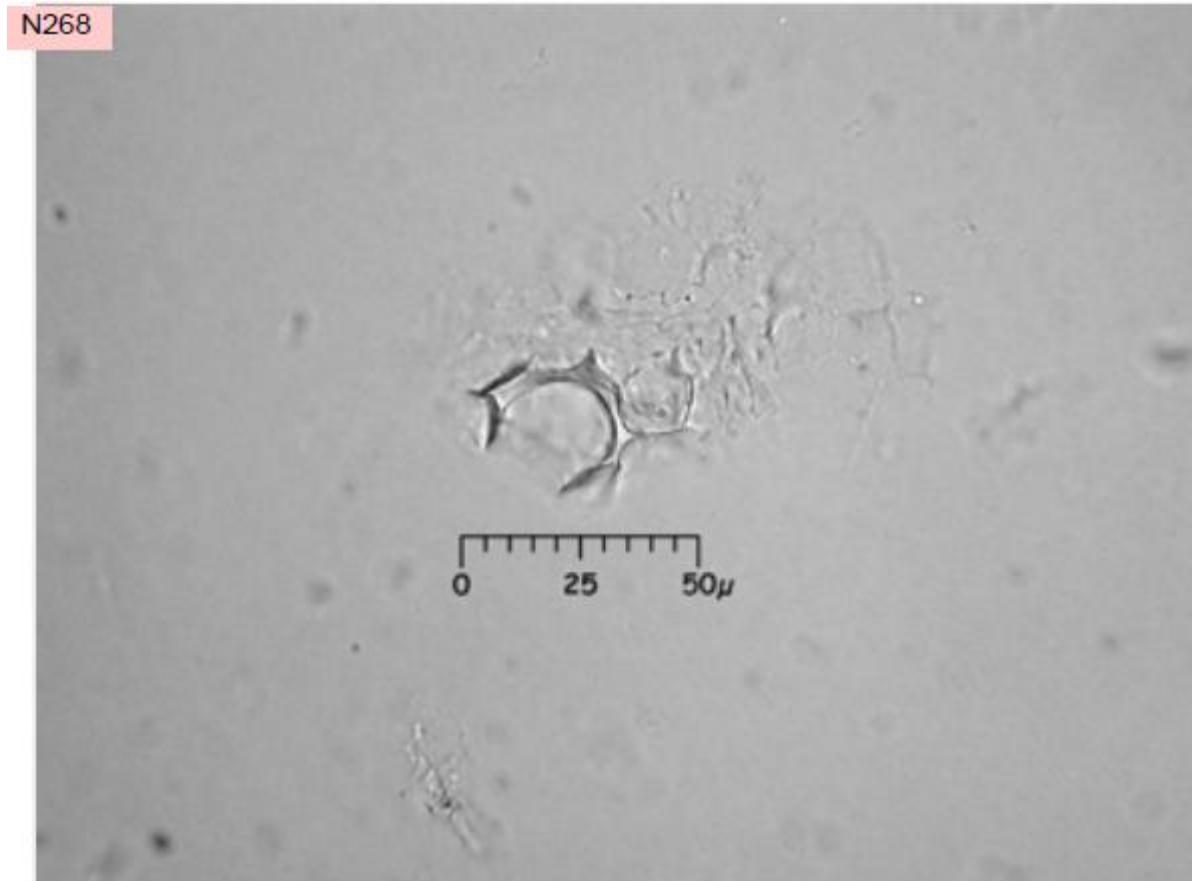


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pachira aquatica

## Phytolith

See alternate view (Record #153) to see bottom of hair cell base. Diagnostic level: genus



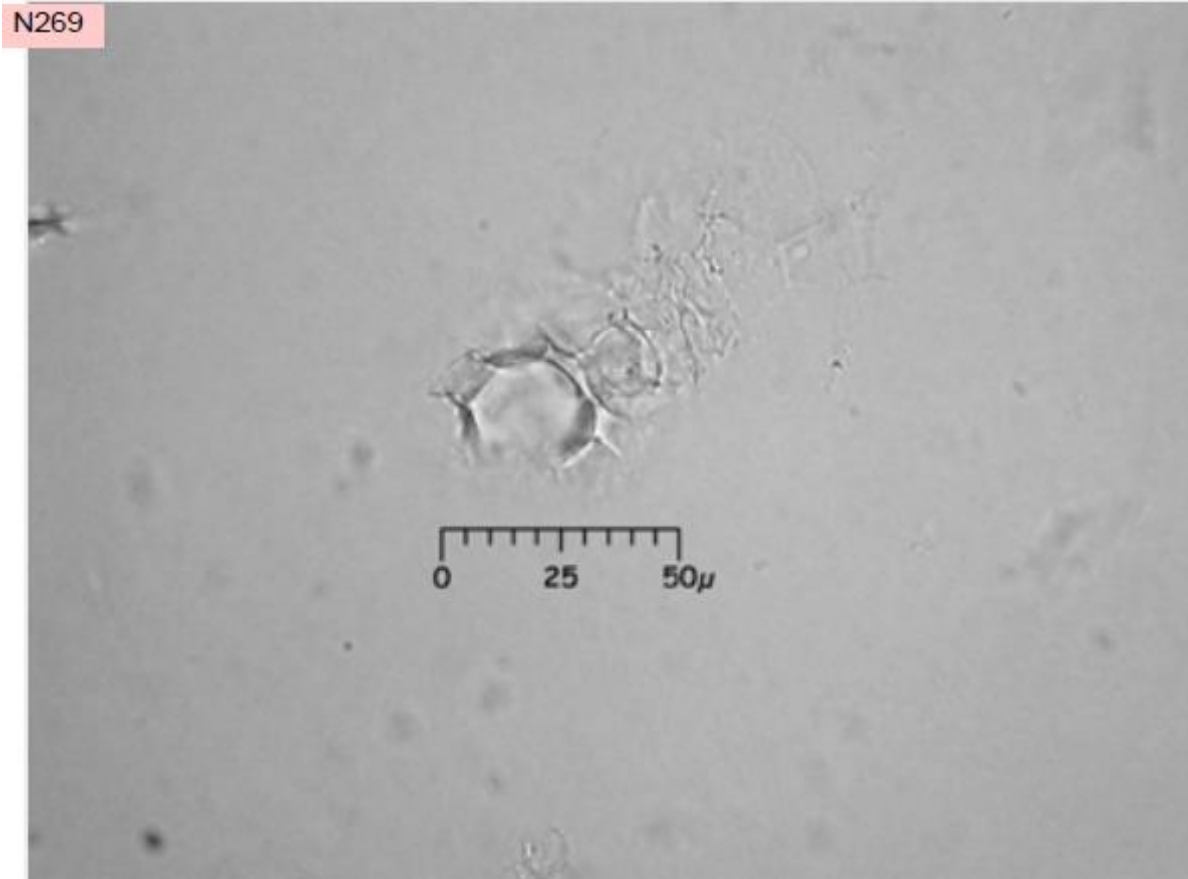
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pachira aquatica

## Phytolith

Hair cell base, view of bottom. See image of hair cell base top also (Record #152).

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pachira aquatica

## Phytolith

Slide 1367c. Diagnostic level: family  
Note the “corners” of the body, where  
angular structure cups rounded interior.  
When broken, forms 20VD See also  
Record #147, 148 and 149. Note angular  
structure. From the bottom, it forms  
one stripe across length of back and  
two crossing body



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Pachira aquatica

## Phytolith

Slide 1367c. Diagnostic level: family  
Note the "corners" of the body, where angular structure cups rounded interior. When broken, forms 20VD See also Record #147, 148 and 149. Note angular structure. From the bottom, it forms one stripe across length of back and two crossing body from side to side. In this top view, they

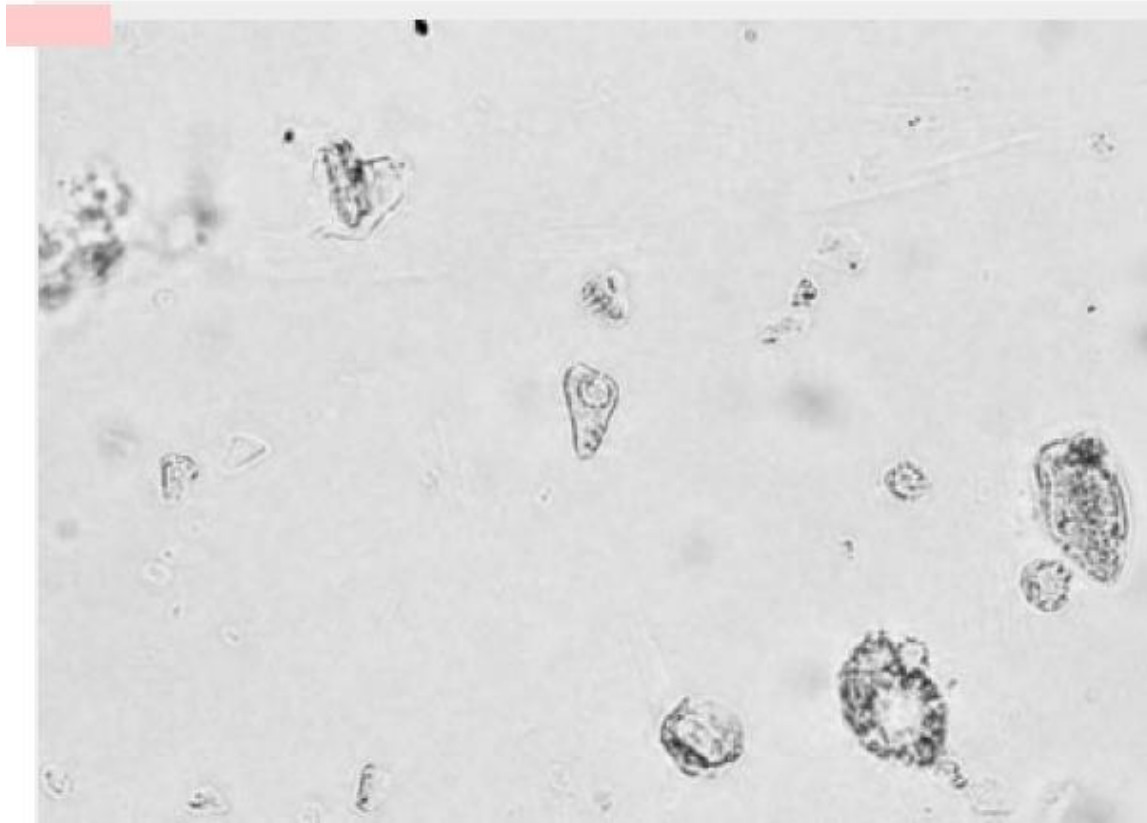


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pseudobombax millei

## Phytolith

This is a verrucose cystolith encased in a short, broad trichome. Slide 813.  
Diagnostic level: genus

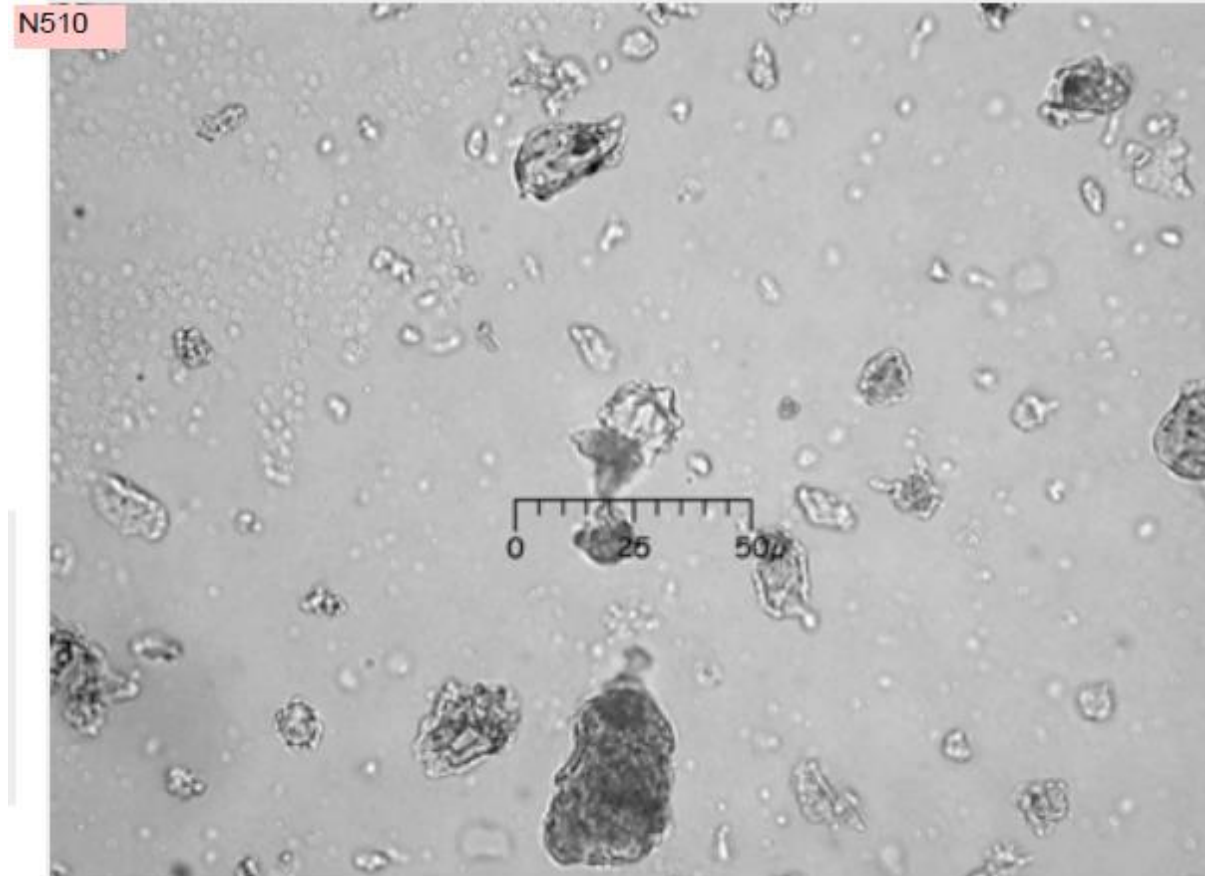


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pseudobombax millei

## Phytolith

Also occurs in the Zingiberaceae  
Diagnostic level: mixed, Zingiberaceae,  
Bombacaceae. There are subtle  
differences in the smoothness and  
abundance of nodules between the two  
families

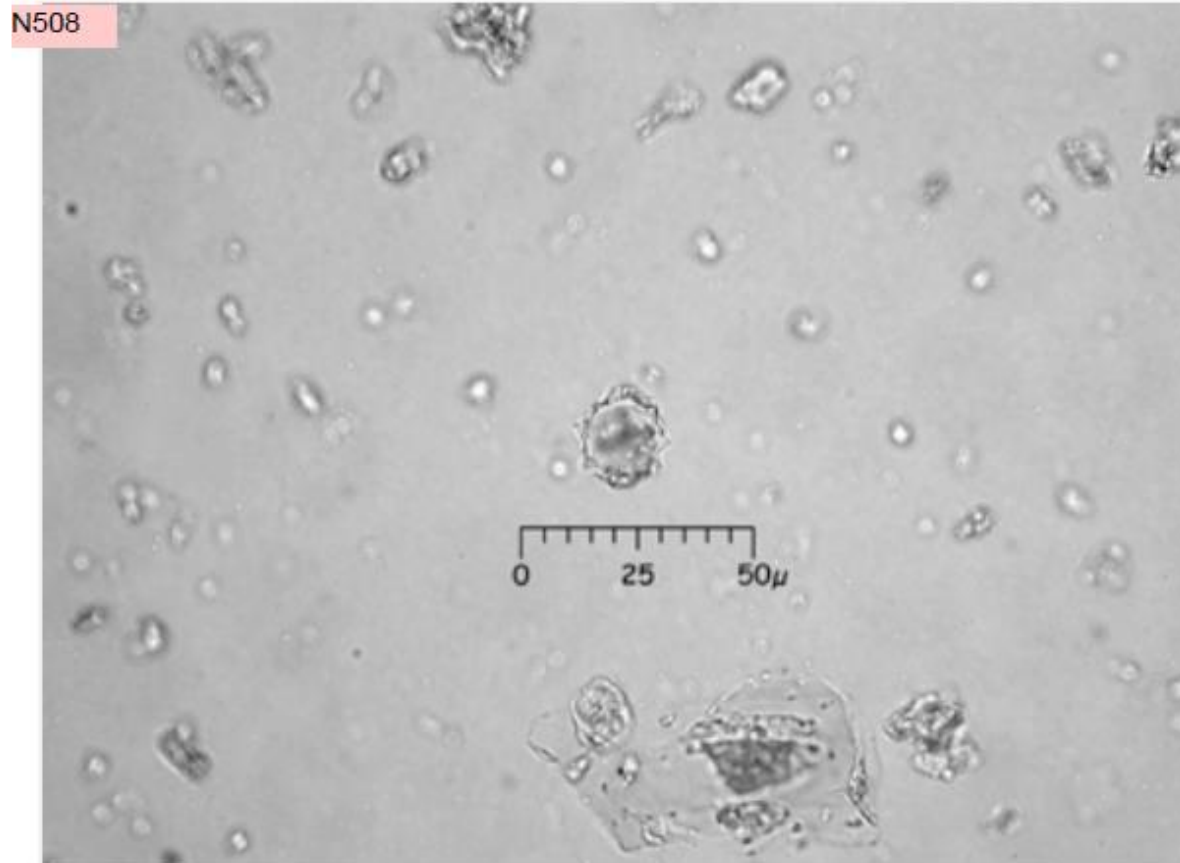


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pseudobombax millei

## Phytolith

Also occurs in the Zingiberaceae  
Diagnostic level: mixed, Zingiberaceae,  
Bombacaceae. There are subtle  
differences in the smoothness and  
abundance of nodules between the two  
families

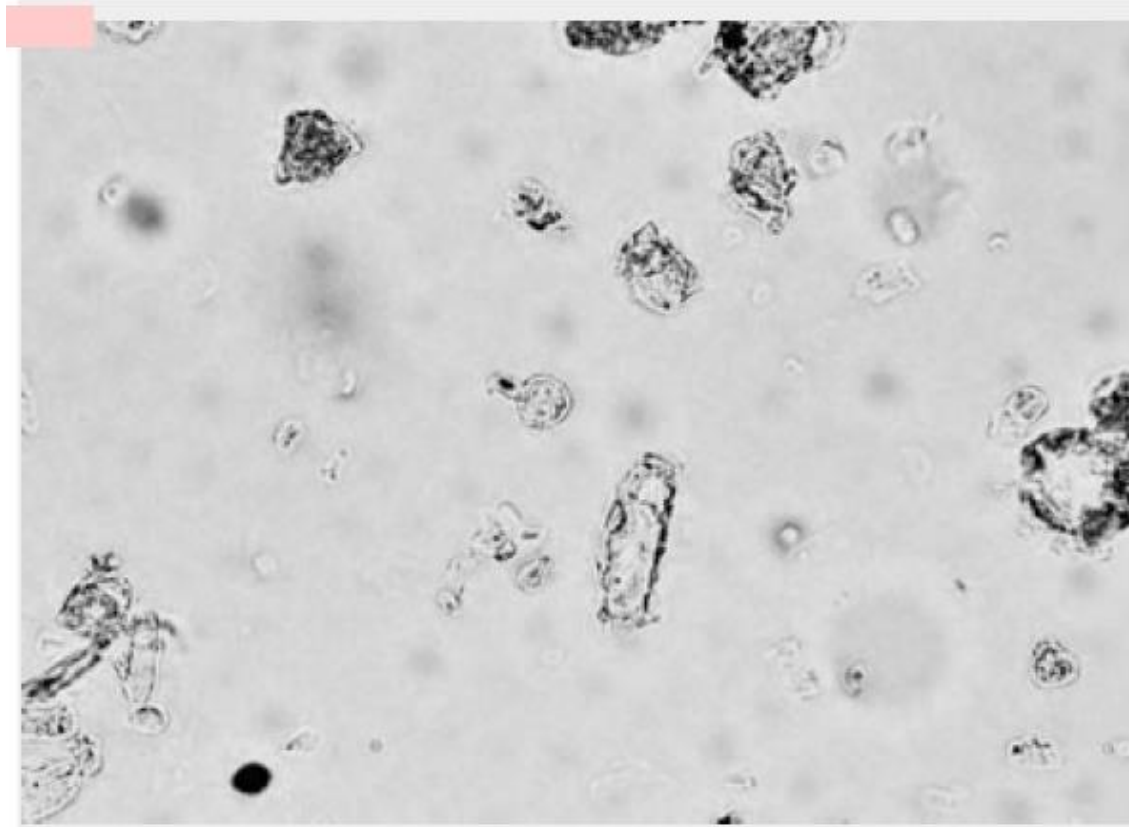


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pseudobombax millei

## Phytolith

Type is not diagnostic to Bombacaceae alone. Cystolith body may be very rugulose, verrucose, or nearly smooth. Diagnostic level: generalized arboreal

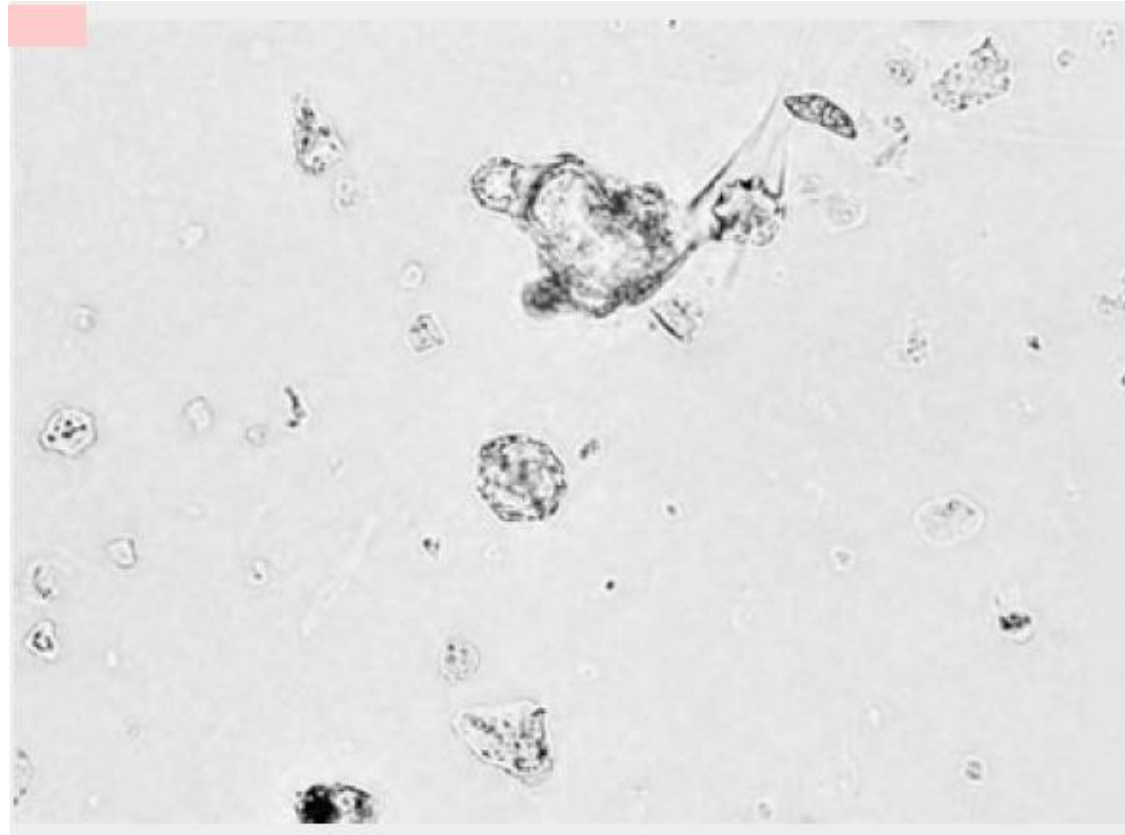


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pseudobombax millei

## Phytolith

Small nodular spheres overlap with  
Marantaceae Diagnostic level:  
Marantaceae/Bombacaceae

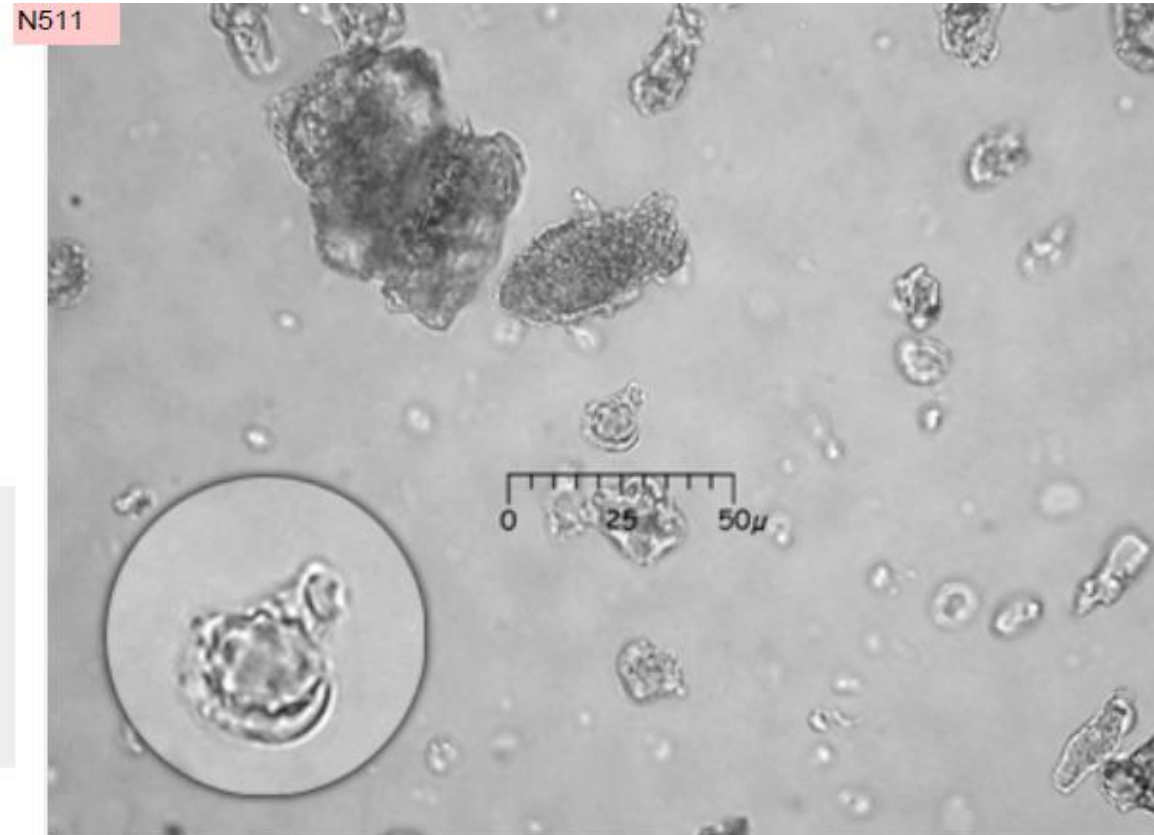


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pseudobombax millei

## Phytolith

This is a verrucose cystolith encased in a short, broad trichome.

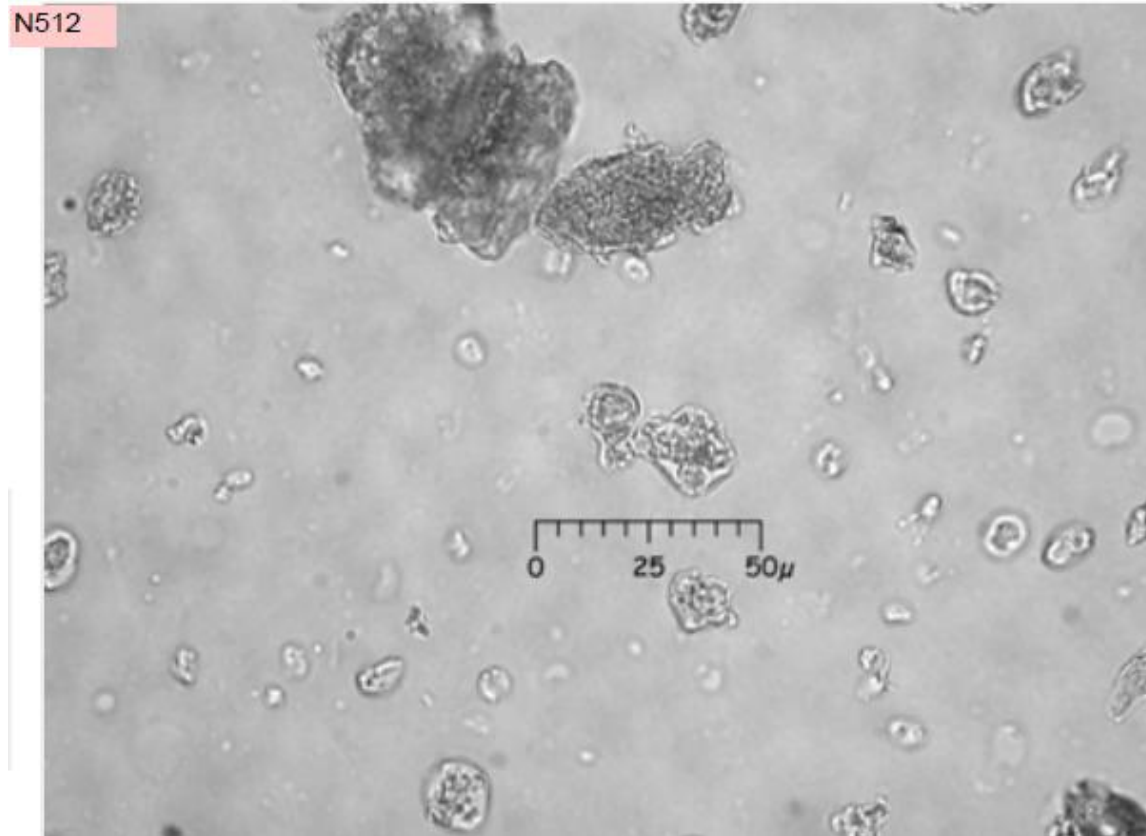


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pseudobombax millei

## Phytolith

Diagnostic level: generalized arboreal



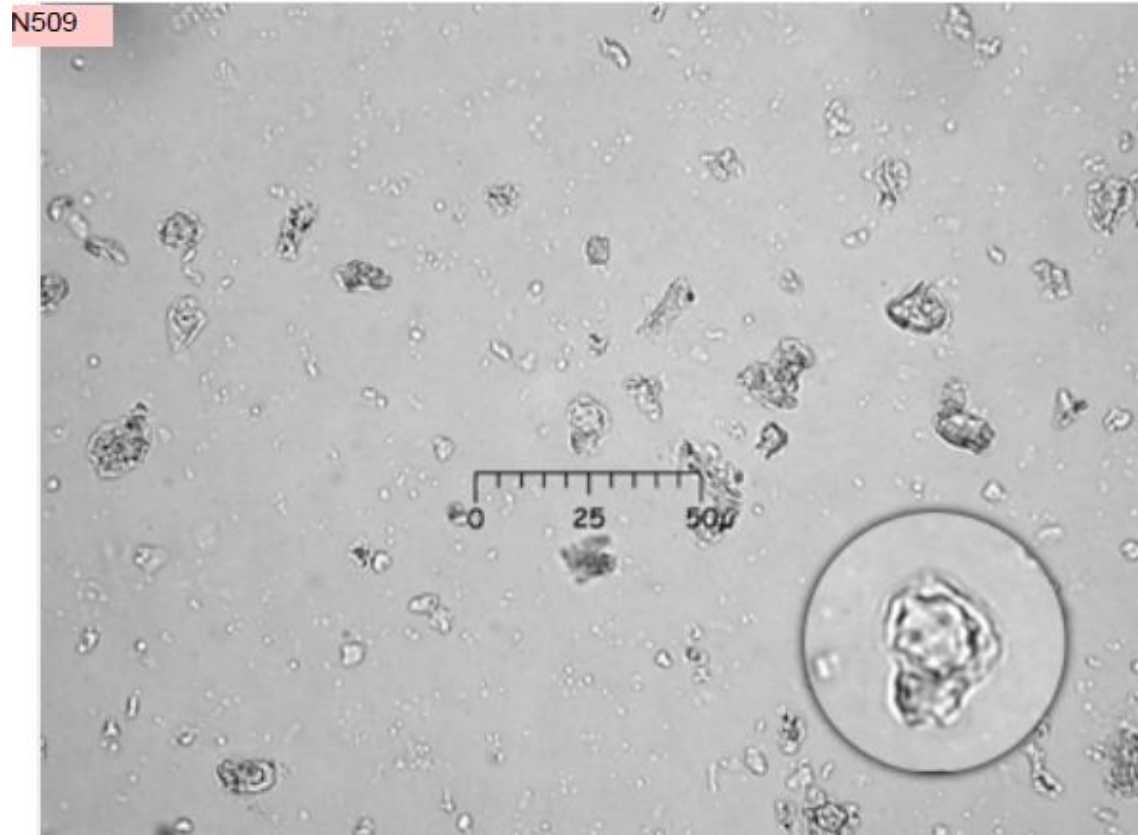
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Pseudobombax millei

## Phytolith

Diagnostic level: generalized arboreal

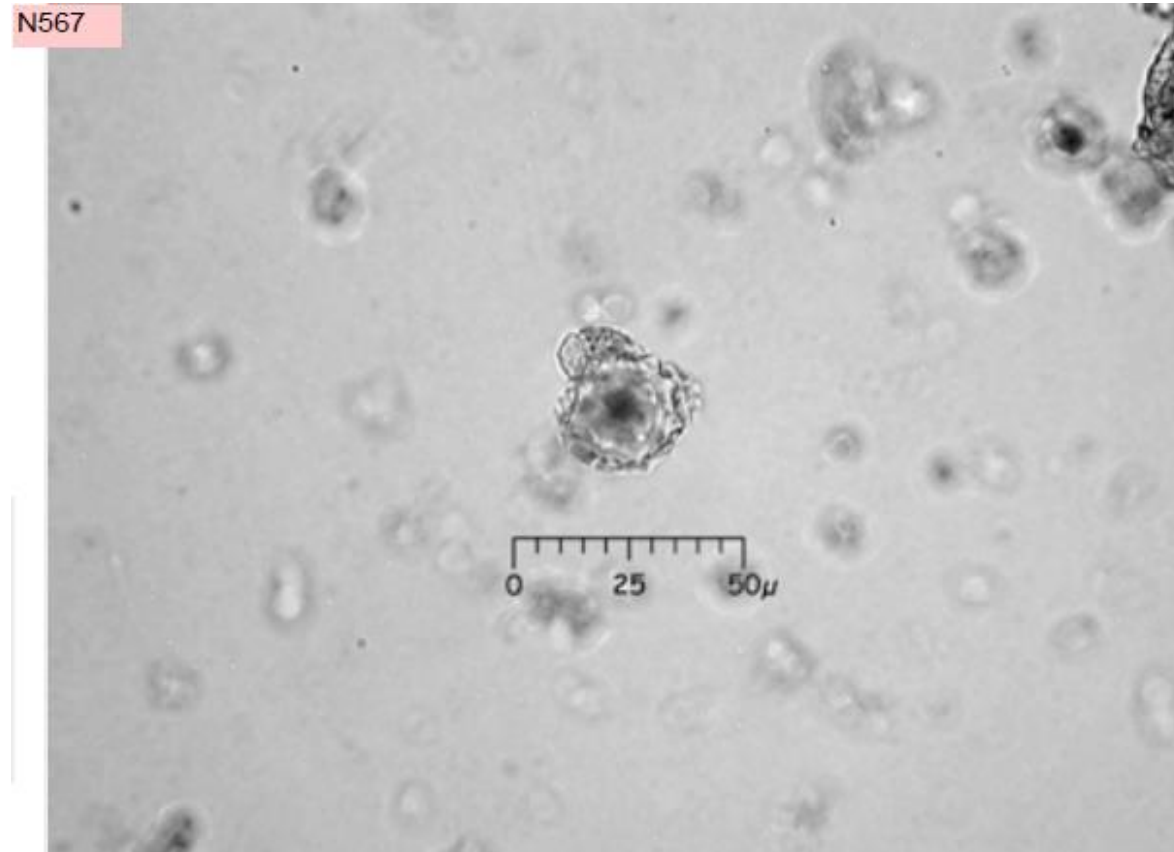


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pseudobombax millei

## Phytolith

Also occurs in the Zingiberaceae  
Diagnostic level: mixed, Zingiberaceae,  
Bombacaceae. There are subtle  
differences in the smoothness and  
abundance of nodules between the two  
families.

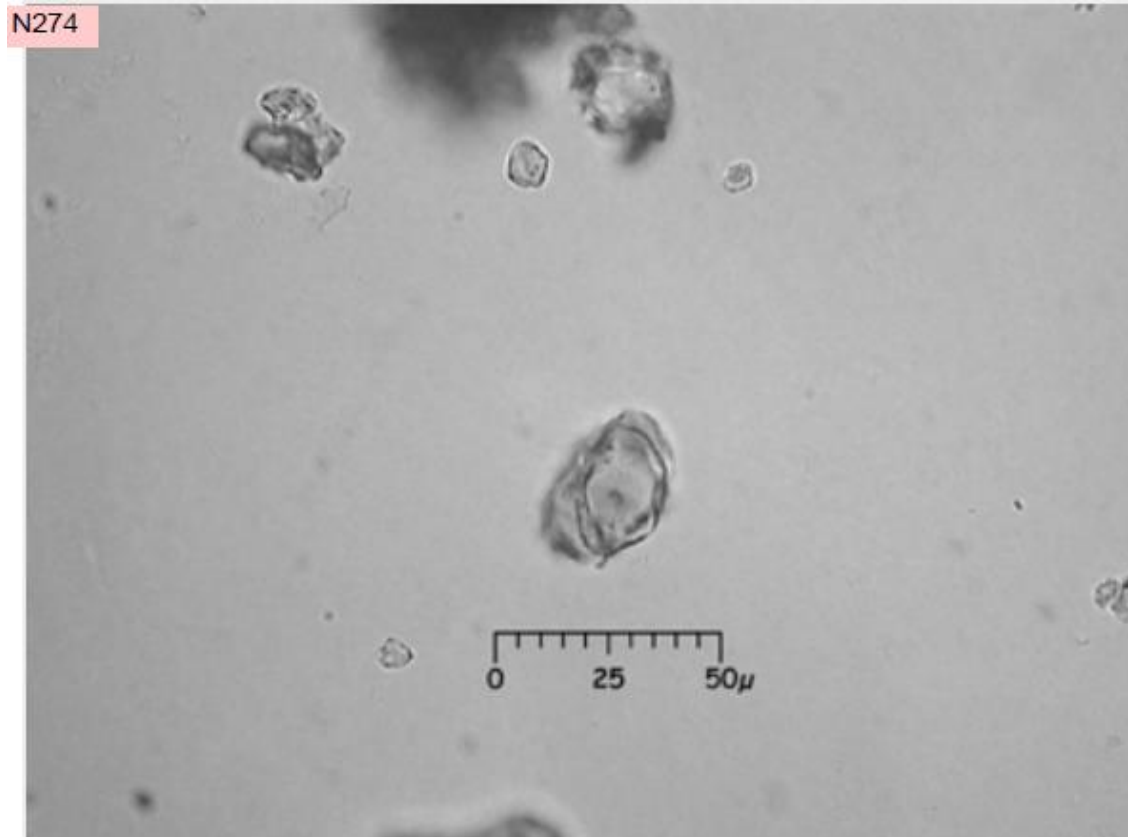


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pseudobombax millei

## Phytolith

Also observed in *Matisia longipes* leaf.  
Diagnostic level: family

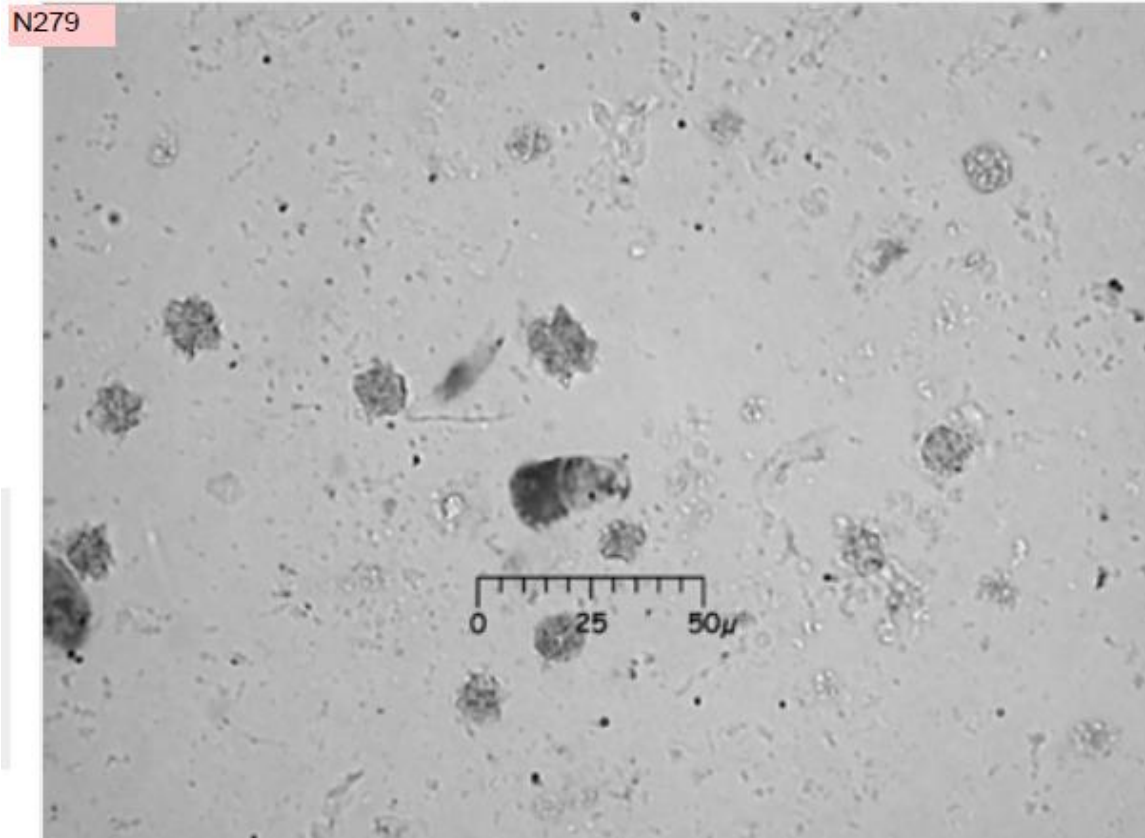


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Quarariba cf. grandifolia

## Phytolith

See Record #171 to compare. Very broad obtuse tip (rarely pointed) and overall broad, short nature of hair distinguishes type. Diagnostic level: genus

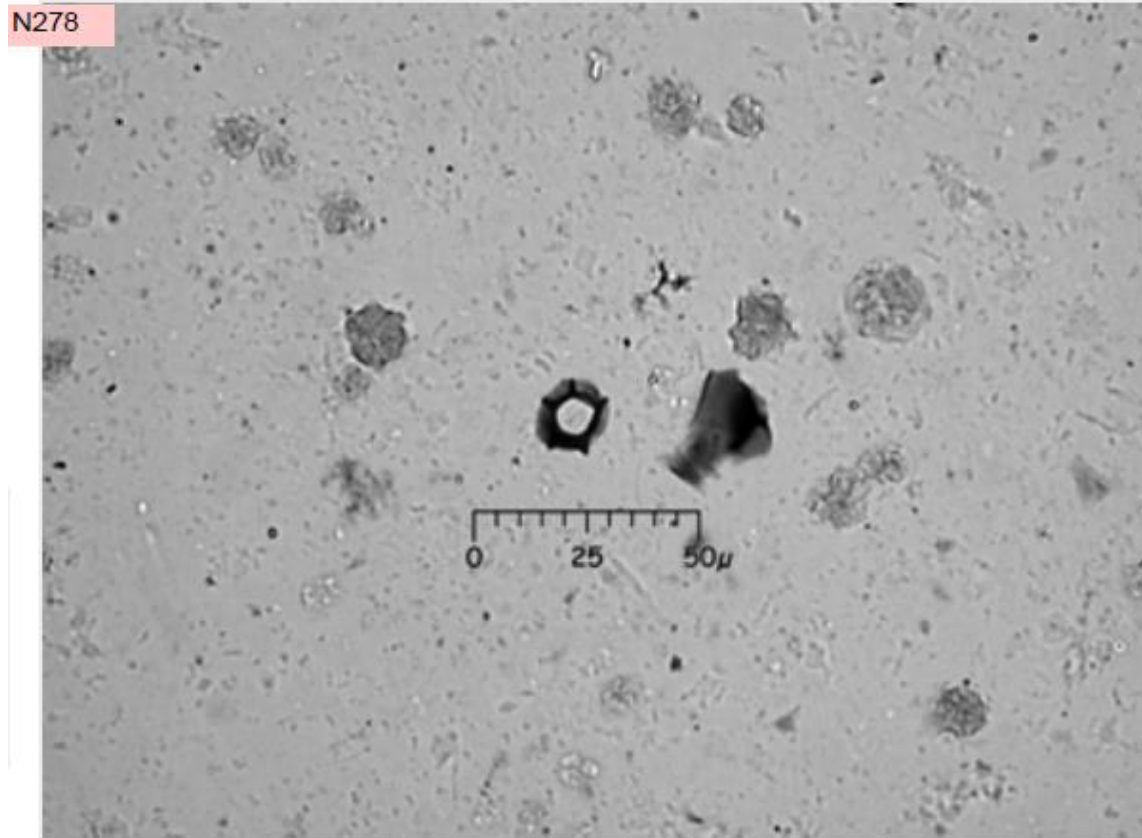


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Quarariba cf. grandifolia

## Phytolith

Unusual because of it's very dark,  
occluded rim and attached tissue.  
Diagnostic level: genus

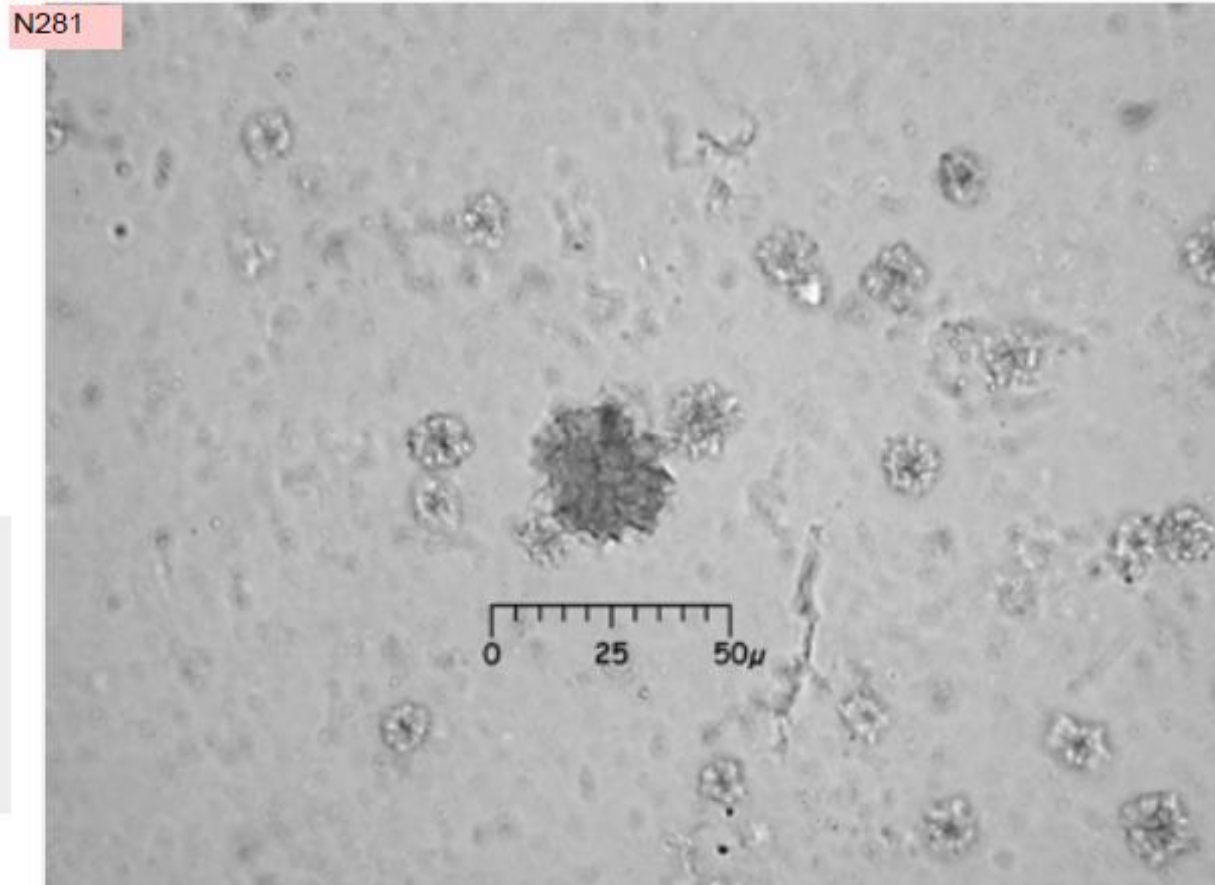


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Quararibea grandifolia

## Phytolith

See size variation in cystoliths.  
Diagnostic level: generalized arboreal



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Quararibea grandifolia

## Phytolith

See Record #170 to compare. Very broad obtuse tip (rarely pointed) and overall broad, short nature of hair distinguishes type. Diagnostic level: genus

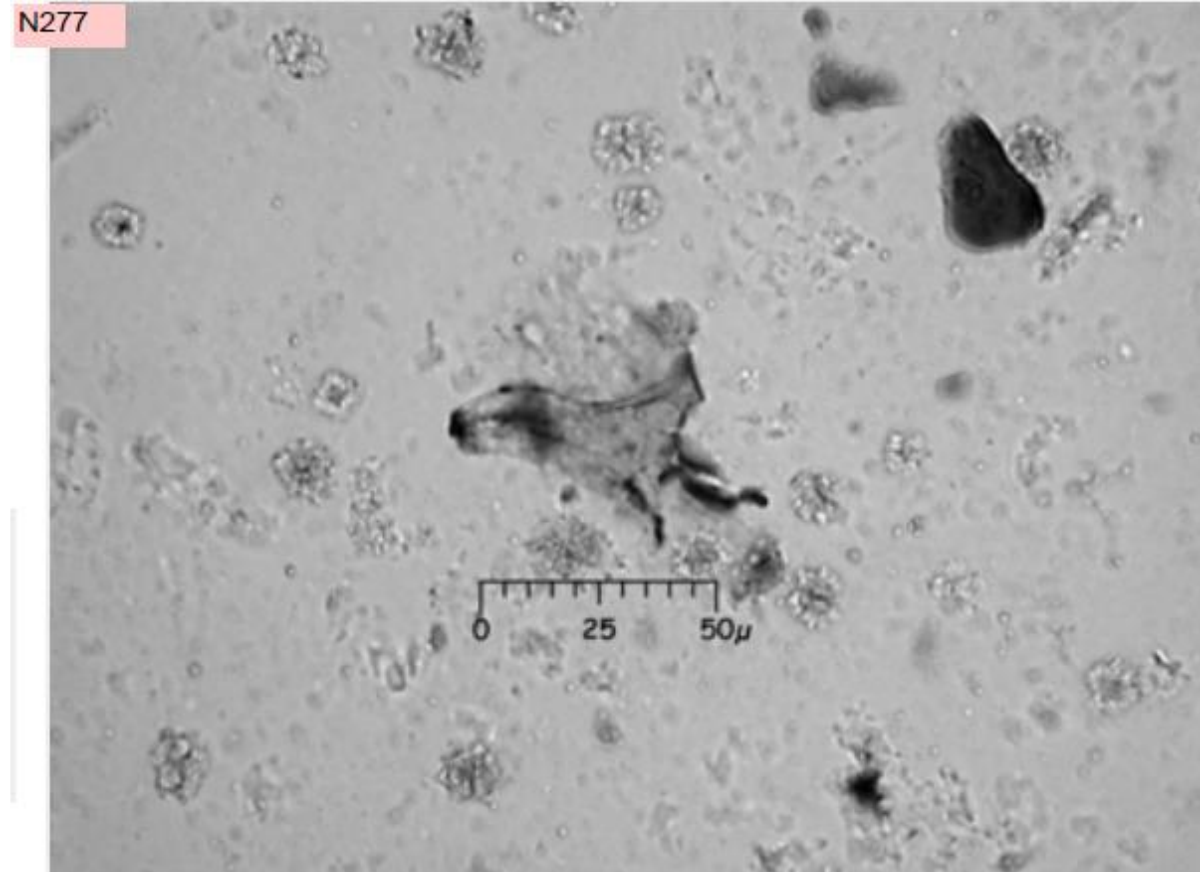


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Quararibea grandifolia

## Phytolith

Sclerids occur widely in woody plants.  
Note distinctive central ridge in this  
body that identifies sclerids.  
Diagnostic level: generalized arboreal



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



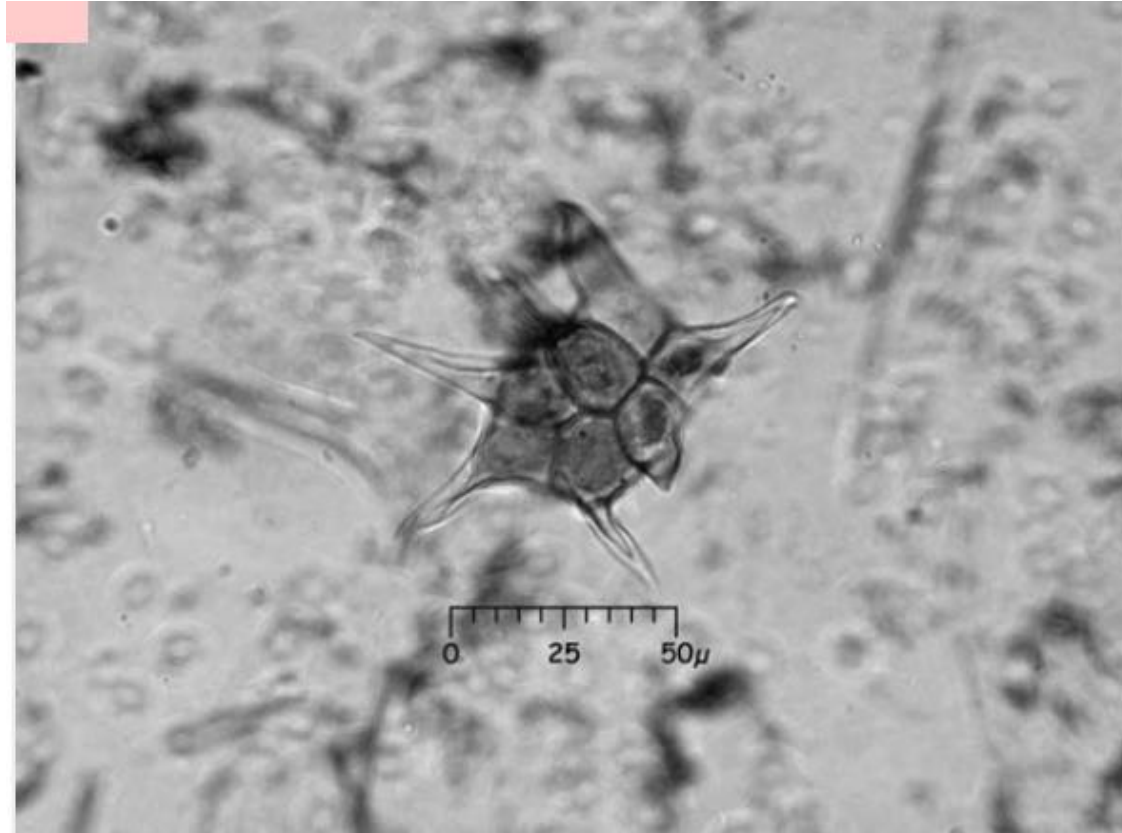
BORAGINACEAE

# Cordia polyantha

## Phytolith

Slide E1030.

Diagnostic level: species?

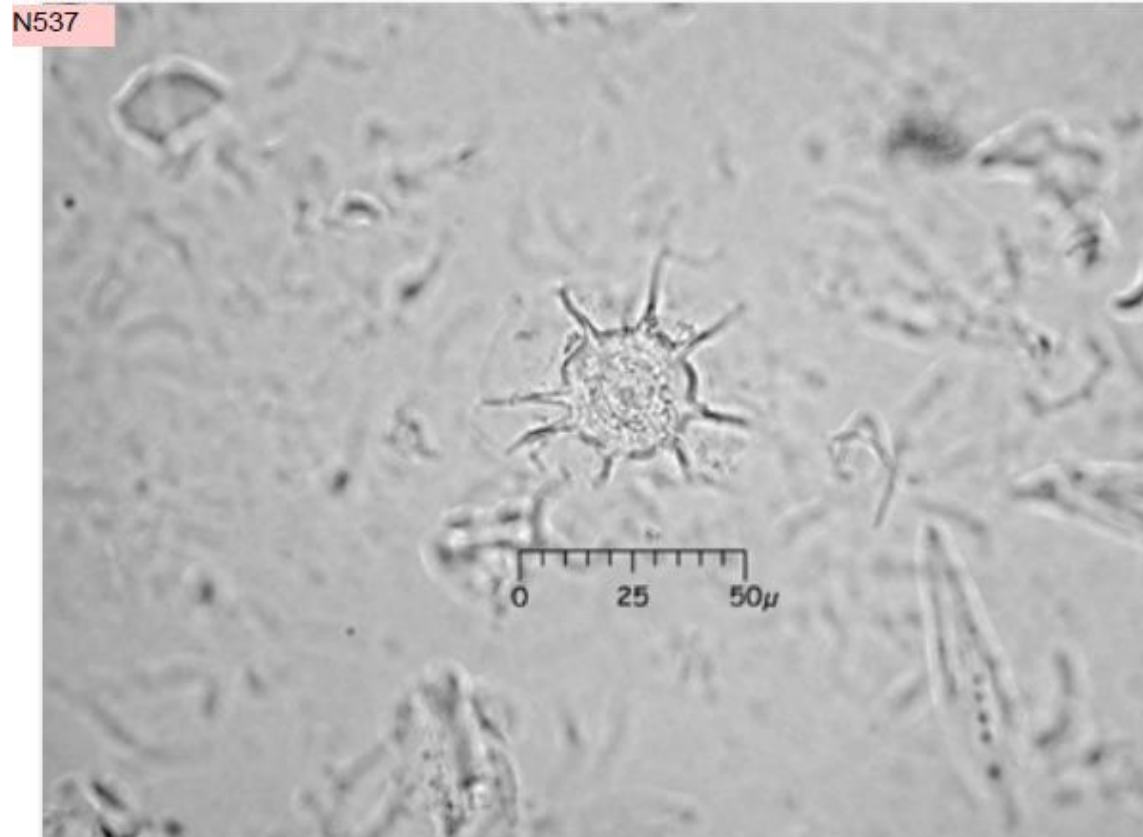


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia hebeclada

## Phytolith

Rotate to see rounded concavity in base where hair inserts. Slide 468 leaf. Type defined by Cesar Veintimilla 06/1991. Diagnostic level: species

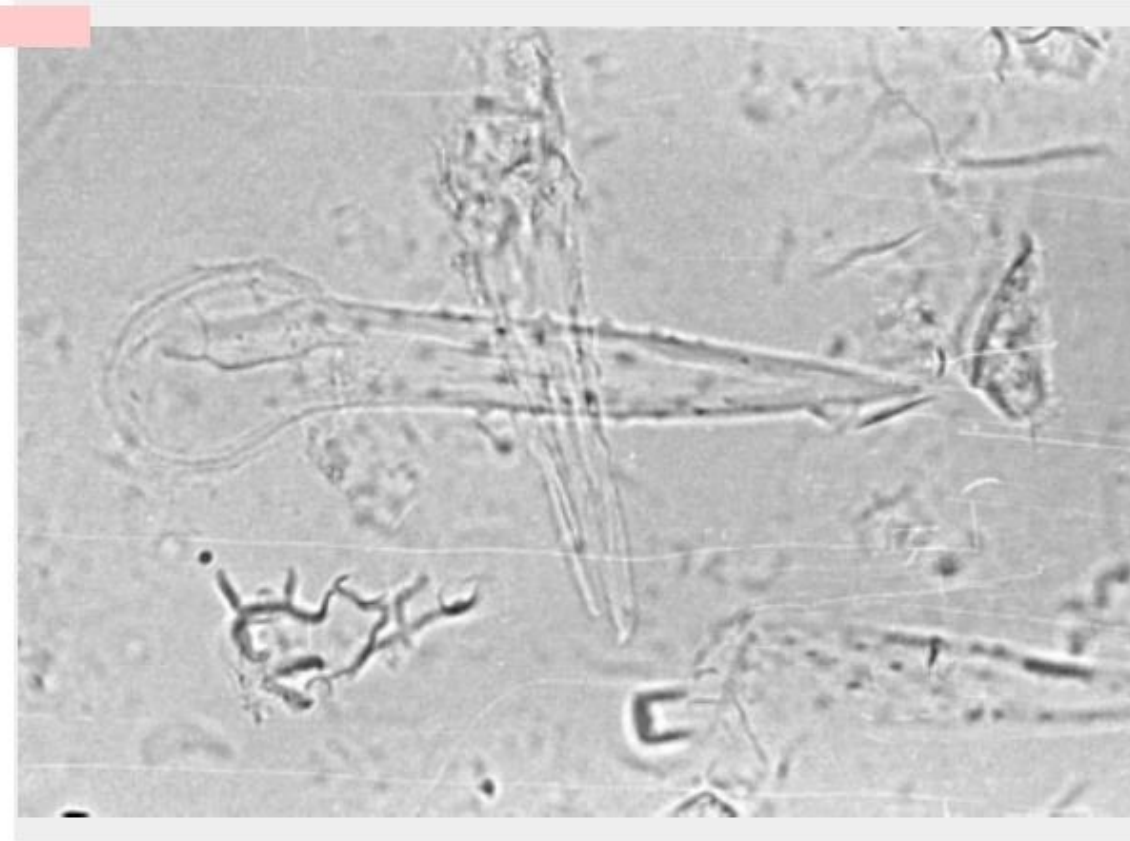


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia hebeclada

## Phytolith

Diagnostic level: Cordia/Heliotropium

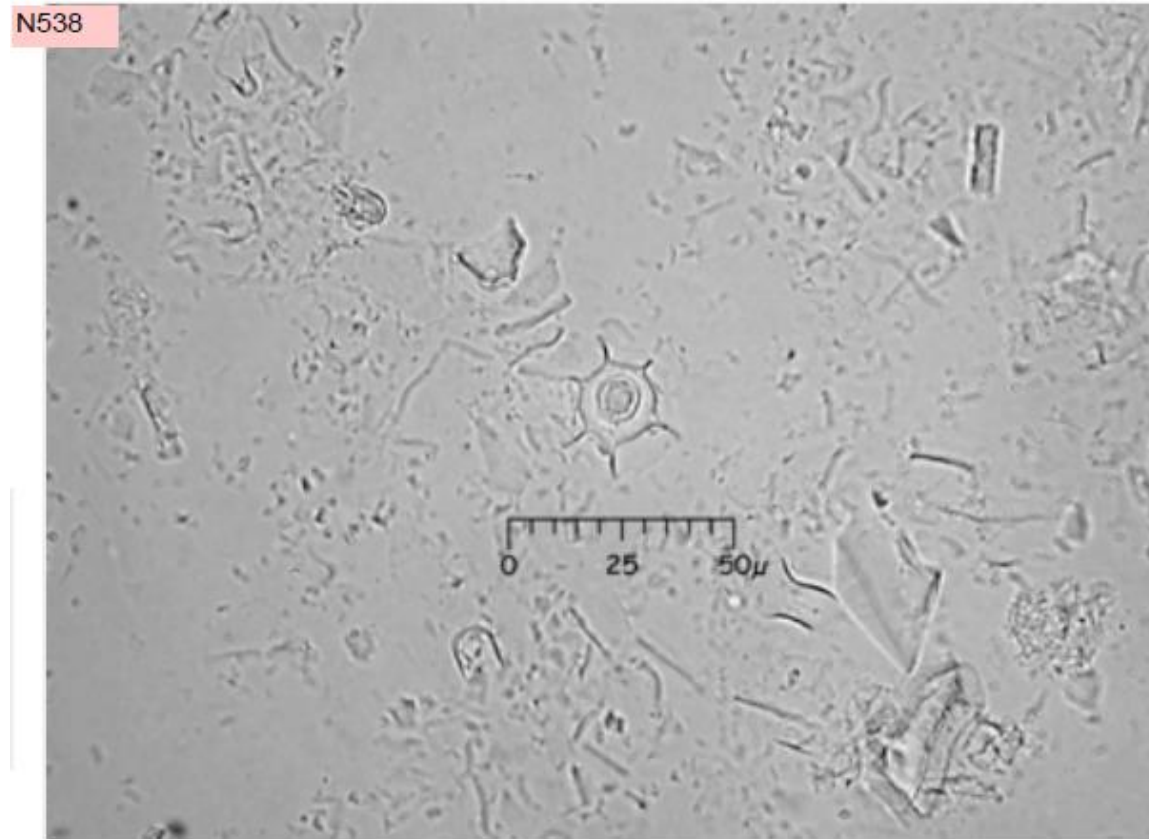


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia hebeclada

## Phytolith

Slide 468 leaf. Type defined by Cesar Veintimilla 06/1991. See also Record #108.

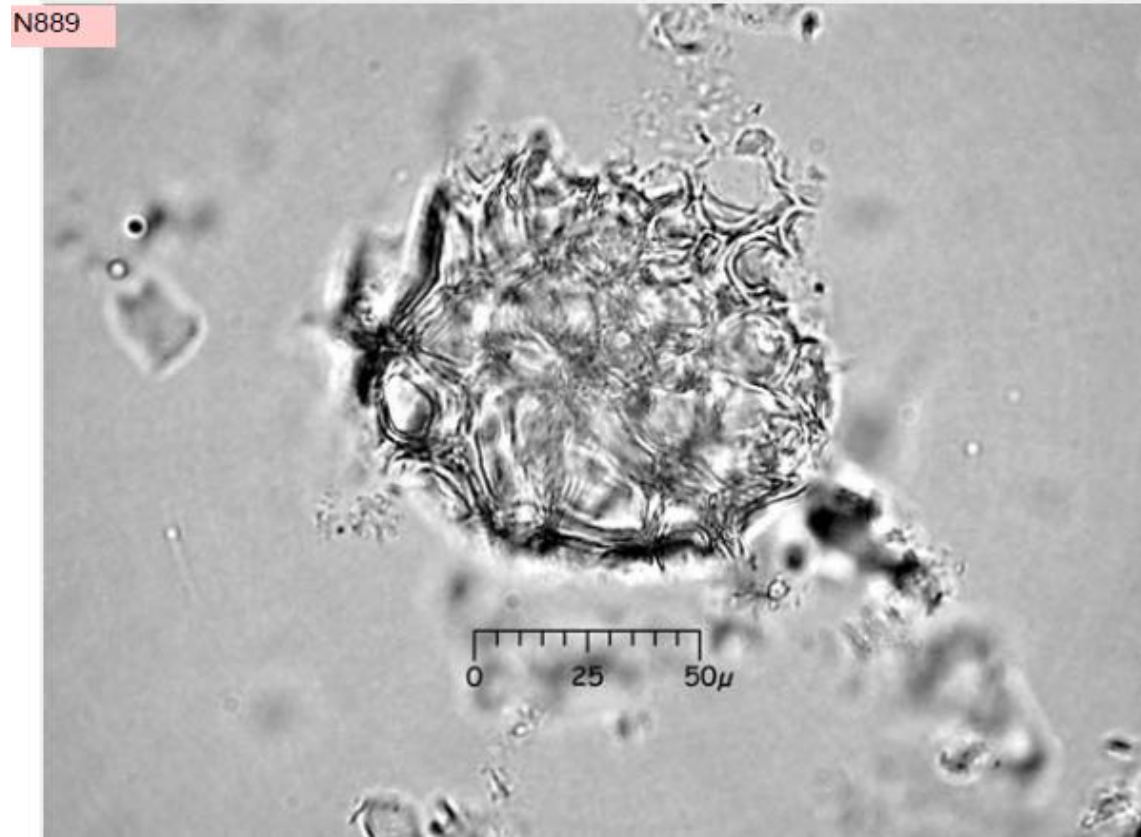


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia hebeclada

## Phytolith

Slide 1772a leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

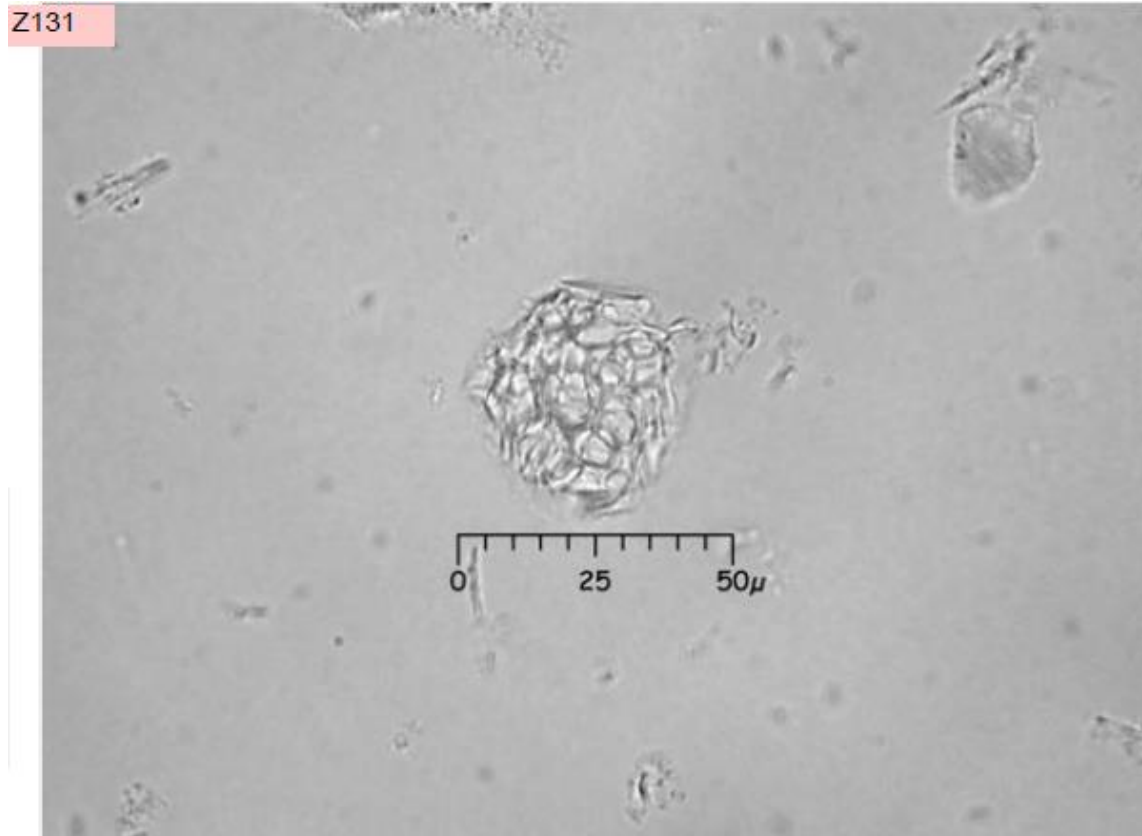


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia hebeclada

## Phytolith

Slide 1772a leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia hebeclada

## Phytolith

Occurs in leaf. Also occurs in *Cordia lutea* (fruit) and *Heliotropium*. Type defined by Cesar Veintimilla. Diagnostic level: *Cordia*/*Heliotropium*



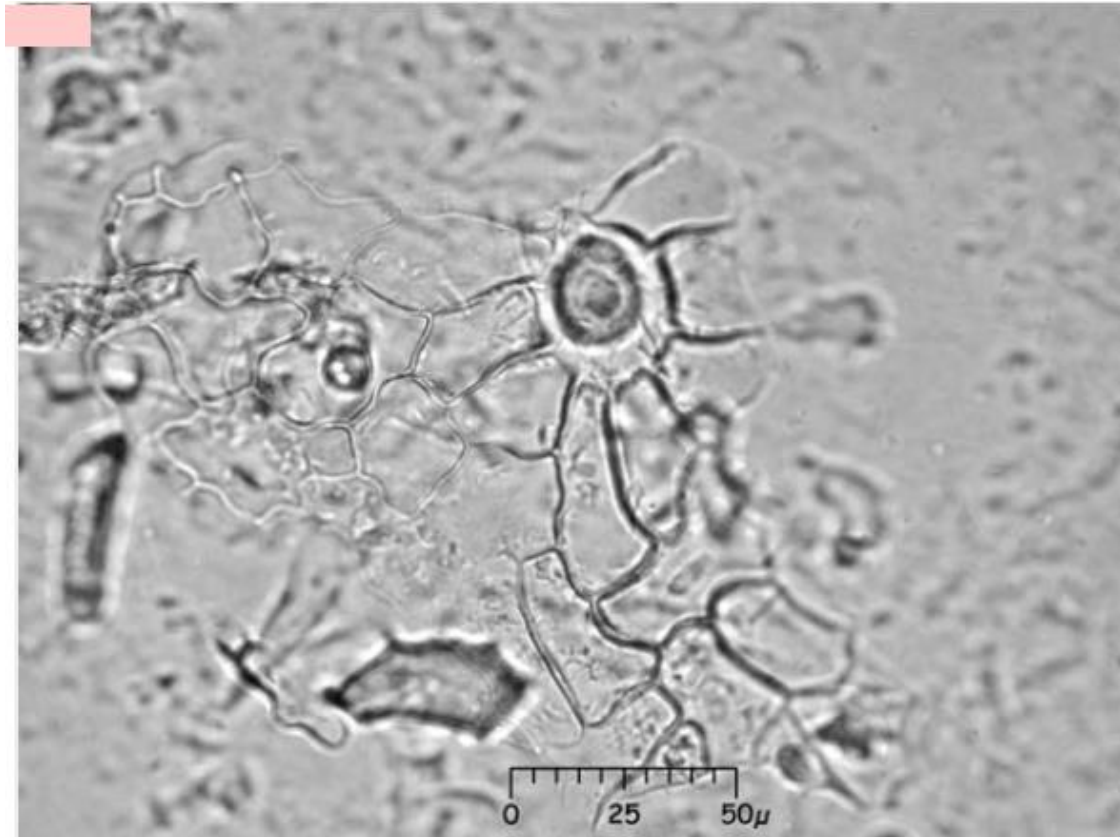
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Cordia hebeclada

## Phytolith

Slide 468 leaf. Type defined by Cesar Veintimilla 06/1991. Diagnostic level: species



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia hebeclada

## Phytolith

Occurs in leaf. Also occurs in *Cordia lutea* (fruit) and *Heliotropium*. Type defined by Cesar Veintimilla. Diagnostic level: family



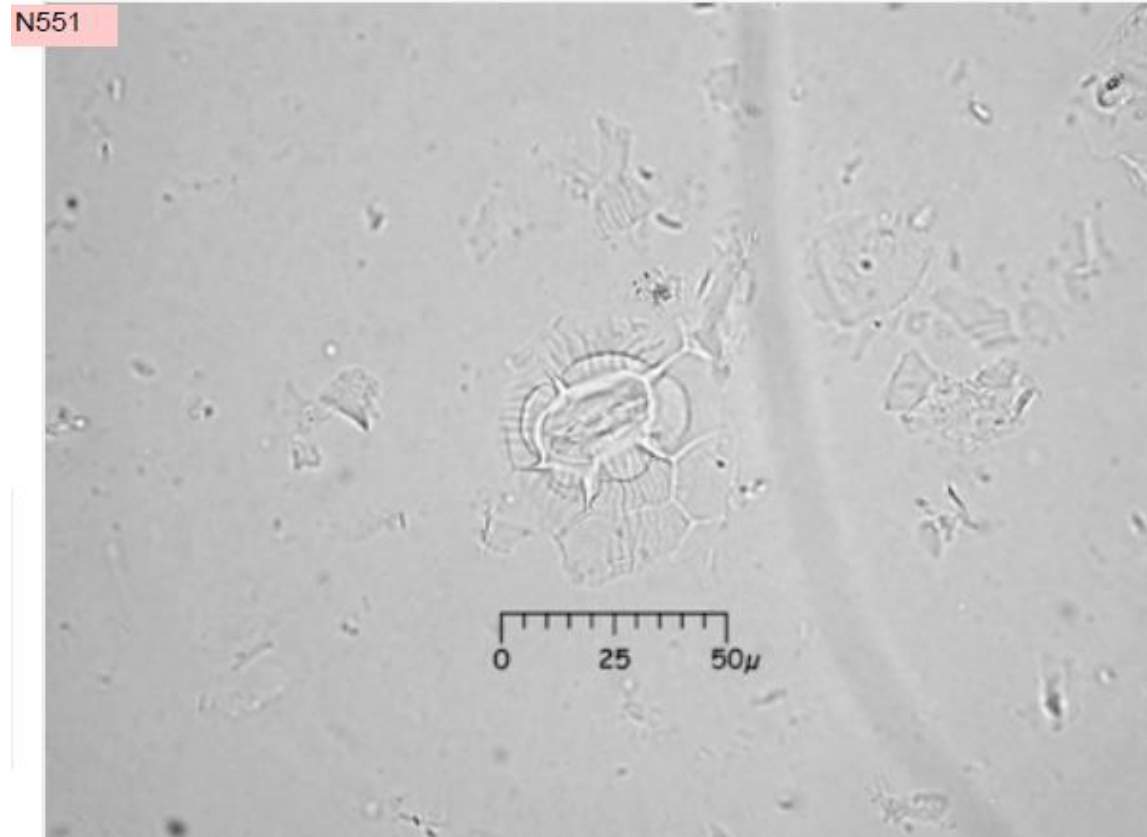
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia lutea

## Phytolith

These simple stomata are not diagnostic to family or even order level at this time.

Diagnostic level: not diagnostic



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia lutea

## Phytolith

Diagnostic level: Cordia/Heliotropium

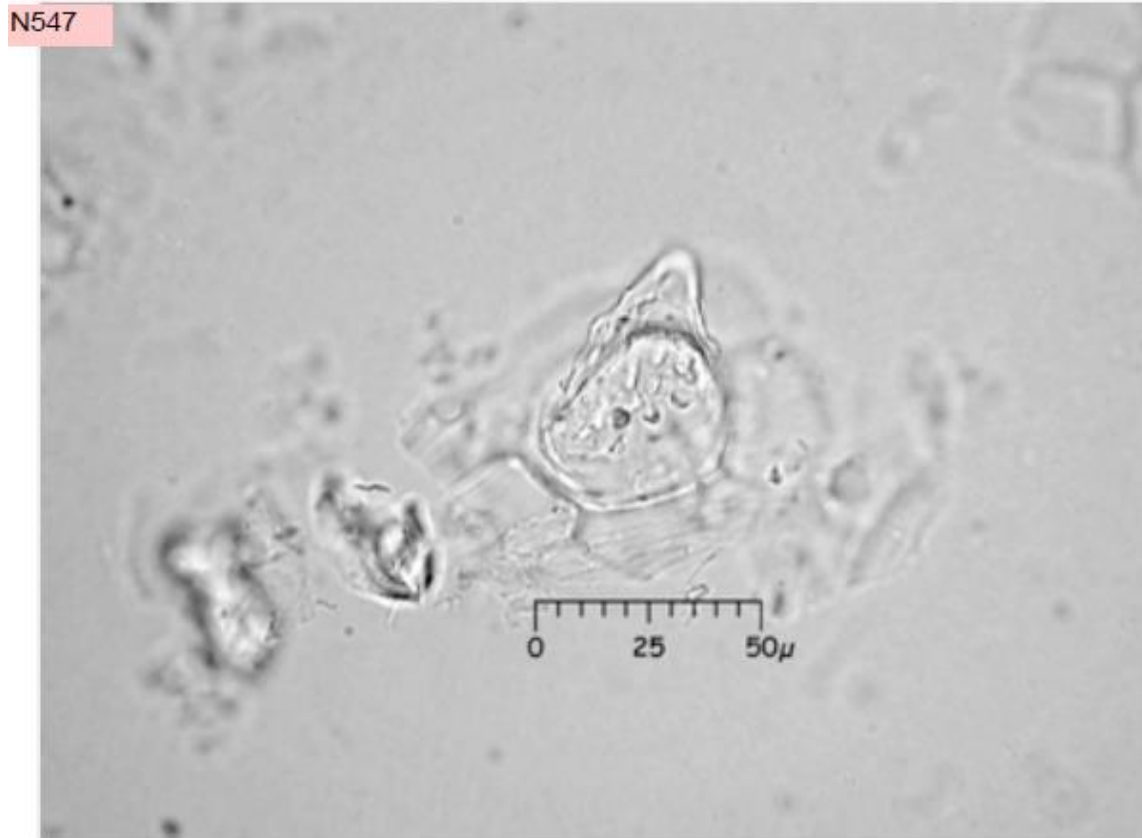


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia lutea

## Phytolith

Diagnostic level: Cordia/Heliotropium



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia lutea

## Phytolith

Type defined by Cesar Veintimilla  
05/1991.

Diagnostic level: species



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia lutea

## Phytolith

Side view.

See *Cordia lutea* hairs (40IIIAb100), conical bodies may come from projections on hair surface. Diagnostic level: species

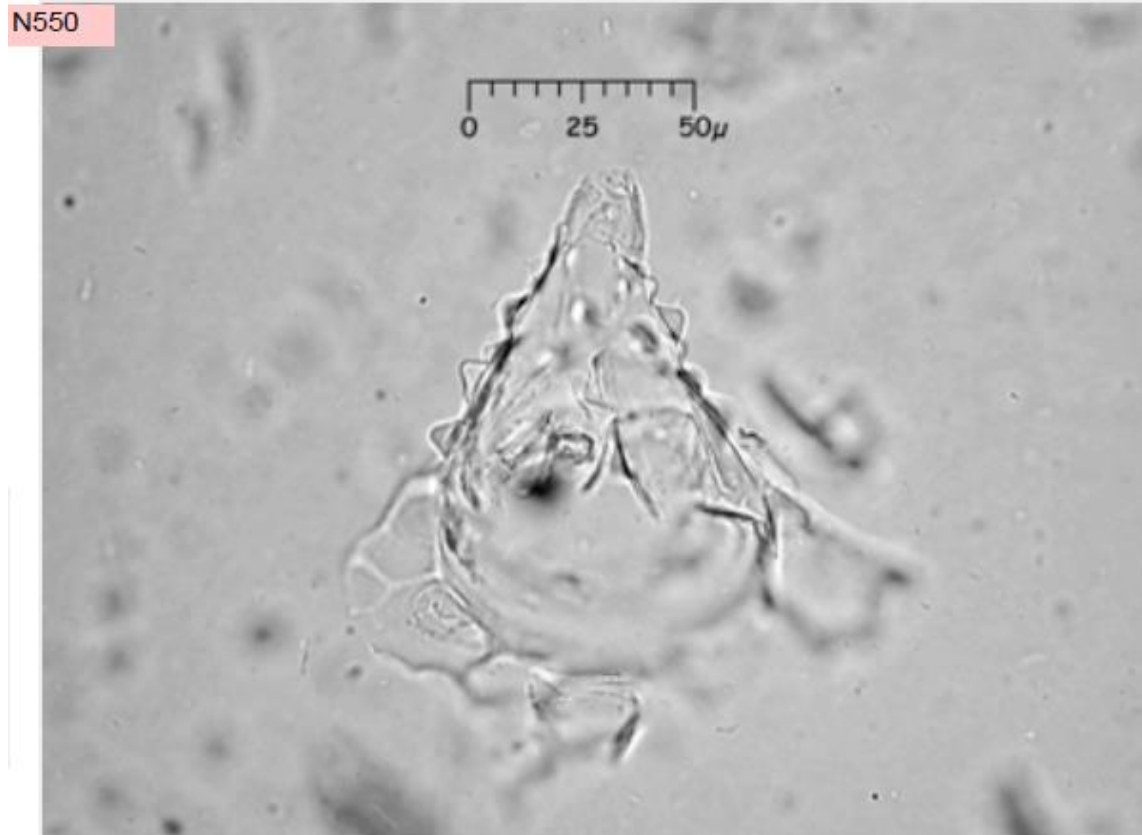


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia lutea

## Phytolith

Top view shows a *Cordia lutea* hair (40IIIAb100) with conical projections. Conical bodies (20VCd) may come from projections on hair surface. Diagnostic level (both): species



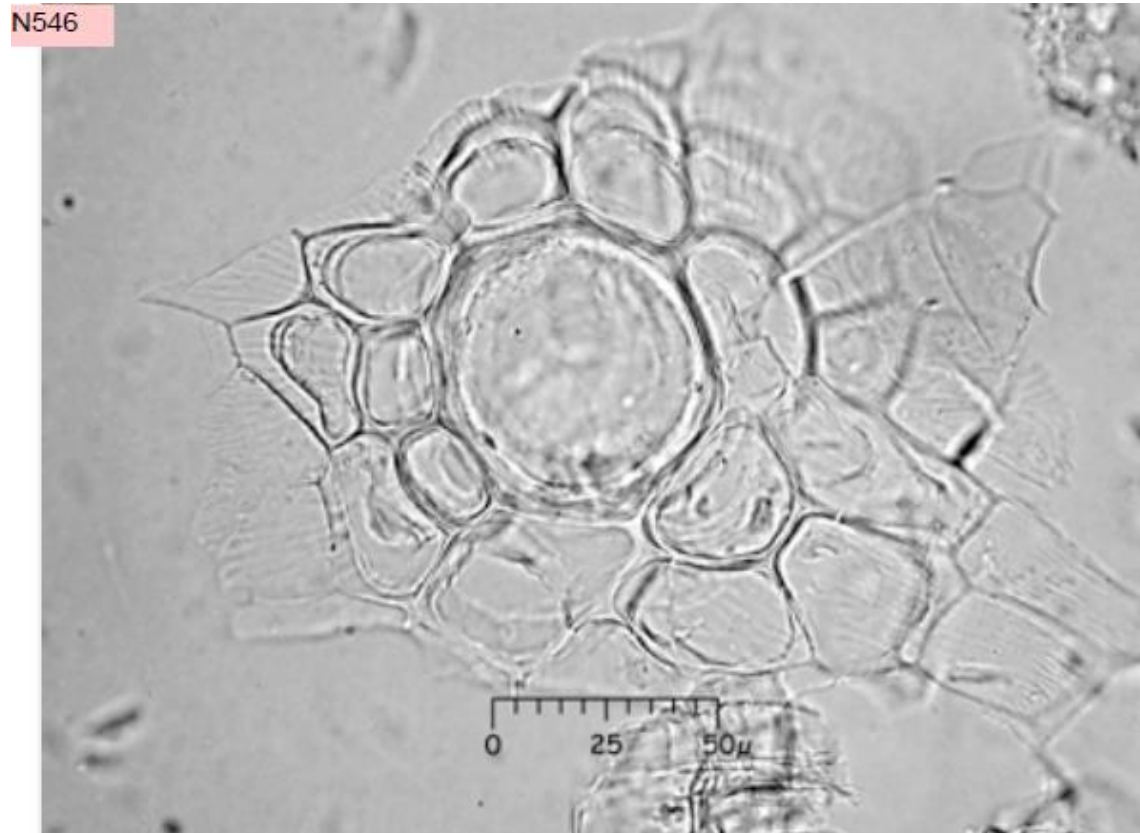
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Cordia lutea

## Phytolith

See Record #112 for another view. See other *Cordia lutea* types (20VCd), conical bodies may be derived from hair surface. Type defined by Cesar Veintimilla 05/1991. Diagnostic level: species



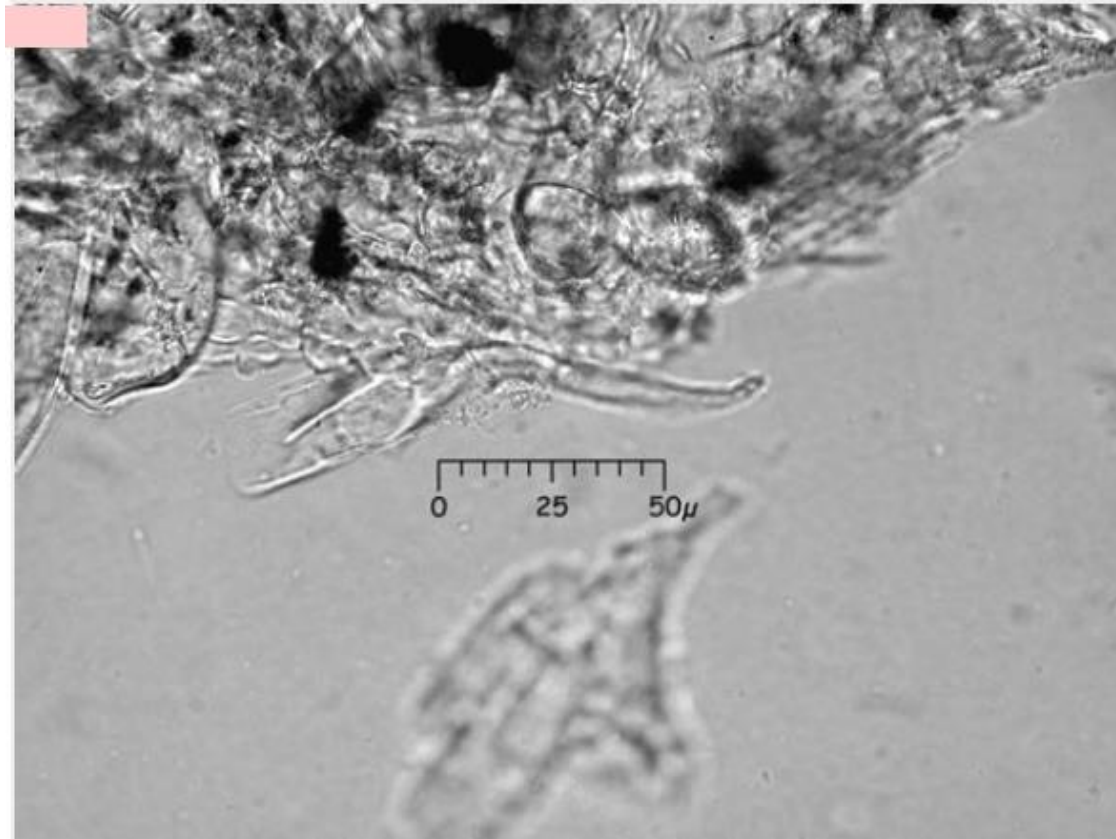
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia lutea

## Phytolith

Occurs in fruit. Type defined by Cesar Veintimilla.

Diagnostic level: species

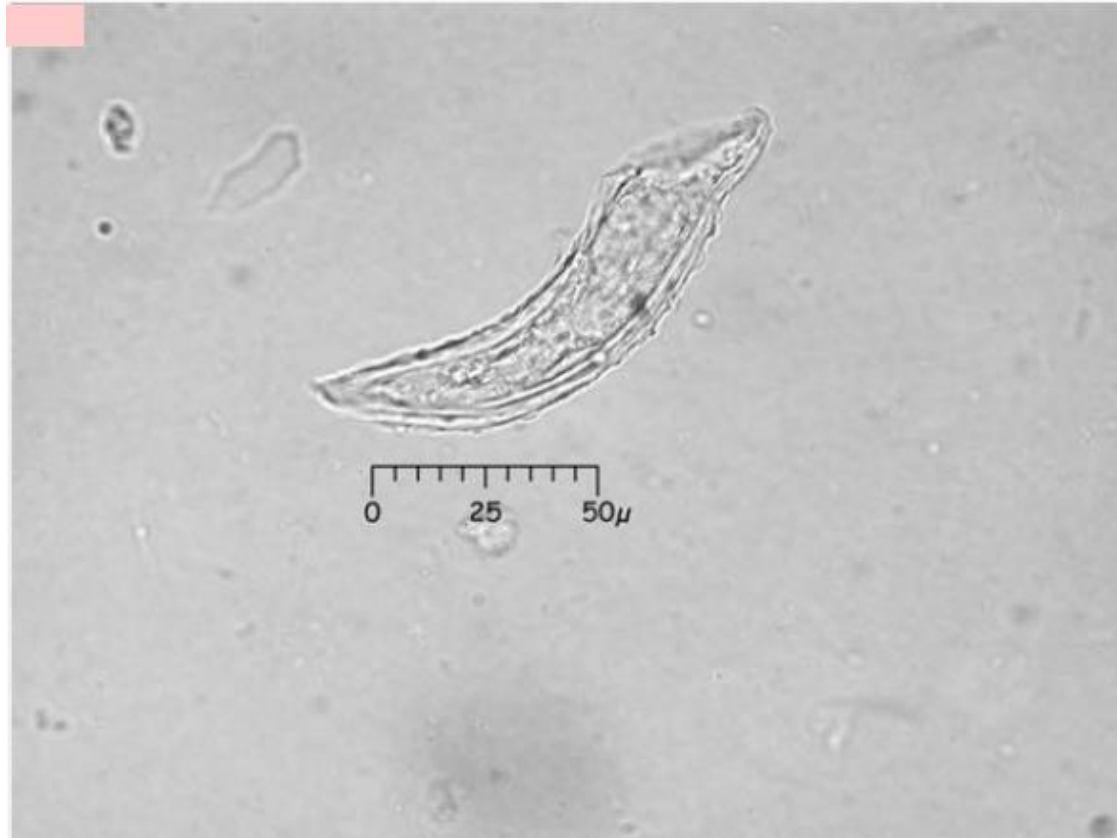


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia lutea

## Phytolith

Occurs in leaf. Also occurs in *Cordia hebeclada* (fruit) and *Heliotropium*.  
Type defined by Cesar Veintimilla.  
Diagnostic level: family

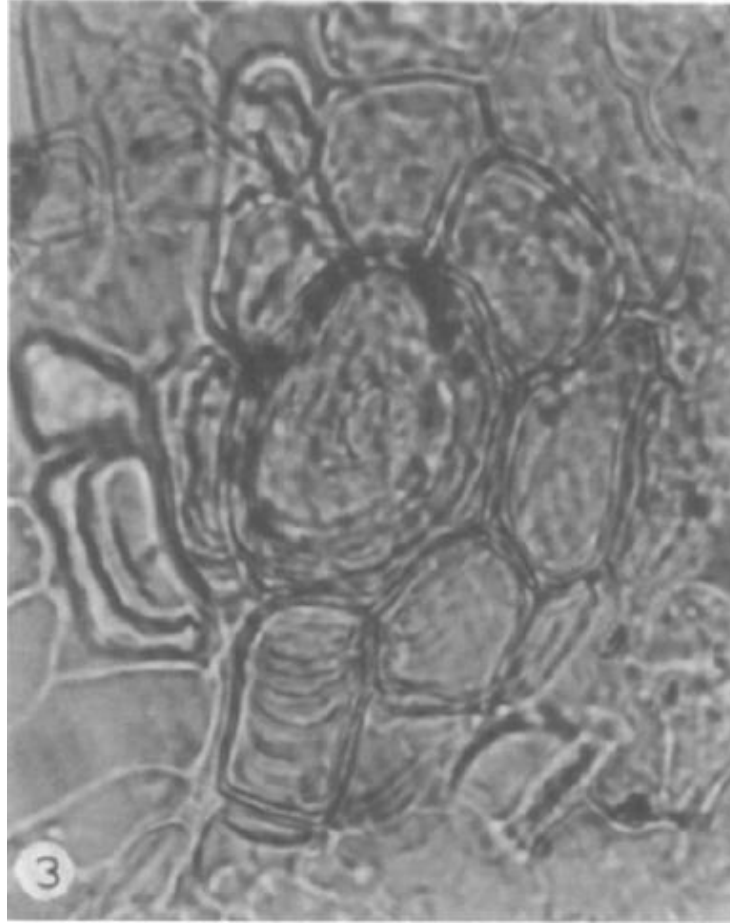


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cordia lutea

## Phytolith

3. A silicified hair base from *Cordia lutea* showing the elliptical pore in the center. It is surrounded by silicified epidermal cells with spherical inclusions (250 x ).

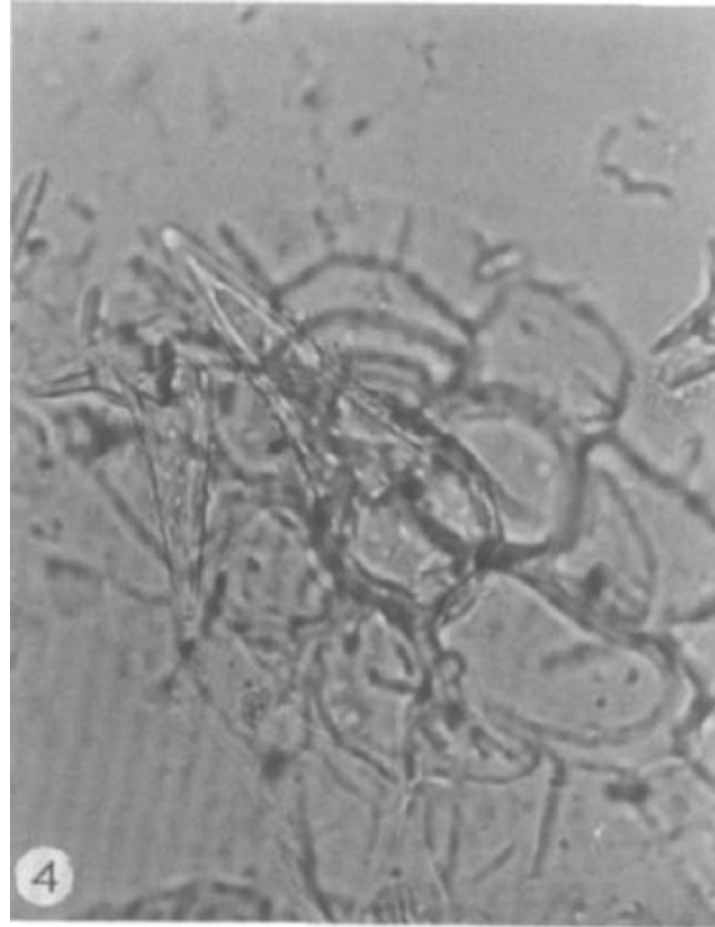


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Ehretia anacua

## Phytolith

4. Non-segmented armed hair from *Ehretia anacua*. It is attached to the hair base (156×)

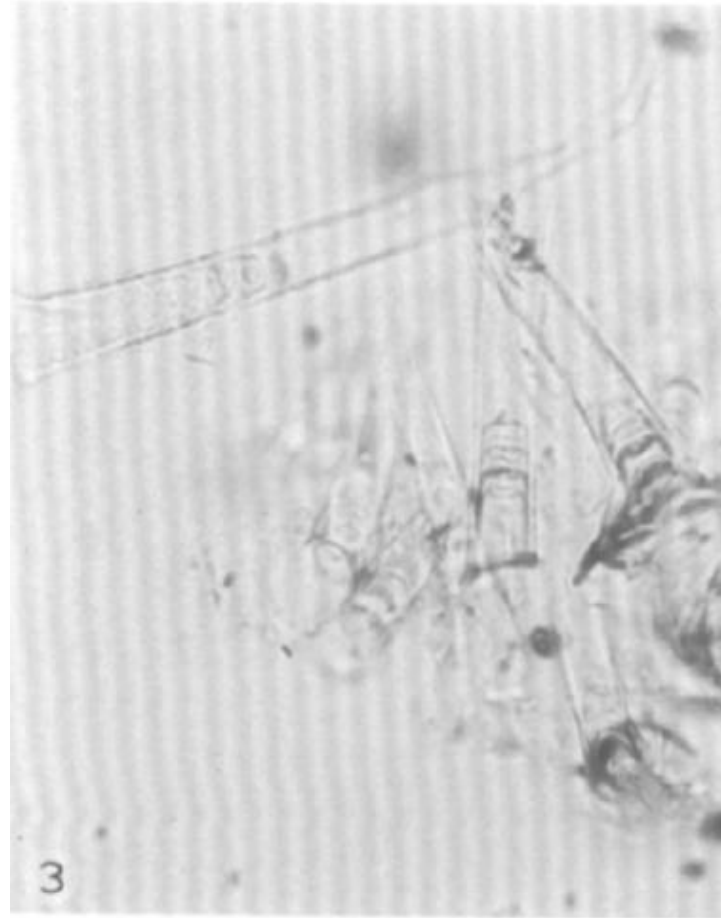


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Hackelia mexicana

## Phytolith

3. Segmented armed hairs with shortly divided segments near the base from *Hackelia mexicana* (156 ×).



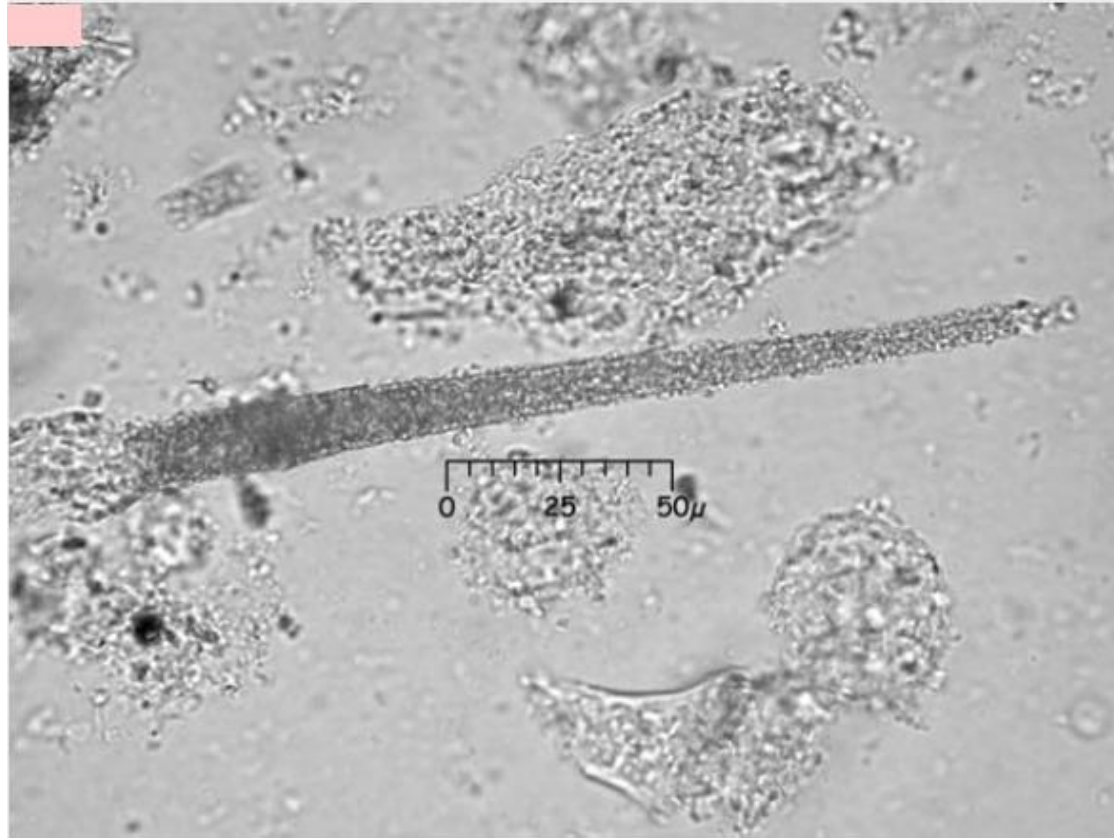
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Heliotropium angiospermum

## Phytolith

Slide E227.

Diagnostic level: genus

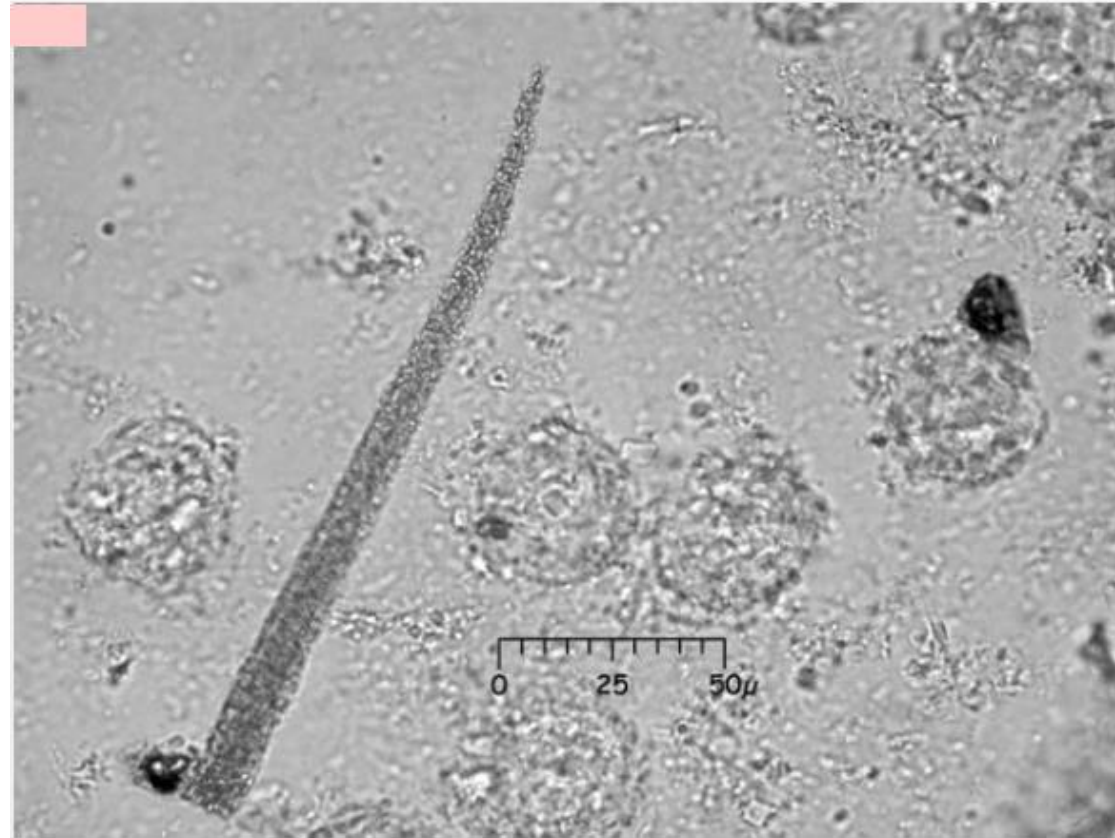


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Heliotropium angiospermum

## Phytolith

Slide E227. Several hair bases occur in picture next to unicellular hair (40IIIAb201). Concentric ring pattern not easily seen in picture. Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

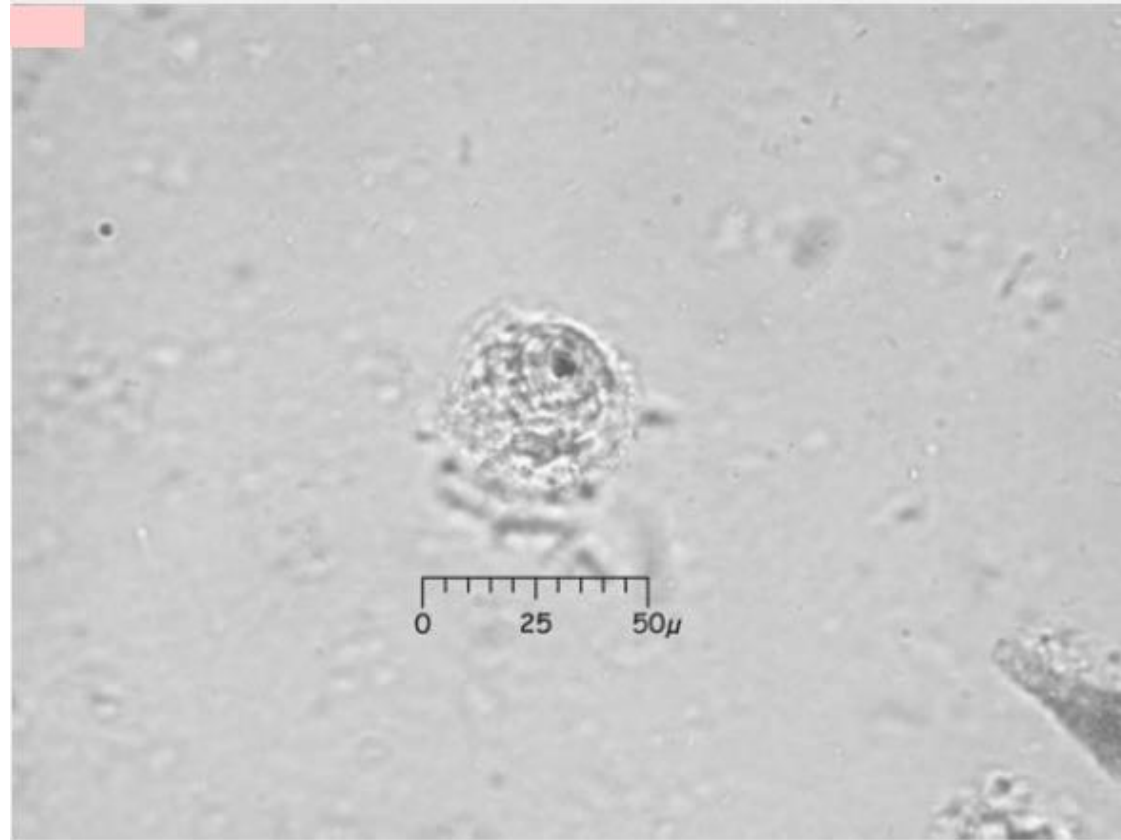


# Heliotropium angiospermum

## Phytolith

Slide E227.

Diagnostic level: genus

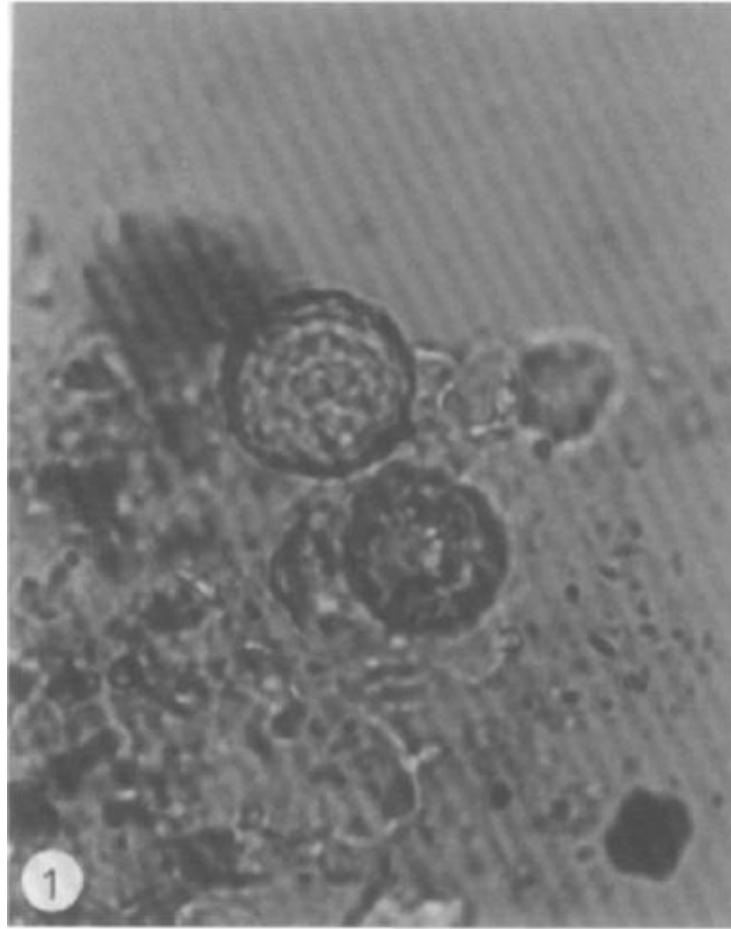


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Heliotropium angiospermum

## Phytolith

1. Silicified hair bases from  
*Heliotropium angiospermum*  
(250 x ).

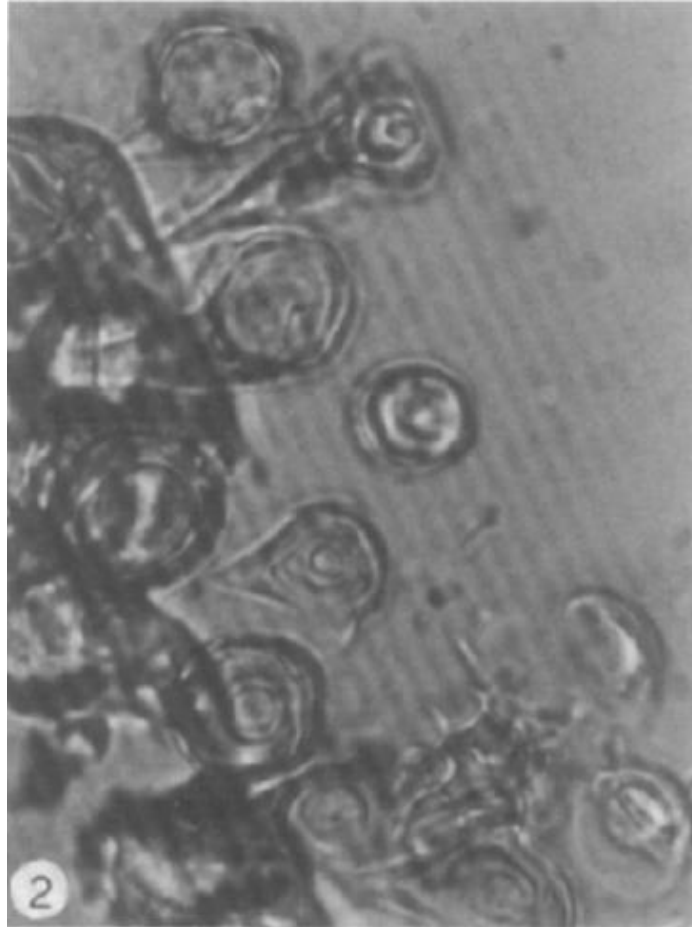


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Heliotropium indicum

## Phytolith

2. Silicified hair bases from *Heliotropium indicum*. Some have hair cells attached (250 x).

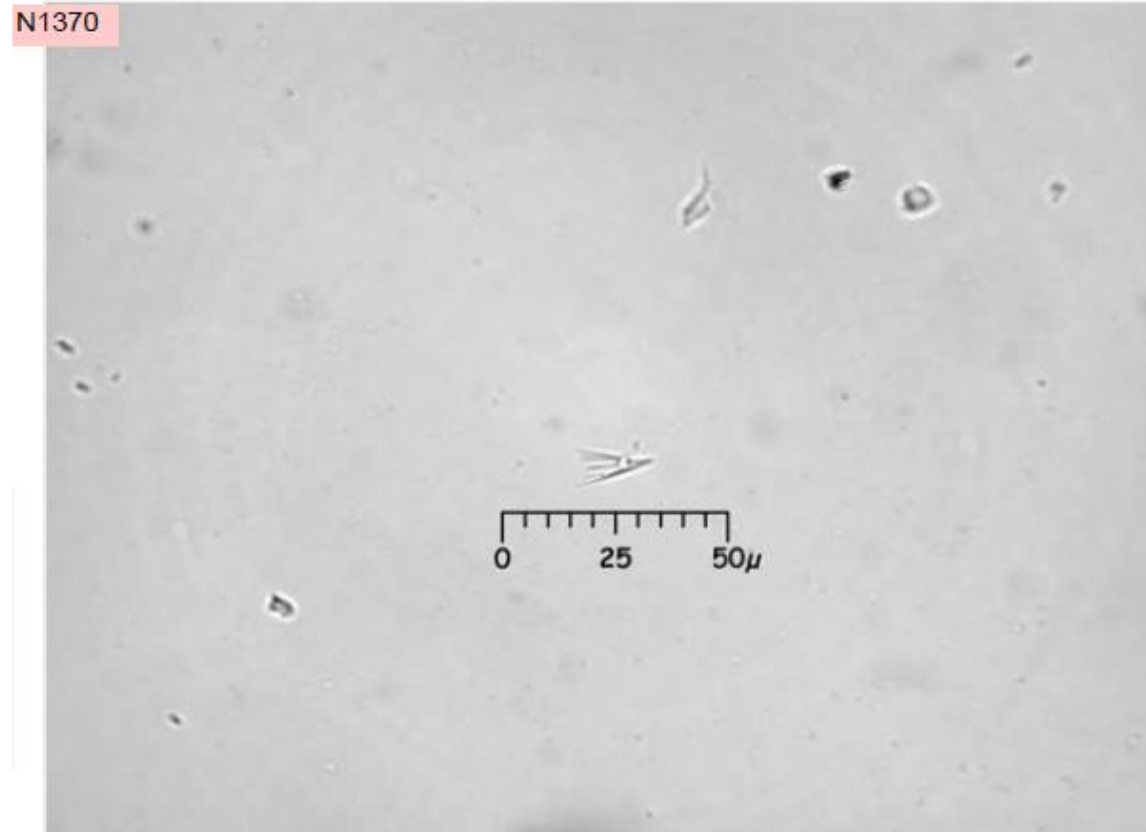


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Lithospermum carolinense

## Phytolith

Slide 1723a. Leaf. Hair tip

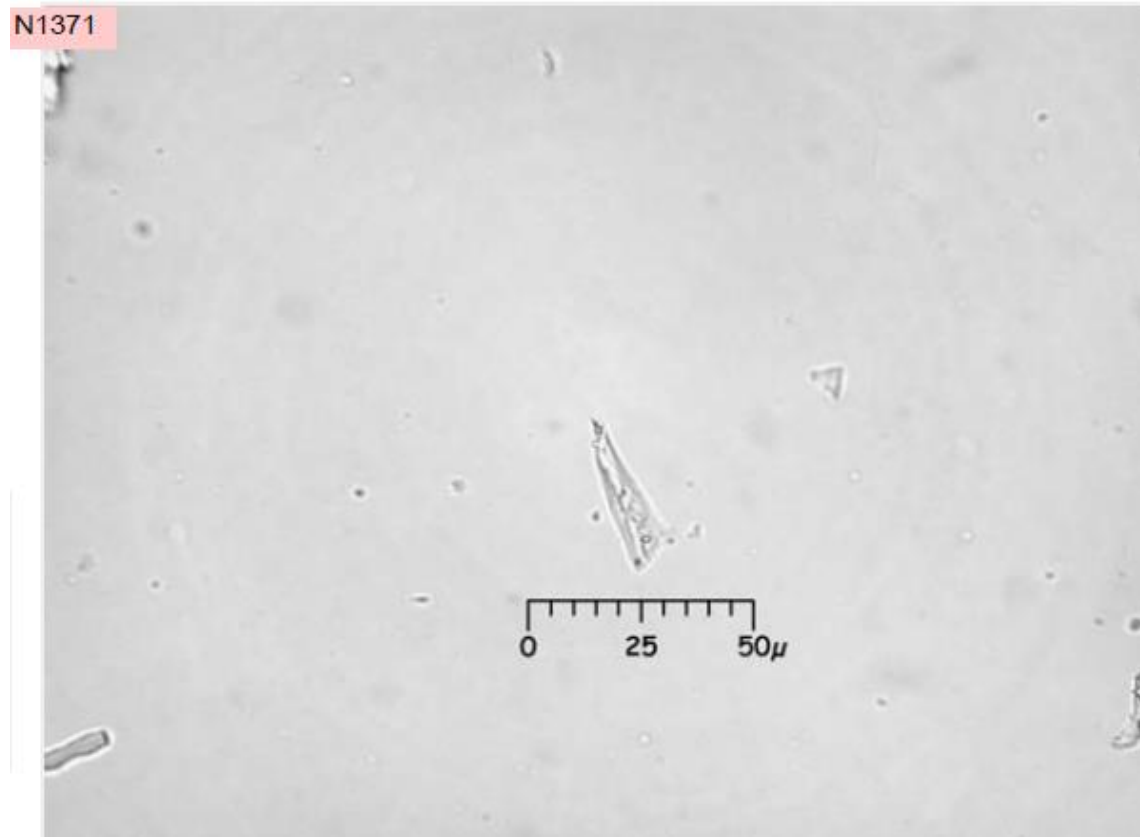


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lithospermum carolinense

## Phytolith

Slide 1723a. Leaf. Hair tip.

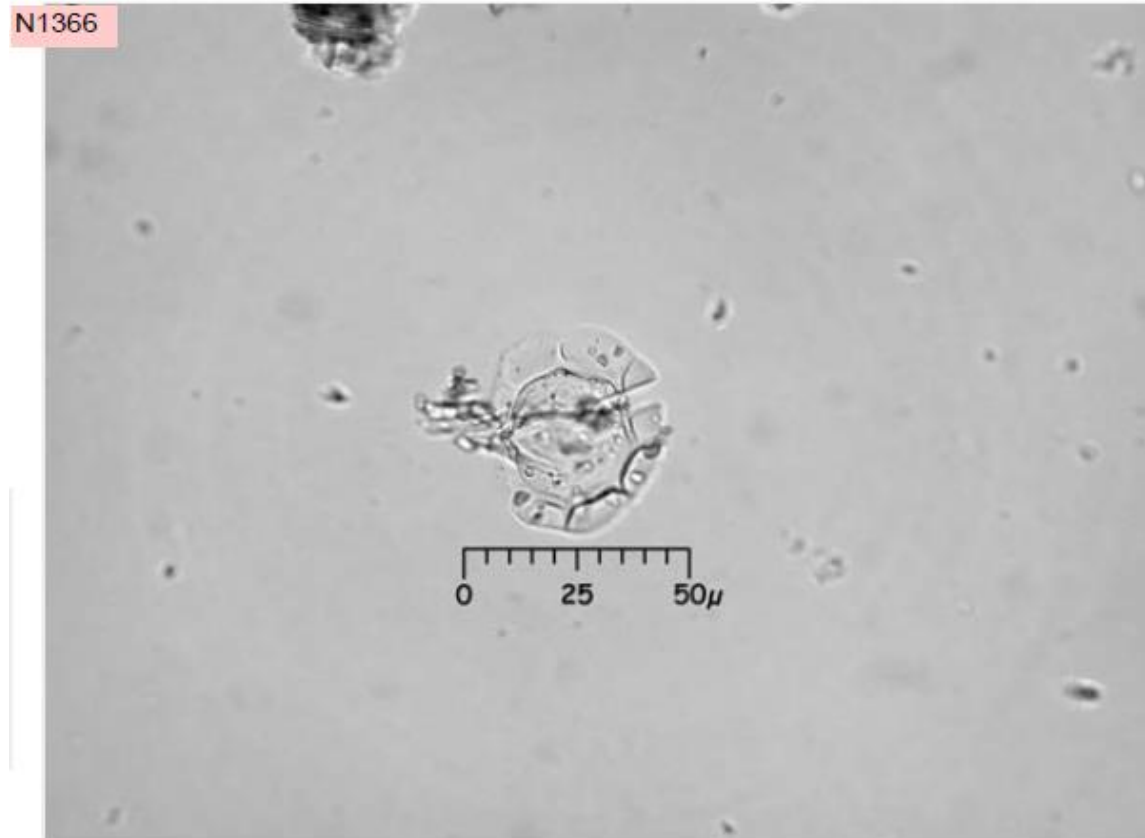


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lithospermum carolinense

## Phytolith

Slide 1723a. Leaf. Hair with base



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lithospermum carolinense

## Phytolith

Slide 1723b. Leaf.  
Hair with partial base attached and tip  
broken off.



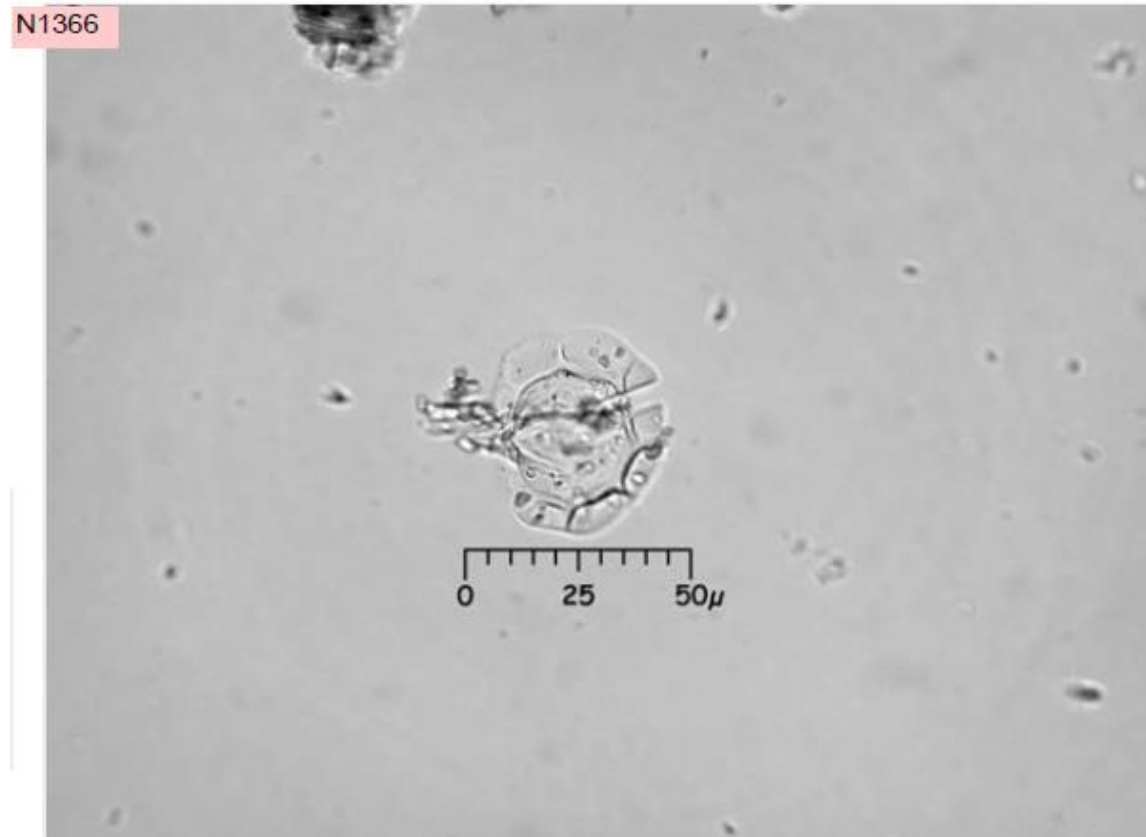
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lithospermum carolinense

## Phytolith

Slide 1723a. Leaf. Hair with base attached.

Diagnostic level: mixed Guazuma, Erythrina, Lithospermum



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

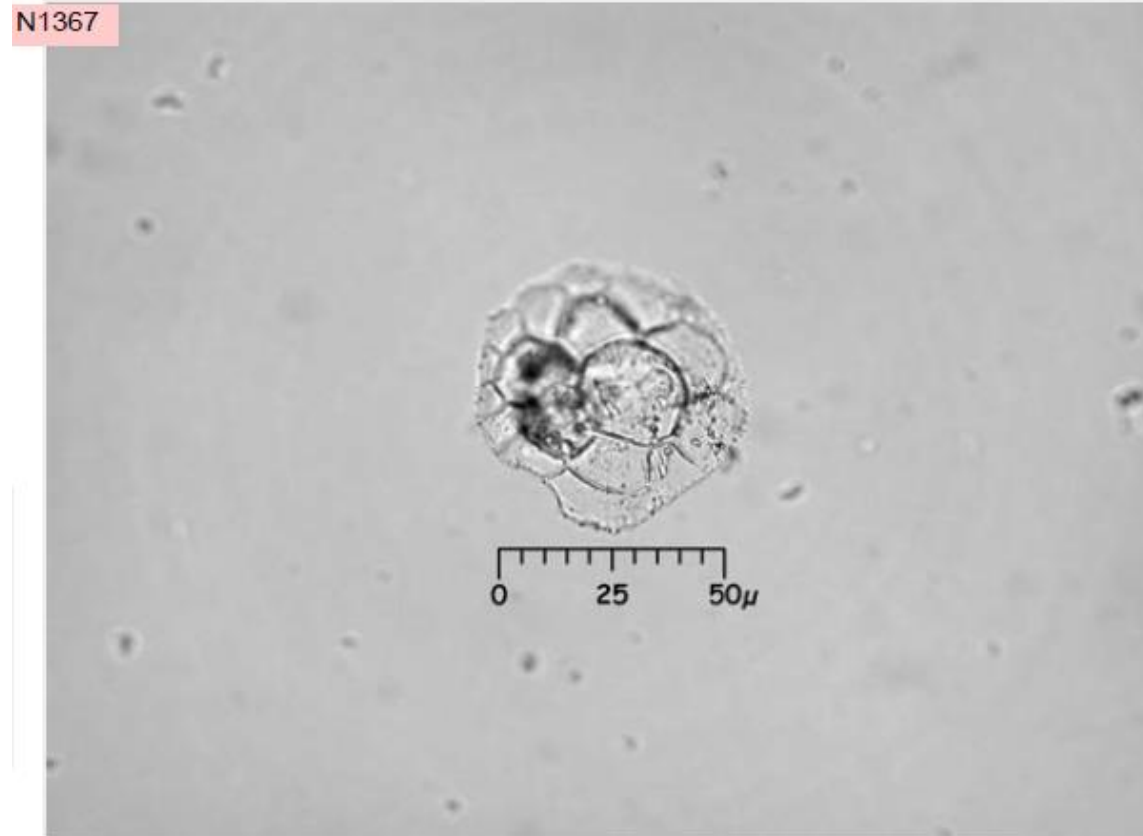


# Lithospermum carolinense

## Phytolith

Slide 1723a. Leaf.

Diagnostic level: mixed Guazuma,  
Erythrina, Lithospermum



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lithospermum carolinense

## Phytolith

Slide 1723c. Leaf.

Diagnostic level: mixed Guazuma,  
Erythrina, Lithospermum



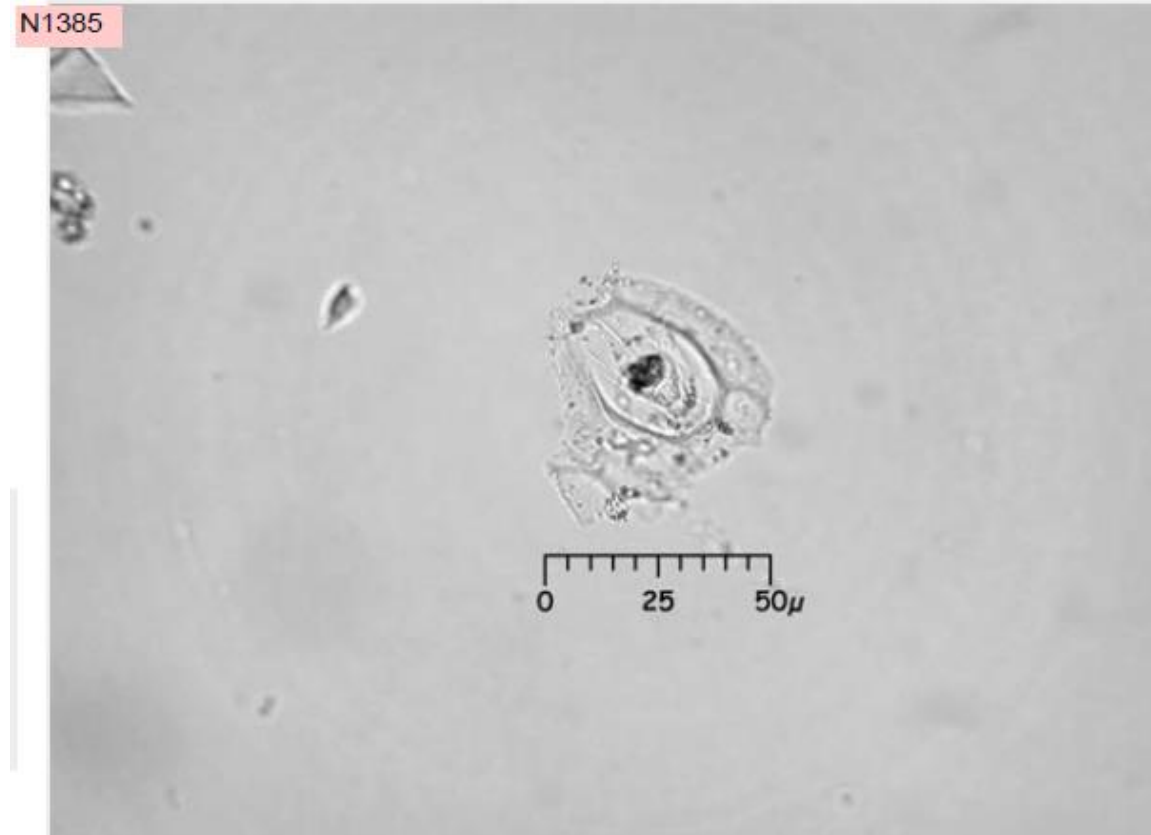
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lithospermum carolinense

## Phytolith

Slide 1723c. Leaf.

Diagnostic level: mixed Guazuma,  
Erythrina, Lithospermum



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

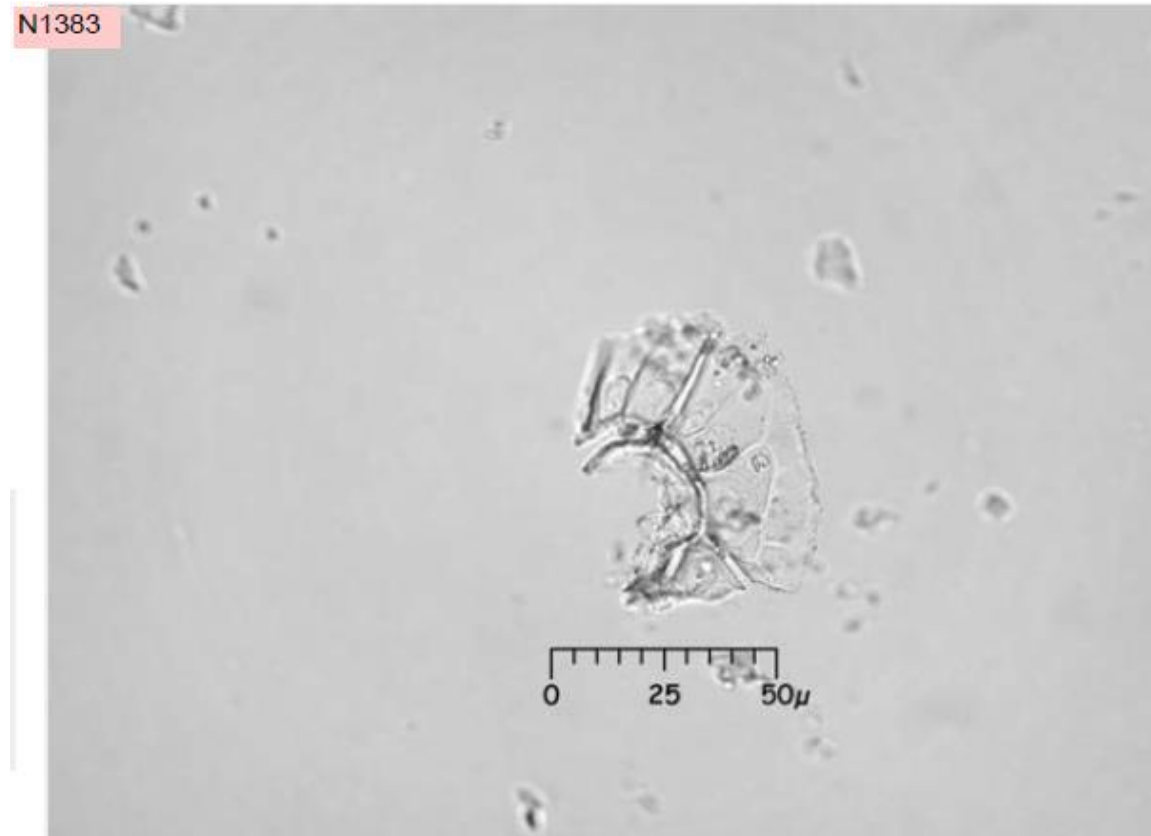
# Lithospermum carolinense

## Phytolith

Slide 1723c. Leaf.

Partial hair base, shows radiating appendages.

Diagnostic level: mixed Guazuma, Erythrina, Lithospermum



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

BRASSICACEAE

# Lepidium meyenii

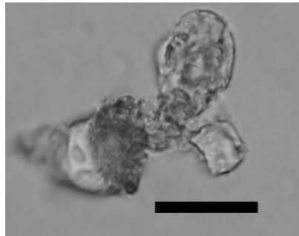
Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

Brassicaceae *Lepidium meyenii* "maca"

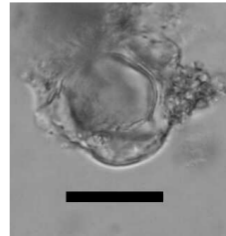
## Phytolith assemblage characterization

Different non diagnostic forms (\*):

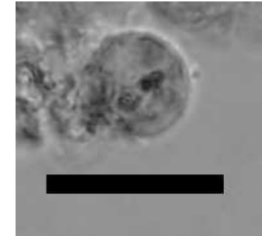
a) Semi-round irregular facetate silicaphytolith. Not common.



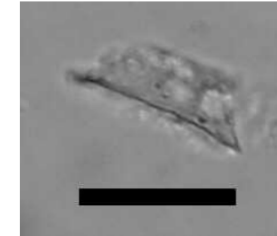
b) Globose concave silica phytolith. Not common.



c) Spherical dense silica phytolith. Rare.



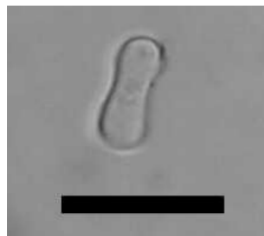
d) Lateral view of a round irregularly perforated silica phytolith. Rare.



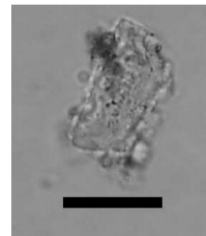
tuber

Different non diagnostic forms (\*):

a) Bilobate psilate silica phytolith. Rare.



b) Sub-rectangular irregularly verrucate silica phytolith. Rare.



leaf attached to the tuber

Scale bar = 20µm.

BROMELIACEAE

# Abromeitiela sp.

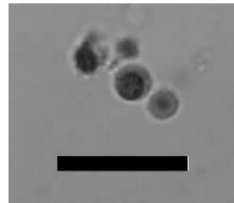
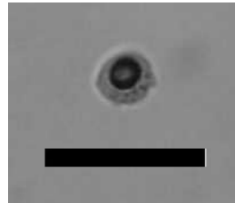
Bromeliaceae *Abromeitiela* sp. "chaguar"

## Phytolith assemblage characterization

Non diagnostic phytoliths (\*):

- a) Spherical centrally cavate silica phytolith.  
Common.

leaf



Scale bar = 20µm.

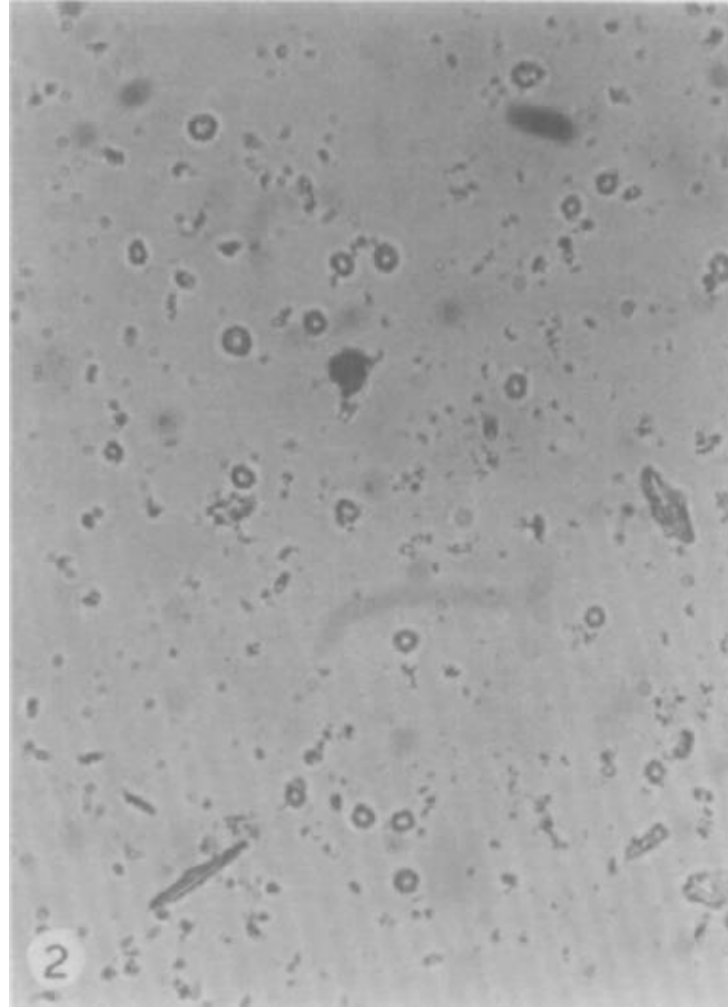
Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection



# Bromelia balanense

## Phytolith

Spherical spinulose phytoliths  
from *Bromelia balanense*  
(400x).

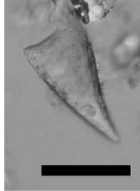
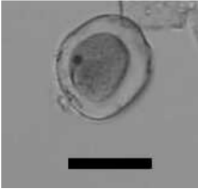
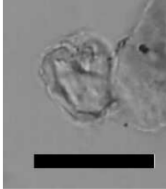


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Tillandisia sp.

Bromeliaceae *Tillandisia* sp. "clavel del aire"

## Phytolith assemblage characterization

leaf	Non diagnostic phytoliths (*): a) Round silica phytolith. Rare.			b) Acuminate silica phytolith. Rare.	<b>References:</b> Reported as not present in Piperno 1988:27, on <i>Tillandisia polystachya</i> sample.
	Lateral view.	Plane view.			
flower	Non diagnostic phytoliths (*): a) Round central cavated silica phytolith. Rare.			b) Irregular silica phytolith. Rare.	<b>References:</b> Reported as not present in Piperno 1988:27, on <i>Tillandisia polystachya</i> sample.
					

Scale bar = 20µm.

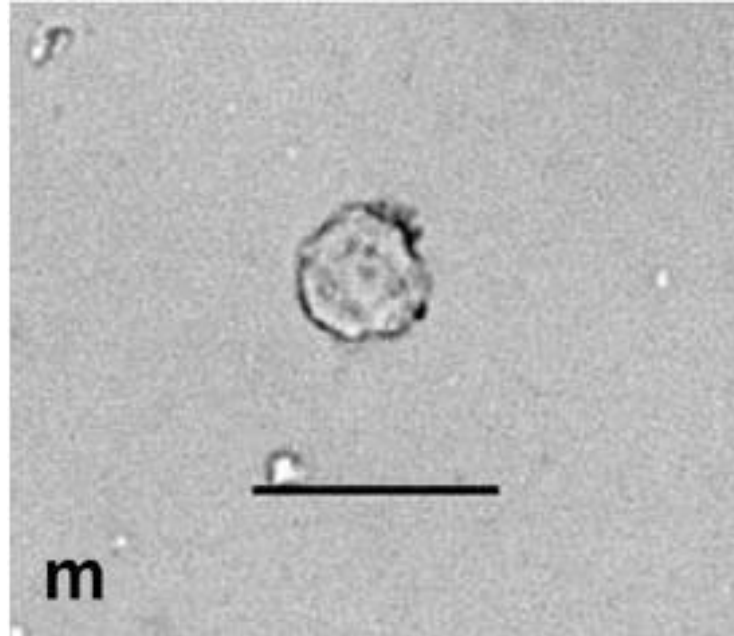
Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

BURMANNIACEAE

# Burmannia bicolor

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. m) Globular granulate phytolith from *Burmannia bicolor*

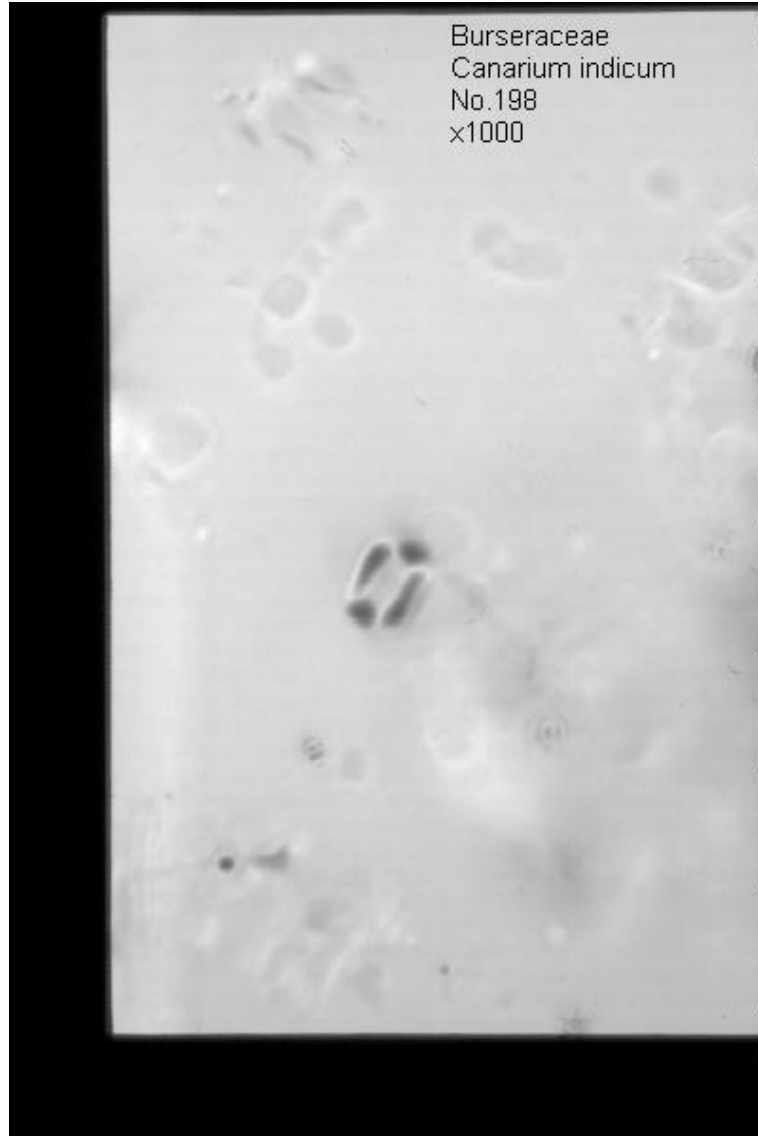


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

BURSERACEAE

# Canarium indicum

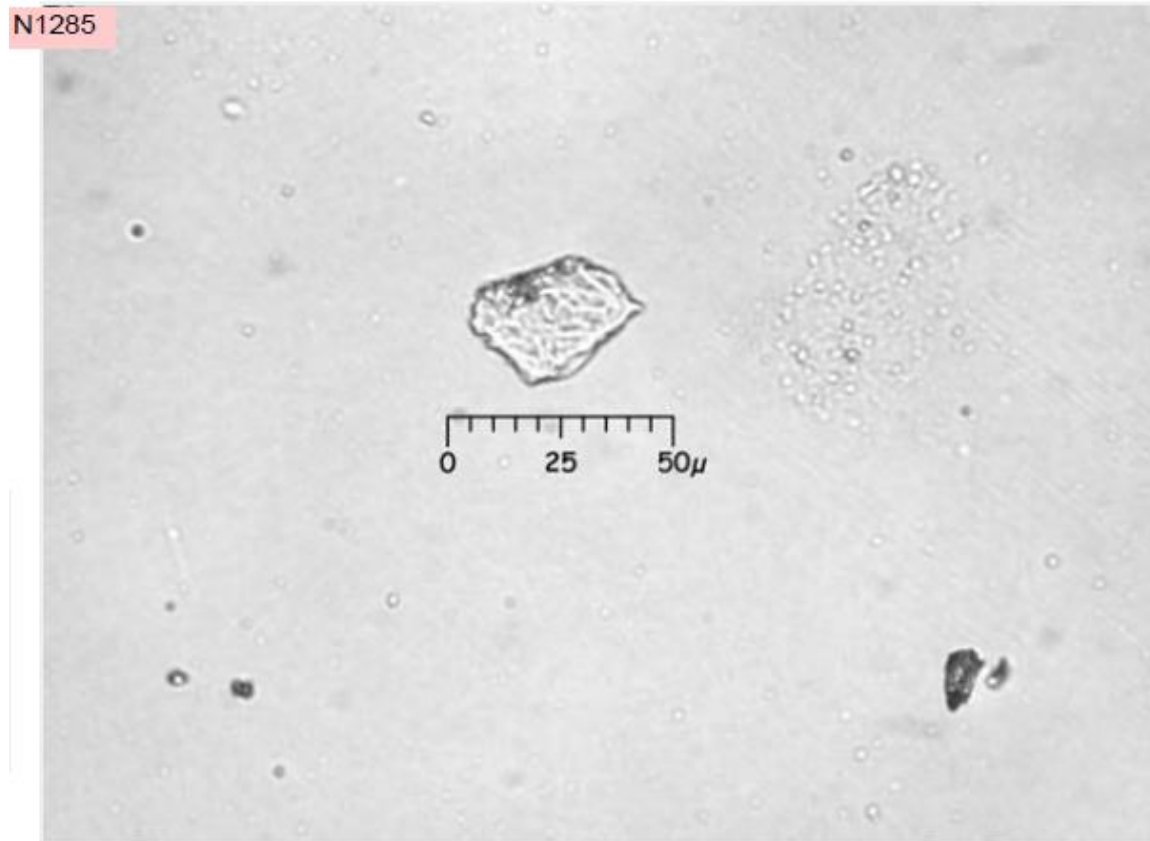
Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Dacryodes occidentalis

## Phytolith

Slide 58. Also occurs in *Trattinnickia glaziouii*, slide 64. Diagnostic level: family

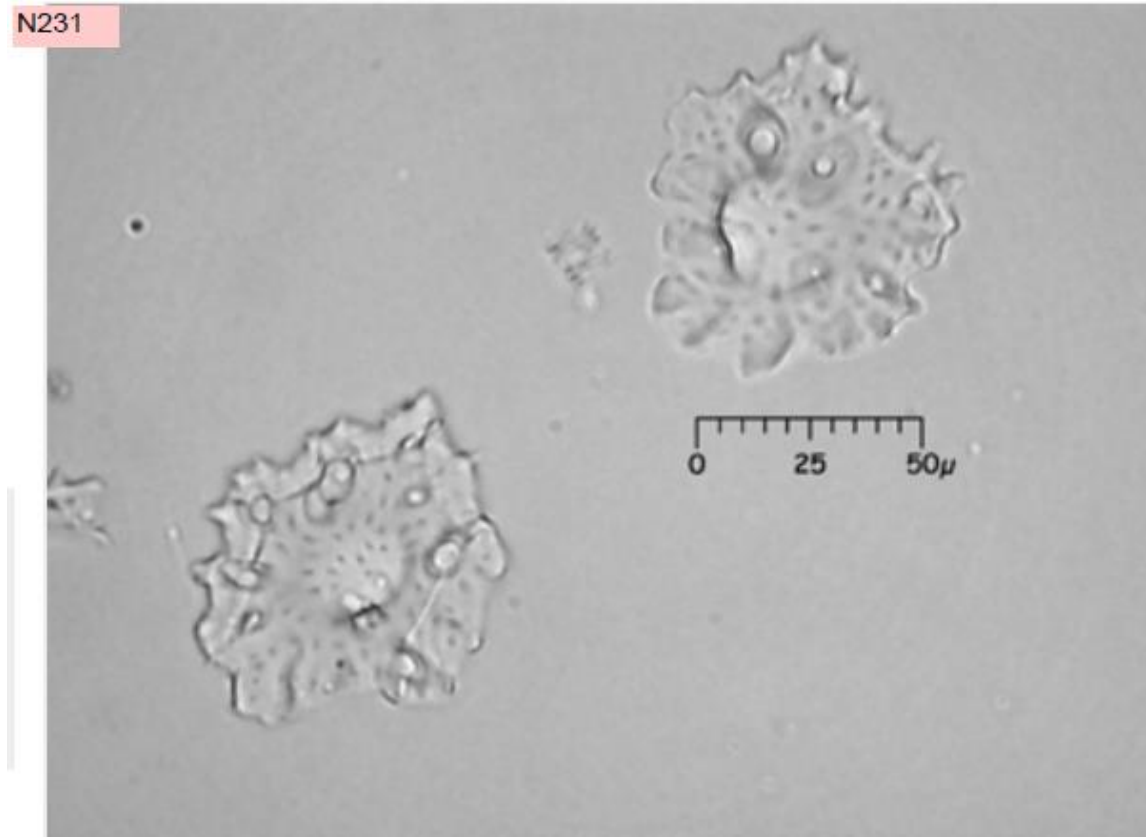


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Protium fimbriatum

## Phytolith

See other rotations (Records 163 and 164) to get an idea of the three-dimensional shape. This body is very tall with a very ruffled or undulating edge. Diagnostic level: family



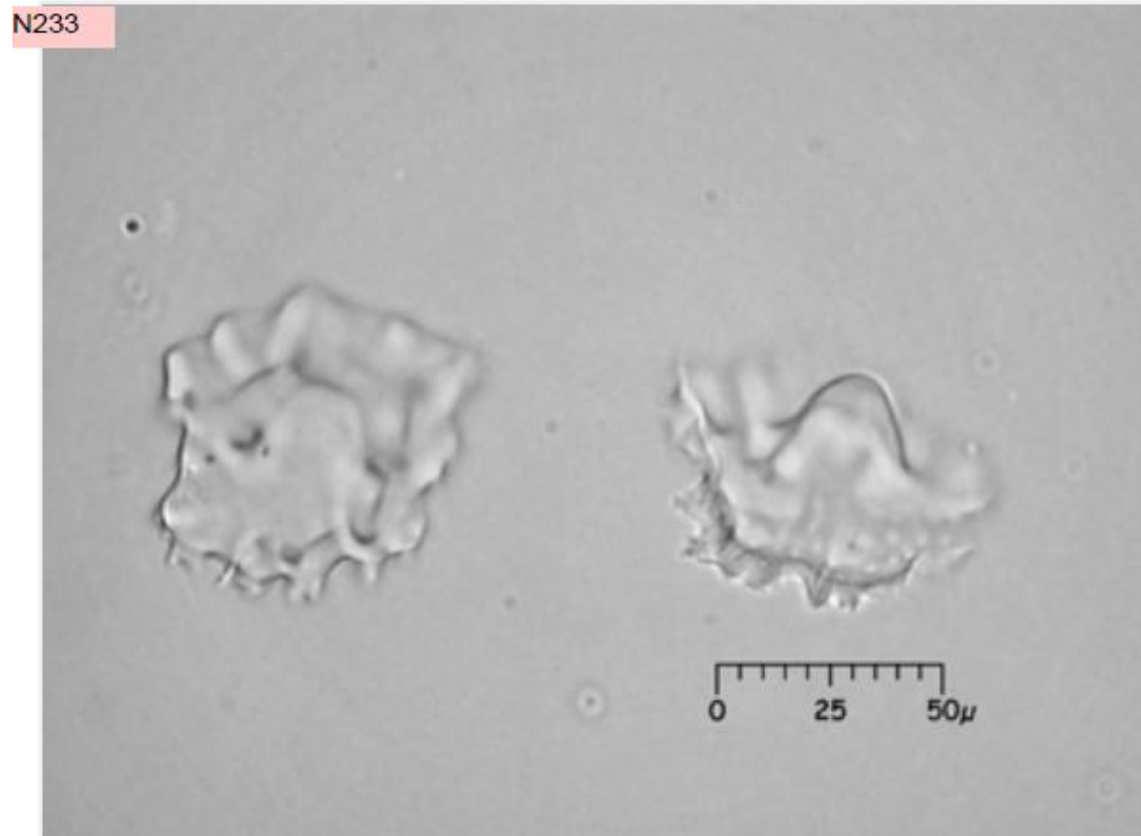
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Protium fimbriatum

## Phytolith

See other rotations (Records 162 and 164) to get an idea of the three-dimensional shape. This body is very tall with a very ruffled or undulating edge. Diagnostic level: family

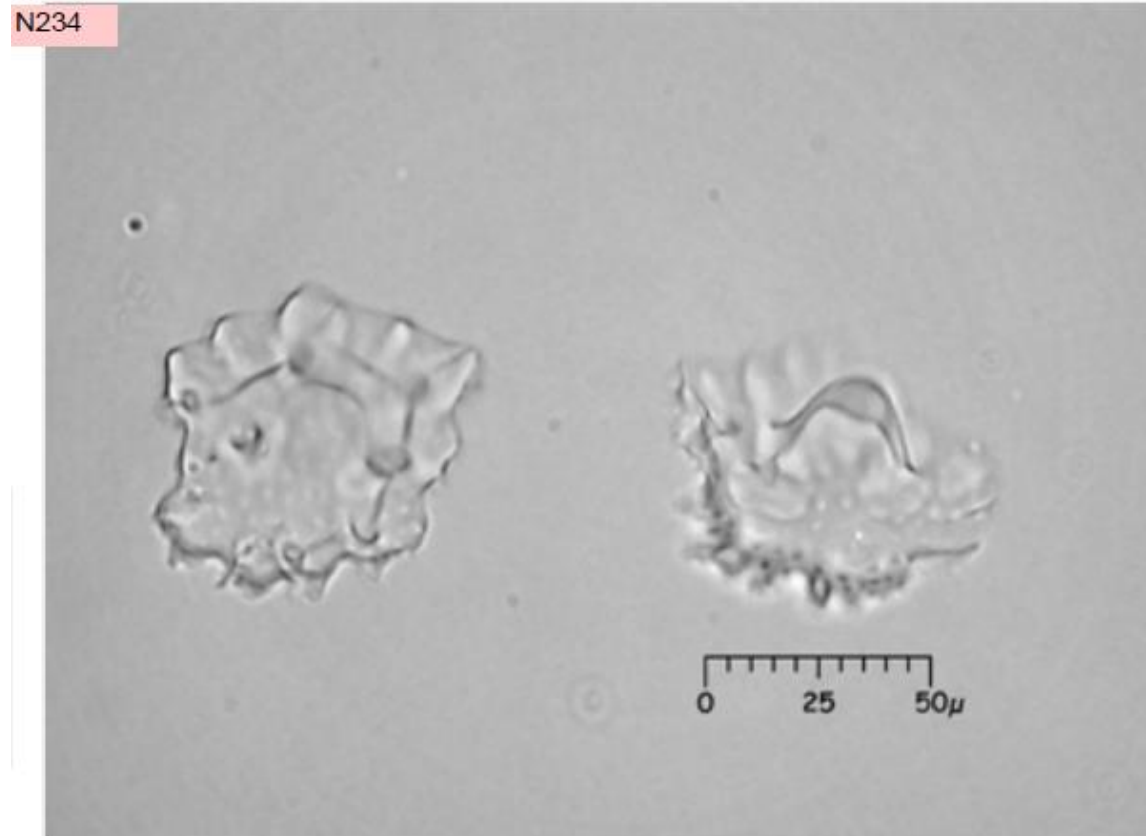


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Protium fimbriatum

## Phytolith

See other rotations (Records 162 and 163) to get an idea of the three-dimensional shape. This body is very tall with a very ruffled or undulating edge. Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Protium guianense

## Phytoliths

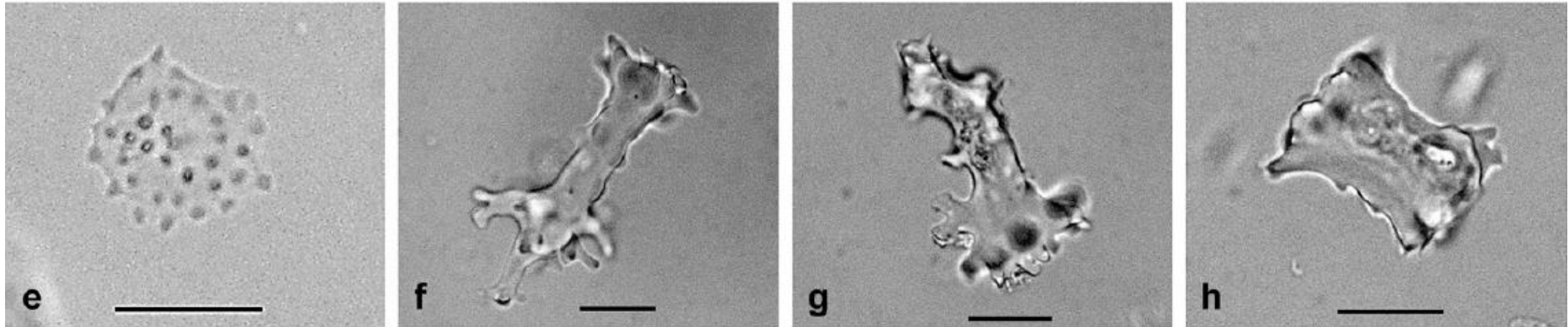
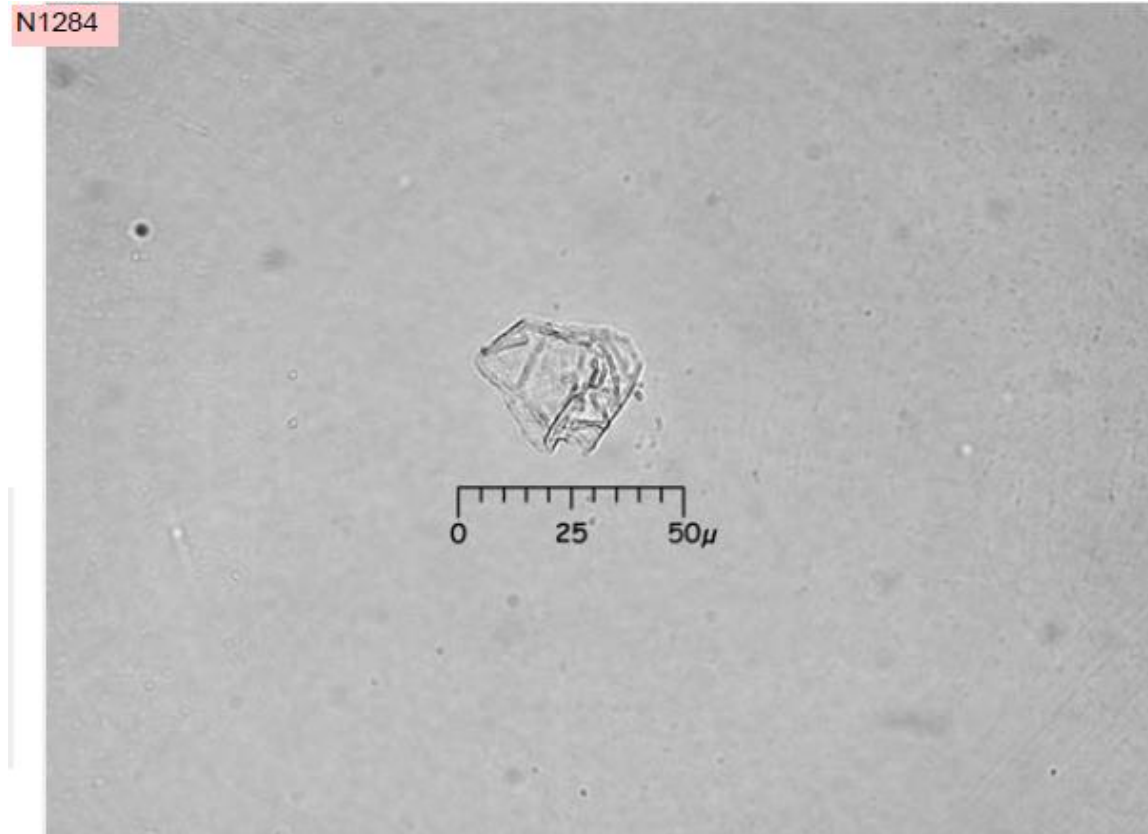


Fig. 5. Phytoliths from dicotyledons. e) Stippled body from *Protium guianense* fruit, f-h) “Boney” bodies from *P. guianense* leaf

# Trattinnickia glaziouii

## Phytolith

Slide 64. Also occurs in *Dacryodes occidentalis*, slide 58. Diagnostic level: family



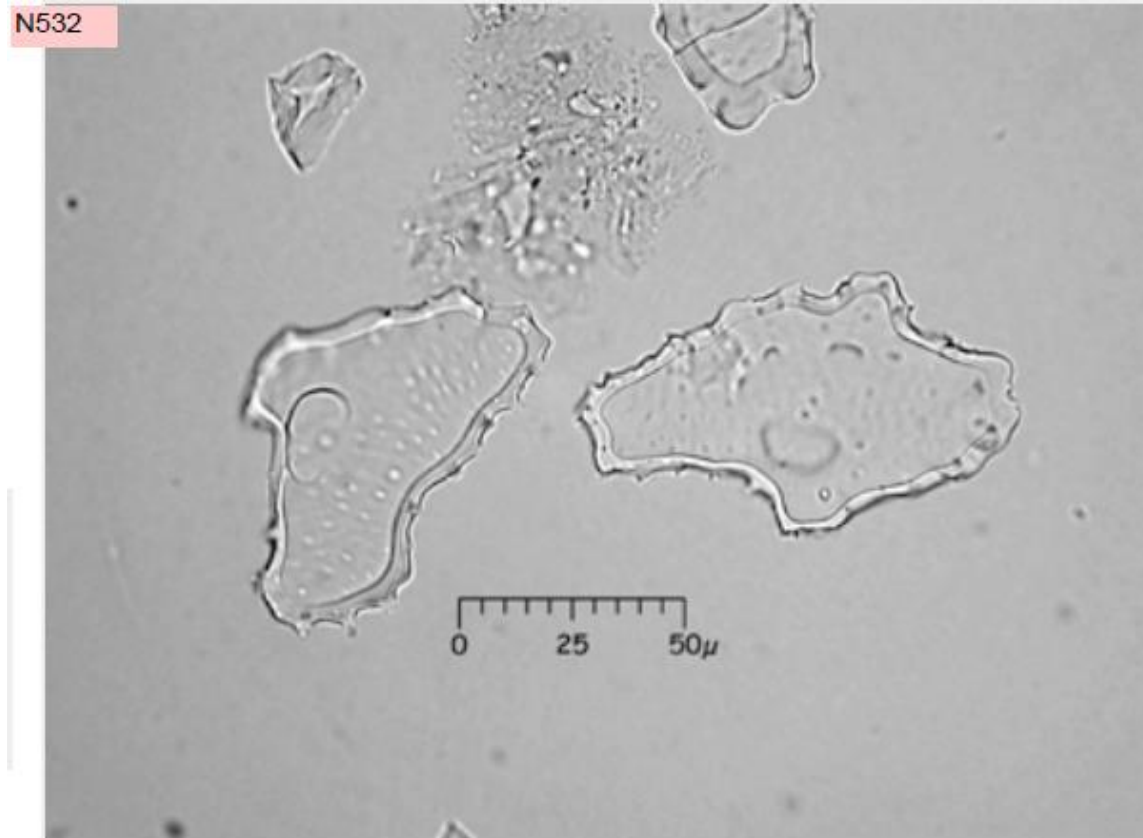
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trattinnickia glaziovii

## Phytolith

Seed epidermis. Projection is not centered and may not be present on all fragments. The projection is often very low. Surface decoration not always evident unless focus is moved up and down.

Diagnostic level: family



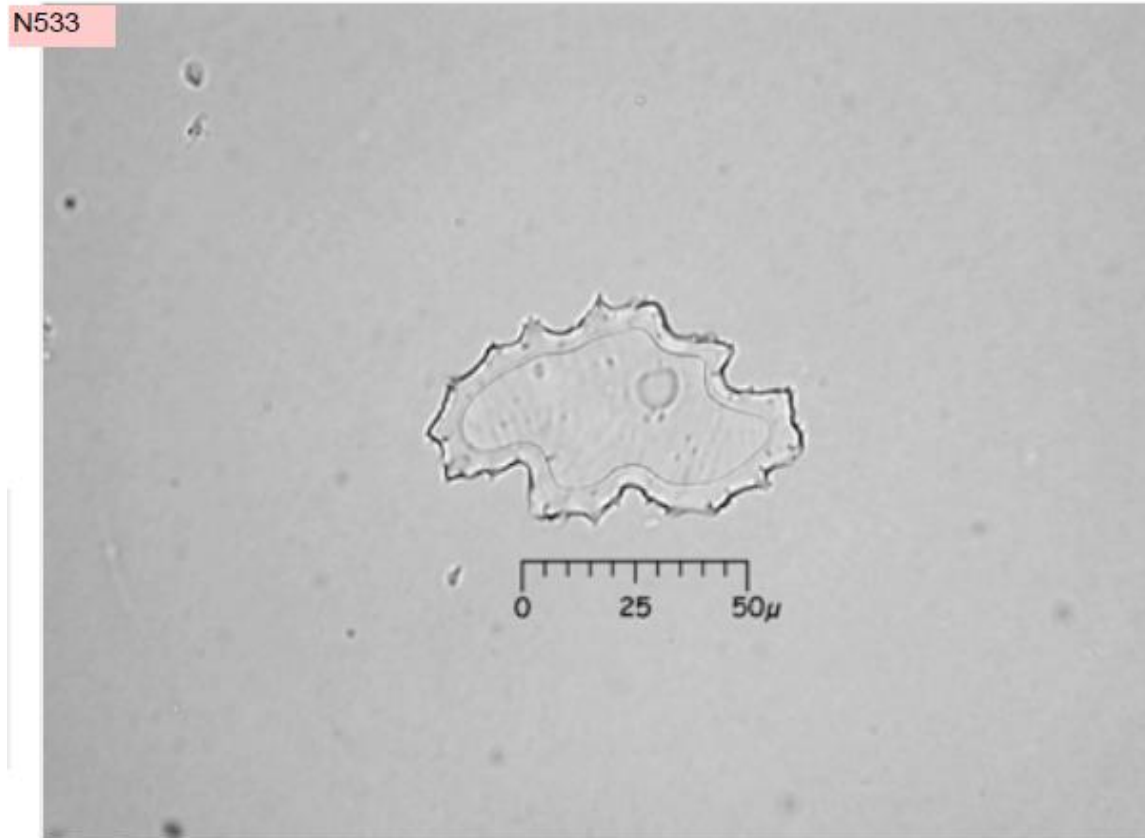
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trattinnickia glaziovii

## Phytolith

Seed epidermis. Projection is not centered and may not be present on all fragments. The projection is often very low. Surface decoration not always evident unless focus is moved up and down.

Diagnostic level: family

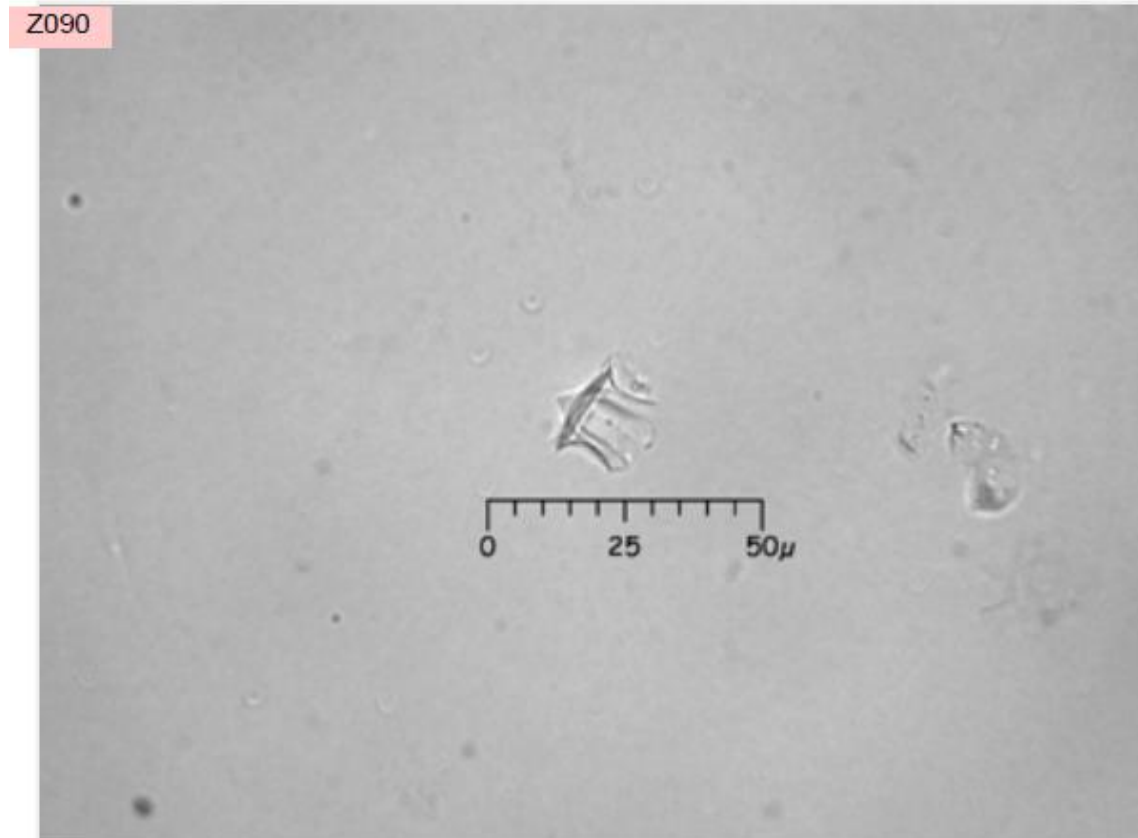


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trattinnickia peruviana

## Phytolith

Side view; see Record #134 for top view.  
Occurs in the leaf. Diagnostic level:  
genus

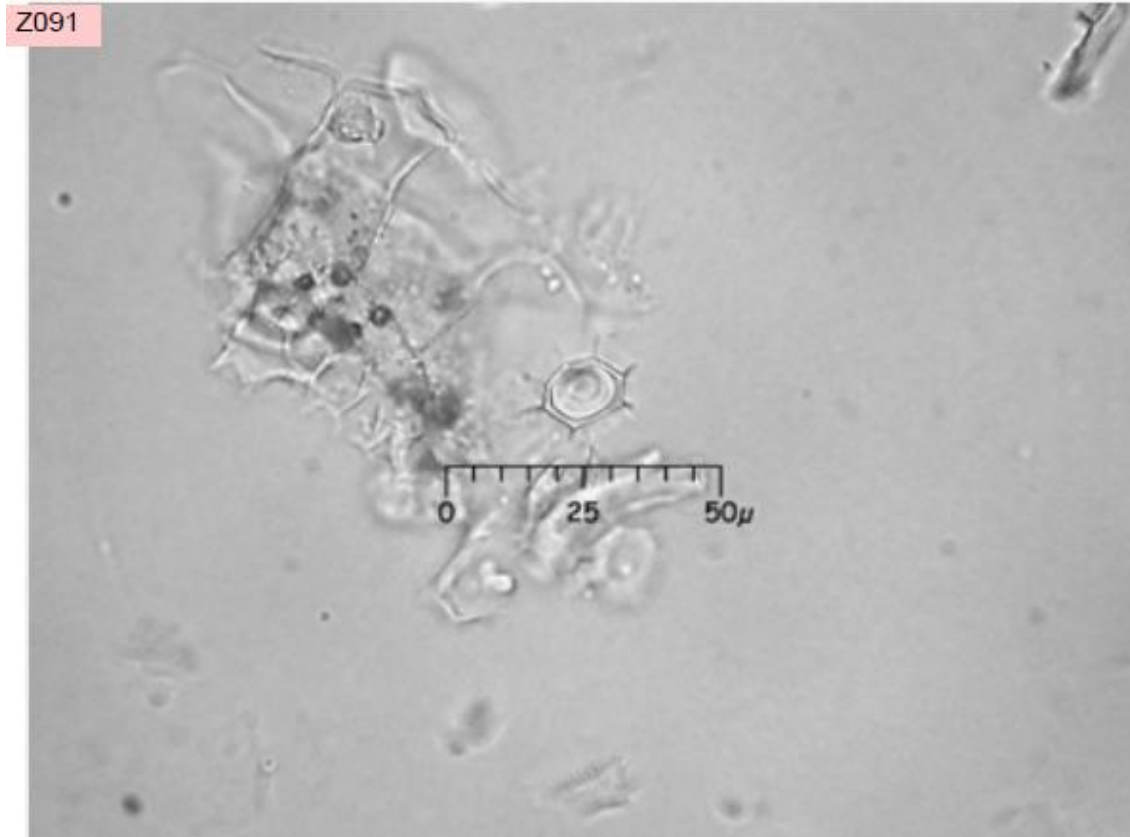


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trattinnickia peruviana

## Phytolith

Top view; see Record #133 for side view.  
Occurs in the leaf. Diagnostic level:  
genus



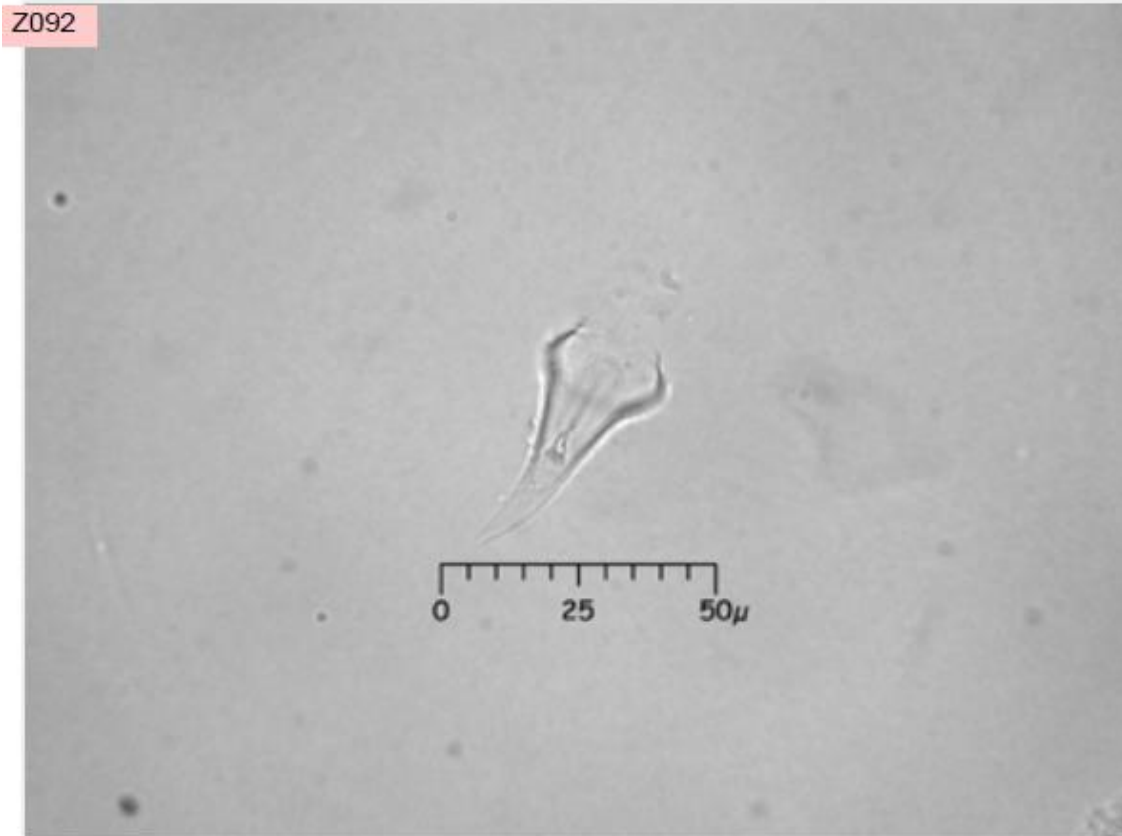
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Trattinnickia peruviana

## Phytolith

Occurs in the leaf. Diagnostic level:  
genus

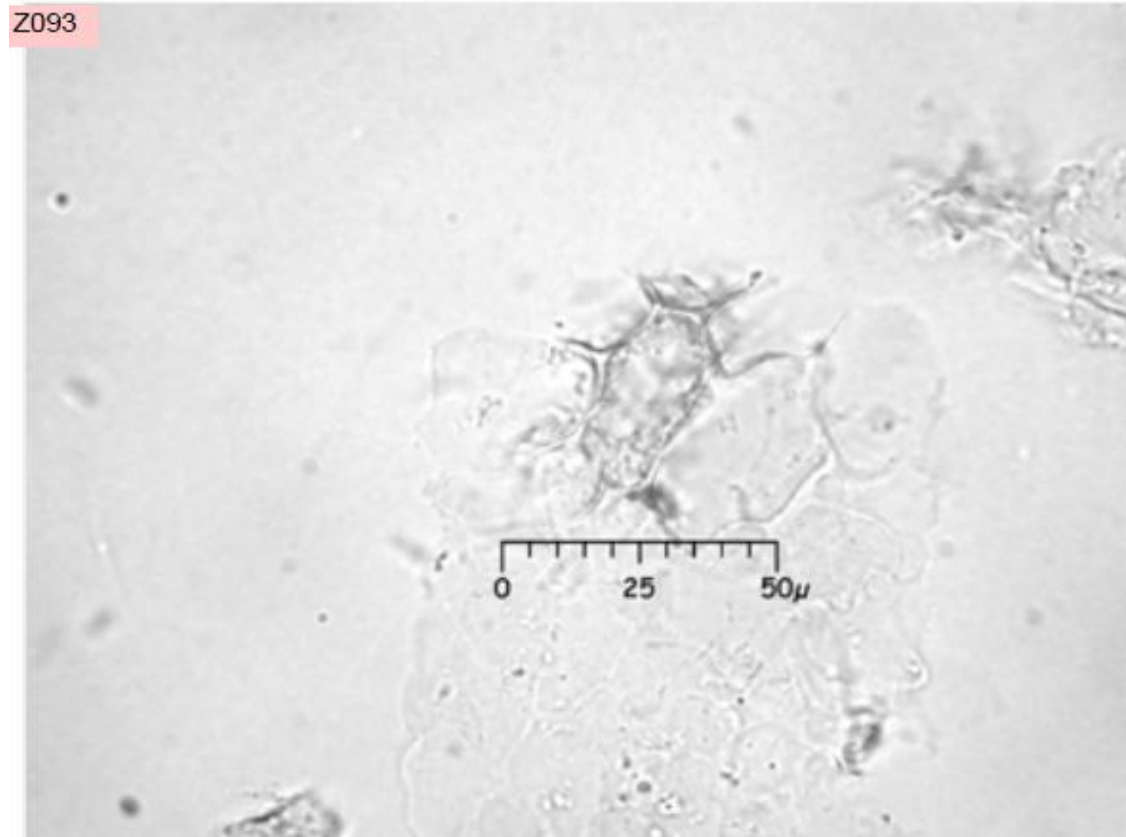


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trattinnickia peruviana

## Phytolith

Top view; see Record #137 for side view.  
The small cells that overlay the large  
central cell appear as a “corona” when  
viewed from the side. Occurs in the leaf.  
Diagnostic level: genus

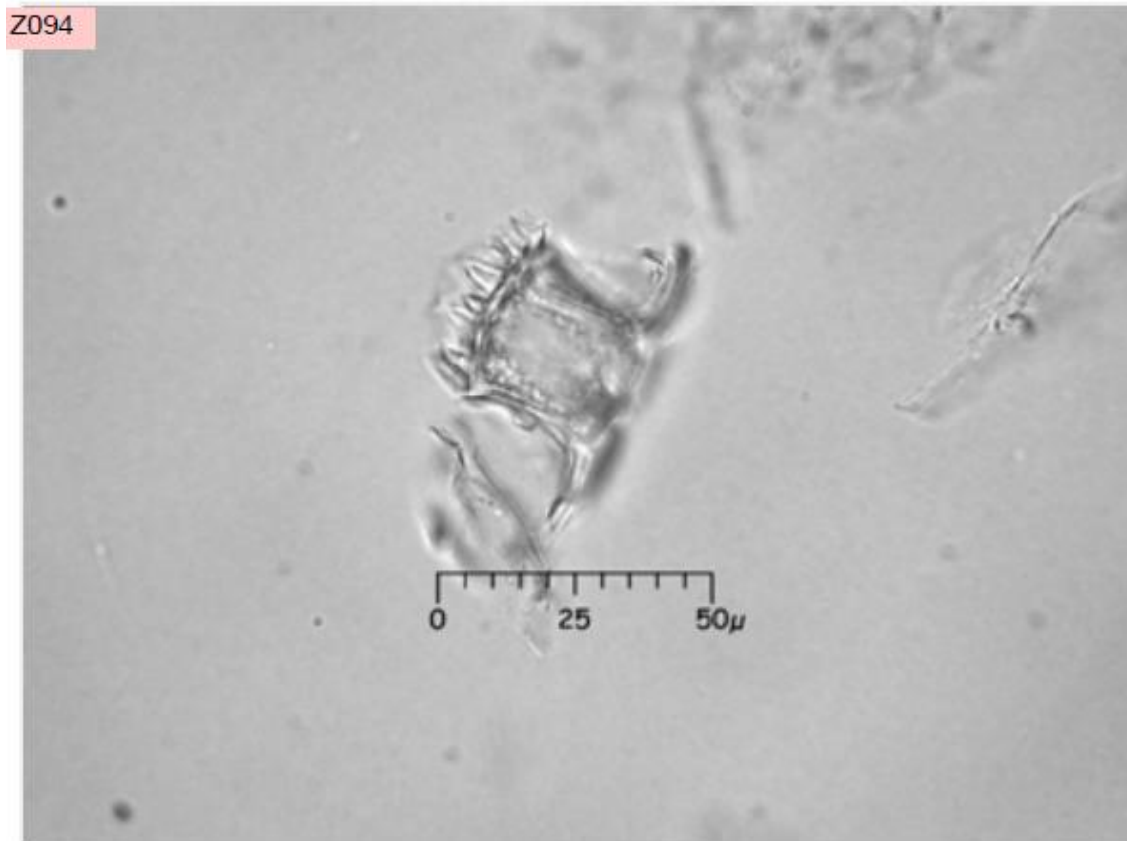


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trattinnickia peruviana

## Phytolith

Side view; see Record #136 for top view.  
The small cells that overlay the large central cell appear as a "corona" when viewed from the side. Occurs in the leaf. Large, 30-50 microns. Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

CACTACEAE

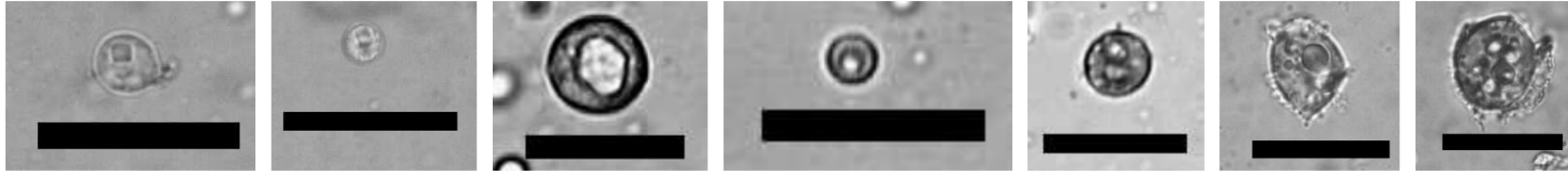
# Opuntia sp.

Cactaceae *Opuntia* sp. "pasacana"

## Phytolith assemblage characterization

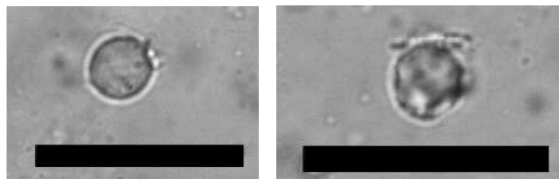
Diagnostic phytoliths (\*):

a) Sub-spherical with central perforations  
silica phytolith. Common.



fruit

b) Sub-spherical silica phytolith.  
Common.



**References:** Reported in Jones and Bryant  
1992 for calcium oxalates.

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

CANNABACEAE

# Celtis iguanea

## Phytolith

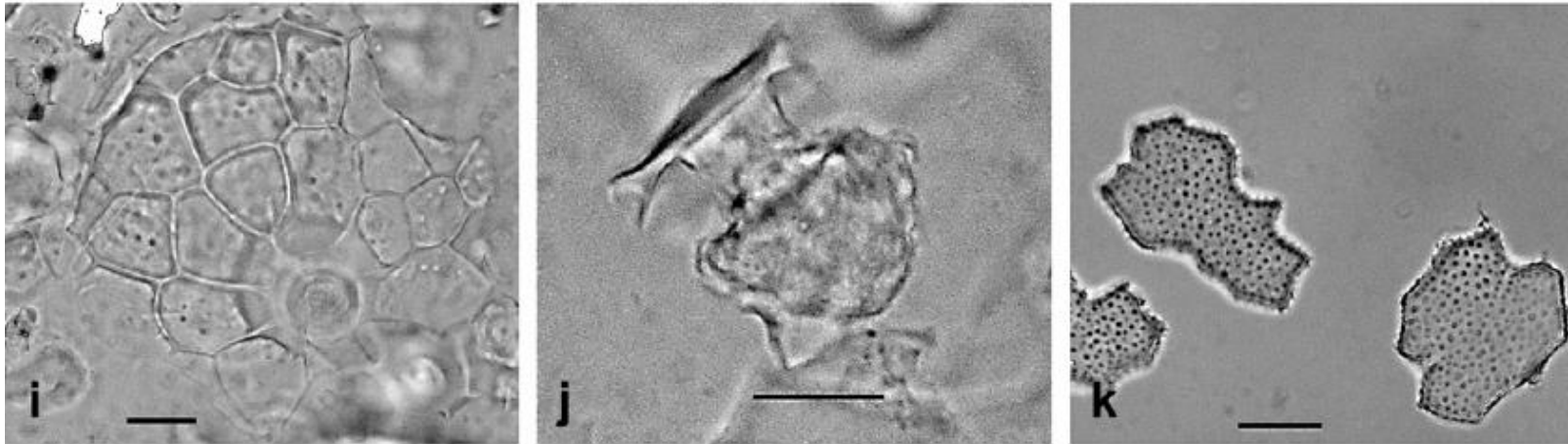
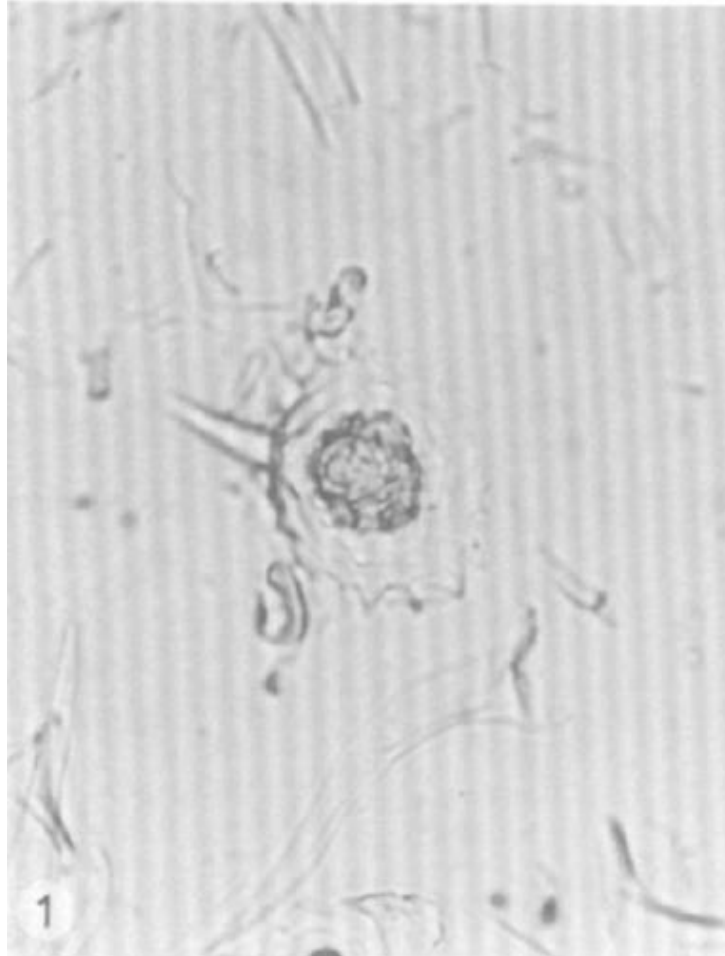


Fig. 5. Phytoliths from dicotyledons. i) Hair base and polyhedral epidermal complex from *C. iguanea* leaf, j) Cystolith from *Celtis iguanea*, k) Stippled epidermis from *C. iguanea* seeds

# Trema micrantha

## Phytolith

1. Center, hair base from *Trema micrantha* with the remnants of armed hairs. Also present are non-segmented hairs (200 x).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.



# Trema micrantha

## Phytolith

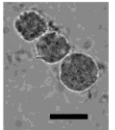
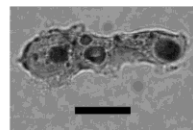
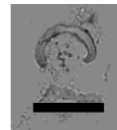
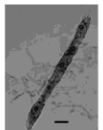
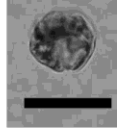
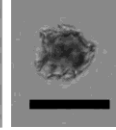
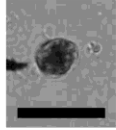
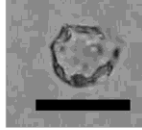
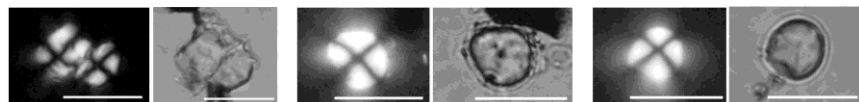
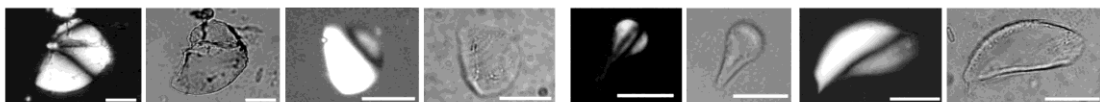
Fig. 4. A genus-specific phytolith from the fruit of *Trema micrantha* (Moraceae).



Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449.  
<http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

CANNACEAE

# Canna edulis

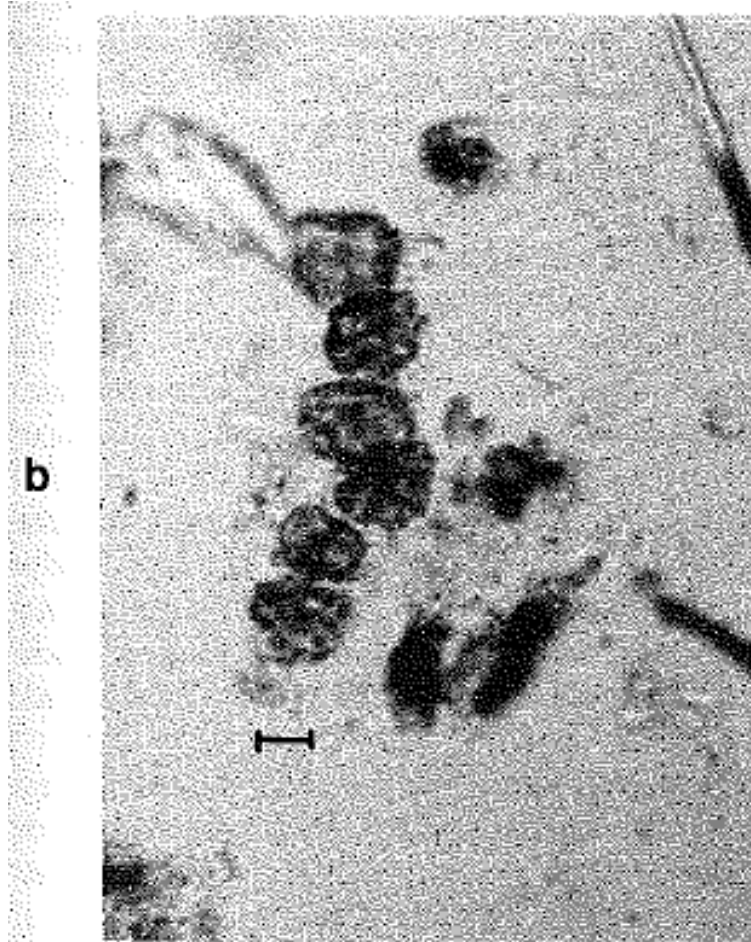
Cannaceae <i>Canna edulis</i> "achira"	
Phytolith assemblage characterization	
leaf	<p>Diagnostic phytoliths:</p> <p>a) Spherical scrobiculate silica phytoliths. Abundant in chains or alone.</p>  <p>References: Reported in Pearsall 1979, and Piperno 1988:64.</p>
flower	<p>Non diagnostic phytoliths (*):</p> <p>a) Elongate irregularly silica phytolith sinuate with dense round spaces. Rare.</p> 
pod	<p>Non diagnostic phytoliths (*):</p> <p>a) Reflexed silica hair.</p>  <p>b) Rectangular narrow silica long cell with dense round spaces. Rare.</p> 
seed	<p>No phytoliths (*).</p>
tuber	<p>Diagnostic phytoliths (*):</p> <p>a) Round dense center and marginal facetate silica phytolith. Not common.</p>    <p>b) Polyhedral marginal facetate silica phytolith. Not common.</p> 
Starch assemblage characterization	
seed	<p>a) Single grains, spherical and ovoid, sometimes with a truncate or wavy end with two acute projections; variable in size, commonly from 12µm to 15µm, but also to 20µm long length; sometimes indistinct, lightly eccentric hilum as a dot at not-truncated end; rarely indistinct lamella; distinct lightly eccentric cross, with four arms visible.</p> 
tuber	<p>a) Single grains, ovoid, oval, teardrop-, bowl-, and kidney-shaped, sometimes having a truncated end with a typical lateral-rounded or central-acute projection, and an opposite well rounded end, one face flat; variable in size, frequently over 100µm, to 145µm long length; distinct, highly eccentric hilum, sometimes double, usually at the smaller truncated or projected end and slightly to the right or left of the longitudinal axis; very distinct lamella; distinct eccentric cross, with one, two, three or four visible arms.</p> 
References: Partially based on French 1984, Iriarte et al. 2001, Le Mieue 1994, Reichert 1913.	

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Canna edulis

## Phytolith



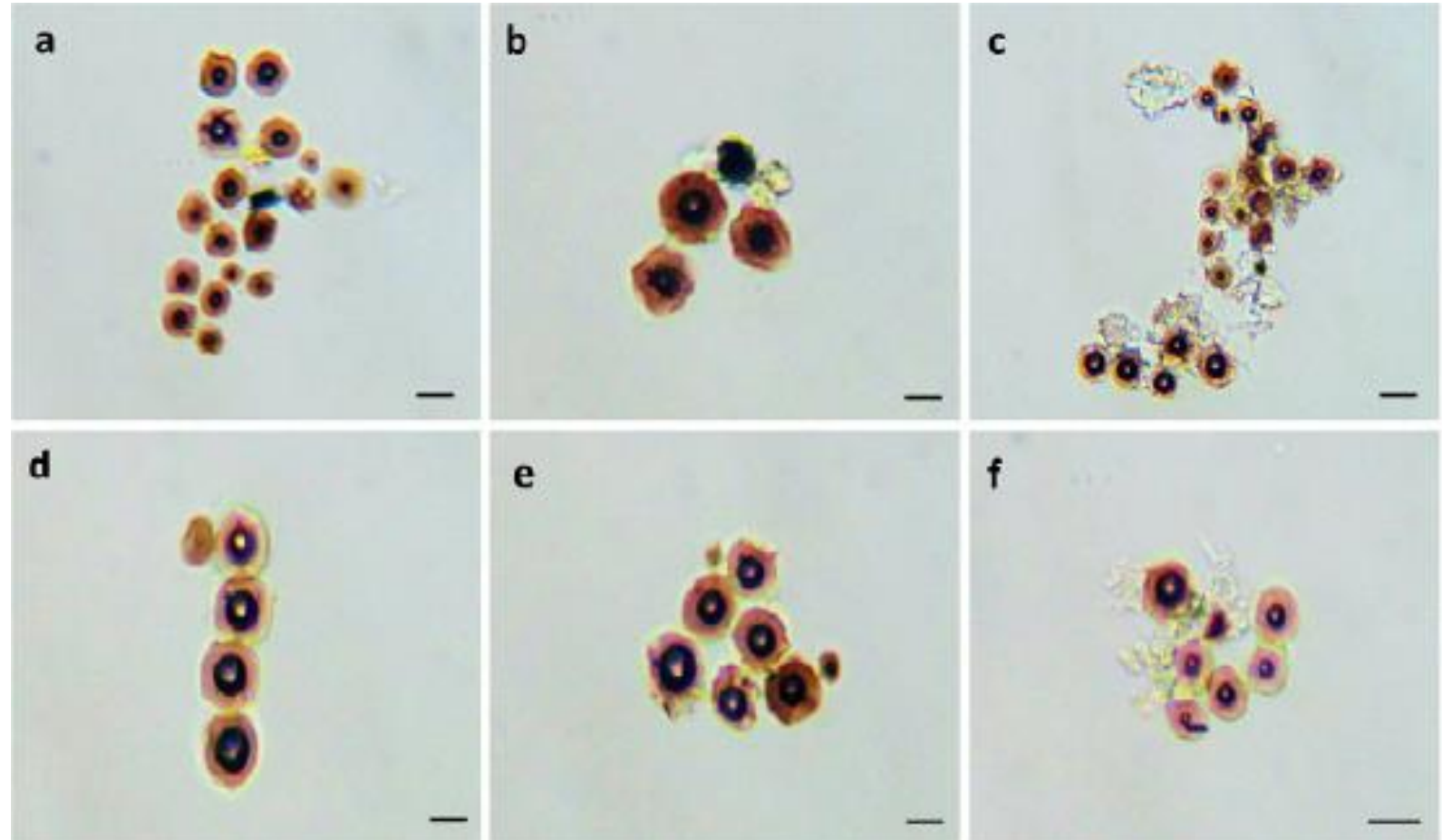
b. Angled and folded spheres from *Canna edulis*

Pearsall, Deborah Marie. 1993. Contributions of Phytolith Analysis for Reconstructing Subsistence: Examples from Research in Ecuador. *Current Research in Phytolith Analysis: Applications in Archaeology and Paleoecology*. MASCA.

# Canna edulis

## Phytolith

Figure 2. Phytoliths found in achira leaves (*Canna indica* L.). a) Major axis: 97.56  $\mu\text{m}$ , minor axis: 82.44  $\mu\text{m}$ ; b) 31.26  $\mu\text{m}$ , 10.45  $\mu\text{m}$ ; c) 36.1  $\mu\text{m}$ , 9.99  $\mu\text{m}$ ; d) 38.58  $\mu\text{m}$ , 14.19  $\mu\text{m}$ ; e) 25.53  $\mu\text{m}$ , 24.91  $\mu\text{m}$ ; f) 24.96  $\mu\text{m}$ , 23.58  $\mu\text{m}$ . Scale: 10  $\mu\text{m}$  by 40X

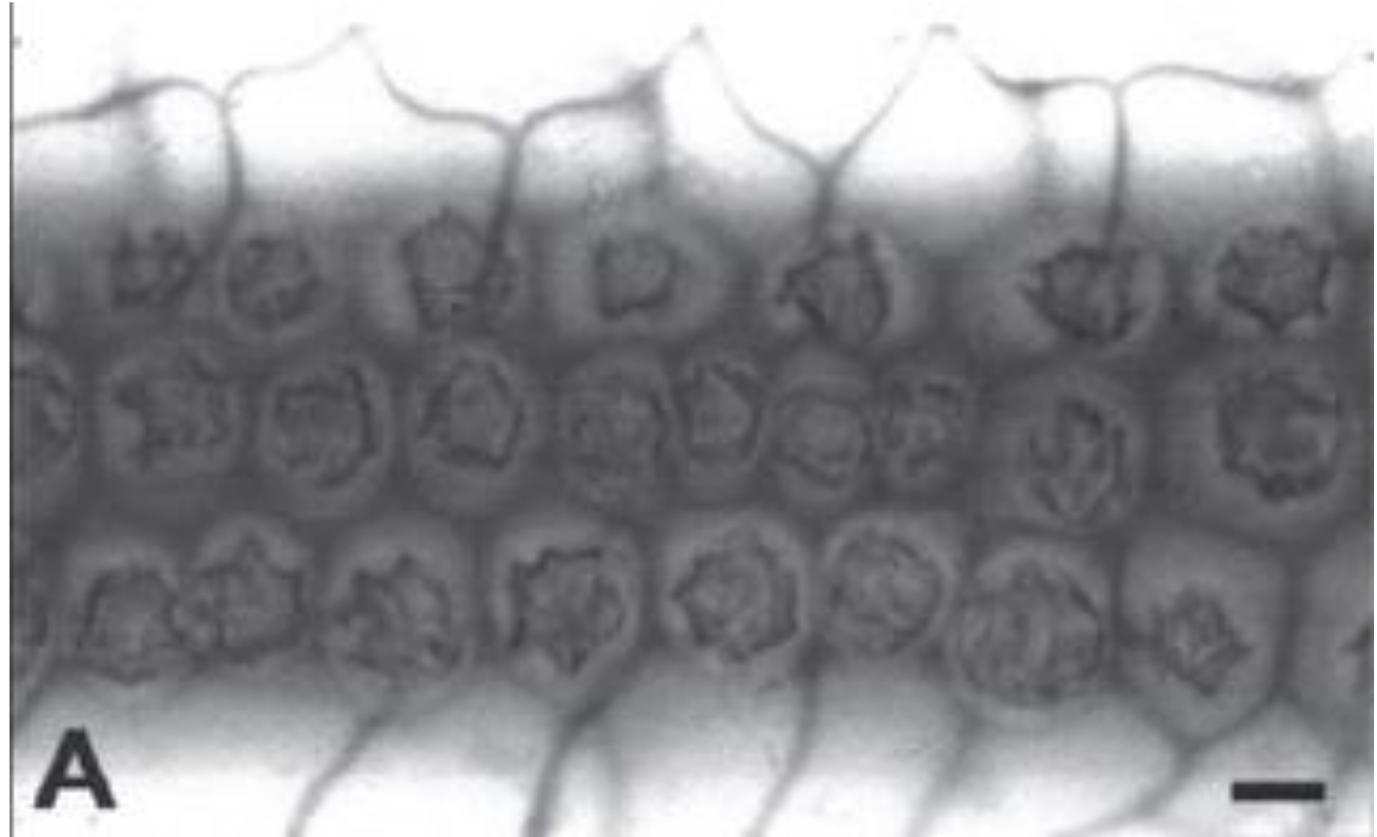


Poveda-Díaz, Nataly, Maria Eugenia Morales-Puentes, and Gregory Vaughan. 2016. Phytoliths Produced by Common Bean (*Phaseolus Vulgaris* L.), Achira (*Canna Indica* L.), and Squash (*Cucurbita Ficifolia* Bouché), Crop Species from Boyacá, Colombia. *Revista de La Academia Colombiana de Ciencias Exactas, Físicas y Naturales* 40 (154):137–46.

# Canna edulis

## Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. A. *Canna edulis* (Cannaceae), druse-like silica bodies over vascular bundle sheath (bar = 10  $\mu\text{m}$ ).

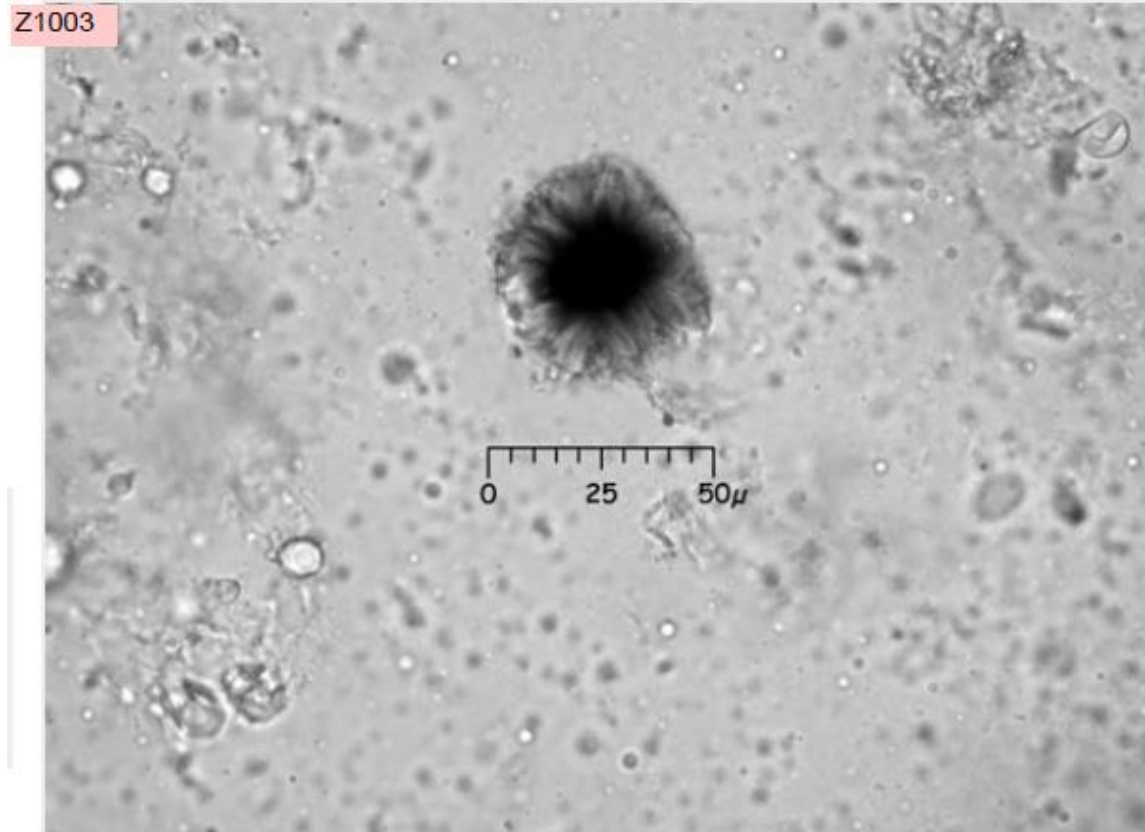


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Canna edulis

## Phytolith

Spheres produced by *Canna* range from smooth to rugulose to irregularly angled or folded. Type 80IAa200 is based on an archaeological specimen of *Canna edulis* leaf, from the coast of Peru. Diagnostic level: Unknown. Does not occur in chemically extracted specimens; probably not silica.

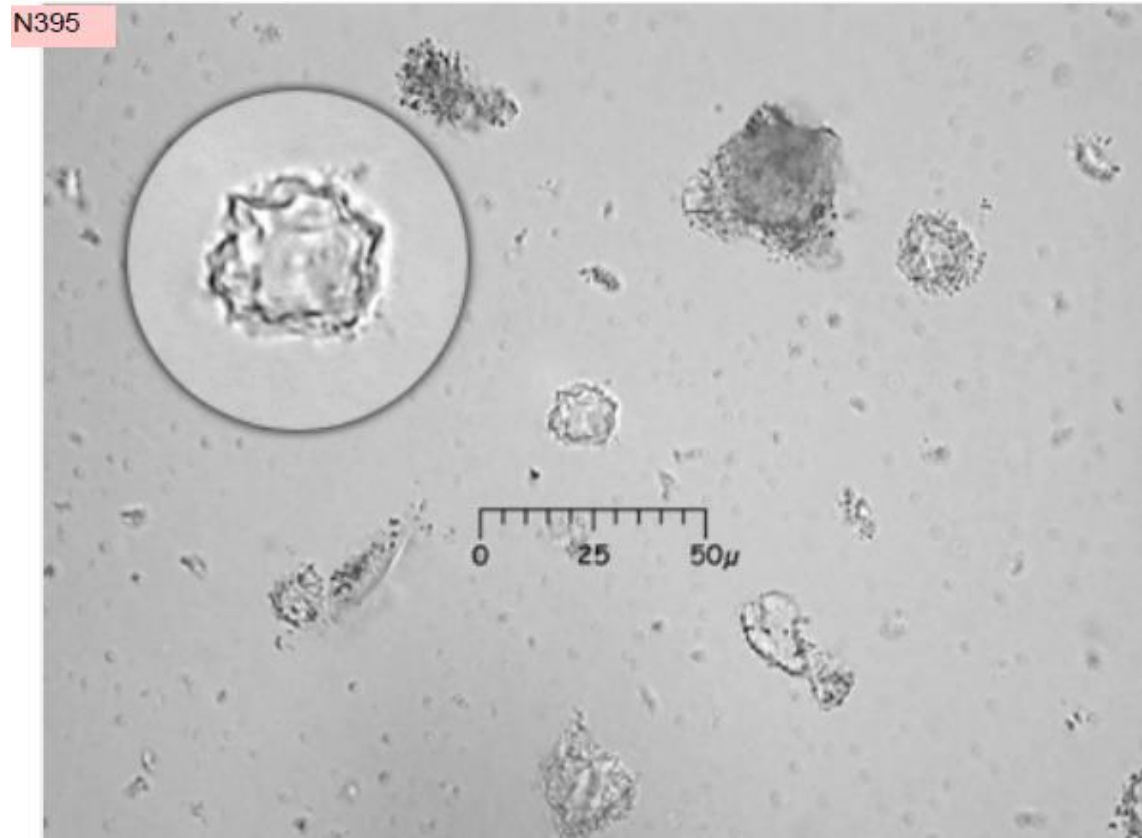


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Canna edulis

## Phytolith

Large rugulose sphere (10-30 microns). Rugulose spheres occur in many taxa, such as the Marantaceae, Bombacaceae, Cannaceae, Heliconiaceae, and Chrysobalanaceae. Large spheres (10-30 microns) characterize Marantaceae and Cannaceae. Diagnostic level: Marantaceae/Cannaceae



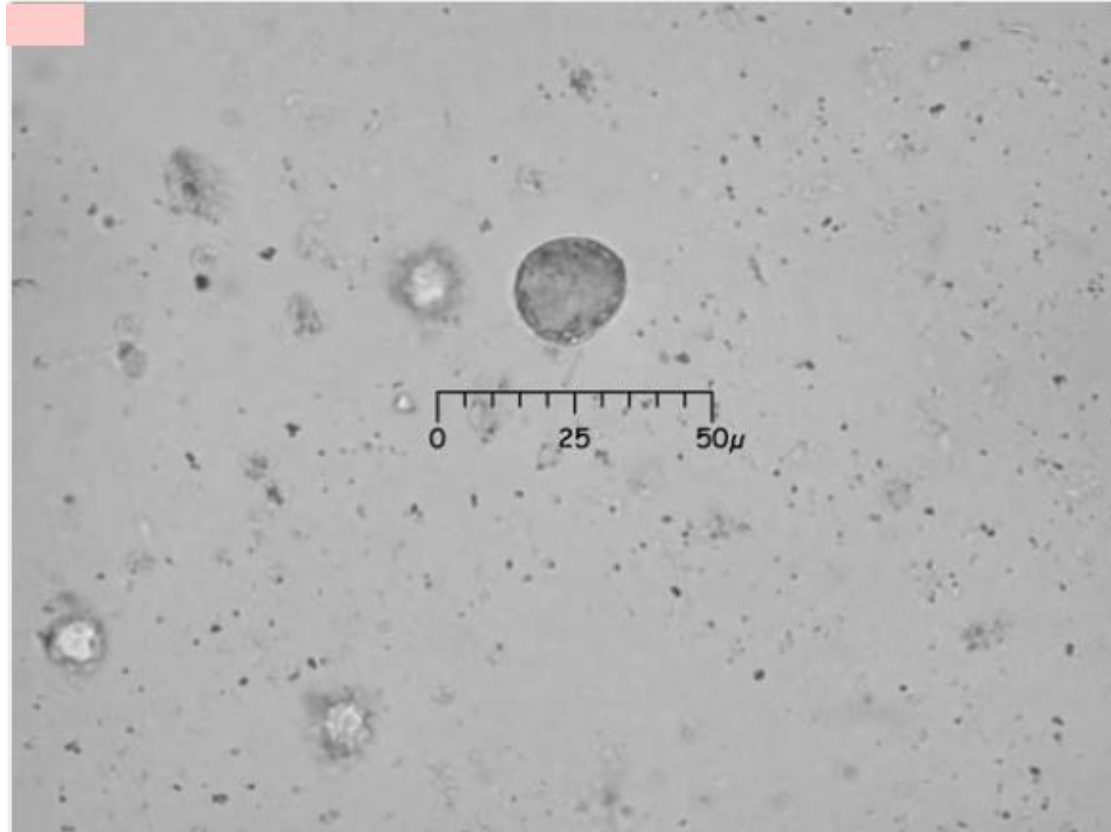
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Canna edulis

## Phytolith

Spheres produced by *Canna* range from smooth to rugulose to irregularly angled or folded. Type 80IAa201 is based on a modern specimen of *Canna edulis* leaf. Ephemeral spherical bodies are not included in this type. Diagnostic level: genus

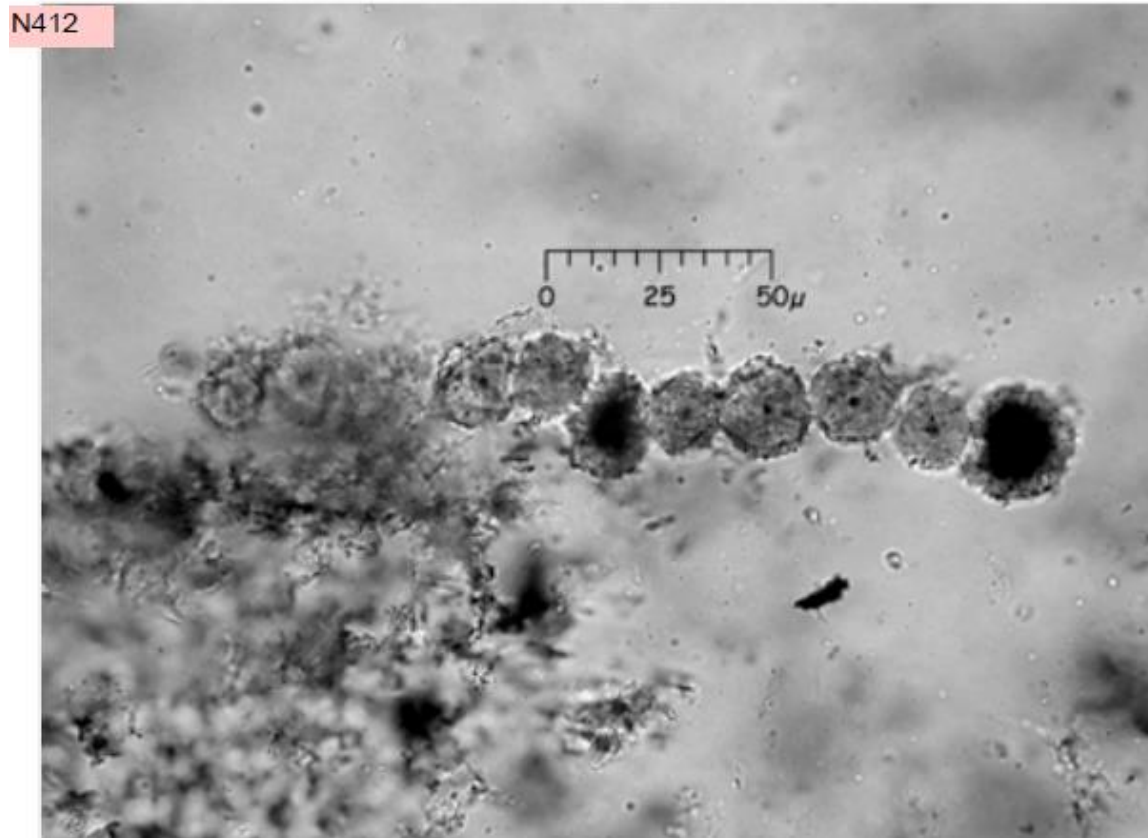


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Canna edulis

## Phytolith

Canna produces smooth, rugulose, and irregularly folded and angled spheres. Diagnostic level (irregularly folded and angled): order Zingiberales



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Canna indica

## Phytolith

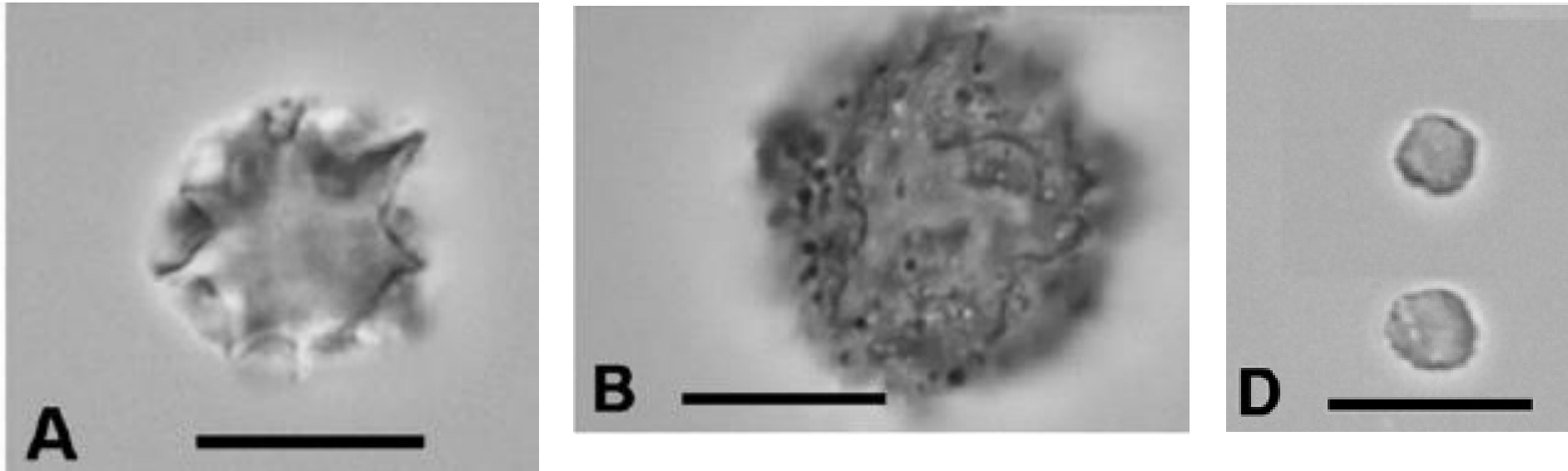


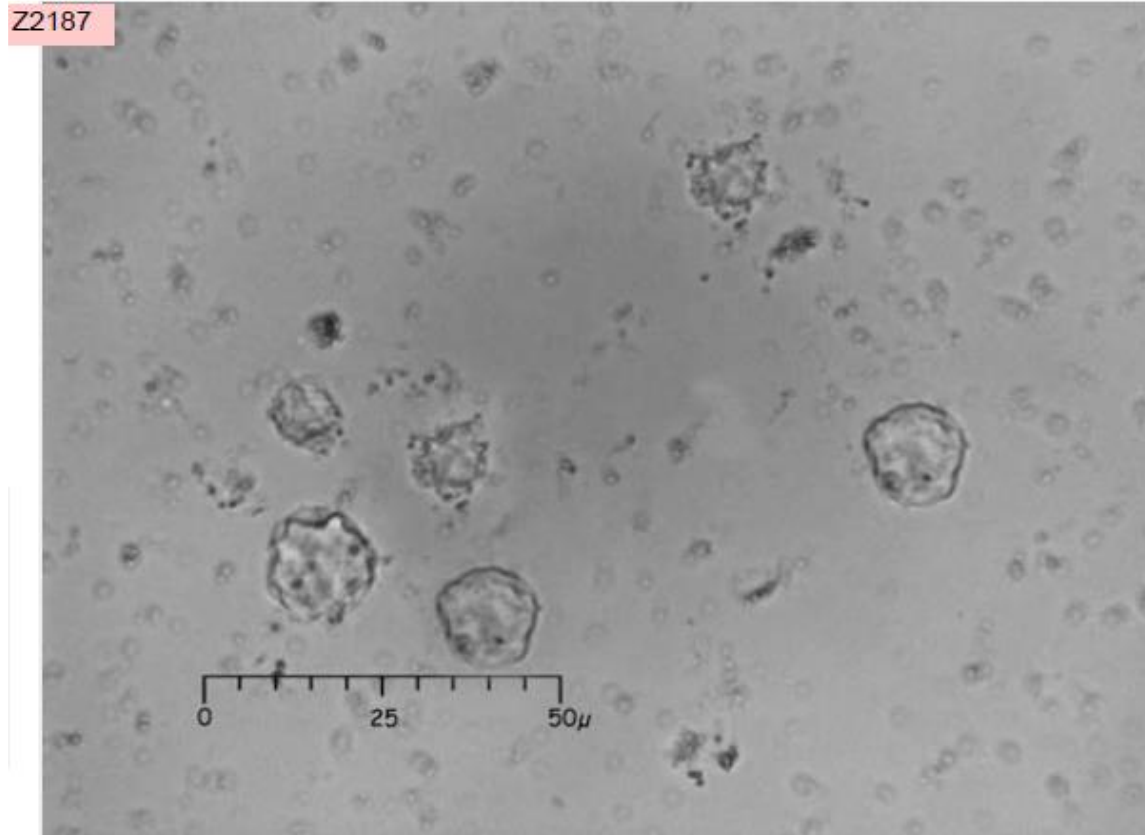
Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). A, D1-type druse with small fringe from *Canna indica* leaf. B, granular D2-type druse from *Canna indica* leaf. D, globular-micropapillate from *Canna indica* seed. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Canna indica

## Phytolith

PC1390, leaf. Contrast irregularly angled and folded spheres (80IEa left above scale bar) and rugulose spheres (80IBb right above scale bar).



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Canna indica

## Starch

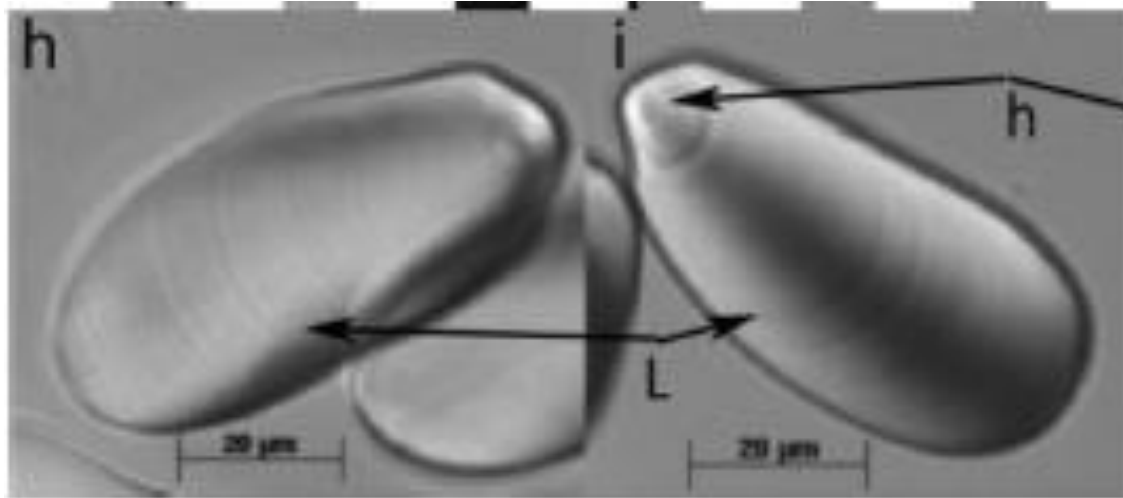
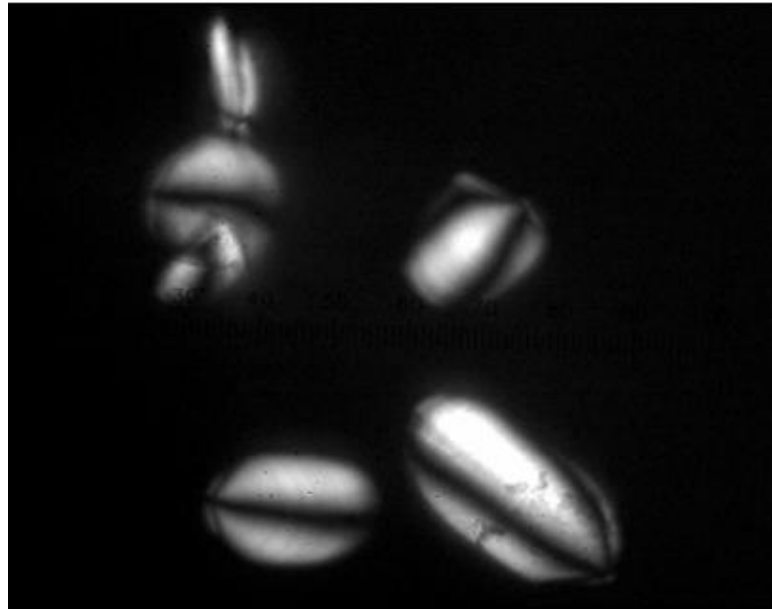
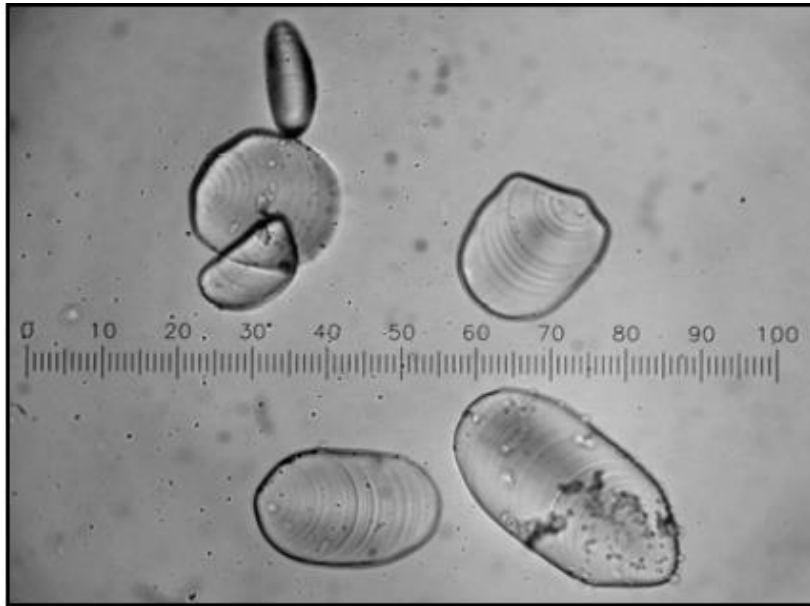


Fig. 9. Modern and unaltered *Canna* spp. starch grains comes from comparative species (Pagan-Jimenez, 2015): h-i, obovate starches (*Canna indica*, Ecuador).

Pagán-Jiménez, Jaime R., Reniel Rodríguez-Ramos, Basil A. Reid, Martijn van den Bel, and Corinne L. Hofman. 2015. Early Dispersals of Maize and Other Food Plants into the Southern Caribbean and Northeastern South America. *Quaternary Science Reviews* 123:231–46. <http://www.sciencedirect.com/science/article/pii/S0277379115300445>.

# Canna indica

## Starch

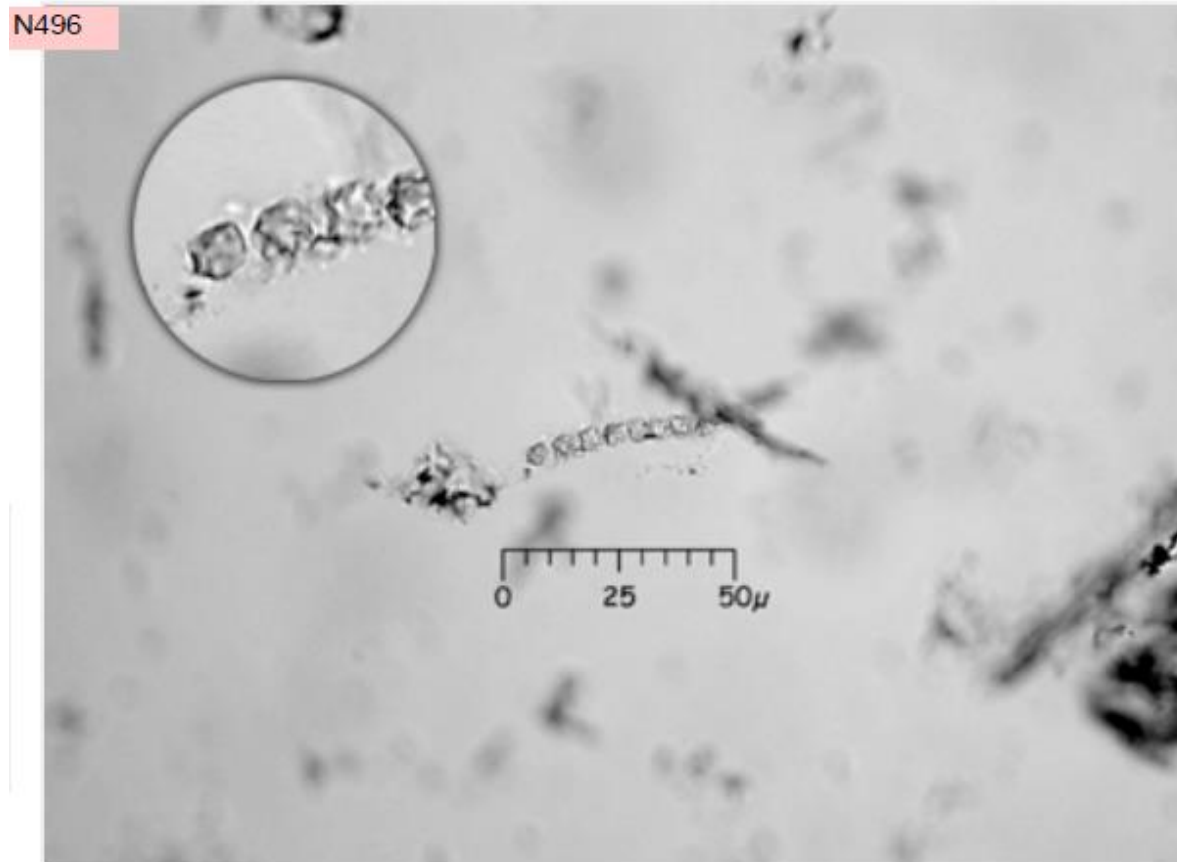


Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Canna jaegeriana

## Phytolith

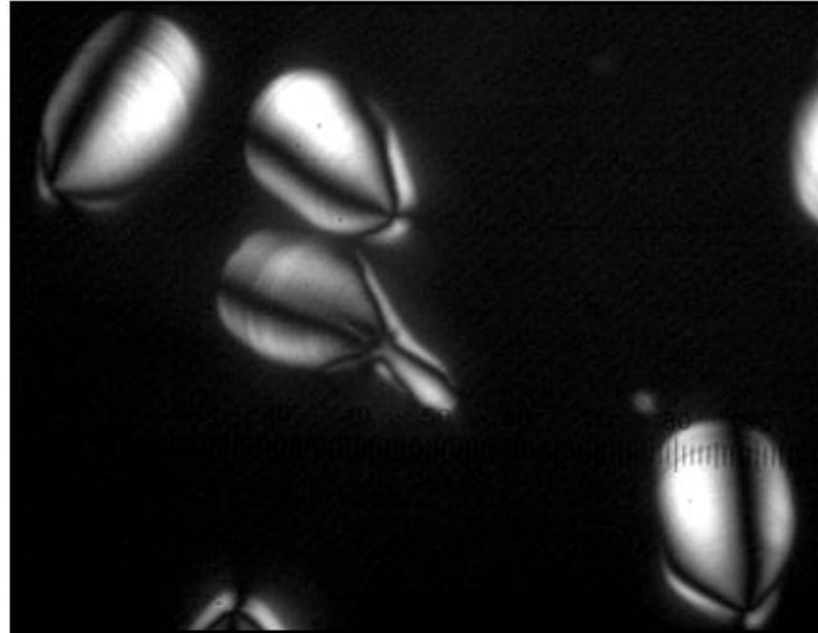
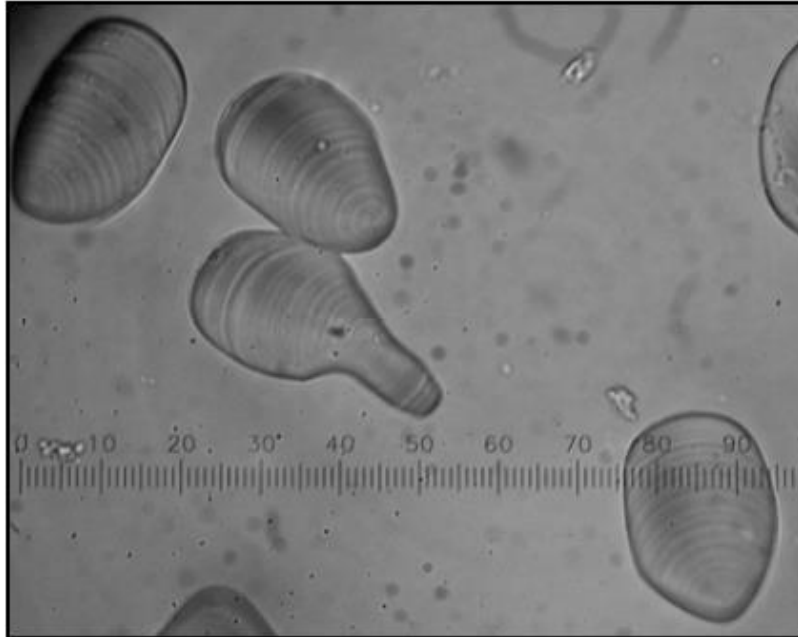
Small rugulose spheres (< 10 microns) that are well silicified (i.e., opaque). According to Iriarte and Piperno, characteristic of woody dicots. Also occur in *Canna* and Marantaceae. Diagnostic level: woody dicot, with above qualification



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# *Canna sylvestris*

## Starch



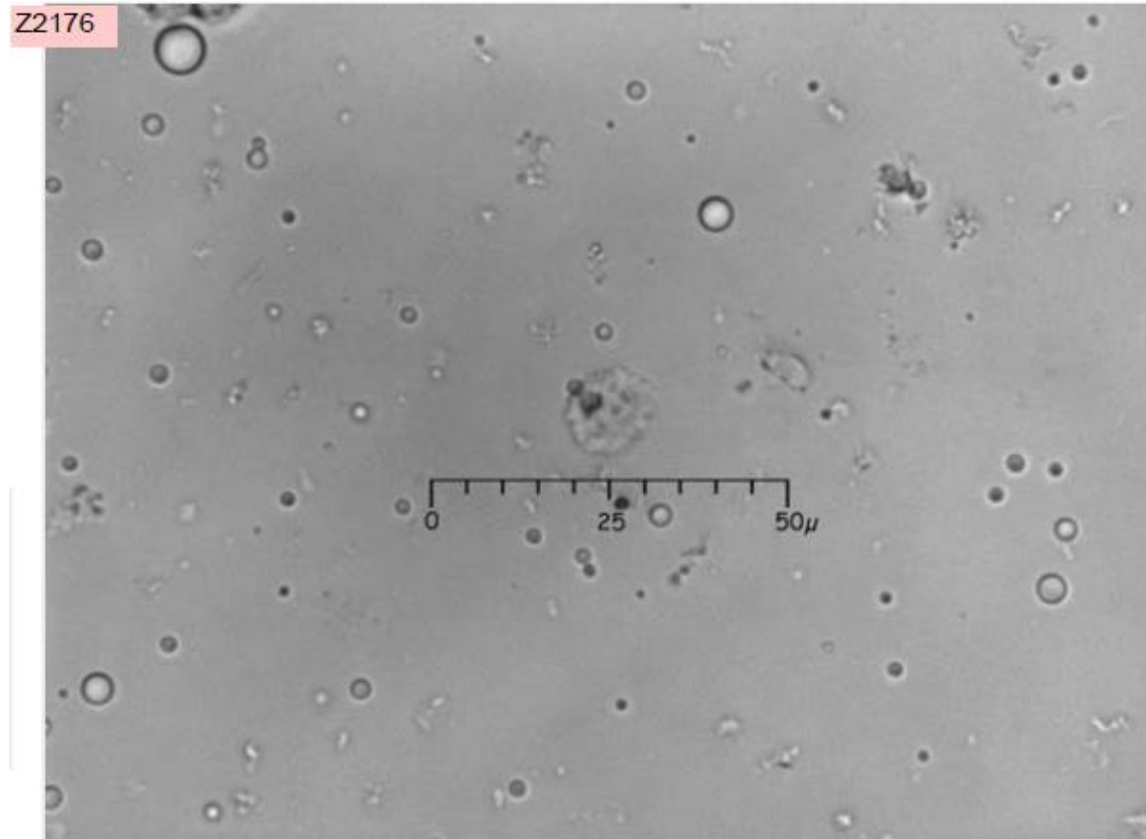
Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.



# *Canna tuerckheimii* (=edulis)

## Phytolith

80IIIB has been considered is a Marantaceae family diagnostic. Occurs rarely in PC2127, *Matisia cordata*, Bombacaceae; VR in PC961 *Canna tuerckheimii* (epidermis) Marantaceae/Cannaceae/Bombacaceae mixed type

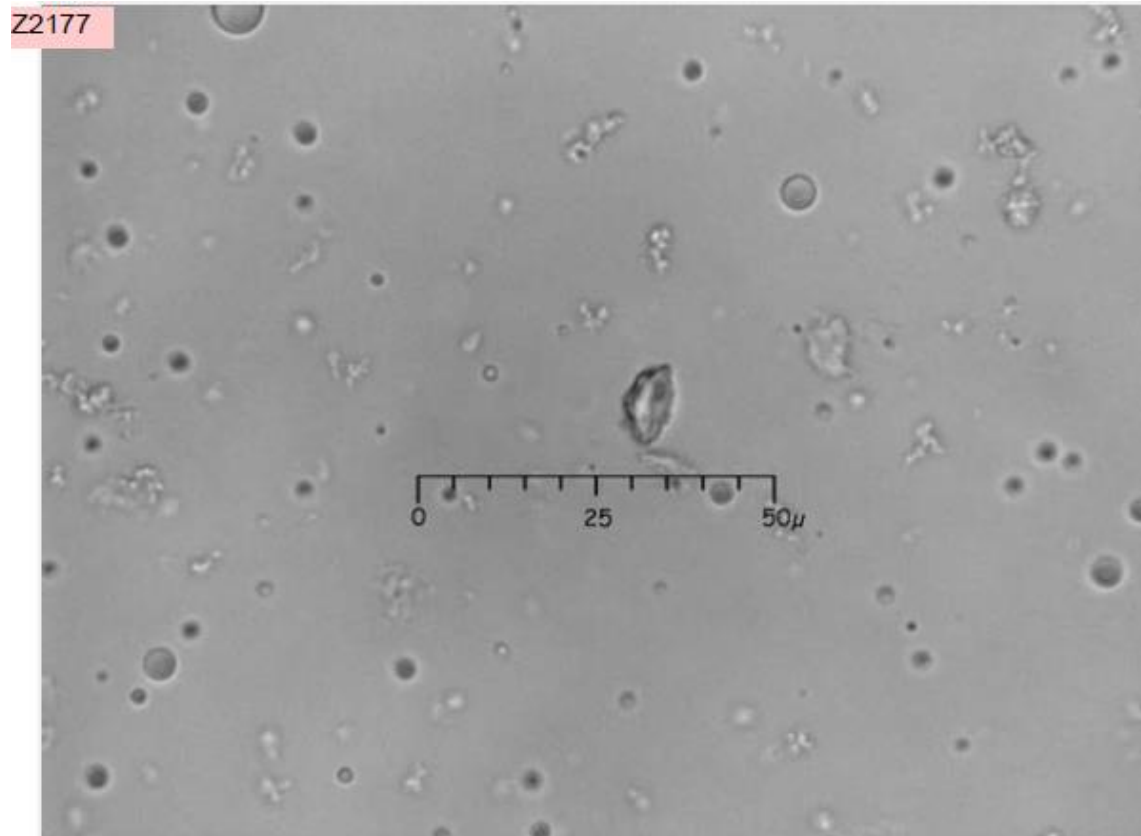


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# *Canna tuerckheimii* (=edulis)

## Phytolith

80IIIB has been considered is a Marantaceae family diagnostic. Occurs rarely in PC2127, *Matisia cordata*, Bombacaceae; VR in PC961 *Canna tuerckheimii* (epidermis) Marantaceae/Cannaceae/Bombacaceae mixed type

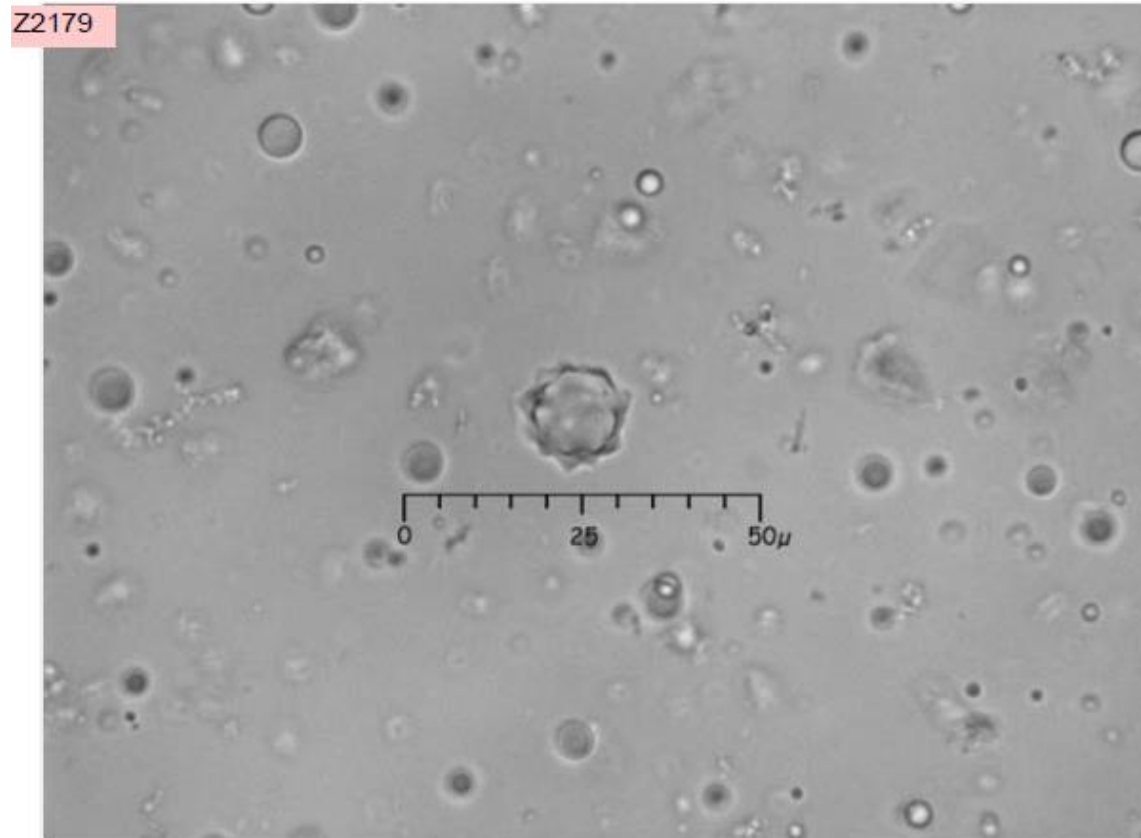


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# *Canna tuerckheimii* (=edulis)

## Phytolith

PC961 (epidermis). Small nodular spheres, moderate in occurrence, variable in size and height of projections. This is a larger example, but smaller than 18 microns. Compare to 80ICc, 80ICa2. Overlaps with Marantaceae/Bombacaceae type



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# *Canna tuerckheimii* (=edulis)

## Phytolith

PC961 (epidermis). Nodular spheres moderate in occurrence, variable in size and height of projections. Compare to 80ICc, 80ICa2.  
Overlaps with  
Marantaceae/Bombacaceae type

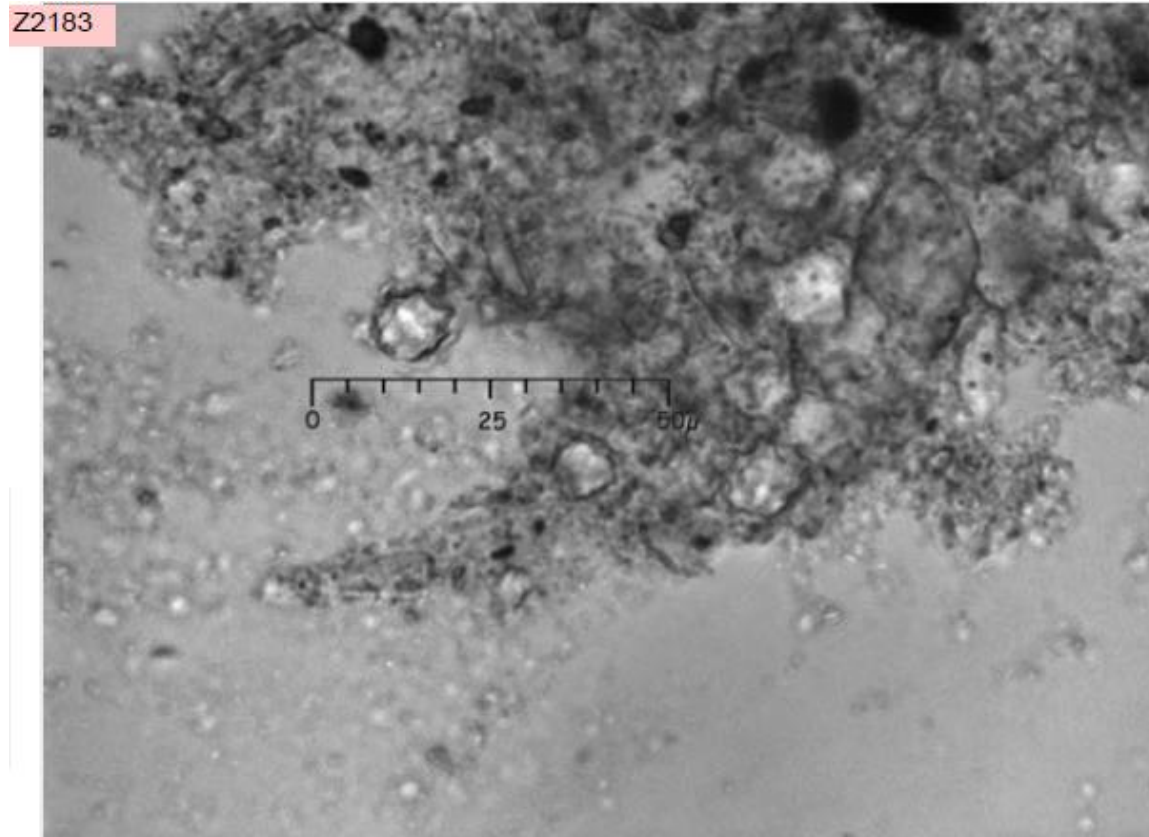


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# *Canna tuerckheimii* (=edulis)

## Phytolith

PC2592, seed. Folded and angled spheres in situ in tissue. Typical size is 10-15 microns.  
Diagnostic: Zingiberales



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# *Canna tuerckheimii* (=edulis)

## Phytolith

OS511, leaf. Chain of irregularly folded/angled spheres  
Diagnostic: Zingiberales



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Canna tuerckheimii

## Starch

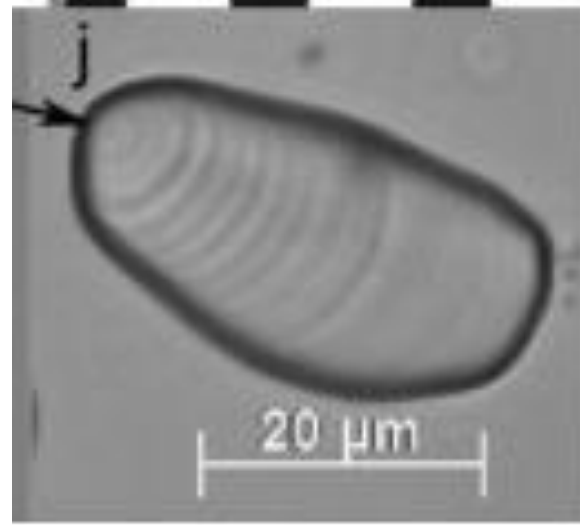


Fig. 9. Modern and unaltered *Canna* spp. starch grains comes from comparative species (Pagan-Jimenez, 2015): j, obovate starch (*Canna tuerckheimii*, Ecuador).

Pagán-Jiménez, Jaime R., Reniel Rodríguez-Ramos, Basil A. Reid, Martijn van den Bel, and Corinne L. Hofman. 2015. Early Dispersals of Maize and Other Food Plants into the Southern Caribbean and Northeastern South America. *Quaternary Science Reviews* 123:231–46. <http://www.sciencedirect.com/science/article/pii/S0277379115300445>.

# Canna sp.

## Phytolith

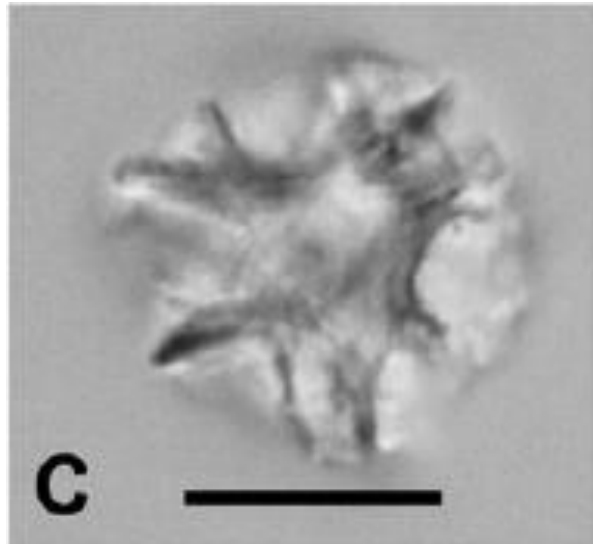


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). C, D1-type druse with fringe from *Canna* sp. rhizome. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.



# Canna spp.

## Starch

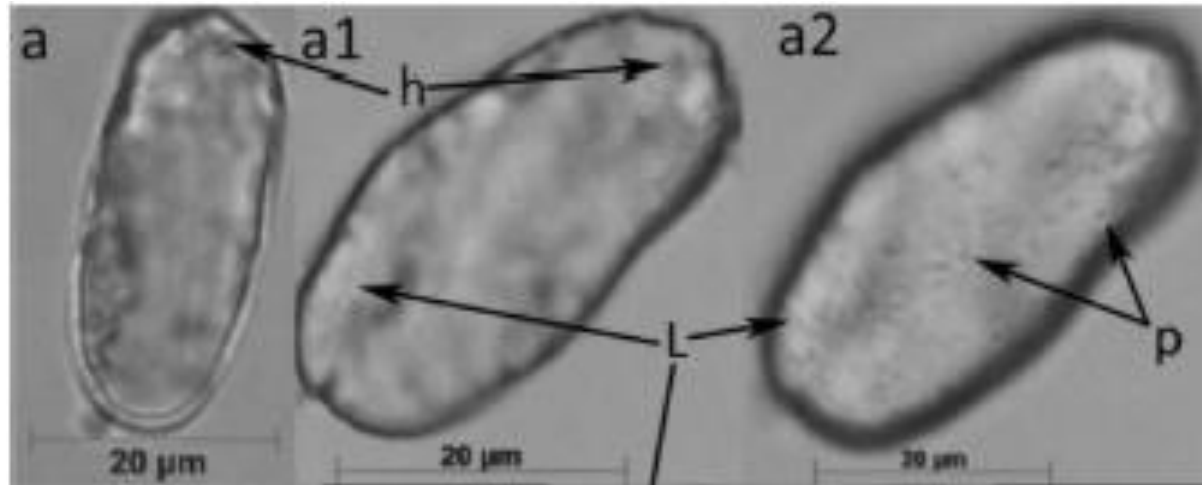


Fig. 9. Other ancient starch grains (a-g) recovered at St. John and Eva 2. a-a2, *Canna* spp. obovate starch with rough surface (in a), with partial view of the hilum (or “h” in a-a1), with partial and diffuse view of the lamellae (or “L” in a1-a2), and pits (or “p”, in a2) over the surface when re-focused.

# Canna sp.

## Starch

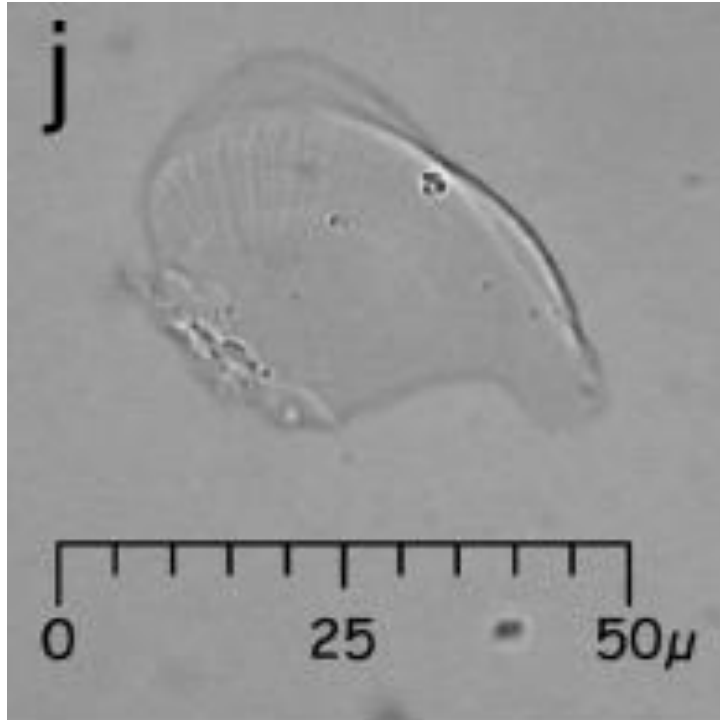


Fig. 5. Selected phytoliths and starch granules recovered from tools. See MU Phytolith website (<http://www.missouri.edu/~phyto>) for other photographs j. Broken Canna starch granule, SS15 FS3290-A. k.

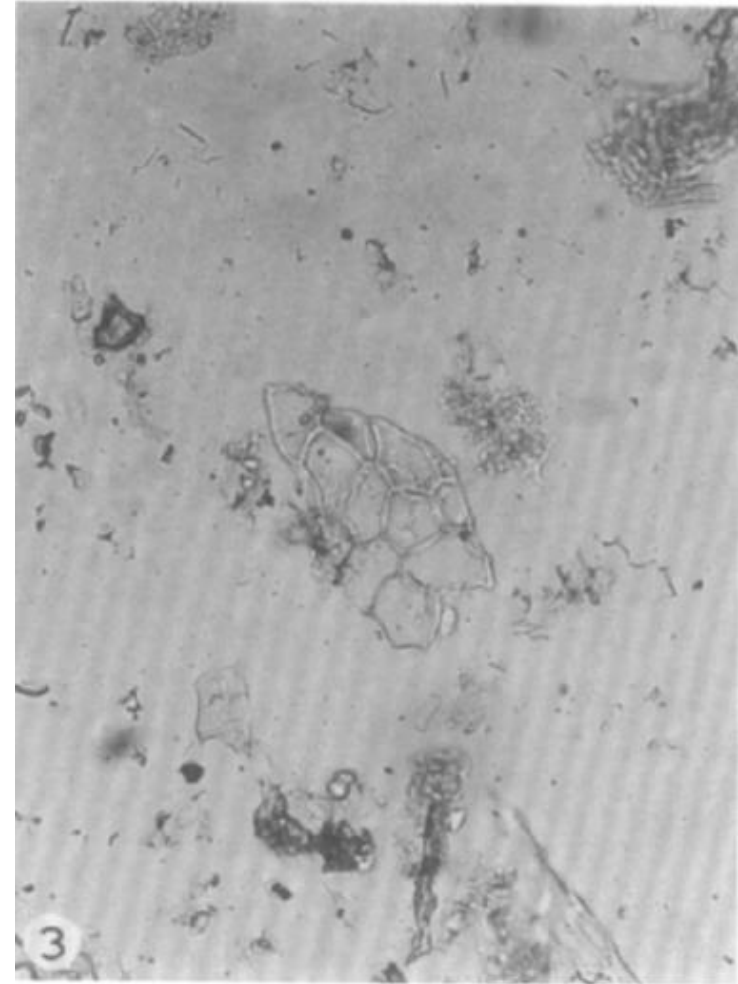
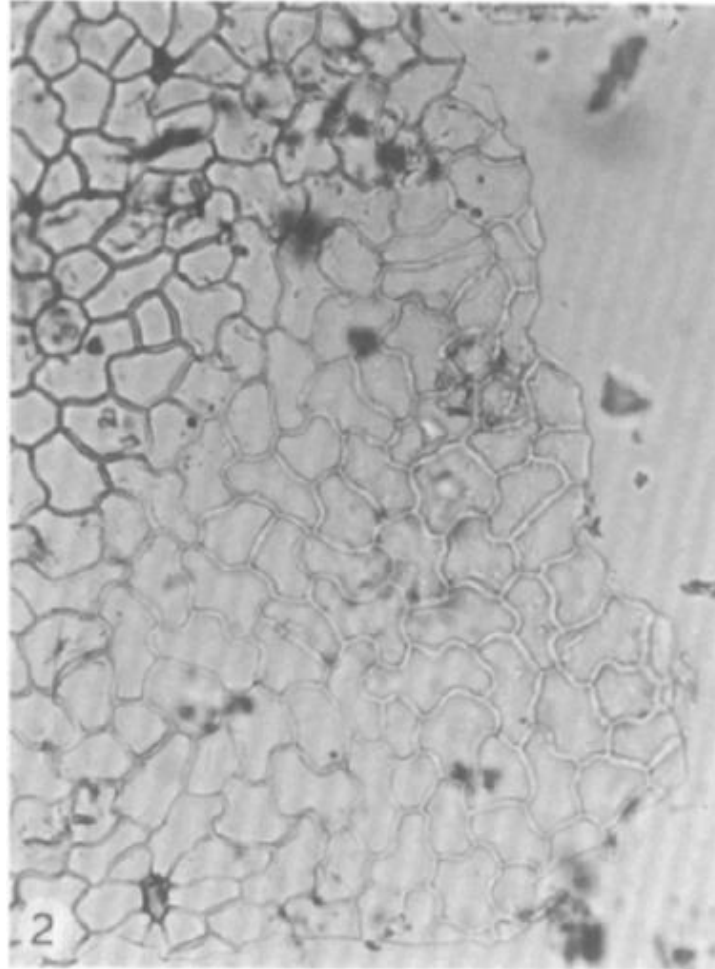
Chandler-Ezell, Karol, Deborah Marie Pearsall, and James A. Zeidler. 2006. Root and Tuber Phytoliths and Starch Grains Document Manioc (*Manihot Esculenta*), Arrowroot (*Maranta Arundinacea*), and Llerén (*Calathea Sp.*) at the Real Alto Site, Ecuador. *Economic Botany* 60 (2):103–20. [http://www.bioone.org/doi/abs/10.1663/0013-0001\(2006\)60%5B103:RATPAS%5D2.0.CO%3B2](http://www.bioone.org/doi/abs/10.1663/0013-0001(2006)60%5B103:RATPAS%5D2.0.CO%3B2).

CHLORANTHACEAE

# Hedyosmum sp.

## Phytolith

- 2. Anticlinal epidermis from Hedyosmum (400 x ).
- 3. Polyhedral epidermis from Hedyosmum (400 x ).

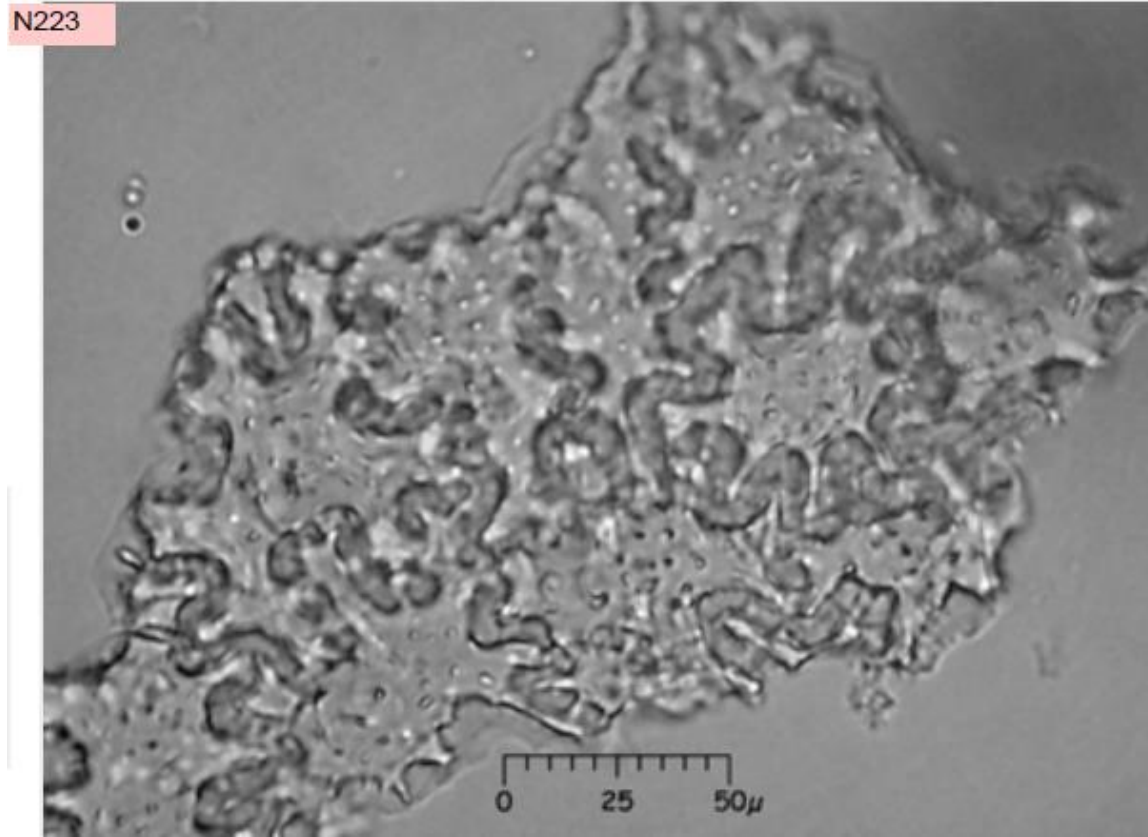


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Hedyosmum goudotianum

## Phytolith

Note how robust and thick bodies are.  
Diagnostic level: family

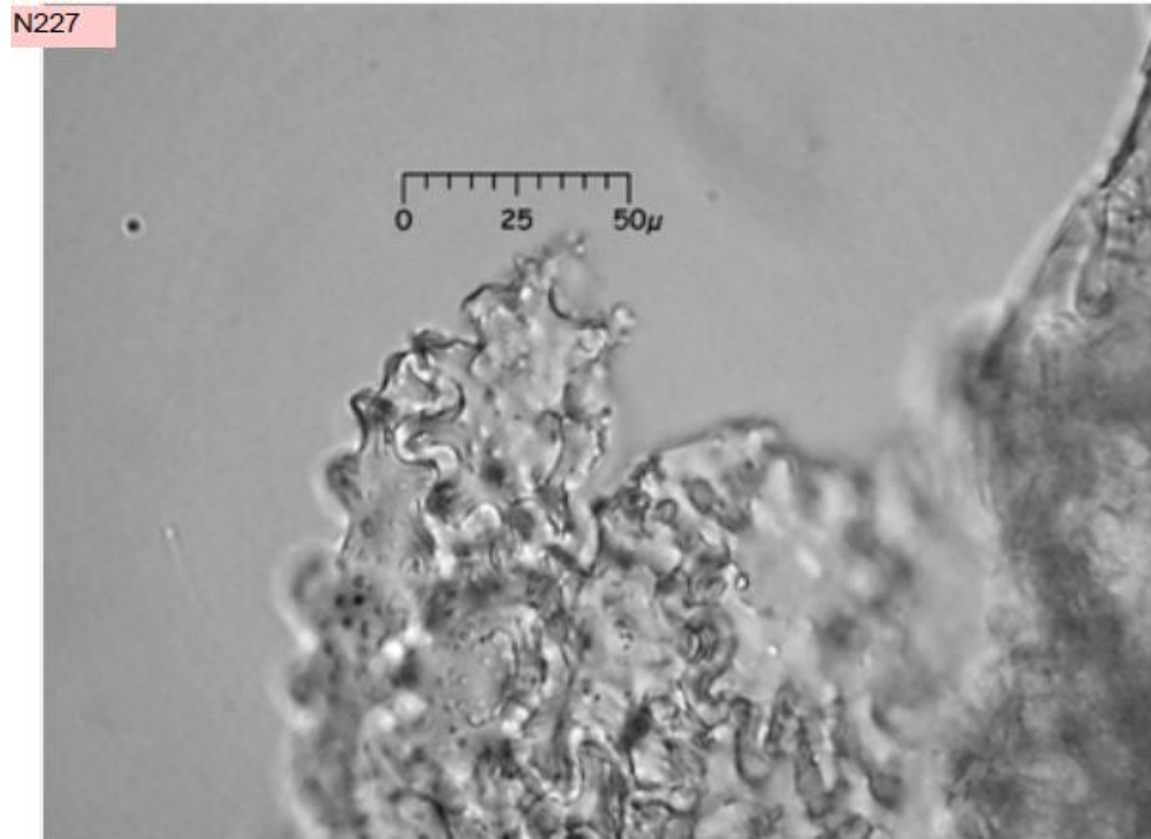


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Hedyosmum goudotianum

## Phytolith

Note that bodies are not flat or smooth in rotation. In this view, they are almost “puffed” and irregularly thick. Diagnostic level: family



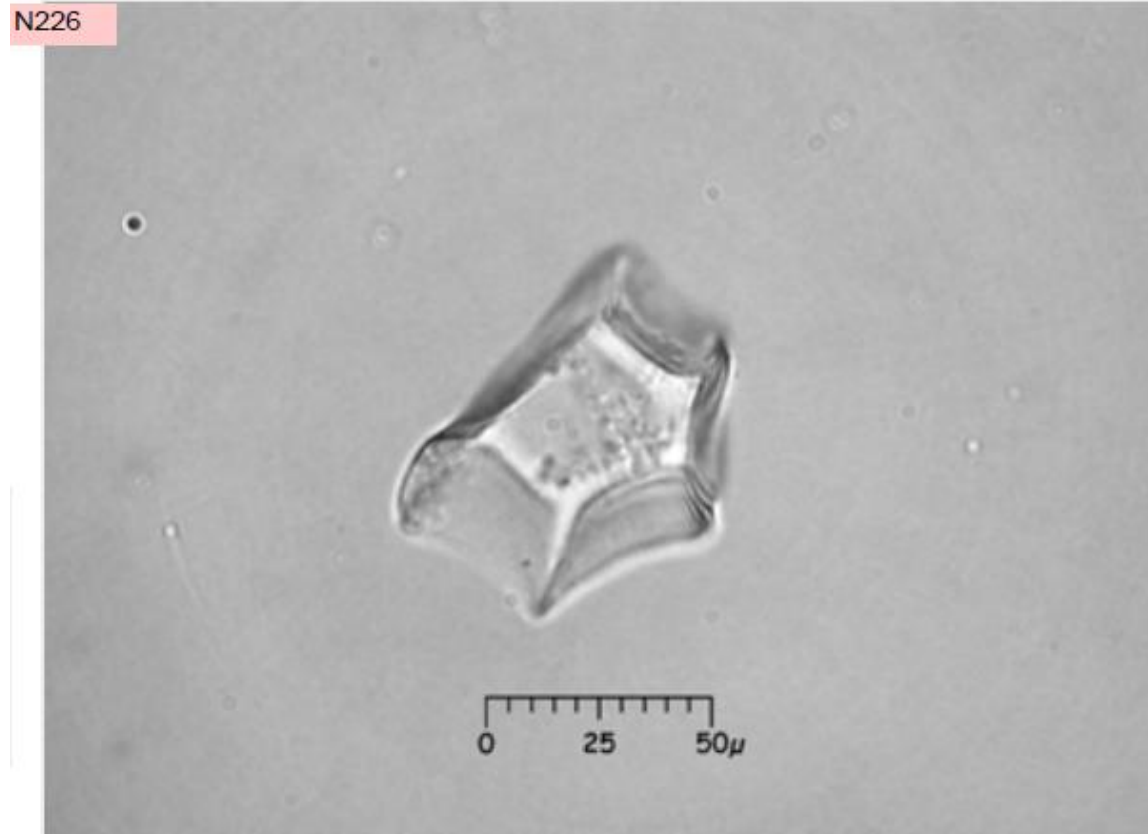
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Hedyosmum goudotianum

## Phytolith

Note large size of these polyhedral bodies.

Diagnostic level: family

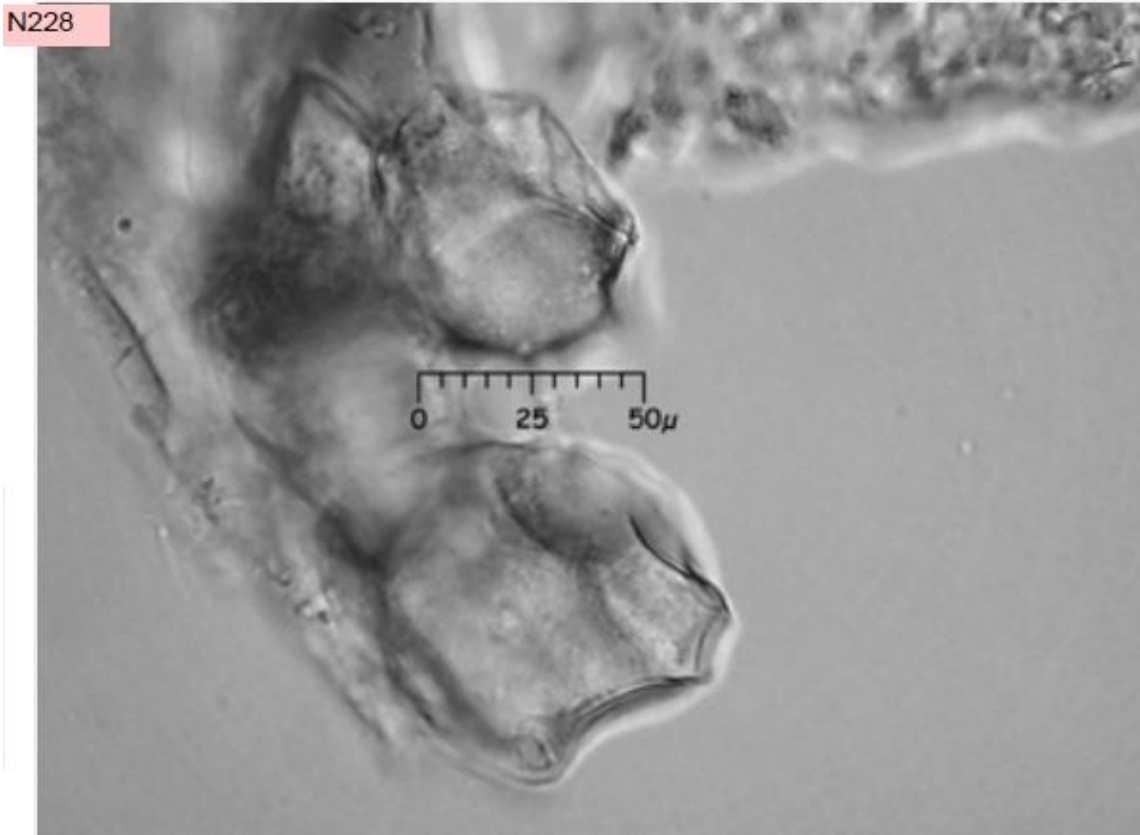


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Hedyosmum goudotianum

## Phytolith

Note large size of these polyhedral bodies. See double outline of "plates" or faces on polyhedron.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



CHRYSOBALANACEAE

# Chrysobalanus icaco

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. h) Hair base from *Chrysobalanus icaco* leaf



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Chrysobalanus icaco

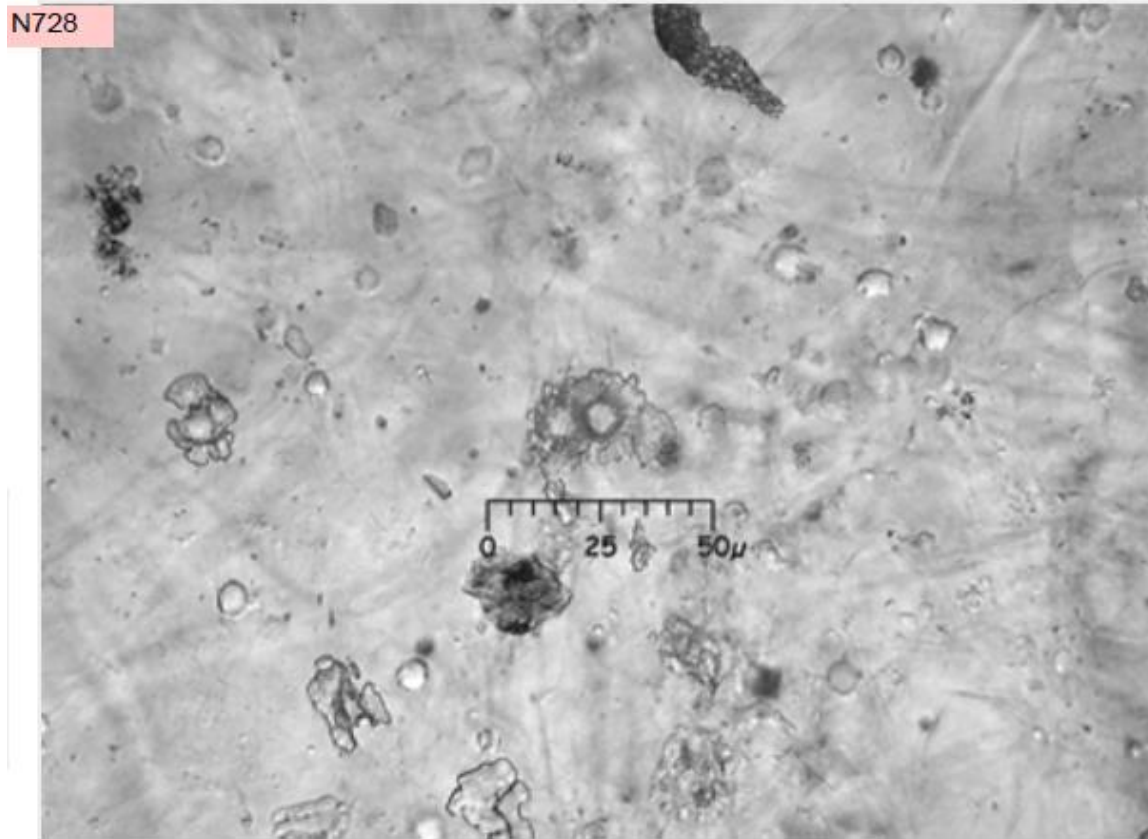
## Phytolith

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: not diagnostic

Entered by Updated

Karol Chandler-Ezell 10/7/2002



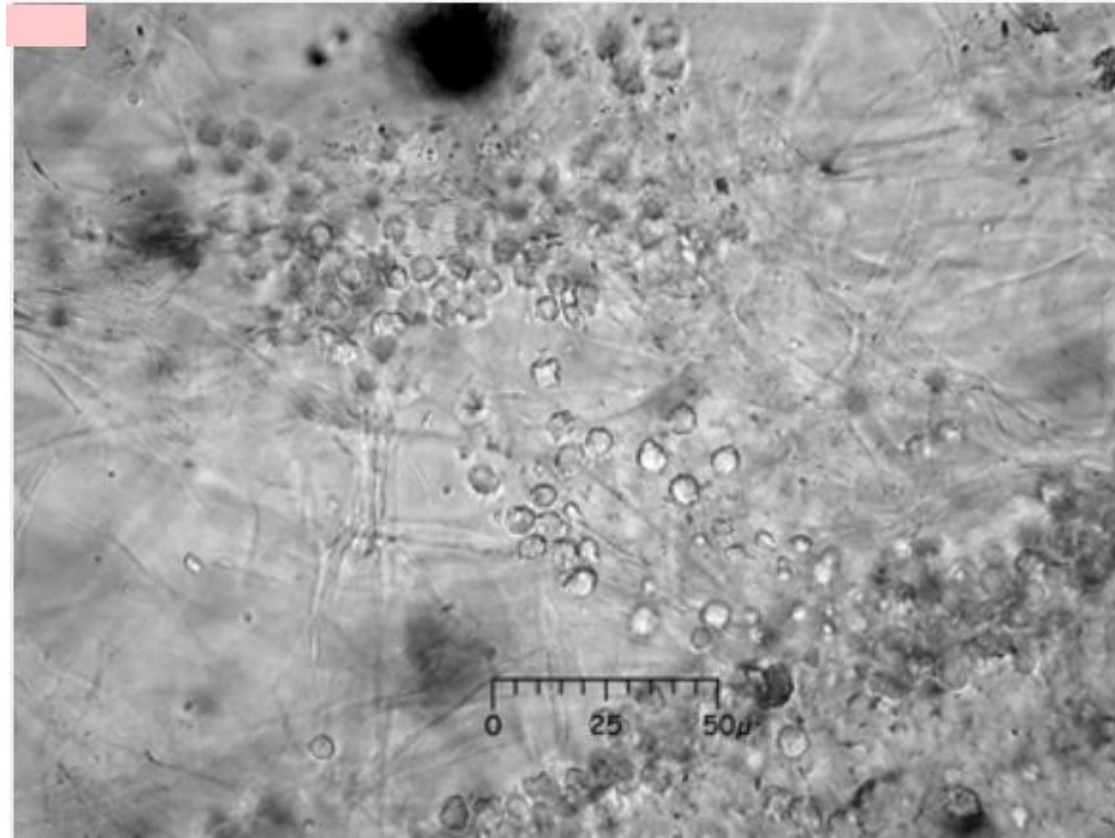
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Chrysobalanus icaco

## Phytolith

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: fruit/seed

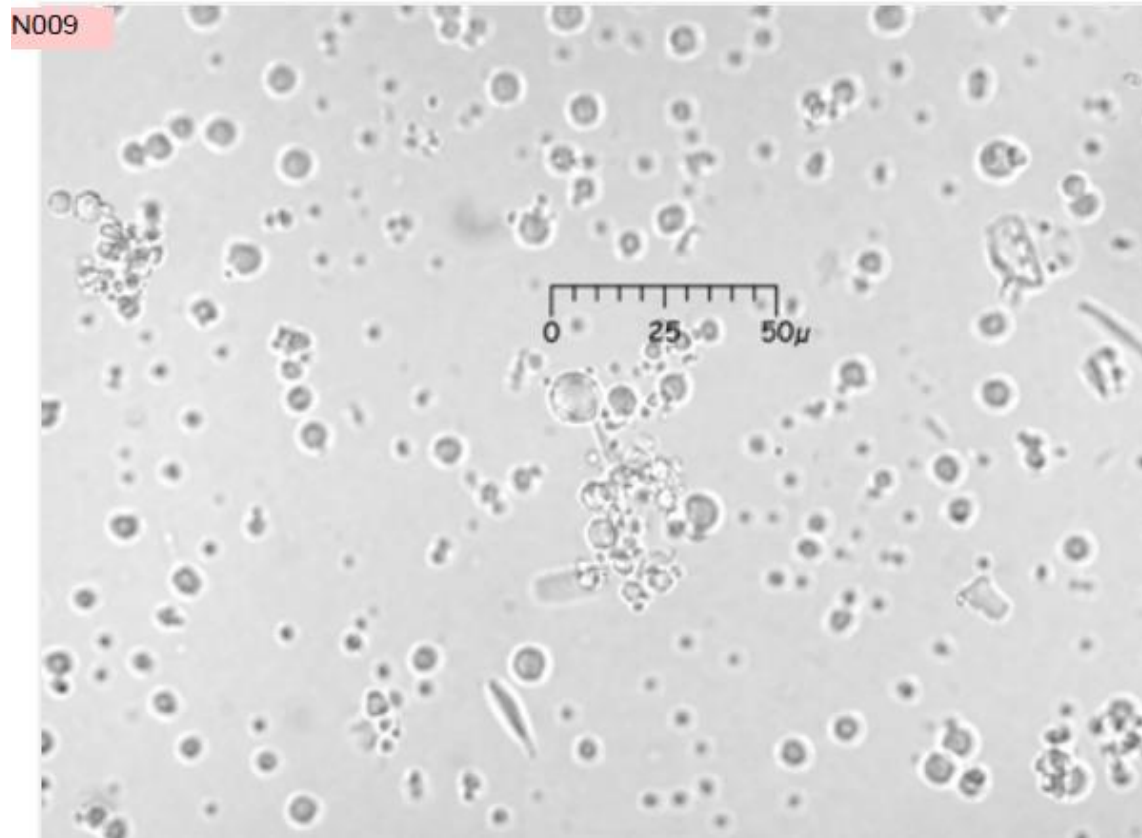


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Hirtella carbonaria

## Phytolith

Sphere, small. Often very difficult to notice in archaeological samples.  
Also produced in *Canna*, *Bixa orellana*. Diagnostic level: mixed:  
*Chrysobalanaceae/Cannaceae/Bixa*



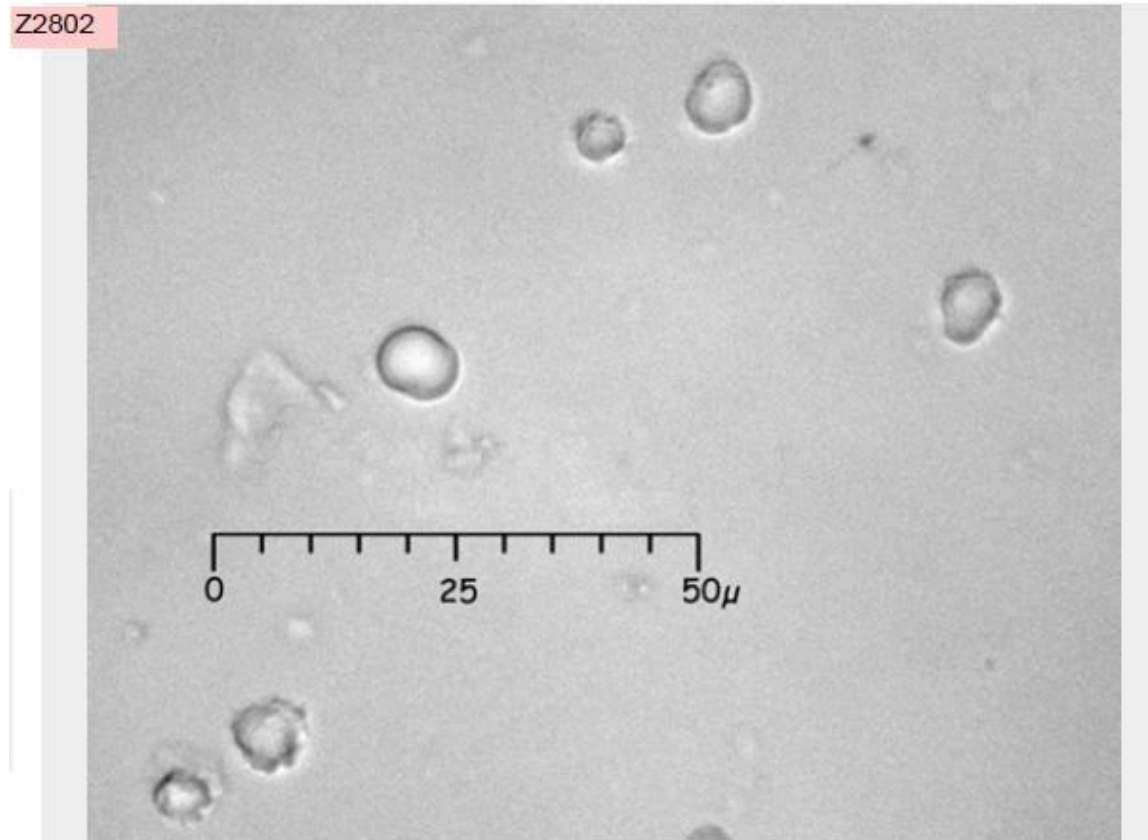
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Hirtella carbonaria

## Phytolith

A very smooth example of 80IAa1 that appears to be two conjoined disks, as in the original description of the Chrysobalanaceae type by Piperno. Appear somewhat elongated.

Chrysobalanaceae/Cannaceae  
mixed type

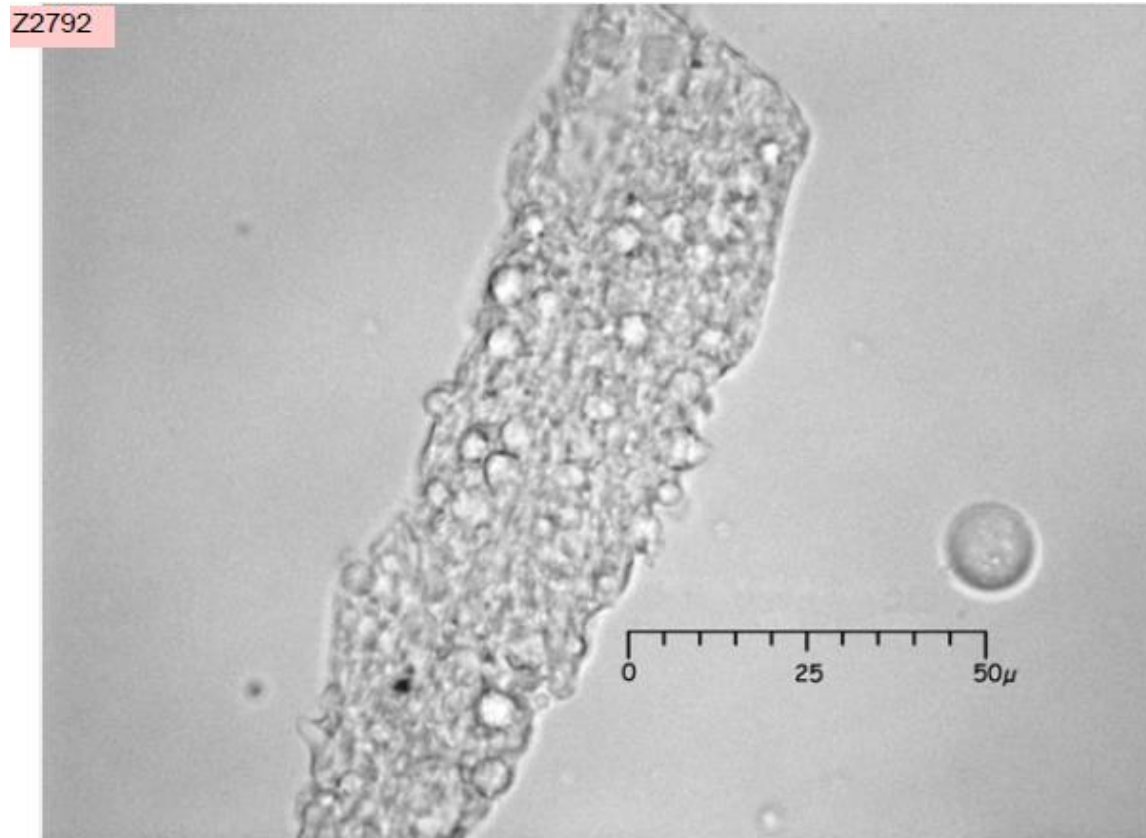


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Licania celiae

## Phytolith

A sheet of 80IAa1. Spheres are not completely smooth.  
Chrysobalanaceae/Cannaceae  
mixed type

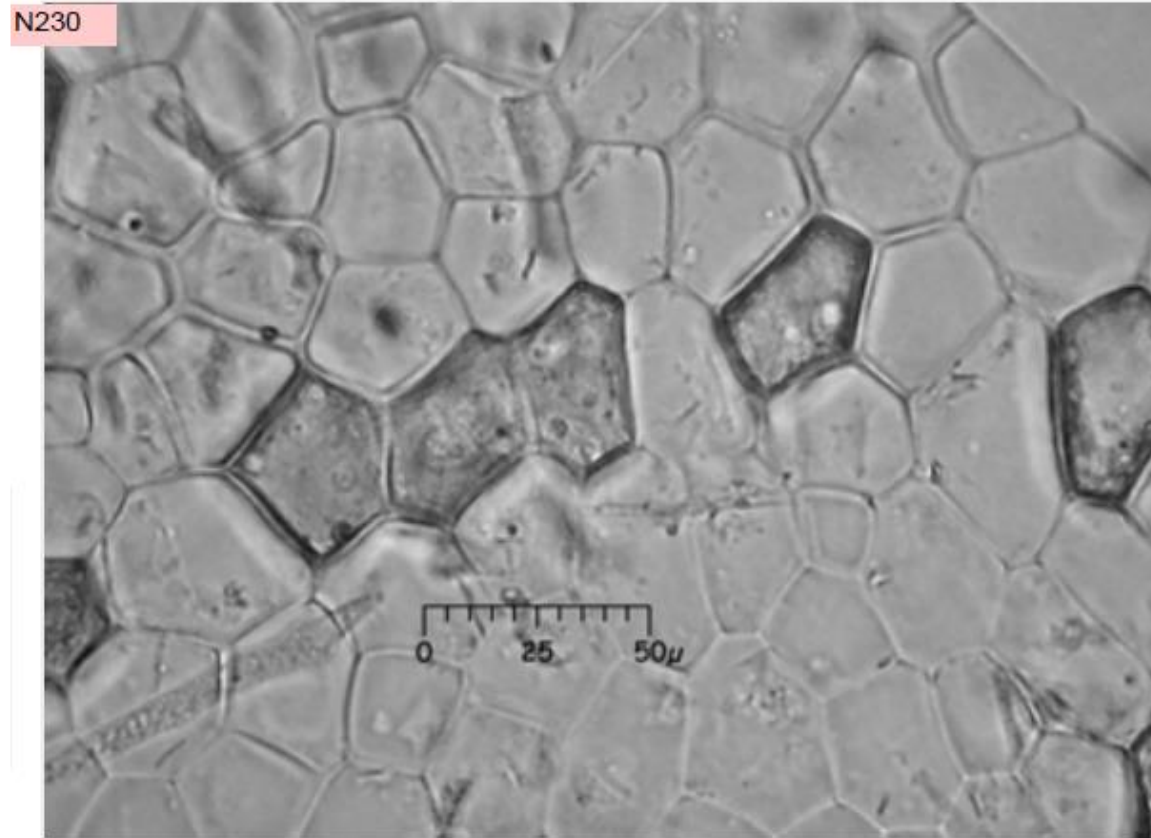


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Licania longistyla

## Phytolith

Darkened cells in center of image.  
Diagnostic level: dicot epidermis



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

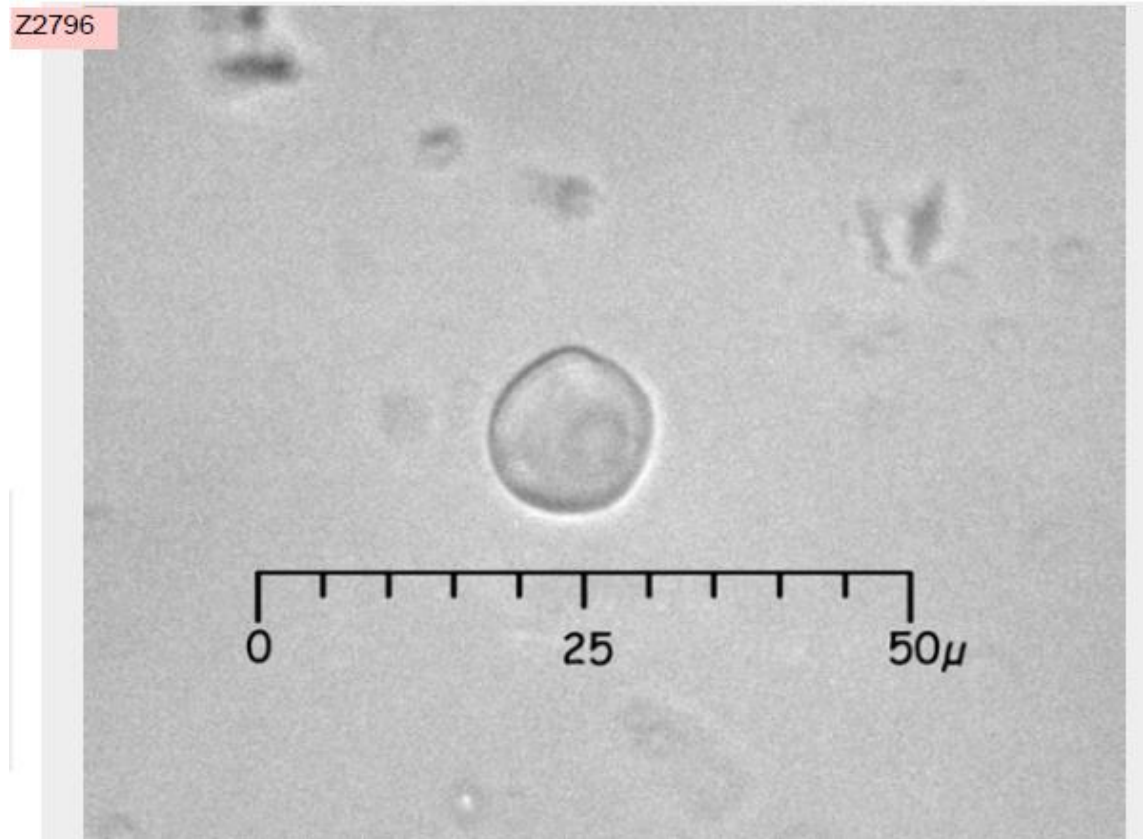


# Licania longistyla

## Phytolith

80IAa1 showing slight irregularity on edge. Slightly flattened in rotation. The irregularity can look like an inclusion until the sphere is rotated.

Chrysobalanaceae/Cannaceae  
mixed type

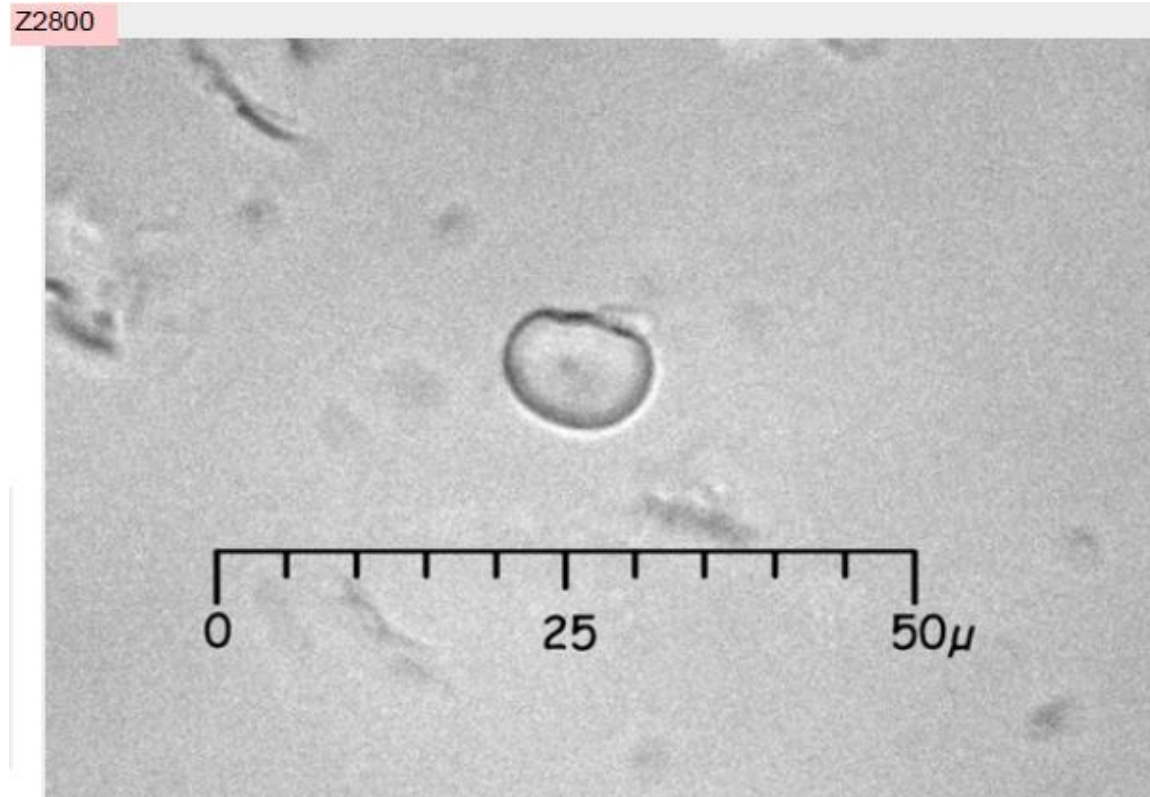


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Licania longistyla

## Phytolith

Same 80IAa1 sphere as image  
Z2796 rotated to show the slight  
flattening and irregularity.  
Chrysobalanaceae/Cannaceae  
mixed type

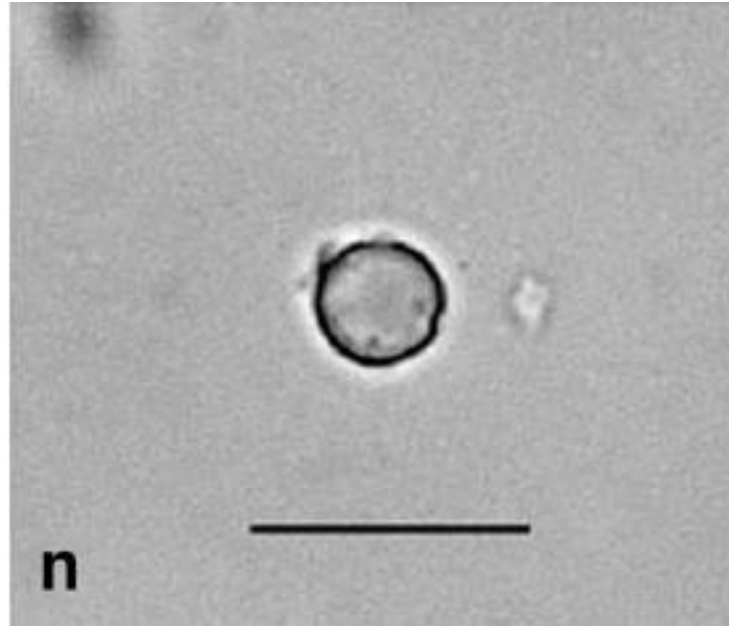


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Licania macrophylla

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. n) Globular psilate phytolith from *Licania macrophylla*



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Licania platypus

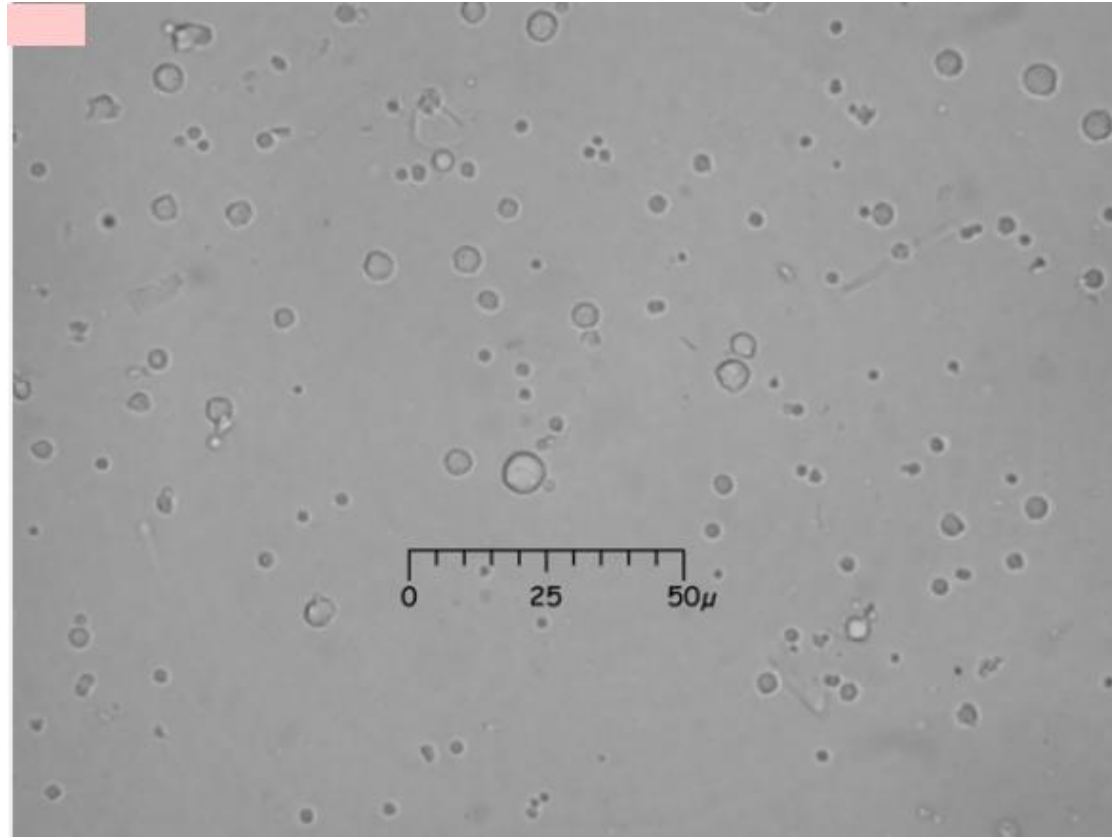
## Phytolith

Sphere, small. Often very difficult to notice in archaeological samples.

Also produced in Canna, Bixa.

Diagnostic level: mixed,  
Chrysobalanaceae/Canna/Bixa

Description

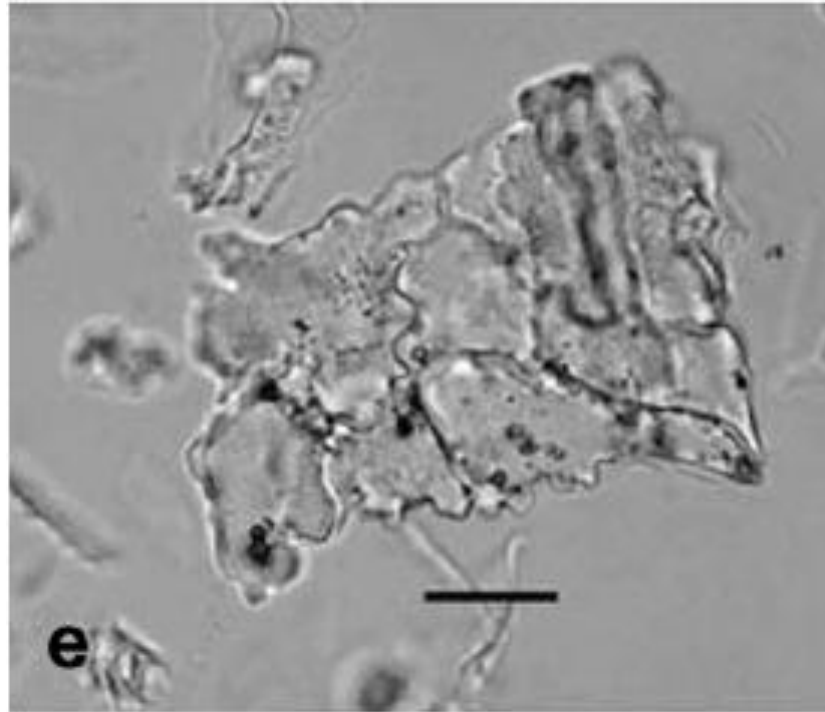


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Parinari campestris

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. e) Thick, irregular polyhedrals from *Parinari campestris*



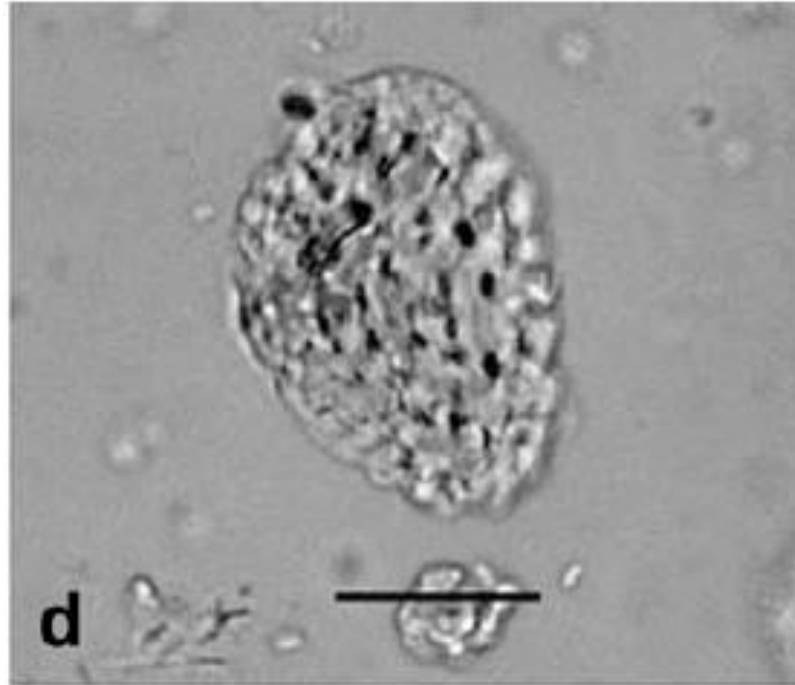
Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

CLUSIACEAE

# Clusia nemorosa

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. d) Decorated epidermis from *Clusia nemorosa*



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

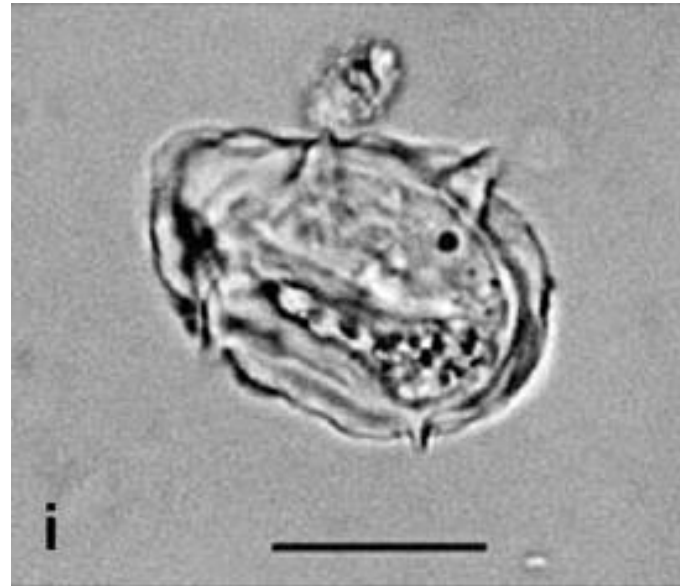
COMBRETACEAE



# Conocarpus erecta

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. i) Hair base from *Conocarpus erecta*



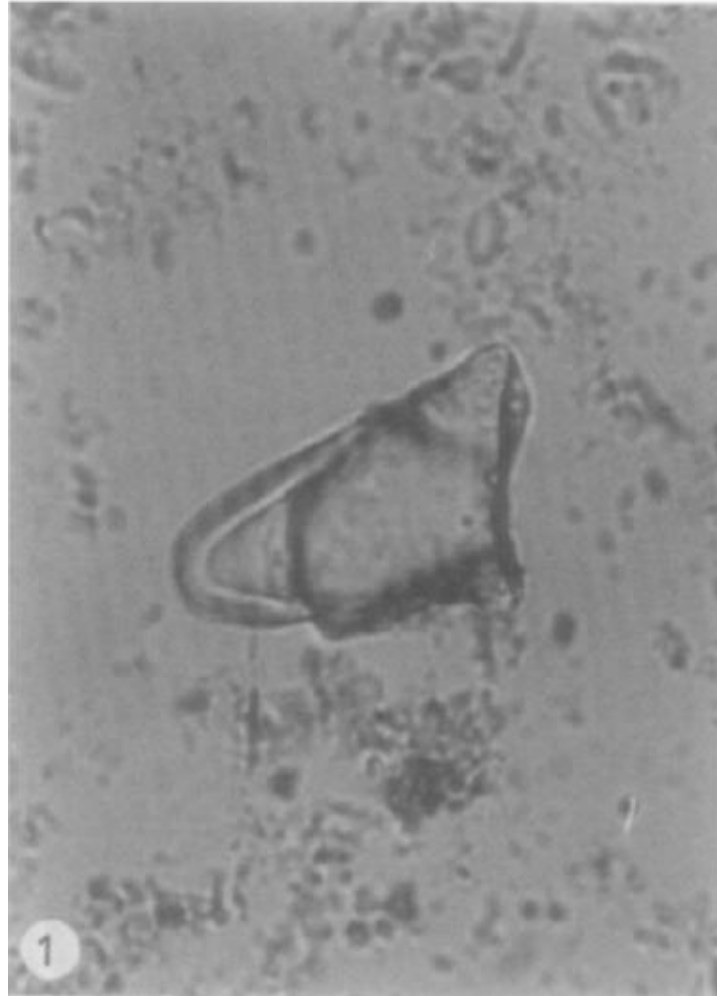
Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

COMMELINACEAE

# Athyrocarpus peraecariefolium

## Phytolith

1. A tongue-shaped phytolith from *Athyrocarpus peraecariefolium* (400 ×).



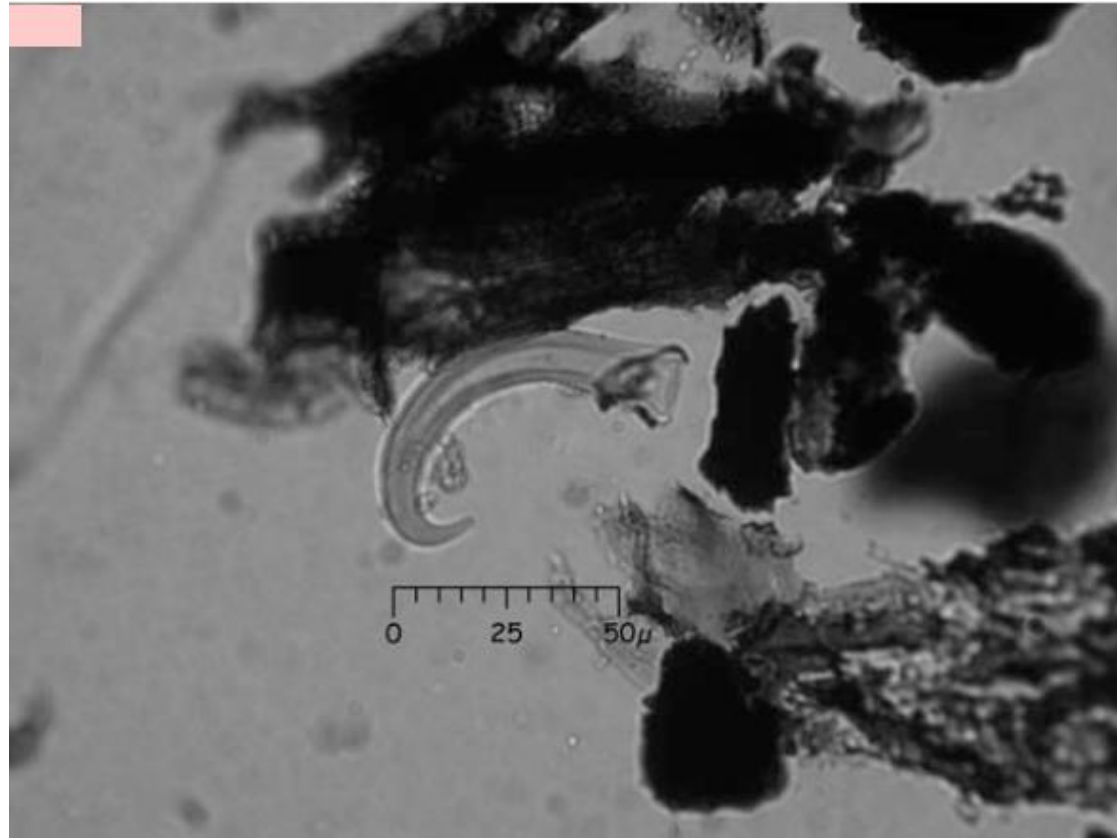
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Commelina celestis

## Phytolith

PC3154 leaf

Described by Neil Duncan. Common to abundant in this species and common in *C. erecta*. Larger and more hooked than similar *Phaseolus* hairs, but would be confusers where *Commelina* also grows. Diagnostic level: genus (in absence of *Phaseolus*)



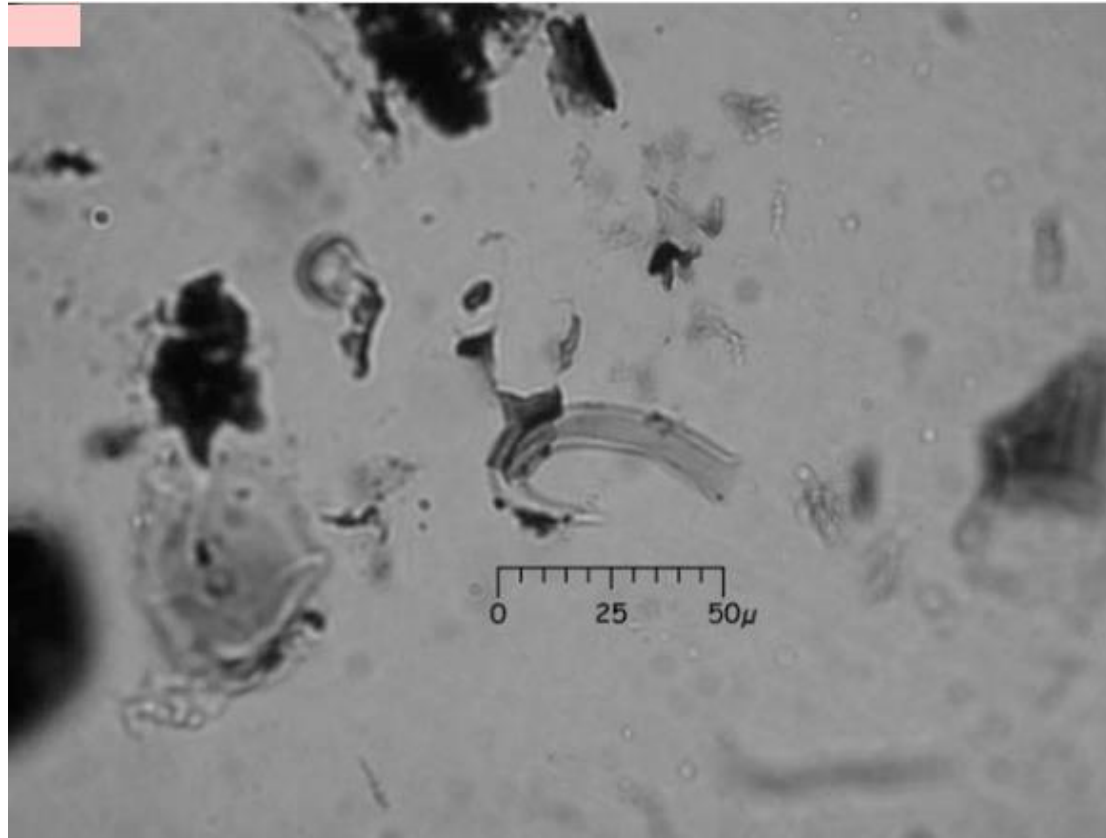
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Commelina celestis

## Phytolith

PC3154 leaf

Described by Neil Duncan. Common to abundant in this species and common in *C. erecta*. Larger and more hooked than similar *Phaseolus* hairs, but would be confusers where *Commelina* also grows. Diagnostic level: genus (in absence of *Phaseolus*)



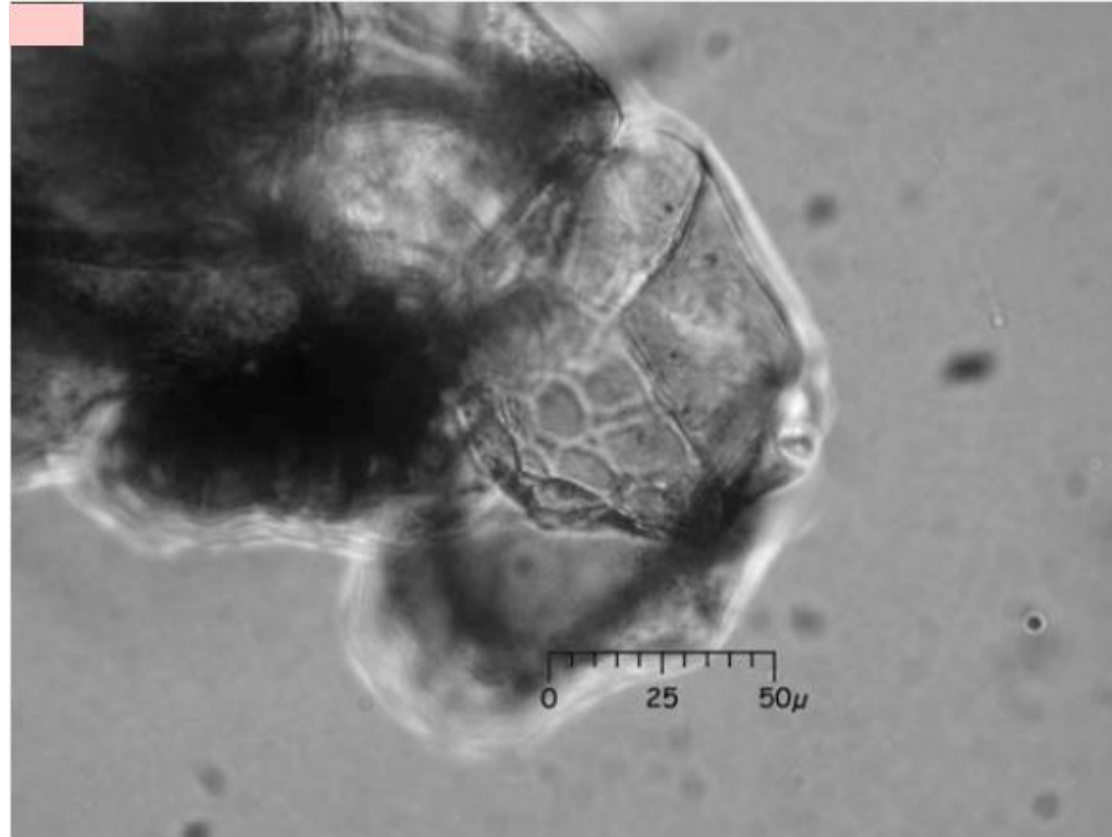
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Commelina dianthafolia

## Phytolith

PC3155, leaf

Described by Neil Duncan. The scallops on these schlerids are somewhat similar to those of *Cucurbita* spheres. The quadrilateral form distinguishes them. Common. Also common in *C. robusta*.  
Diagnostic level: not diagnostic



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Commelina erecta

## Phytolith

Type established by Karol Chandler- Ezell, 2004

*C. erecta* photos by Neil Duncan, 2011

Side view of flat domed rhizome cylinder, potential *Calathea* "confuser." Note small size.



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Commelina erecta

## Phytolith

Type established by Karol Chandler- Ezell, 2004

*C. erecta* photos by Neil Duncan, 2011

Side view of flat domed rhizome cylinder, potential *Calathea* "confuser." Note smaller size.



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Commelina erecta

## Phytolith

Type established by Karol Chandler- Ezell, 2004

*C. erecta* photos by Neil Duncan, 2011  
Bottom view (base of ciliate or beaded cylinder) of flat domed rhizome cylinder



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Commelina erecta

## Phytolith

Type established by Karol Chandler- Ezell,  
2004

*C. erecta* photos by Neil Duncan, 2011

A group of cylinders in partial rotation;  
note decoration of base



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Commelina erecta

## Phytolith

Type established by Karol Chandler- Ezell,  
2004

*C. erecta* photos by Neil Duncan, 2011

A cylinder in partial rotation; note  
smooth, transparent head



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

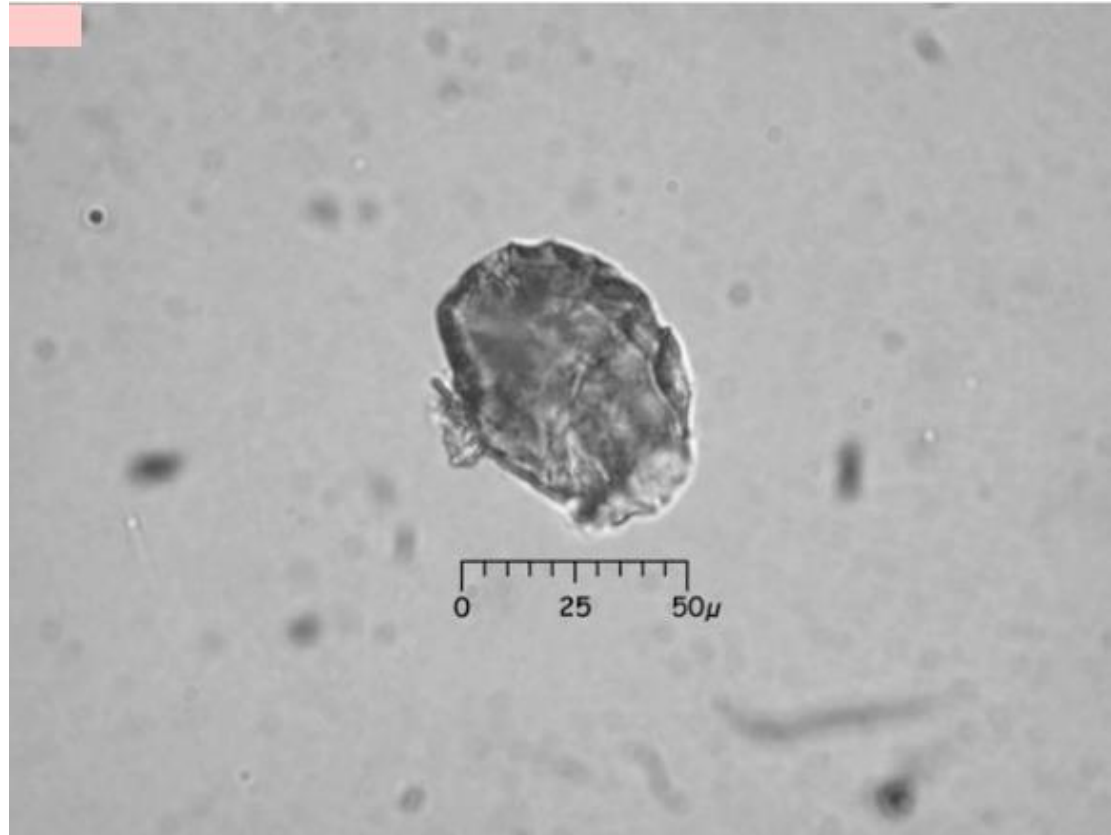
# Commelina erecta

## Phytolith

PC3157, leaf

Described by Neil Duncan. The scallops on these schlerids are somewhat similar to those of Cucurbita spheres. The quadrilateral form distinguishes them. Smaller, less robust, and rarer in this species.

Diagnostic level: not diagnostic



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Commelina erecta

## Phytolith

PC3157, leaf Described by Neil Duncan.  
Unicellular hairs. Rare to moderate  
abundance.  
Diagnostic level: not diagnostic

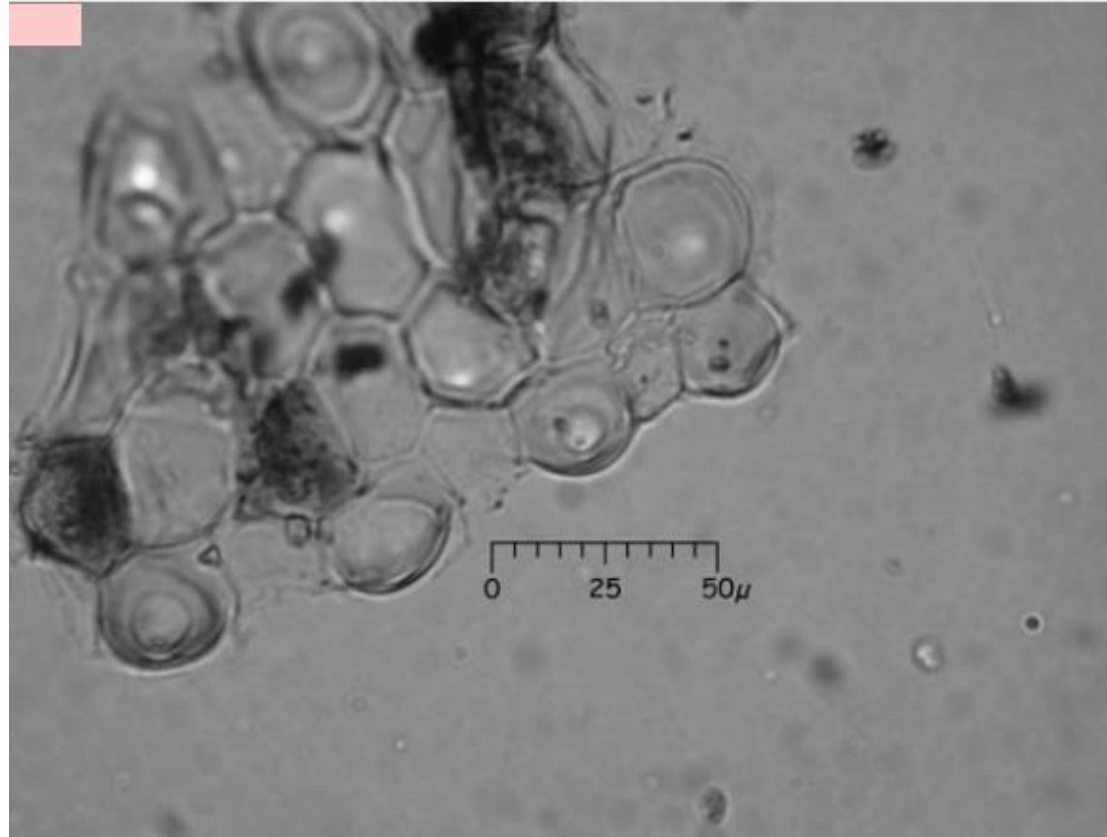


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Commelina scabra

## Phytolith

PC3160, leaf Described by Neil Duncan.  
Unicellular hairs, more “hat-shaped” than  
the hairs in *C. erecta*. Diagnostic level:  
not diagnostic

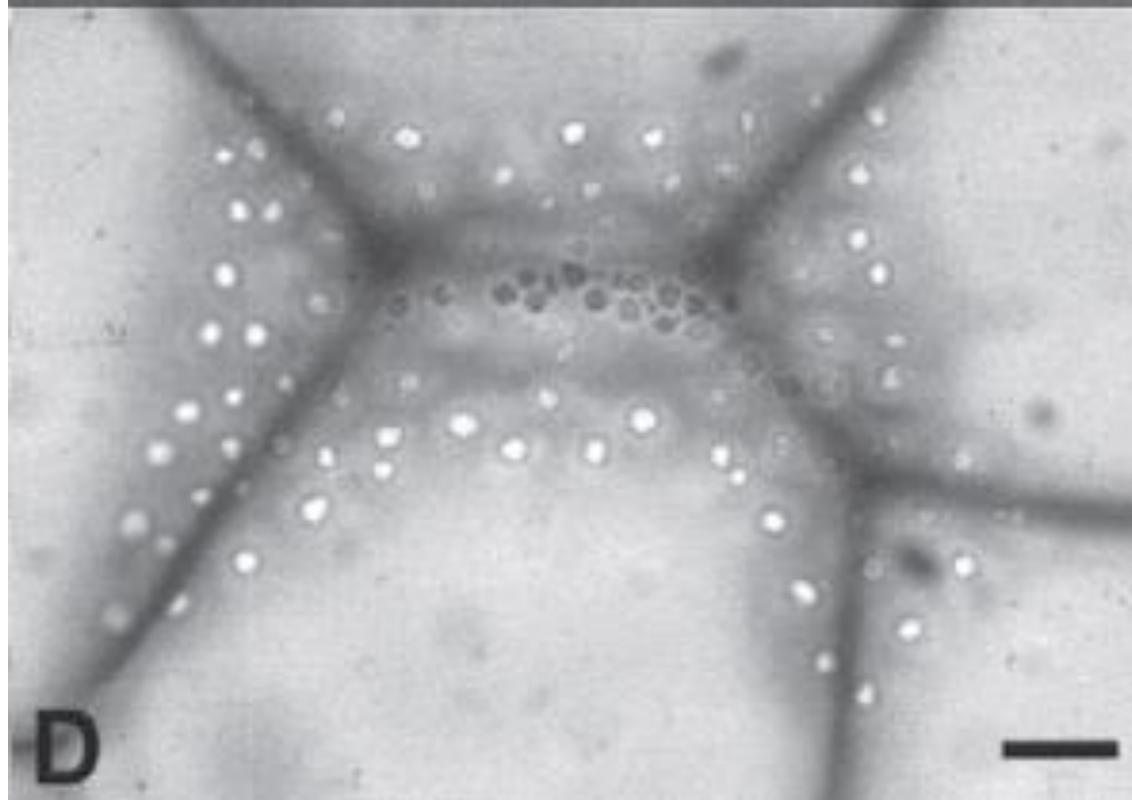


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyanotis arachnoidea

## Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. D. *Cyanotis arachnoidea* (Commelinaceae), small, spherical, spinulose bodies in epidermal cells, apparently following the cell wall (bar = 20  $\mu$ m).



Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

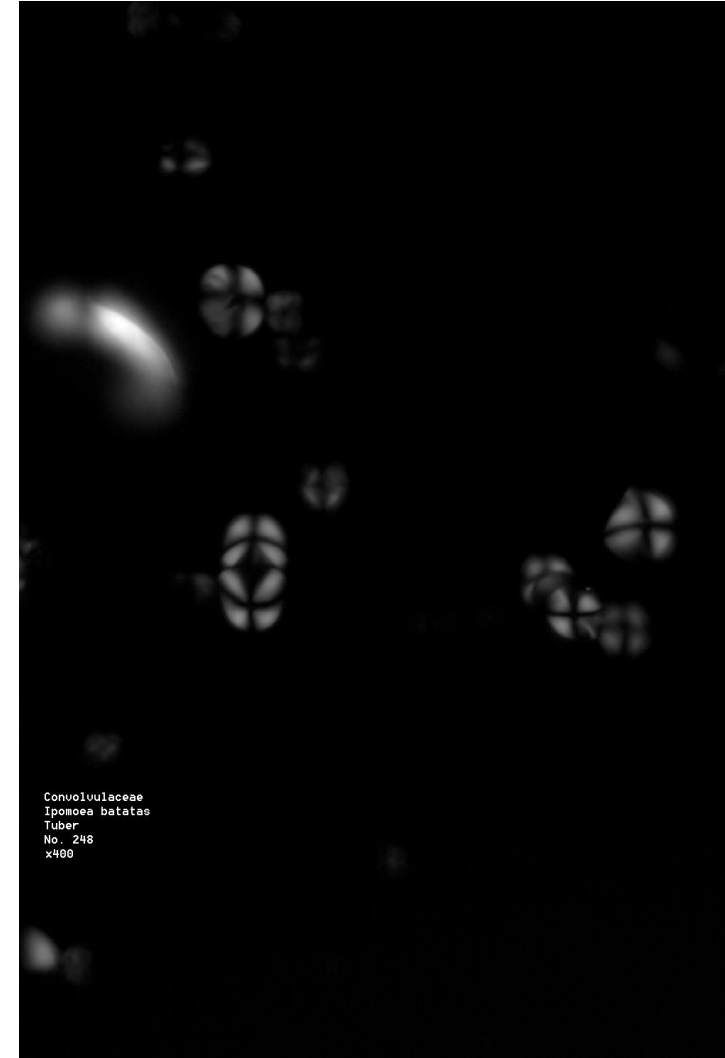
CONVULVULACEAE



# Ipomoea batatas

Starch

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Ipomoea batatas

Convolvuleaceae *Ipomoea batatas* "batata"

## Phytolith assemblage characterization

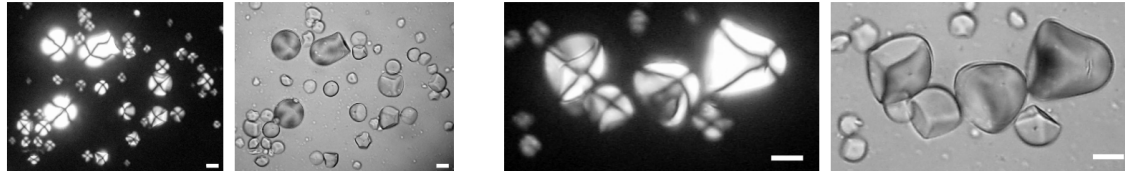
root

**References:** Reported as not present in leaf and tuber (Piperno 1988:31).  
Reported as a family where phytoliths have been found to be not present, rare or not taxonomically significant (Pearsall 2000:371).  
Cristaline druses of calcium oxalate with no consistent shape; no raphides (Loy 1994).

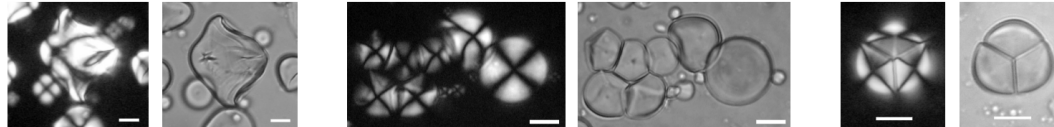
## Starch assemblage characterization

root

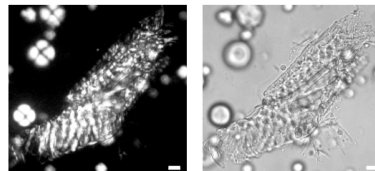
a) Single grains, ovoid, oval, polyhedral, bowl- and bell-shaped, sometimes with two or more facets; variable in size from 2,5µm to 55µm long length; mainly distinct eccentric hilum as a dot or line, usually at rounded or smaller end; distinct lamella; sometimes radiating fissures; very distinct margins; mainly distinct eccentric cross, with four arms visible. May occur in aggregates.



b) Compound grains, compounded by two or more granula, without a single external packing. Granula variable in shape and size, polyhedral, bell- or bowl-shaped, with one or more facets, and plane, wavy or acute truncations; size from 2,5µm to 55µm; mainly distinct eccentric hilum as a dot or line; distinct lamella; sometimes radiating fissures; mainly distinct eccentric cross with four arms visible.



c) Another compound grains, with a single external package variable in shape, size, and number of granula. Granula variable in size to 20µm long length; very distinct hilum as a line or v-shaped; not visible lamella; distinct centric cross, with four arms visible.



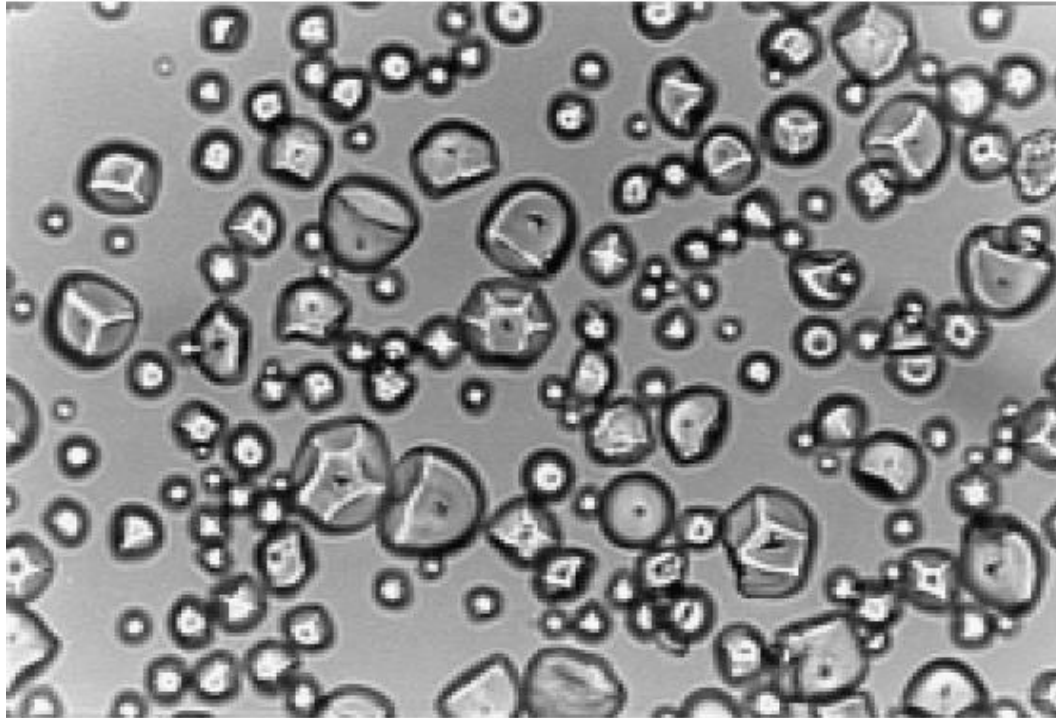
**References:** Partially based on Loy 1994,  
Piperno and Holst 1998, Reichert 1913,  
Shannon and Garwood 1984.

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Ipomoea batatas

## Starch



Starch grains from a modern sweet potato tuber. 80x

### APPENDIX:

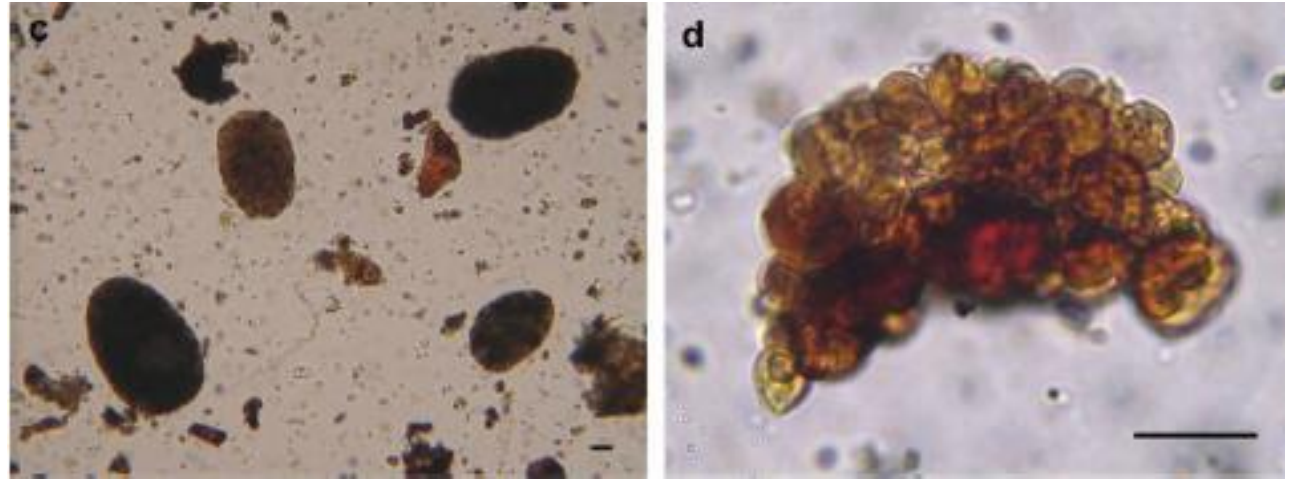
*Ipomoea batatas* (sweet potato) (Figure 2). Mostly compound grains, laminated, often with a diagnostic small and transverse fissure. The pressure facets have very distinct margins. Size: 4–34 microns long

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Ipomoea batatas

## Starch

Fig. 7. Plant microfossils from Kona (a, b mounted in Caedax; c–h mounted in glycerol jelly; 100x,400x or 600x; scale bars: 20 mm). (c) Low magnification view of soil-stained dense material within ovate cell membranes (four) (c.f. parenchyma starch storage cells of *Ipomoea batatas*, Fig. 8c). (d) High magnification view of fragment of ovate cell showing densely packed starch grains (membrane has been lost) (c.f. parenchyma storage cells of *I. batatas*, Fig. 8c). Individual soil-stained starch grains are more easily seen in cells that are disintegrating than in intact cells because the grains are tightly packed in the latter.

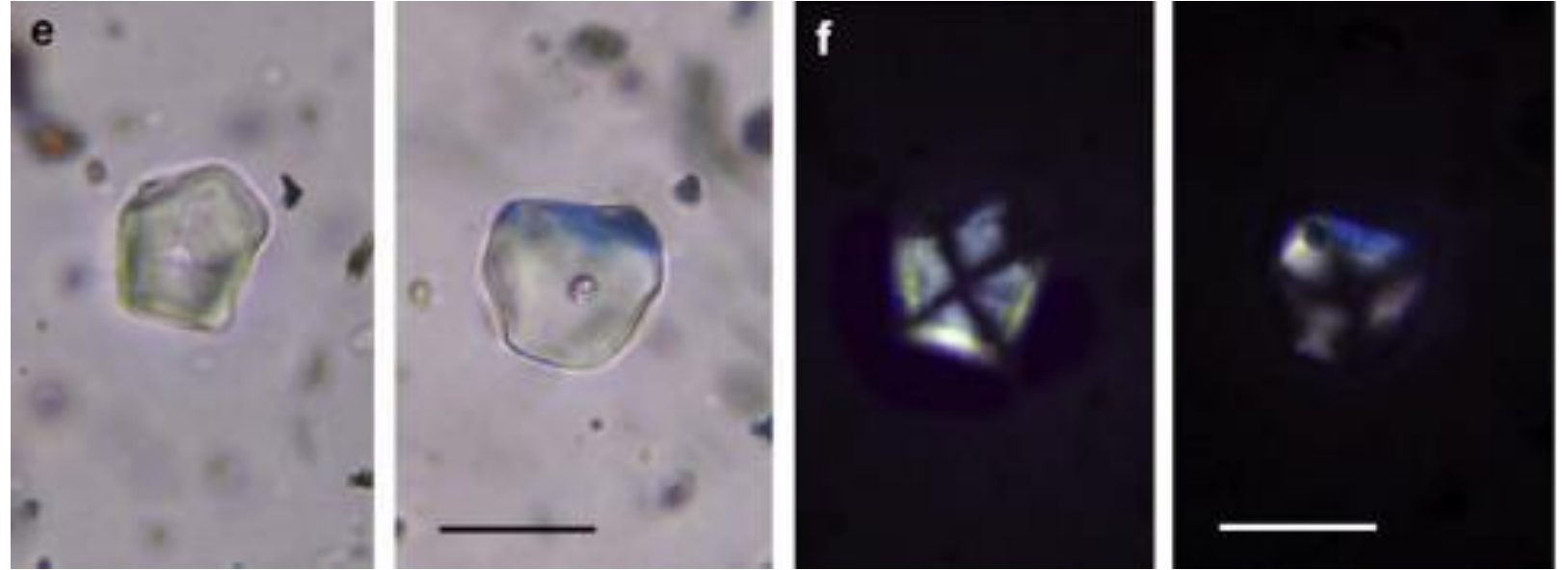


Horrocks, Mark, and Robert B. Rechtman. 2009. Sweet Potato (*Ipomoea Batatas*) and Banana (*Musa Sp.*) Microfossils in Deposits from the Kona Field System, Island of Hawaii. *Journal of Archaeological Science* 36 (5). Elsevier Ltd:1115–26. <http://dx.doi.org/10.1016/j.jas.2008.12.014>.

# Ipomoea batatas

## Starch

Fig. 7. Plant microfossils from Kona (a, b mounted in Caedax; c–h mounted in glycerol jelly; 100x, 400x or 600x; scale bars: 20 μm). (e, f) Faceted starch grains with central vacuole (c.f. starch grains of *I. batatas*, Fig. 8d, e). (f) Shows the grains in (e) viewed under cross-polarised light, showing central Maltese cross.

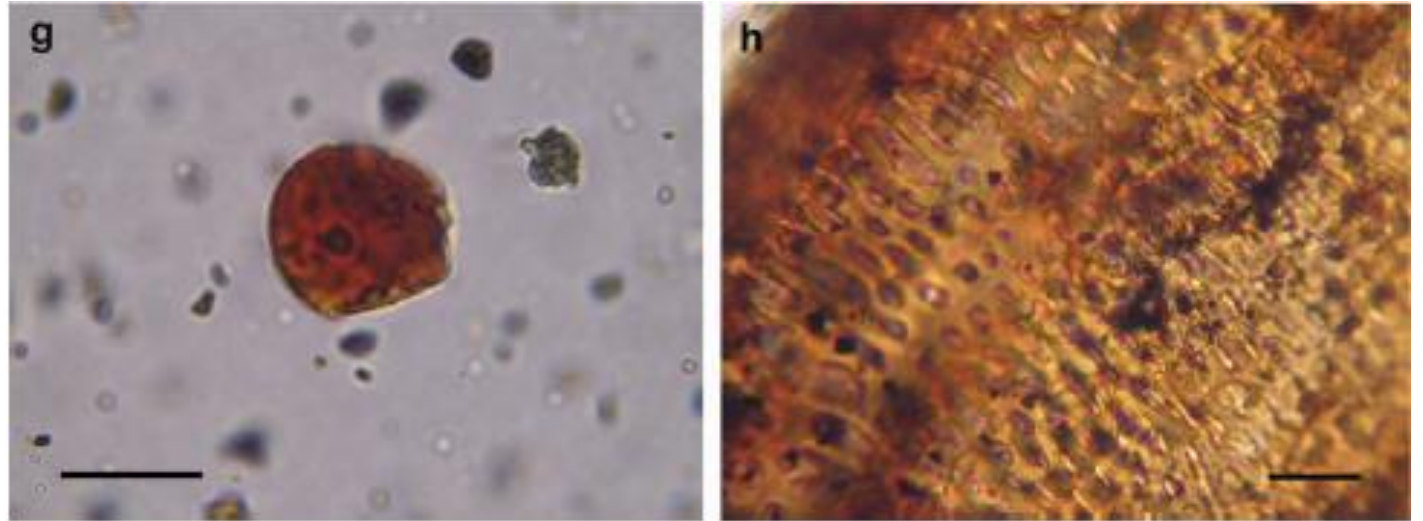


Horrocks, Mark, and Robert B. Rechtman. 2009. Sweet Potato (*Ipomoea Batatas*) and Banana (*Musa Sp.*) Microfossils in Deposits from the Kona Field System, Island of Hawaii. *Journal of Archaeological Science* 36 (5). Elsevier Ltd:1115–26. <http://dx.doi.org/10.1016/j.jas.2008.12.014>.

# Ipomoea batatas

## Starch

Fig. 7. Plant microfossils from Kona (a, b mounted in Caedax; c–h mounted in glycerol jelly; 100x, 400x or 600x; scale bars: 20 μm). (g) Soil-stained starch grain with central vacuole (c.f. starch grains of *I. batatas*, Fig. 8d). Although facets are not clearly visible, two straight edges of these are. (h) Xylem vessel element with alternate slit-like pits (c.f. xylem vessel element of *I. batatas*, Fig. 8f).

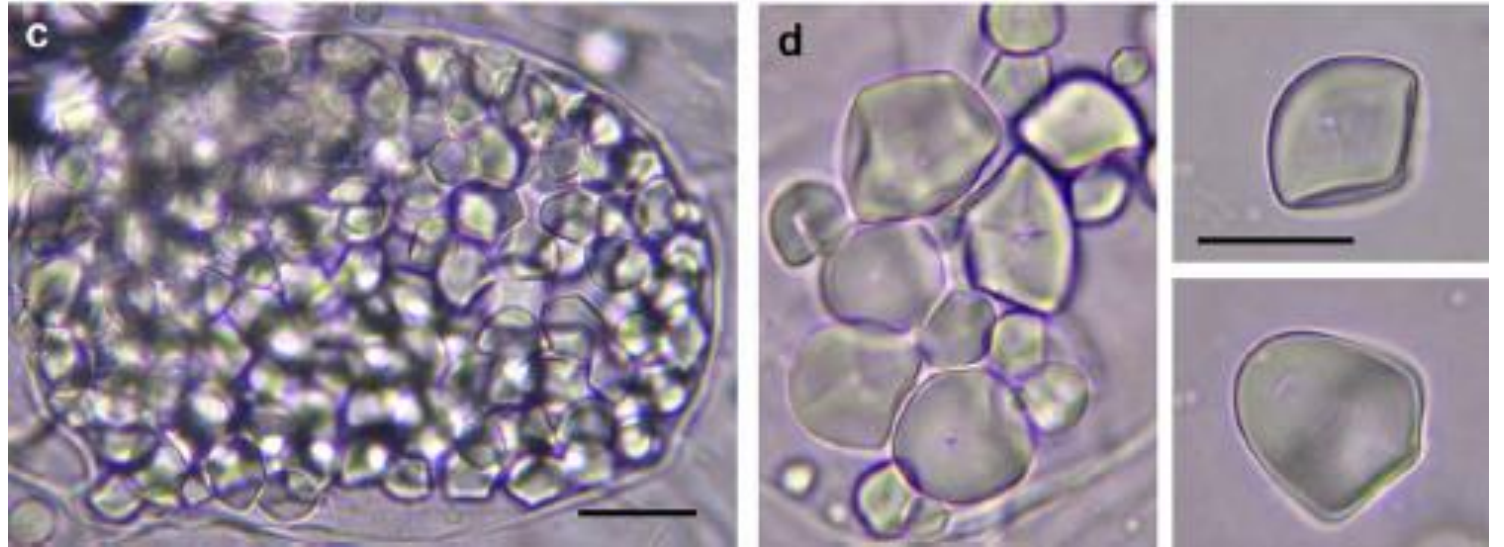


Horrocks, Mark, and Robert B. Rechtman. 2009. Sweet Potato (*Ipomoea Batatas*) and Banana (*Musa Sp.*) Microfossils in Deposits from the Kona Field System, Island of Hawaii. *Journal of Archaeological Science* 36 (5). Elsevier Ltd:1115–26. <http://dx.doi.org/10.1016/j.jas.2008.12.014>.

# Ipomoea batatas

## Starch

Fig. 8. Modern reference samples ((a, b mounted in Caedax; c–f mounted in glycerol jelly; 400x or 600x; scale bars: 20  $\mu$ m). (c) Parenchyma storage cell of *Ipomoea batatas* root, with densely packed, immature starch grains. Storage cells are typically ovate, up to  $\approx 115 \mu$ m diam., with thin walls,  $<0.5 \mu$ m thick. (d) Typical starch grains of *I. batatas* root. Grains are spherical to sub-spherical, often bell-shaped, up to  $\approx 26 \mu$ m diam., with a vacuole at the central hilum (seen here as a dot) and up to six flattened pressure facets. Reichert (1913) described the hilum as “eccentrically placed. in or slightly to one side of the median line”. However, as this appears more or less central, to avoid confusion with the several Pacific starch taxa that have elongated grains with very eccentric hila (i.e. well off the median line, e.g. four of the five Remote Oceanic *Dioscorea* spp.), we describe the *Ipomoea* hilum as central, as did Loy et al. (1992). Many of the grains shown here are more mature than those in (c), hence are larger.

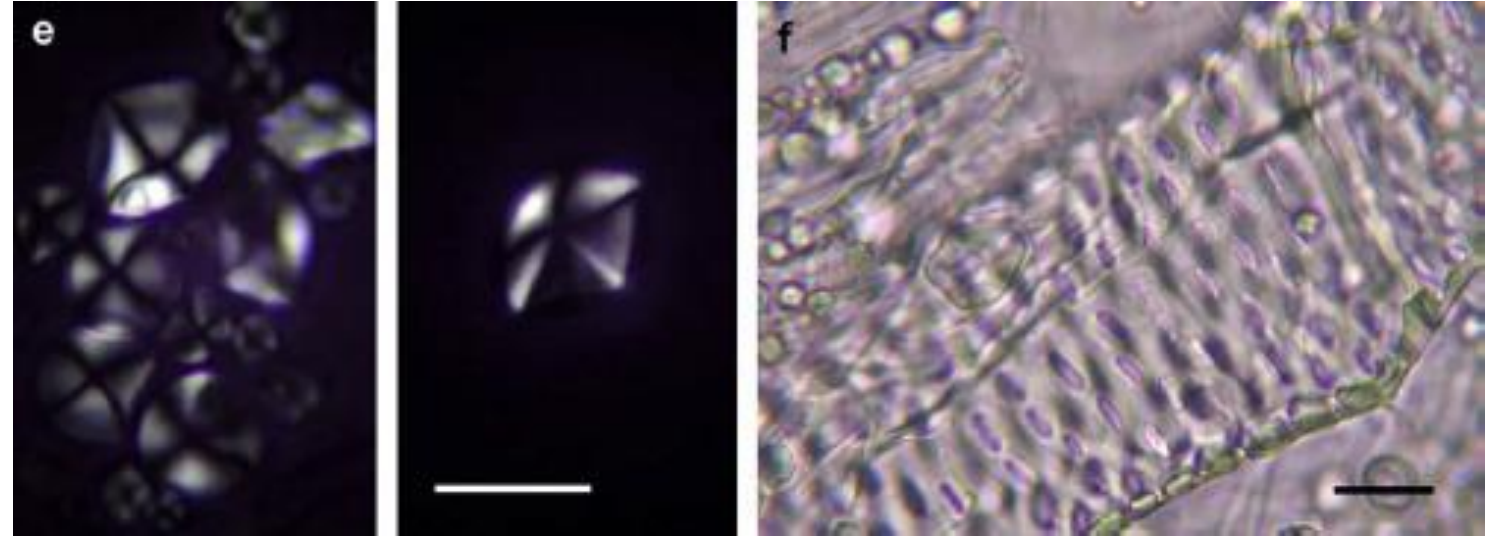


Horrocks, Mark, and Robert B. Rechtman. 2009. Sweet Potato (*Ipomoea Batatas*) and Banana (*Musa Sp.*) Microfossils in Deposits from the Kona Field System, Island of Hawaii. *Journal of Archaeological Science* 36 (5). Elsevier Ltd:1115–26. <http://dx.doi.org/10.1016/j.jas.2008.12.014>.

# Ipomoea batatas

## Starch

Fig. 8. Modern reference samples ((a, b mounted in Caedax; c–f mounted in glycerol jelly; 400x or 600x; scale bars: 20  $\mu$ m). (e) Starch grains in left and upper right panels of (d) viewed under cross-polarised light, showing central Maltese crosses. (f) Xylem vessel element of *I. batatas* root. Vessel elements are up to c. 90  $\mu$ m across with walls up to 5  $\mu$ m thick, and alternate slit-like pits up to 20  $\mu$ m across



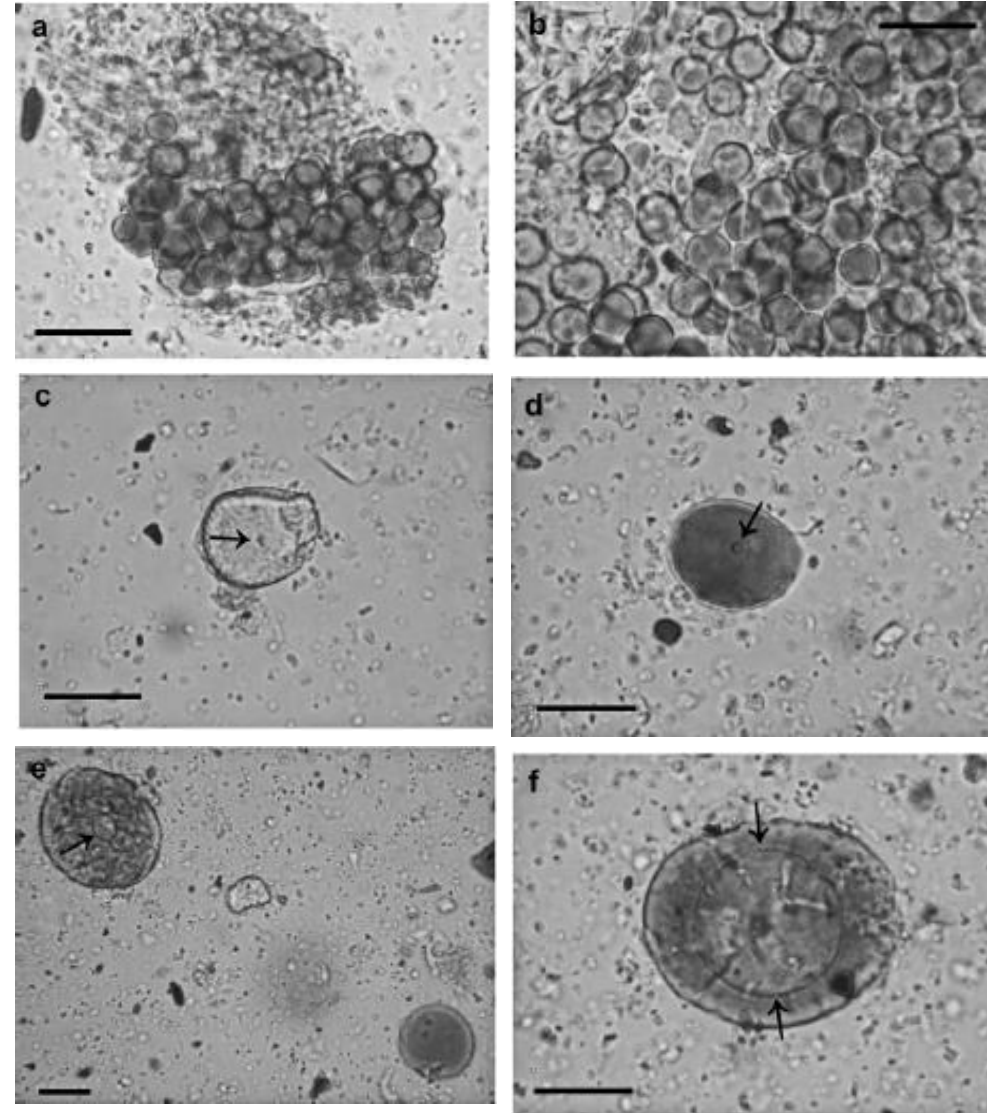
Horrocks, Mark, and Robert B. Rechtman. 2009. Sweet Potato (*Ipomoea Batatas*) and Banana (*Musa Sp.*) Microfossils in Deposits from the Kona Field System, Island of Hawaii. *Journal of Archaeological Science* 36 (5). Elsevier Ltd:1115–26. <http://dx.doi.org/10.1016/j.jas.2008.12.014>.



# Ipomoea batatas

## Starch

Fig. 2. Microfossils characteristic of introduced *Ipomoea batatas* root from Hamurana Rd (400? or 600?). (a, b) Clumps of immature, brown-stained starch grains in cellulose material (c.f. starch grains of *I. batatas* root, Fig. 4a-d). (c, d) Bell-shaped starch grains, one brown-stained, with central vacuole (arrows) (c.f. bell-shaped starch grains of *I. batatas* root, Fig. 4c). (e) Two brown-stained starch grains. The larger shows signs of corrosion: pitting and expansion of the vacuole (arrow). (f) Brown-stained starch grain showing extreme vacuole expansion (arrows).

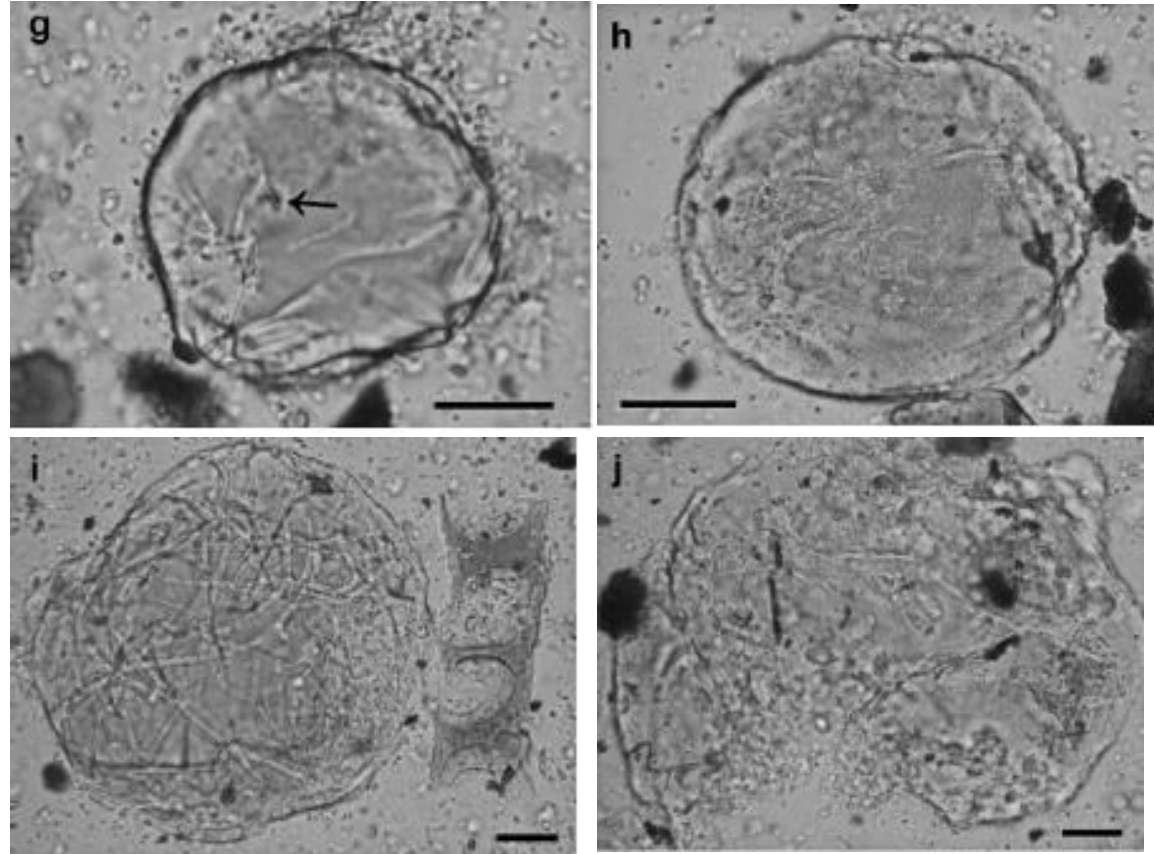


Horrocks, Mark, Matthew Campbell, and Warren Gumbley. 2007. A Short Note on Starch and Xylem of *Ipomoea Batatas* (Sweet Potato) in Archaeological Deposits from Northern New Zealand. *Journal of Archaeological Science* 34 (9):1441–48.

# Ipomoea batatas

## Starch

Fig. 2. Microfossils characteristic of introduced *Ipomoea batatas* root from Hamurana Rd (400? or 600?). (g-j) Starch grains showing extreme swelling, and corrosion with cracking and disintegration. Vacuole (arrow) is visible in (g). A degraded xylem fragment with expanded wall pits (see below) is visible in (i).

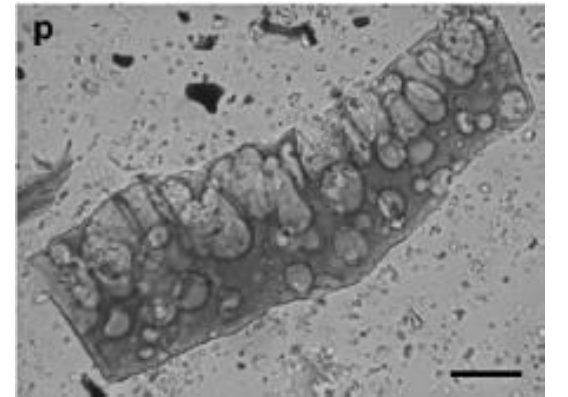
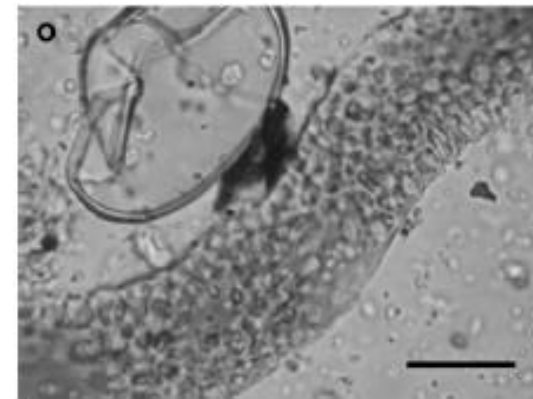
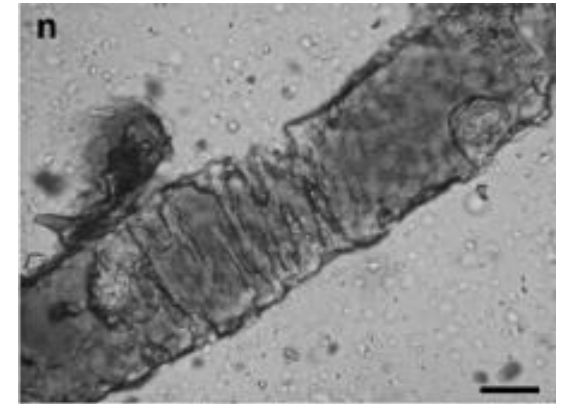
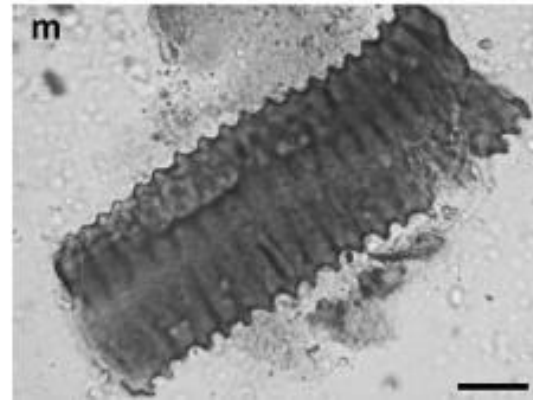
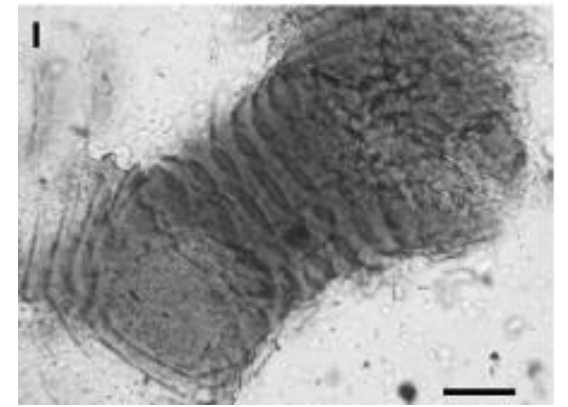
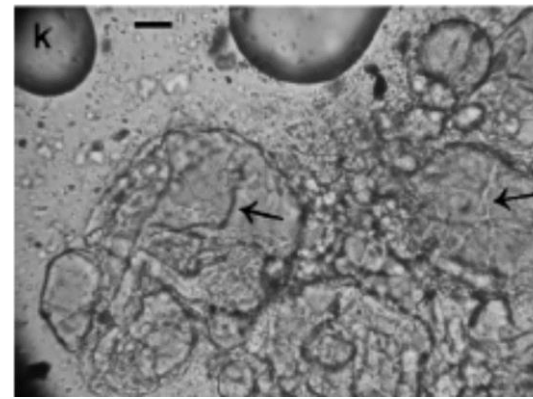


Horrocks, Mark, Matthew Campbell, and Warren Gumbley. 2007. A Short Note on Starch and Xylem of *Ipomoea Batatas* (Sweet Potato) in Archaeological Deposits from Northern New Zealand. *Journal of Archaeological Science* 34 (9):1441–48.

# Ipomoea batatas

## Starch

Fig. 2. Microfossils characteristic of introduced *Ipomoea batatas* root from Hamurana Rd (400? or 600?). (k) Clump of starch grains showing variable swelling and disintegration. Note cracks (arrows). (The two dark-outlined objects top centre and left are air bubbles.) (l-p) Brown-stained xylem tracheary elements with slit-like pits (c.f. xylem vessel elements of *I. batatas* root, Fig. 4e-h). (n-p) show expansion of wall pits. In (l), the inside of the cell is visible through the large opening, lower end. (The other large object in o is a *Cyathea* fern spore.) Scale bars, 20 mm.

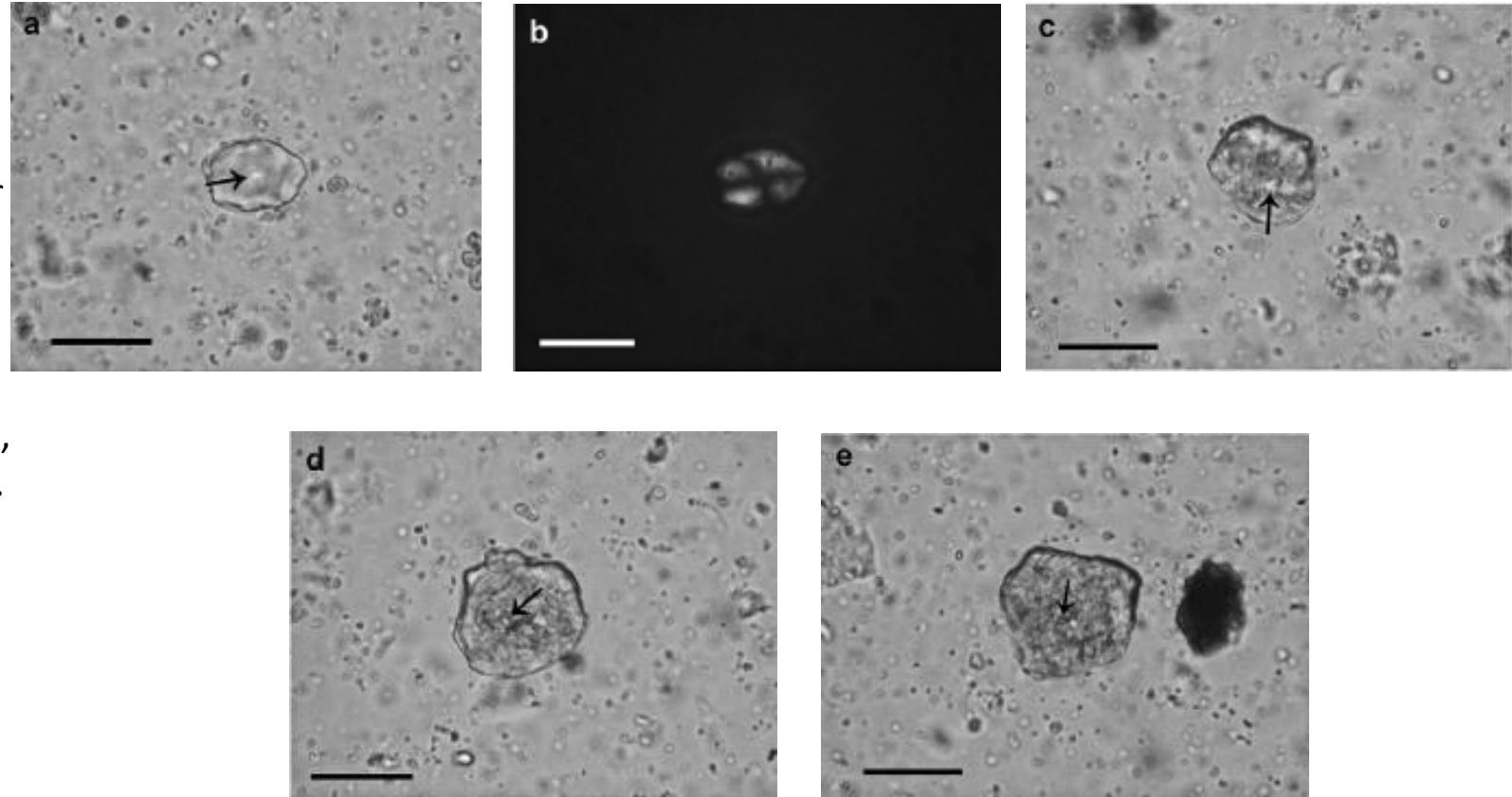


Horrocks, Mark, Matthew Campbell, and Warren Gumbley. 2007. A Short Note on Starch and Xylem of *Ipomoea Batatas* (Sweet Potato) in Archaeological Deposits from Northern New Zealand. *Journal of Archaeological Science* 34 (9):1441–48.

# Ipomoea batatas

## Starch

Fig. 3. Microfossils characteristic of introduced *Ipomoea batatas* root from Whangapoua (400? or 600?). (a) Well-preserved, multi-faceted starch grain with central vacuole (arrow) (c.f. multi-faceted starch grain of *I. batatas* root, Fig. 4d, bottom). (b) Starch grain is viewed under cross-polarised light, showing central Maltese cross, i.e., dark areas of cross-intersect in centre of grain (c.f. Fig. 4b). (c-k) Individual and pairs (f-h, j) of starch grains, showing brown-staining, facetting, central vacuole (arrows) and variable swelling. The vacuole in (f) is distorted length-wise.

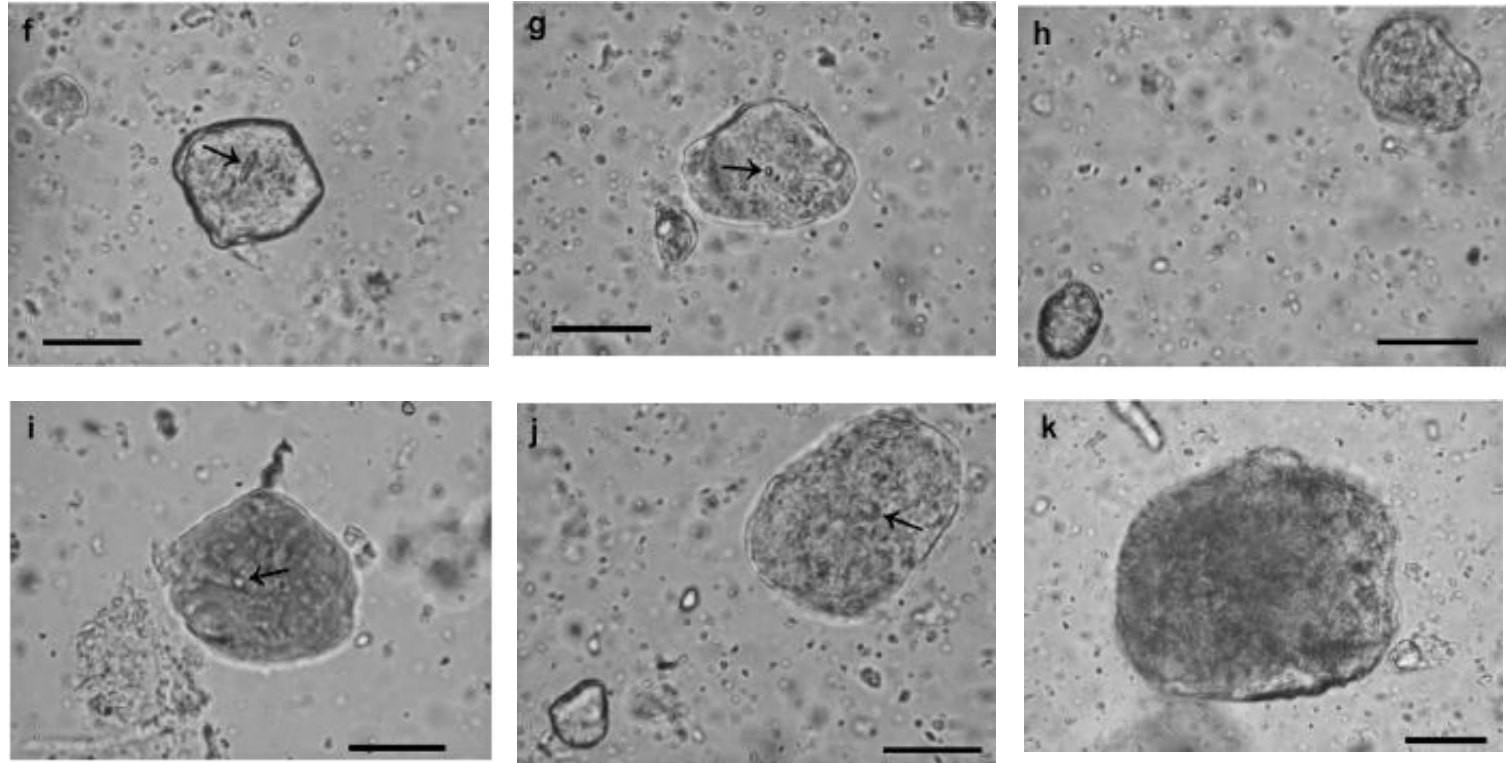


Horrocks, Mark, Matthew Campbell, and Warren Gumbley. 2007. A Short Note on Starch and Xylem of *Ipomoea Batatas* (Sweet Potato) in Archaeological Deposits from Northern New Zealand. *Journal of Archaeological Science* 34 (9):1441–48.

# Ipomoea batatas

## Starch

Fig. 3. Microfossils characteristic of introduced *Ipomoea batatas* root from Whangapoua (400? or 600?). (a) Well-preserved, multi-faceted starch grain with central vacuole (arrow) (c.f. multi-faceted starch grain of *I. batatas* root, Fig. 4d, bottom). (b) Starch grain is viewed under cross-polarised light, showing central Maltese cross, i.e., dark areas of cross-intersect in centre of grain (c.f. Fig. 4b). (c-k) Individual and pairs (f-h, j) of starch grains, showing brown-staining, faceting, central vacuole (arrows) and variable swelling. The vacuole in (f) is distorted length-wise.

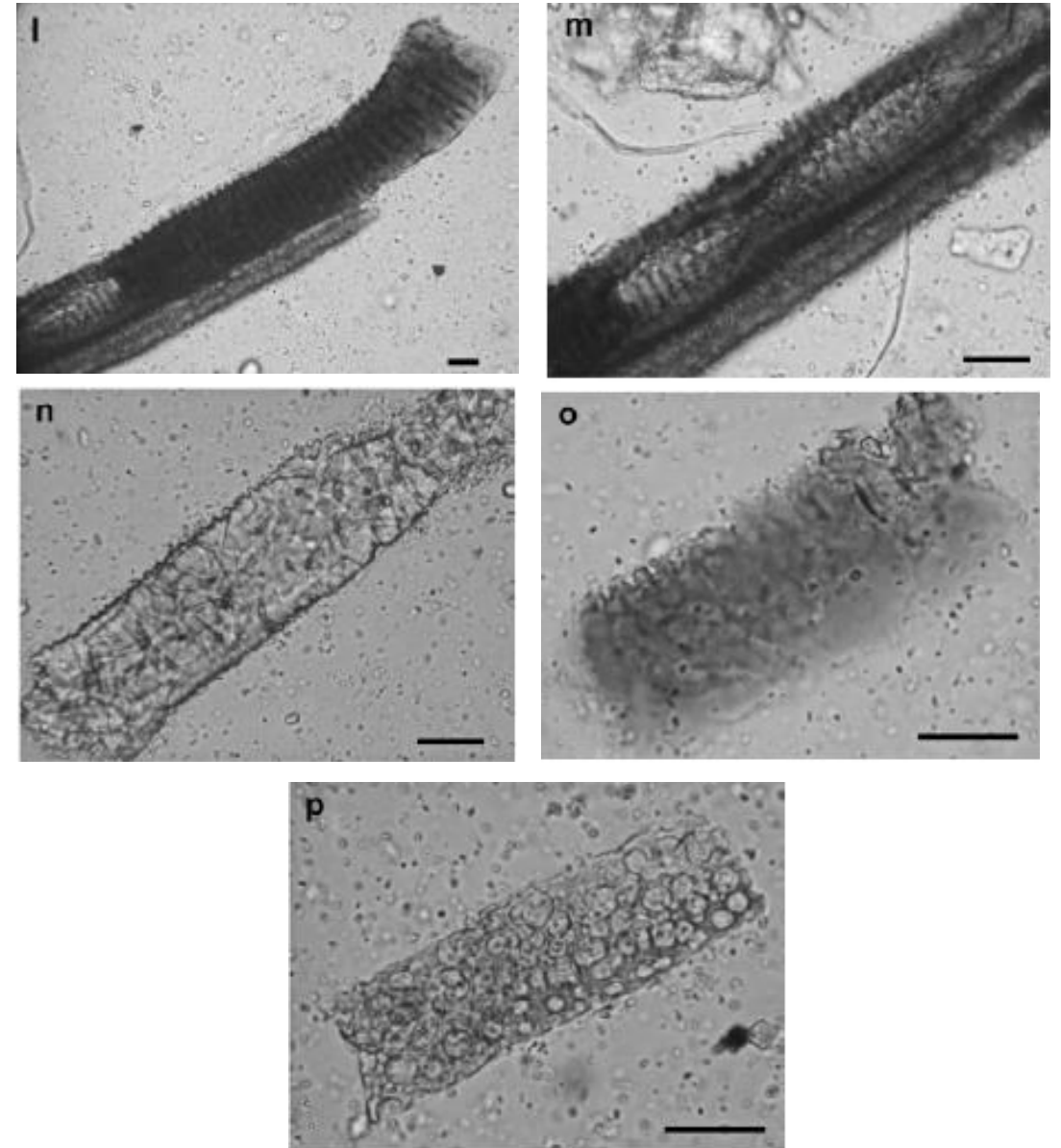


Horrocks, Mark, Matthew Campbell, and Warren Gumbley. 2007. A Short Note on Starch and Xylem of *Ipomoea Batatas* (Sweet Potato) in Archaeological Deposits from Northern New Zealand. *Journal of Archaeological Science* 34 (9):1441–48.

# Ipomoea batatas

## Starch

Fig. 3. Microfossils characteristic of introduced *Ipomoea batatas* root from Whangapoua (400? or 600?). (l-p) Brown-stained xylem tracheary elements with slit-like pits (c.f. xylem vessel elements of *I. batatas*, Fig. 4e-h). (l) and (m) are of the same specimen (a pair of elements: one wide and one narrow), photographed at different points and magnifications. (n) and (p) show cracks and pit expansion, respectively. Scale bars, 20 mm

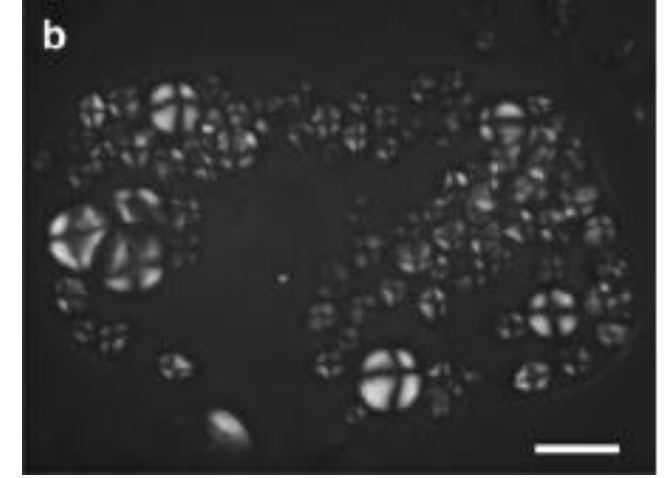


Horrocks, Mark, Matthew Campbell, and Warren Gumbley. 2007. A Short Note on Starch and Xylem of *Ipomoea Batatas* (Sweet Potato) in Archaeological Deposits from Northern New Zealand. *Journal of Archaeological Science* 34 (9):1441–48.

# Ipomoea batatas

## Starch

Fig. 4. Microparts of *Ipomoea batatas* root from modern reference samples (400? and 600?). (a-d) Starch grains of various ages (mature grains are larger). Grains are colourless, spherical to sub-spherical, often bell-shaped, smooth, up to 26 mm in diameter, with a vacuole at the central hilum (arrows), and nearly all have one domed surface and up to six (rarely more than three) flattened pressure facets. Viewed from the top facets may be obscured with grains appearing completely round. In (b), grains in (a) are viewed under cross-polarised light, showing central Maltese crosses. Scale bars are present in the bottom right of each panel.

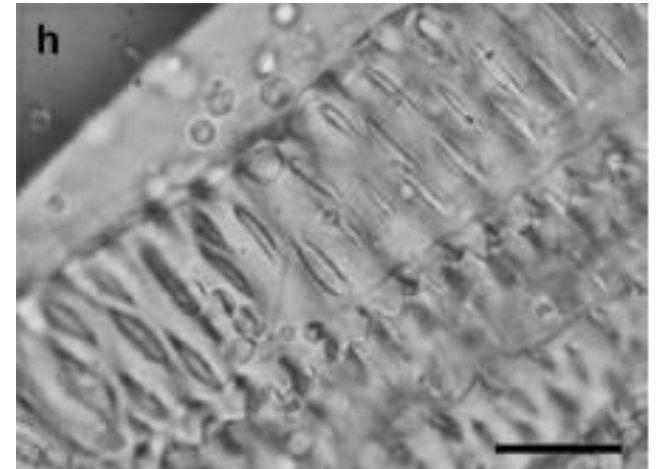
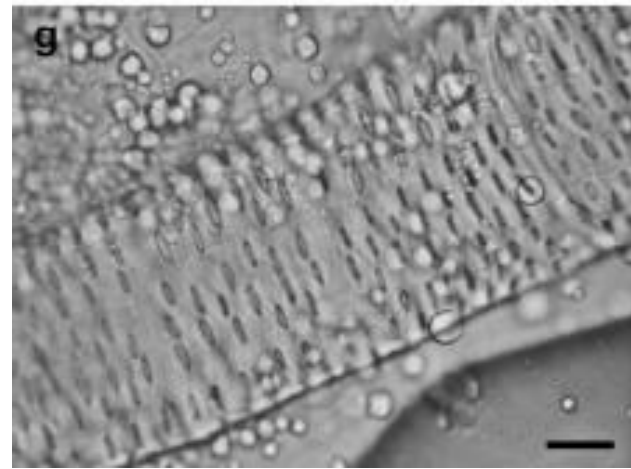
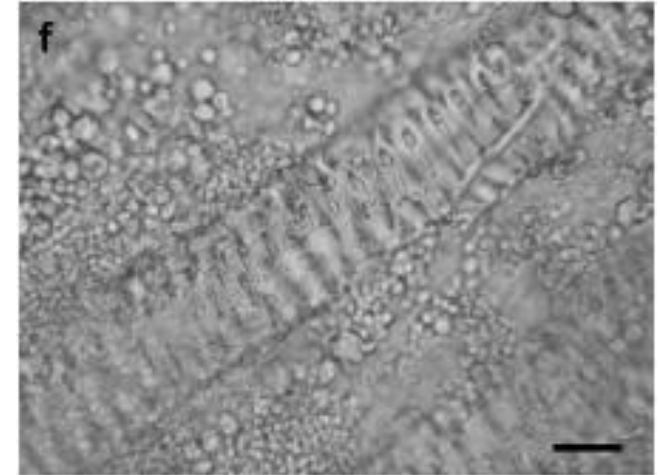
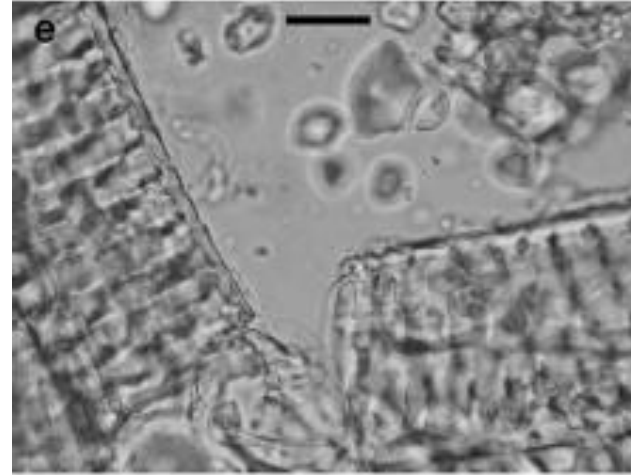


Horrocks, Mark, Matthew Campbell, and Warren Gumbley. 2007. A Short Note on Starch and Xylem of *Ipomoea Batatas* (Sweet Potato) in Archaeological Deposits from Northern New Zealand. *Journal of Archaeological Science* 34 (9):1441–48.

# Ipomoea batatas

## Starch

Fig. 4. Microparts of *Ipomoea batatas* root from modern reference samples (400? and 600?). (e-h) Xylem vessel elements. Elements are up to 90  $\mu\text{m}$  across with walls up to 5  $\mu\text{m}$  thick, and alternate slit-like pits up to 20  $\mu\text{m}$  across. The vessel in (e) has been damaged during slide preparation. Starch grains in various concentrations are also visible. Scale bars, 20  $\mu\text{m}$



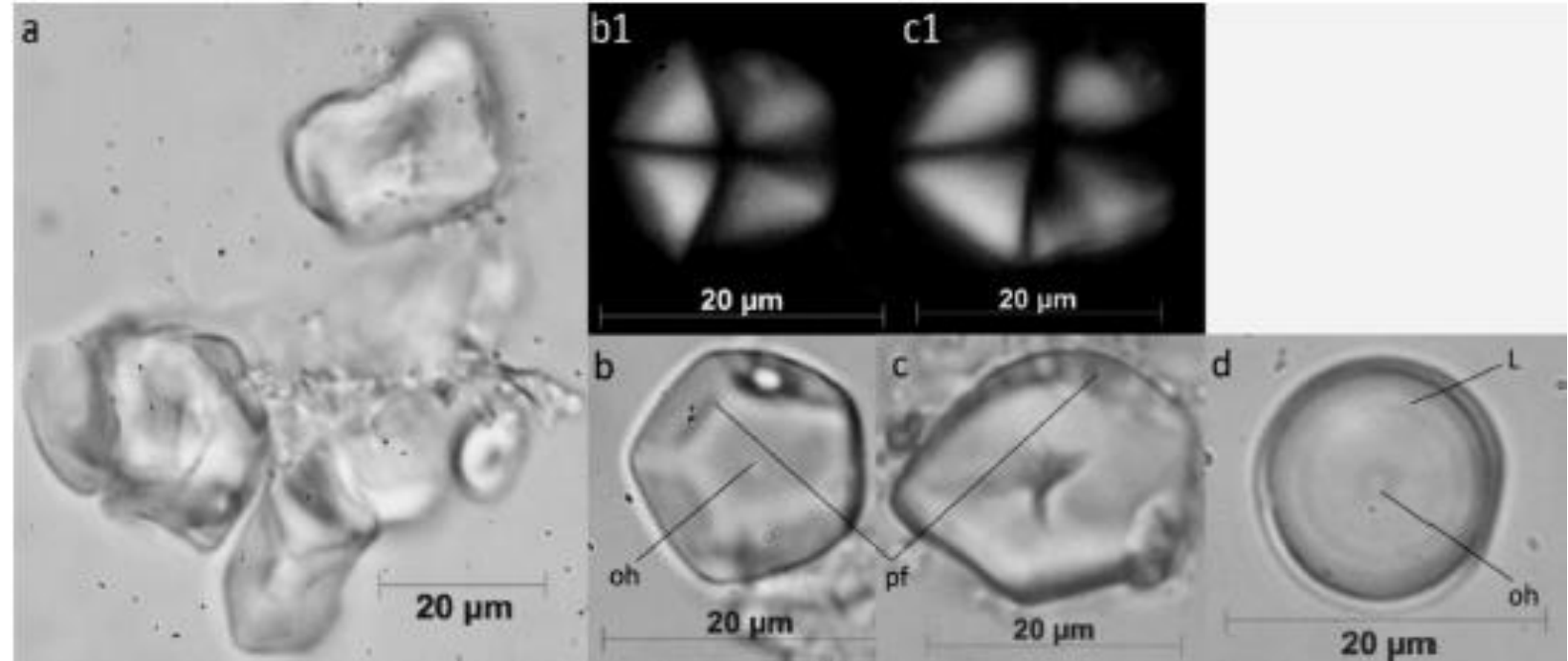
Horrocks, Mark, Matthew Campbell, and Warren Gumbley. 2007. A Short Note on Starch and Xylem of *Ipomoea Batatas* (Sweet Potato) in Archaeological Deposits from Northern New Zealand. *Journal of Archaeological Science* 34 (9):1441–48.



# Ipomoea batatas

## Starch

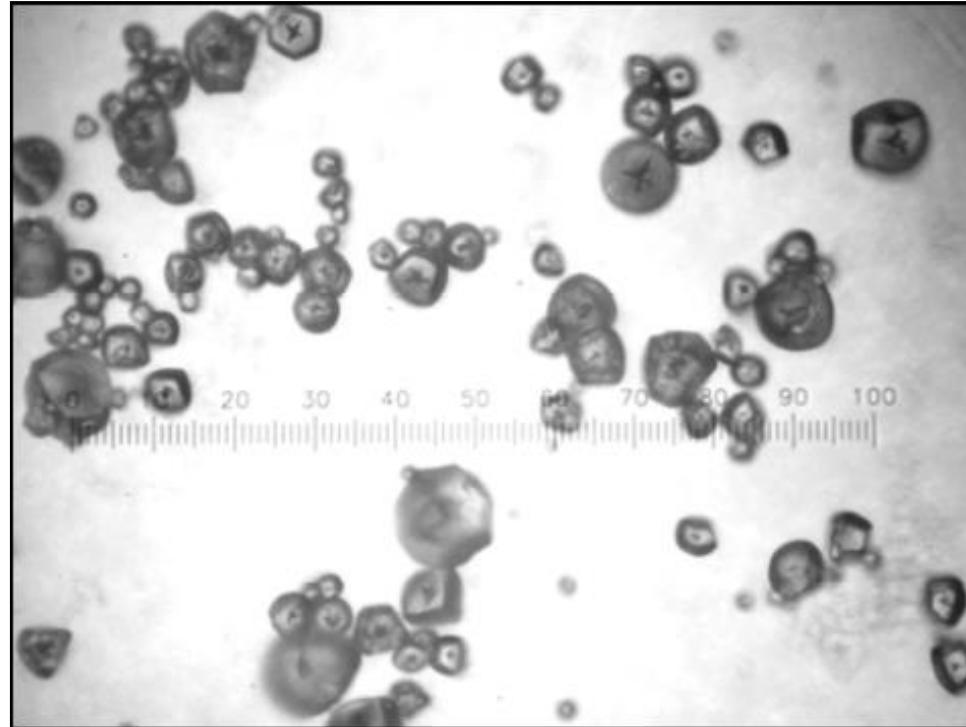
Fig. 6. Sweet potato starch grains from St. John and Eva 2. a, cluster of at least six starches possibly of sweet potato with smooth signatures associated to heat damaging in a low humidity environment; b and c, diagnostic polyhedral shapes with two to five pressure facets (“pf”), and diagnostic extinction crosses (b1, c1) consisting in two or three lightly curved-very thin arms with the fourth arm been wider and triangular; d, spherical starch showing the open hilum (“oh”) and lamellae (“L”) in the form of concentric rings. Provenances: starches a (artifact E-1), b and d (artifact E-2), c (artifact SJ-3)



Pagán-Jiménez, Jaime R., Reniel Rodríguez-Ramos, Basil A. Reid, Martijn van den Bel, and Corinne L. Hofman. 2015. Early Dispersals of Maize and Other Food Plants into the Southern Caribbean and Northeastern South America. *Quaternary Science Reviews* 123:231–46. <http://www.sciencedirect.com/science/article/pii/S0277379115300445>.

# Ipomoea batatas

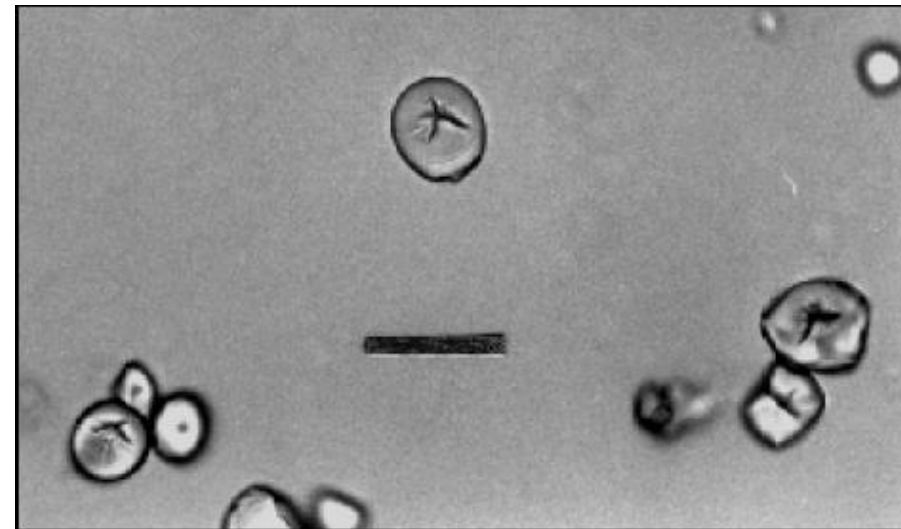
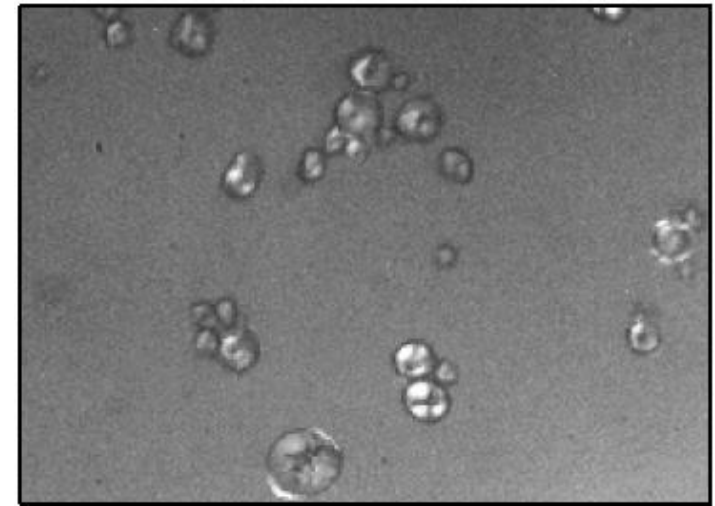
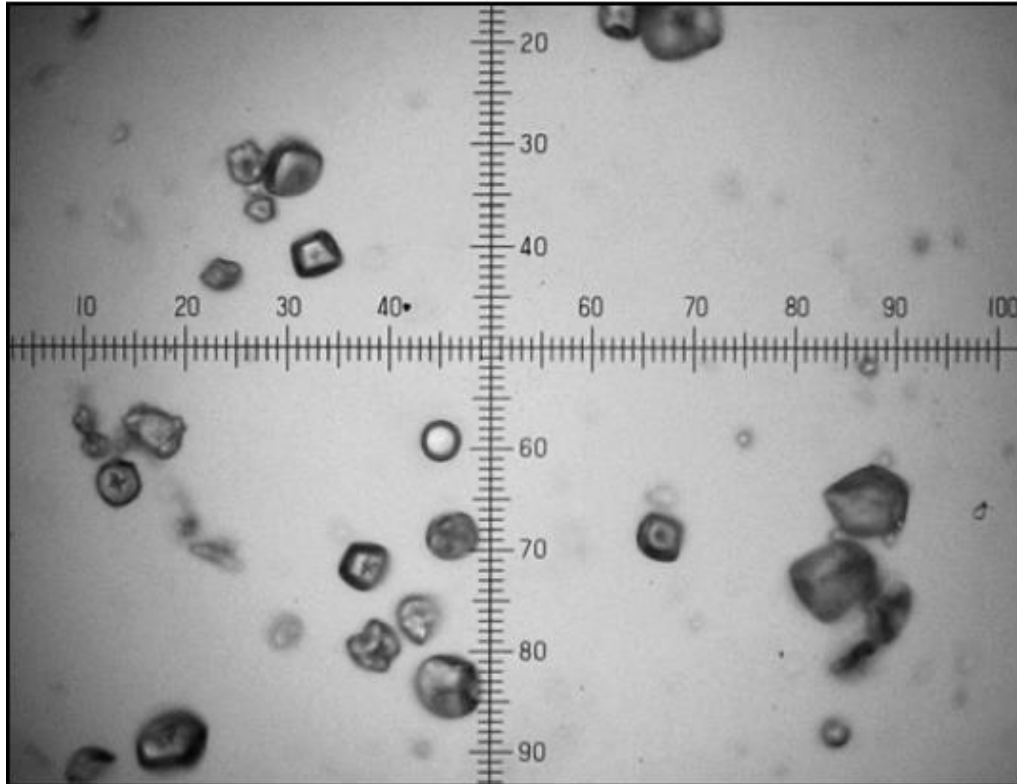
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# *Ipomoea* cf. *repanda*

Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

COSTACEAE

# Chamaecostus cuspidatus

## Phytolith

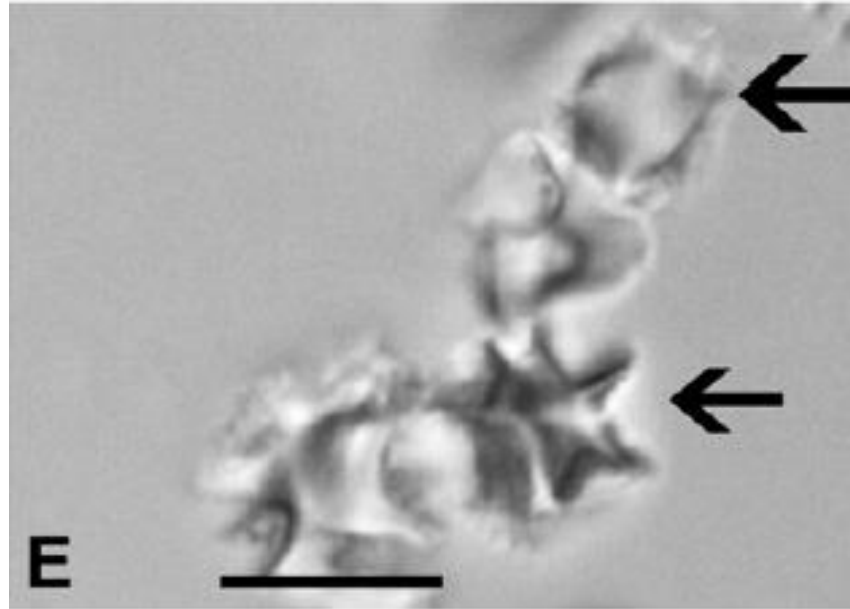


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). E, non-fringed D1 (bottom arrow) and D2 (top arrow) druses from *Chamaecostus cuspidatus* leaf. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Cheilocostus speciosus

## Phytolith

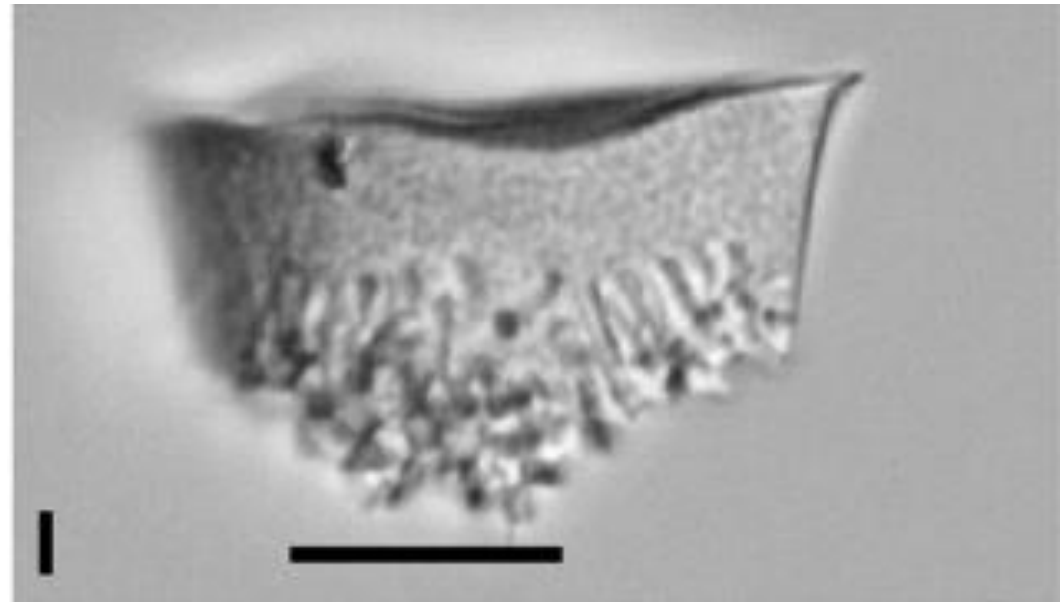
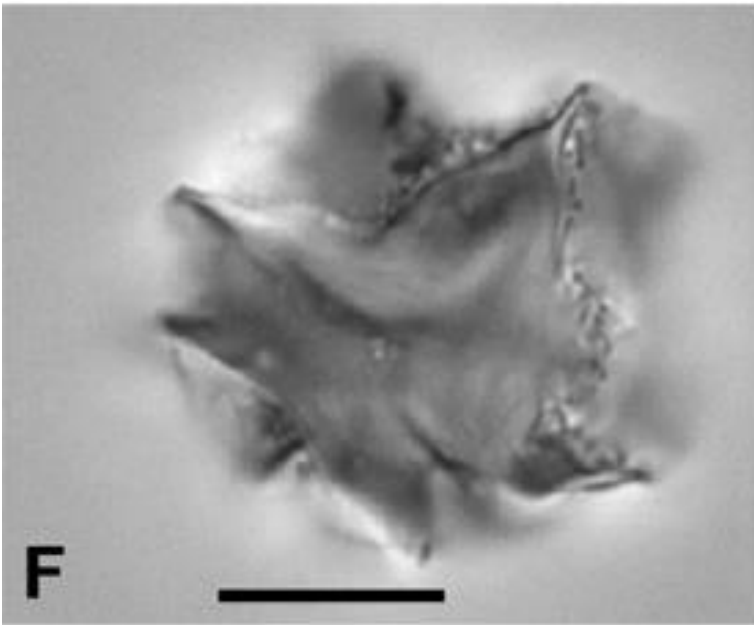


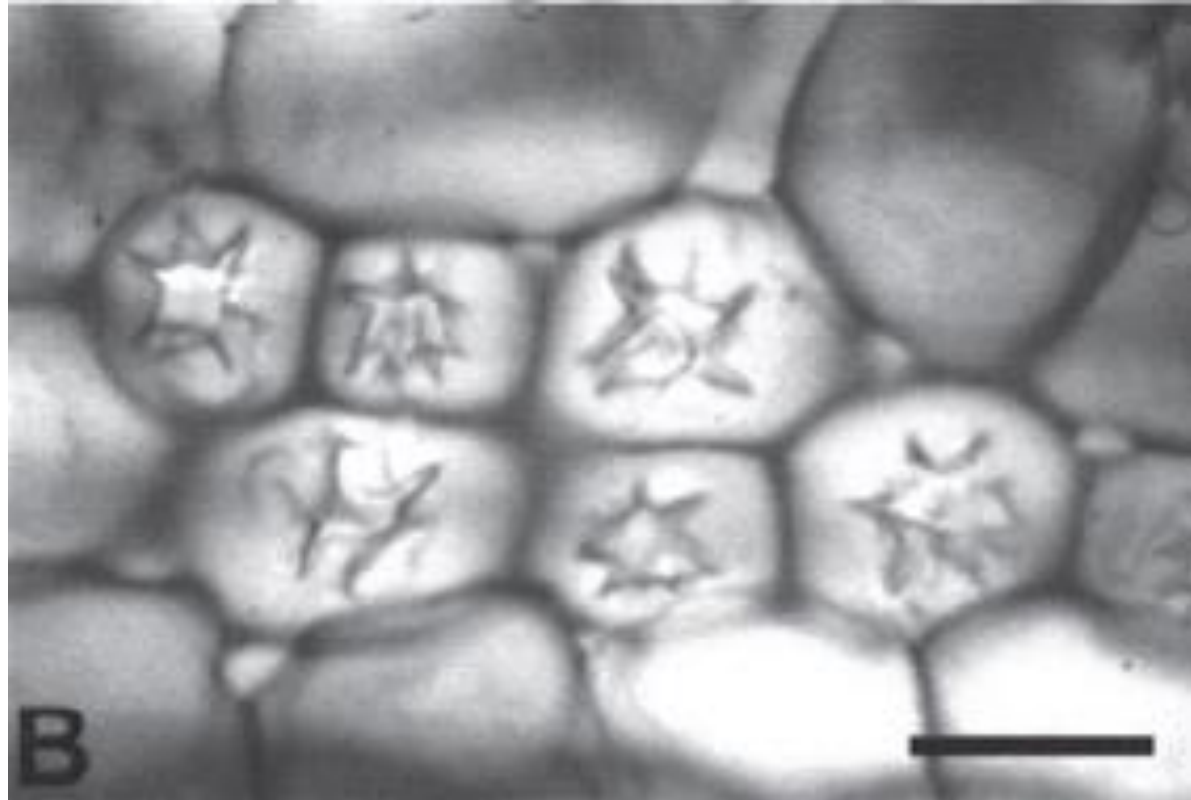
Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). F, non-fringed D1 druse from *Cheilocostus speciosus* rhizome. I, side-view of Ta1 from *Cheilocostus speciosus* seed. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Costus englerianus

## Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. B. *Costus englerianus* (Costaceae), druse-like silica bodies over bundle-sheath cells (bar = 20 $\mu$ m).



Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Costus lacerus

## Phytolith

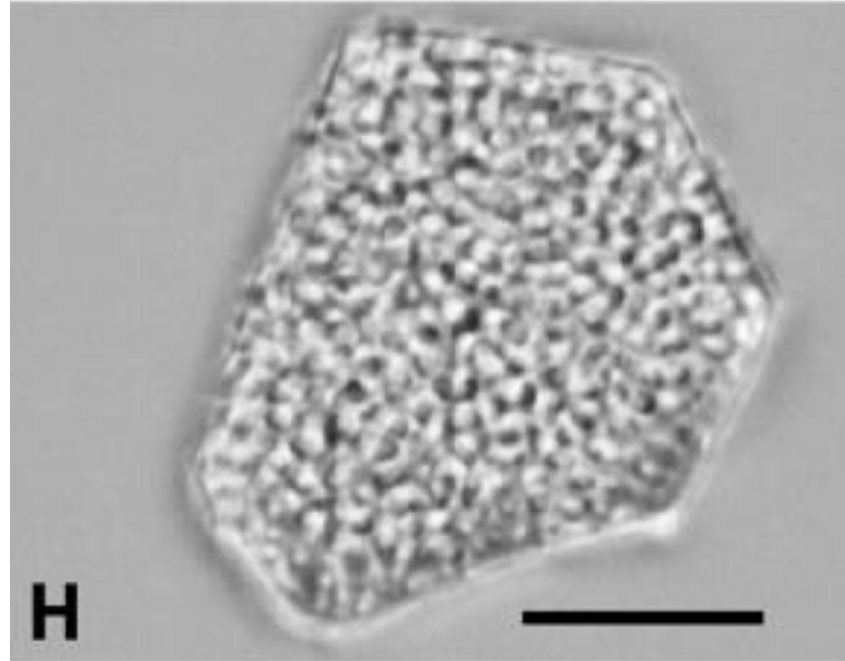


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). H, top-view of Ta1 (tabular-columellate) from *Costus lacerus* seed. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.



# Costus pulverulentus

## Phytolith

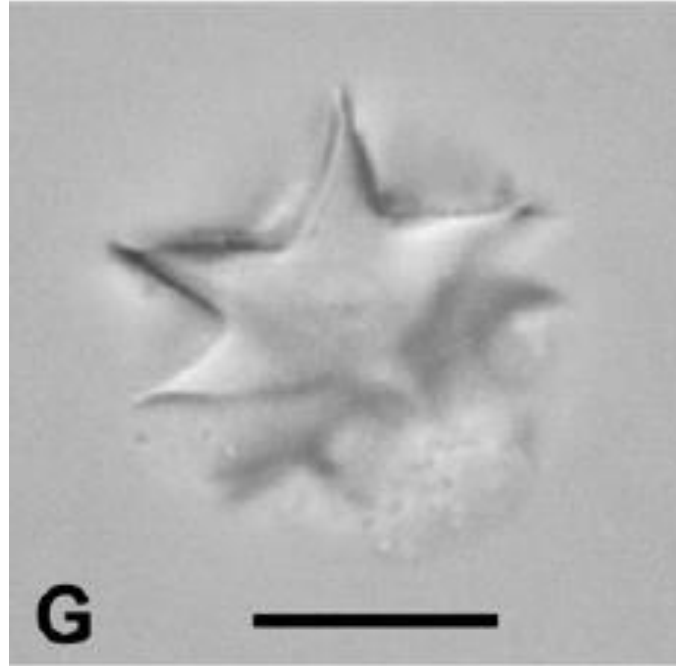


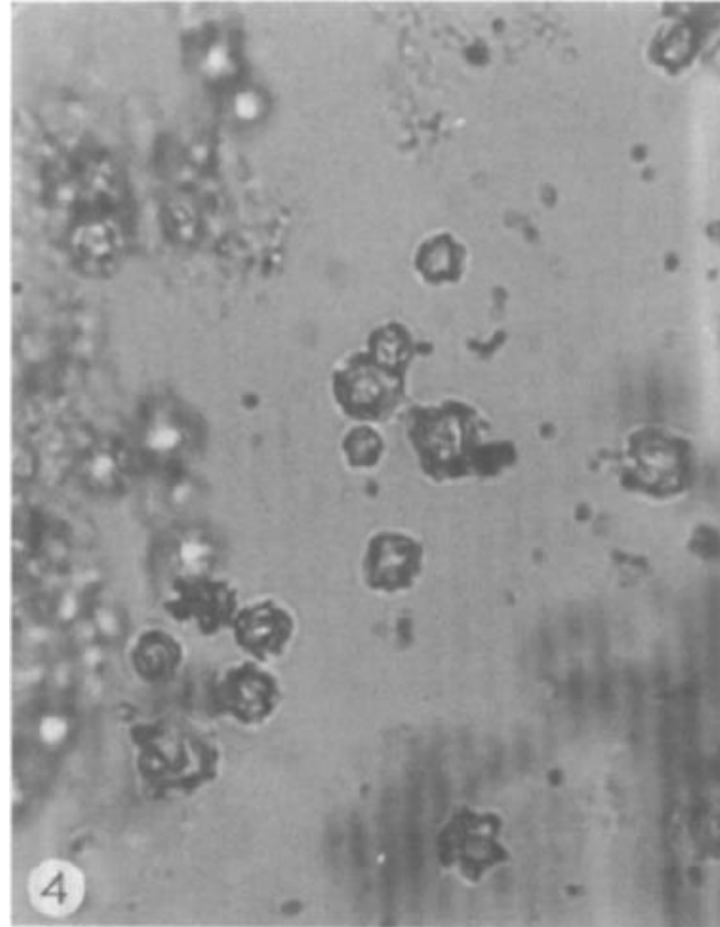
Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). G, non-fringed D1 druse from *Costus pulverulentus* rhizome. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Dimerocostus uniflorus

## Phytolith

Phytoliths with irregularly angled or folded surfaces from *Dimerocostus uniflorus* (250x).

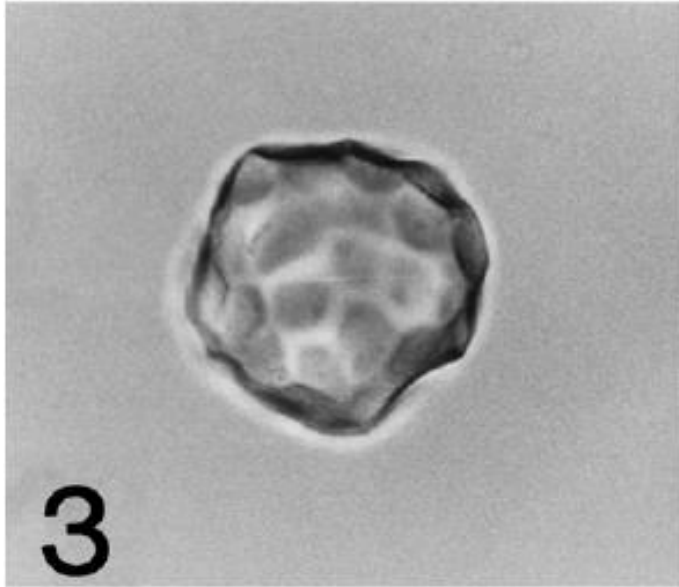


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

CUCURBITACEAE

# Calycophysum pedunculatum

## Phytolith

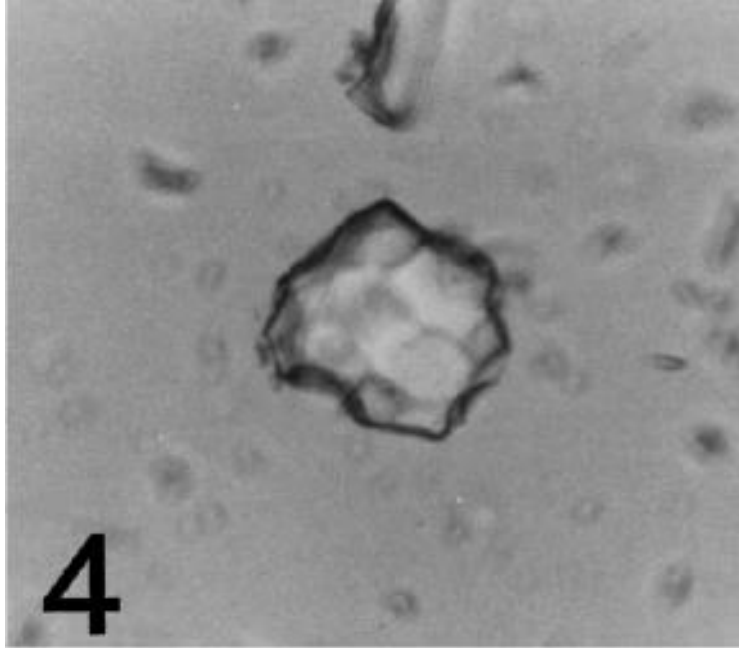


3. A scalloped phytolith from *Calycophysum pedunculatum*. In contrast to *Cucurbita* it has irregular borders, shallow scallops, and usually only one decorated hemisphere.

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in Cucurbita and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.

# Cionosicycys macrantha

## Phytolith



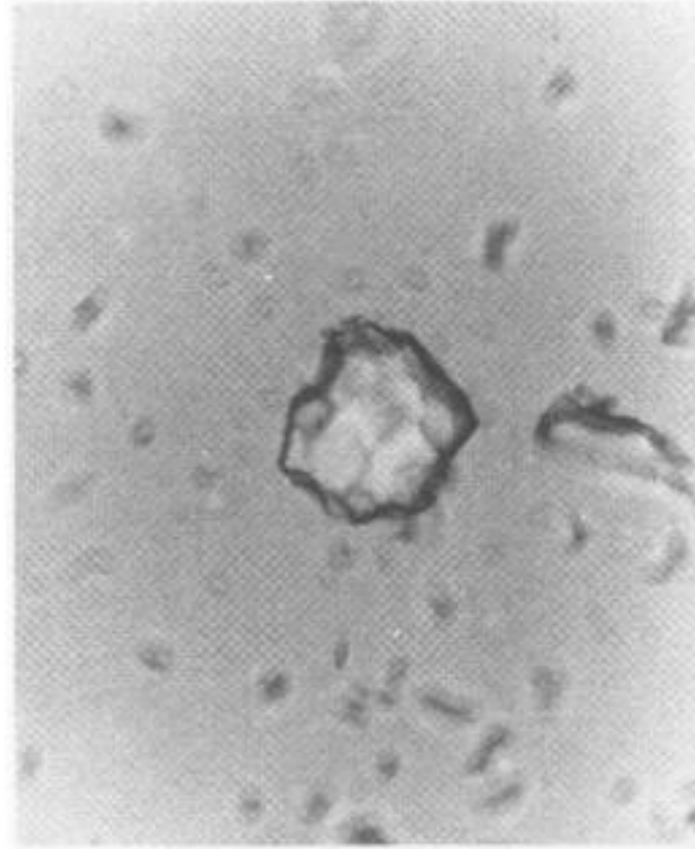
4. An irregular, scalloped phytolith from *Cionosicycys macrantha*. Its longest dimension is 44  $\mu$ m. Most of these phytoliths are flat, and they do not possess hemispheres with different scallop sizes.

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in Cucurbita and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.

# Cionosicya macrantha

## Phytolith

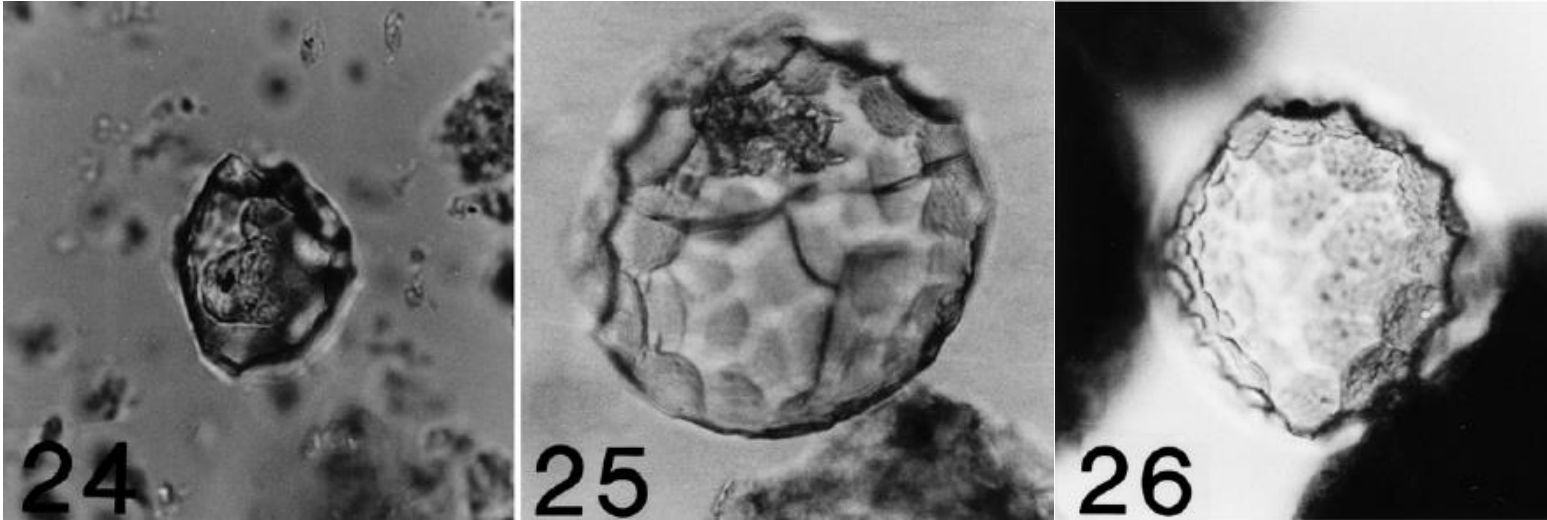
Fig. 16. Scalloped phytolith from a wild species in the Cucurbitaceae, *Cionosicya macrantha* (see caption for Fig. 15).



Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449. <http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Cucurbita sp.

## Phytolith



24. A *Cucurbita* phytolith from the pre-10,000 BP occupation at Vegas. It is 53 μm long.

25. A *Cucurbita* phytolith from the assemblage directly dated to 9060 BP (Unit E 8–9, 110–120 cm below surface). It is 104 μm long.

26. A *Cucurbita* phytolith from Vegas, same context as above. It is partially turned, revealing the hemisphere with smaller scallops. It is 80 μm long.

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in *Cucurbita* and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.

# Cucurbita sp.

## Phytolith

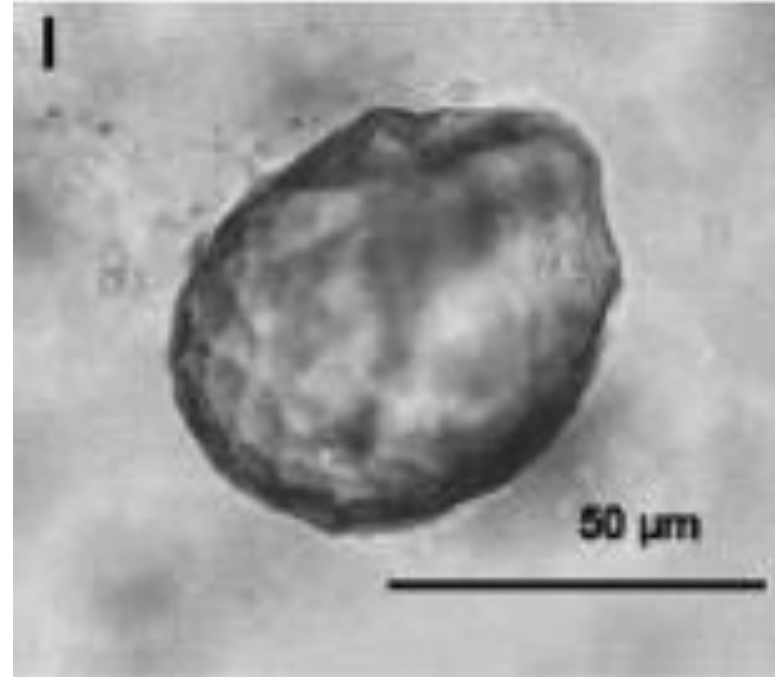


Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. I) Cucurbita scalloped sphere (P Ridged Field 2, 10-20 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.



# Cucurbita sp.

## Phytolith

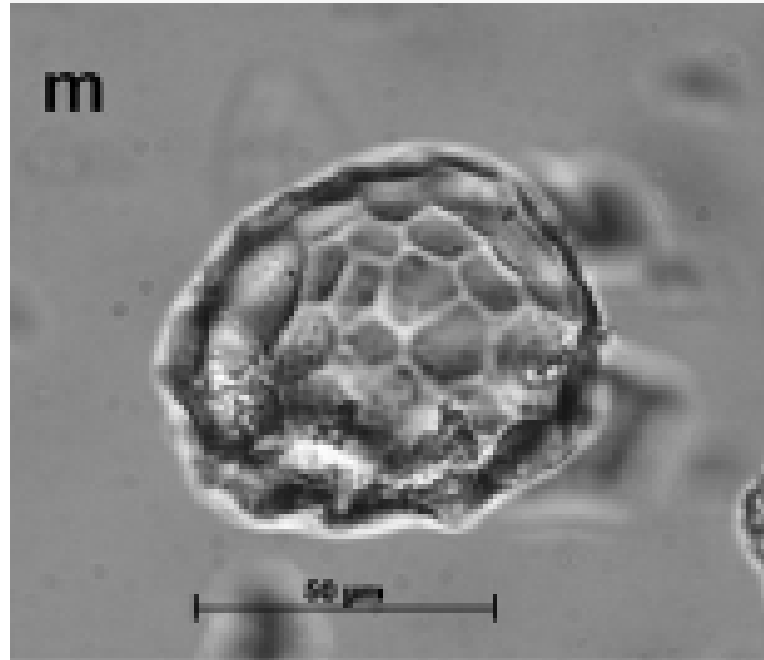


Fig. 5. Selected microbotanical remains. Phytoliths: m) *Cucurbita* sp. rind scalloped sphere (Sed. Sample 3)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Cucurbita sp.

## Phytolith

Hair base. Central cell often not obvious unless phytolith is rotated. Cells are transparent, allowing you to look down or through the base. Diagnostic level: Asteraceae/Cucurbitaceae

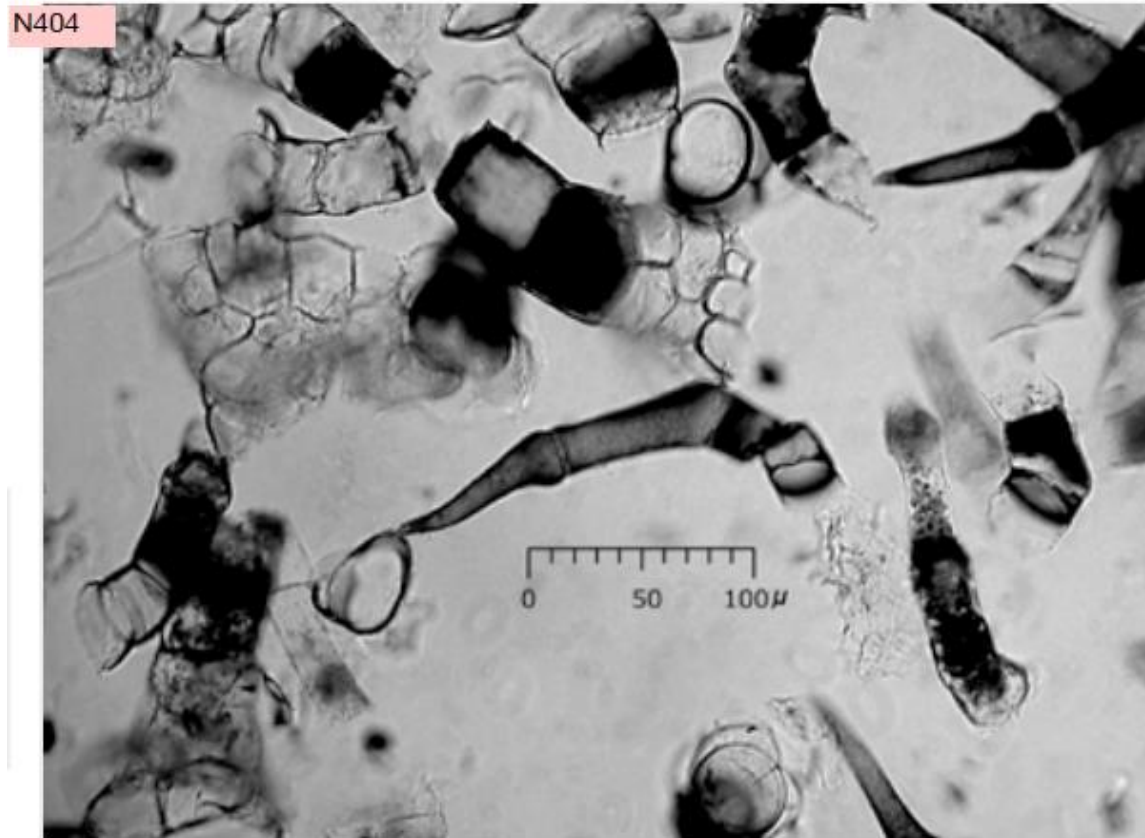


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cucurbita sp.

## Phytolith

In some cases, base of hair is still inserted, making central cell very dark and obvious Diagnostic level: Asteraceae/Cucurbitaceae



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cucurbita sp.

## Phytolith

Number of joints varies. Diagnostic level:  
Cucurbitaceae/Asteraceae

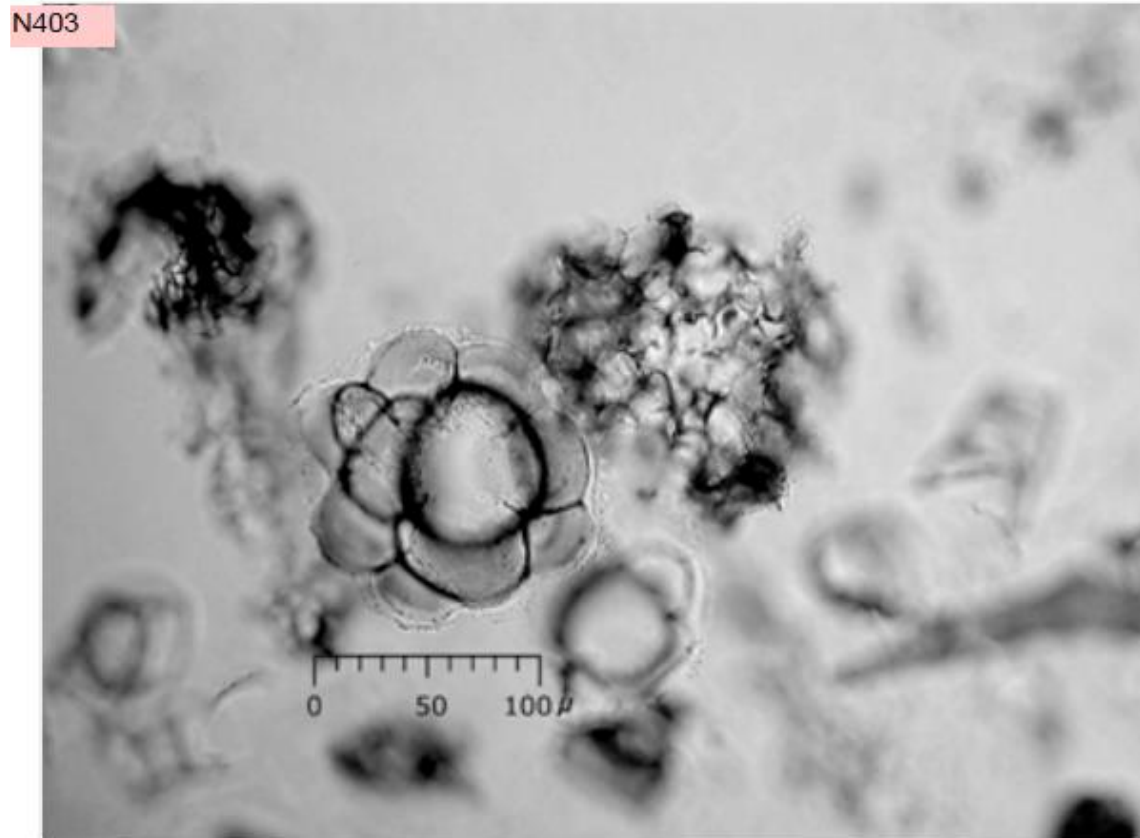


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cucurbita sp.

## Phytolith

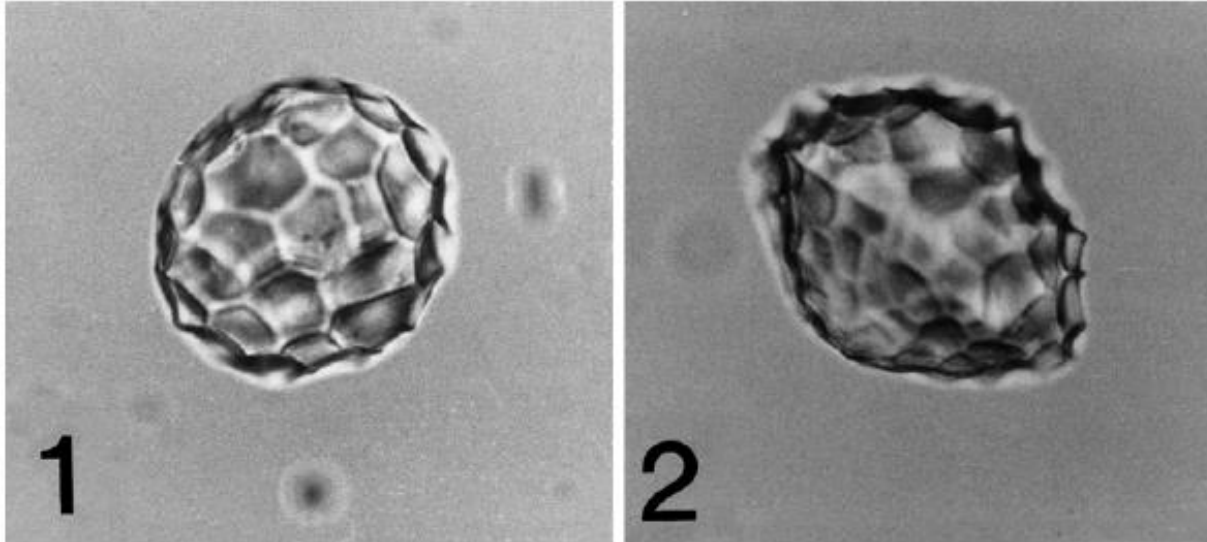
Hairbase and attached cells form a large sphere. This particular base is darkened/occluded. Also visible in image:  
A rotated, partial hairbase.  
Diagnostic level:  
Cucurbitaceae/Asteraceae



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cucurbita argyosperma ssp. sororia

## Phytolith



1. A spherical, deeply scalloped phytolith from *Cucurbita argyosperma* ssp. *sororia* from Panama. Its longest dimension is 64  $\mu$ m.
2. A phytolith like the one in Figure 1 rotated so that the two different hemispheres can be seen.

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in Cucurbita and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.

# Cucurbita ficifolia

## Phytolith



Figure 12. A phytolith from *Cucurbita ficifolia*. One hemisphere has a grainy type of decoration (compare with Figures 2 & 13–16). It is 99  $\mu$ m long.

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in Cucurbita and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.

# Cucurbita ficifolia

## Phytolith



Fig. 1. Scalloped phytoliths from the fruit rind of the domesticated species *Cucurbita ficifolia*, native to Andean South America. The phytolith on the bottom is 125mm long.

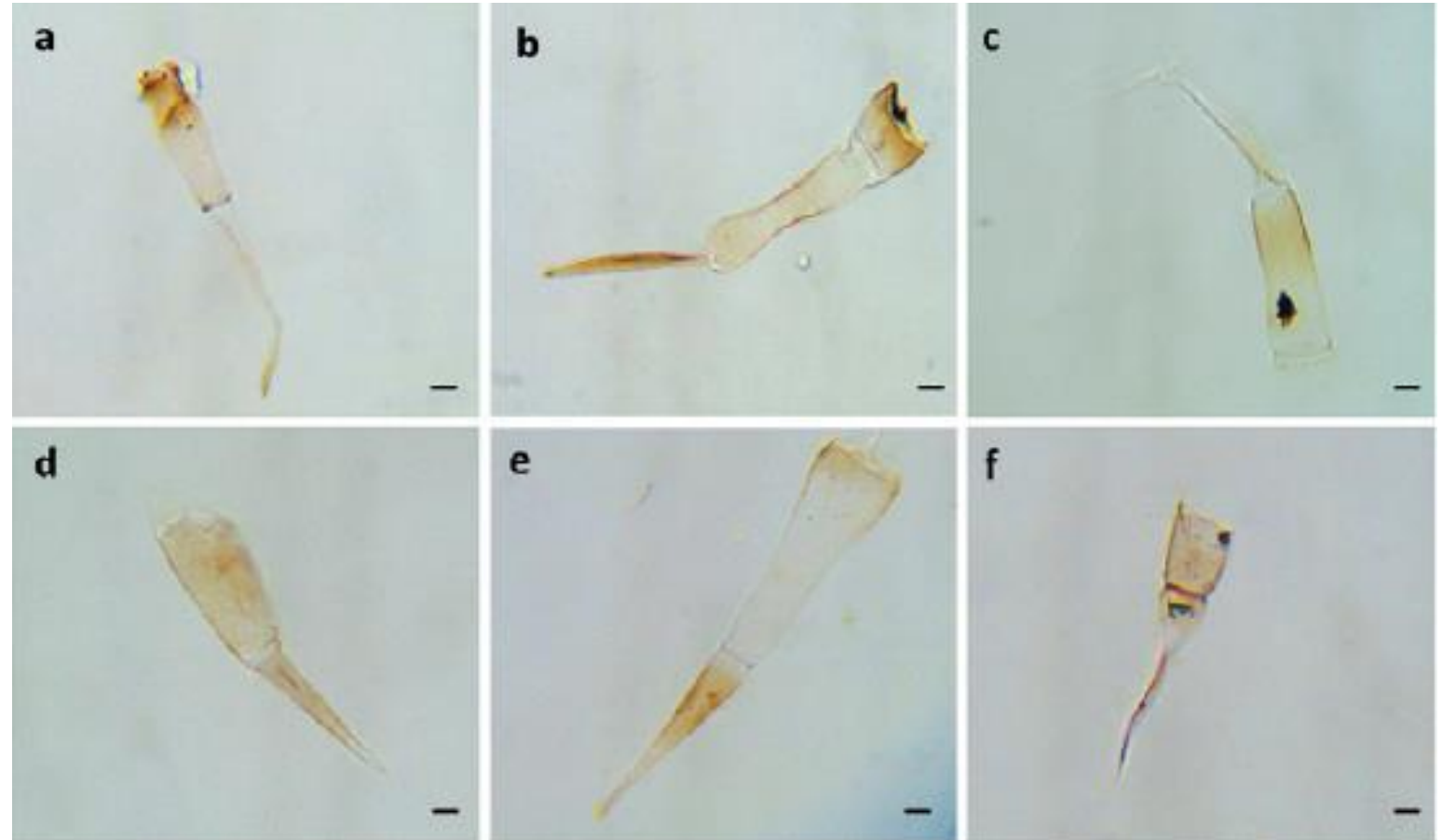
Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.



# Cucurbita ficifolia

## Phytolith

Figure 3. Squash leaf phytoliths (*Cucurbita ficifolia* Bouché. a) 137.97 $\mu$ m, 20.58 $\mu$ m; b) 88.23 $\mu$ m, 16.3 $\mu$ m; c) 123.78 $\mu$ m, 23.78 $\mu$ m; d) 100.7 $\mu$ m, 21.48 $\mu$ m; e) 93.6 $\mu$ m, 18.54 $\mu$ m; f) 53.32 $\mu$ m, 13.64 $\mu$ m. Scale: 10  $\mu$ m by 40X

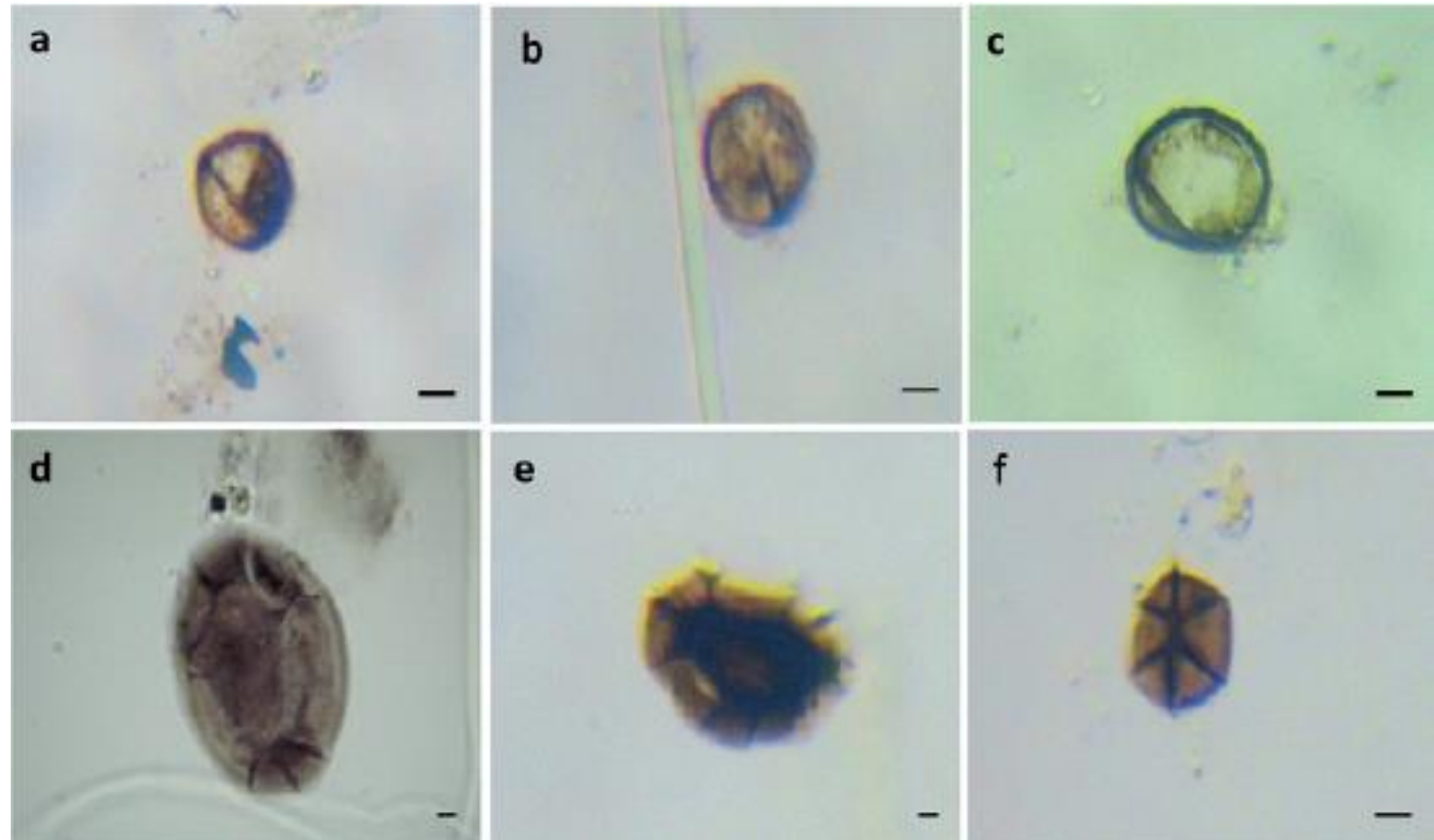


Poveda-Díaz, Nataly, Maria Eugenia Morales-Puentes, and Gregory Vaughan. 2016. Phytoliths Produced by Common Bean (*Phaseolus Vulgaris* L.), Achira (*Canna Indica* L.), and Squash (*Cucurbita Ficifolia* Bouché), Crop Species from Boyacá, Colombia. *Revista de La Academia Colombiana de Ciencias Exactas, Físicas y Naturales* 40 (154):137–46.

# Cucurbita ficifolia

## Phytolith

Figure 4. Phytoliths from the epidermis of squash fruit (*Cucurbita ficifolia* Bouché). a) 23.25 $\mu$ m, 21.63 $\mu$ m; b) 47.97 $\mu$ m, 28.62  $\mu$ m; c) 38.7 $\mu$ m, 23.86 $\mu$ m; d) 21.63  $\mu$ m, 16.88  $\mu$ m; e) 22.24 $\mu$ m, 21.26 $\mu$ m; f) 32.93  $\mu$ m, 21.14  $\mu$ m. Scale: 10  $\mu$ m by 40X.



Poveda-Díaz, Nataly, Maria Eugenia Morales-Puentes, and Gregory Vaughan. 2016. Phytoliths Produced by Common Bean (*Phaseolus Vulgaris* L.), Achira (*Canna Indica* L.), and Squash (*Cucurbita Ficifolia* Bouché), Crop Species from Boyacá, Colombia. *Revista de La Academia Colombiana de Ciencias Exactas, Físicas y Naturales* 40 (154):137–46.

# Cucurbita ficcifolia

**Cucurbitaceae *Cucurbita ficcifolia* "cayote"**

**Phytolith assemblage characterization**

**Rind.**  
Diagnostic phytoliths:

a) Spherical facetate silica phytolith. Common.

b) Sub-spherical facetate opaque interior silica phytolith. Common.

c) Sub-spherical facetate cavate silica phytolith. Common.

d) Spherical marginal facetate silica phytolith. Common.

e) Segmented silica hair and hair base. Common.

**References:** Reported in Piperno et al. 2000.

---

**Starch assemblage characterization**

**Rind.**  
a) Single grains, variable in shape, oval, spherical, triangulate with rounded sides and vortex, ovoid pear- and teardrop-shaped; variable in size, from 7µm to 25µm at long length; not-visible hilum and lamella; a hollow at the center with similar shape to the contour of the grain; distinct centric cross with four arms visible, meeting at a dark ragged oval or circular hollow.

**Pulp.**  
a) Single grains, oval, and bell-shaped with a truncated concave-convex or concave-concave end, and a well rounded opposite one; variable in size from 10µm to 22µm long length; indistinct eccentric hilum as a dot at rounded end; sometimes distinct lamella; distinct eccentric to very eccentric cross, with four arms visible at the rounded end. Some bunch aggregates.

**seed**  
a) Single grains, spherical, and polyhedral; variable in size from 5µm to 9µm long length; not visible hilum and lamella; mainly centric cross, with four arms visible.

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Cucurbita lundelliana

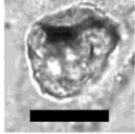
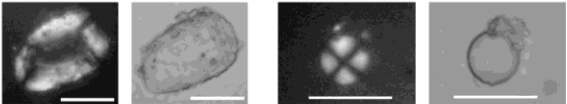
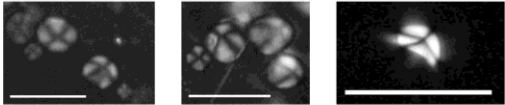
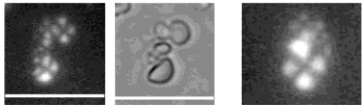
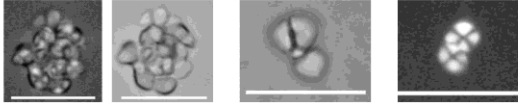
## Phytolith

Fig. 12. A phytolith from *Cucurbita lundelliana* like the one in Fig. 11, turned on its side to reveal the different pattern of scallop shape and size on the hemispheres of *Cucurbita* phytoliths.



Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449. <http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Cucurbita maxima

Cucurbitaceae <i>Cucurbita maxima</i> "zapallo"	
<b>Phytolith assemblage characterization</b>	
fruit	<p><b>Rind.</b> Diagnostic phytoliths: a) Sub-round facetate silica phytolith. Common.</p> 
	<p><b>References:</b> Reported in Bozarth 1987 and Piperno et al 2000.</p>
<b>Starch assemblage characterization</b>	
fruit	<p><b>Rind.</b> a) Single grains, variable in shape, oval, spherical, triangulate with rounded sides and vortex, ovoid pear- and teardrop-shaped; variable in size, to 40µm long length; non visible hilum and lamella; a centric hollow with similar shape to the contour of the grain; rough surface; distinct centric cross with four arms visible, meeting at dark oval or circular, sometimes ragged, hollow. b) Also common spherical grains, to 12µm long length.</p> 
	<p><b>Pulp.</b> a) Single grains, spherical to oval, bowl- and sausage-shaped, sometimes truncated; variable in size from 2µm to 12µm long length; not visible hilum and lamella; distinct centric or lightly eccentric cross, with four arms visible.</p> 
seed	<p>a) Mainly single grains, spherical to oval, and bowl-shaped, with a truncated wavy concave-convex or convex end; variable in size from 2µm to 8µm long length; not visible hilum and lamella; distinct centric cross, with four arms visible.</p> 
	<p>b) Some compound grains, oval and teardrop-shaped, compounded by three or four granula, and compound grains, irregular in shape, compounded by variable number of granula. Granula different in size and shape, with one or two oblique truncations. Aggregates.</p> 

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Cucurbita mixta

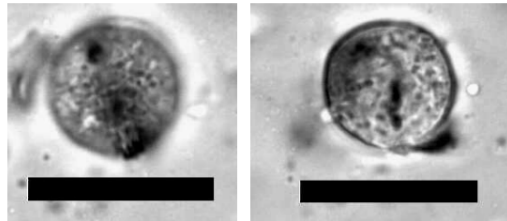
Cucurbitaceae *Cucurbita mixta* "angola"

## Phytolith assemblage characterization

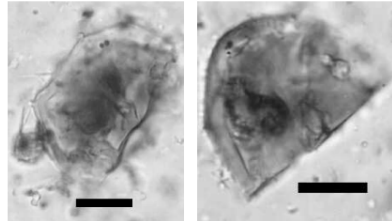
### **Rind.**

Non diagnostic phytoliths:

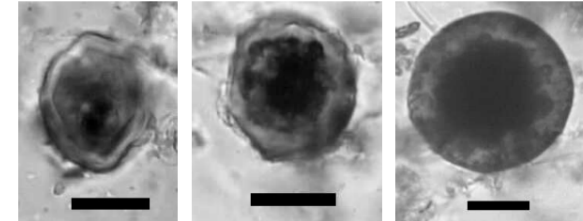
a) Round granulate silica phytolith.  
Very common.



b) Polyhedral sub facetate silica phytolith. Common.



c) Sub-spherical opaque interior silica phytolith. Common.

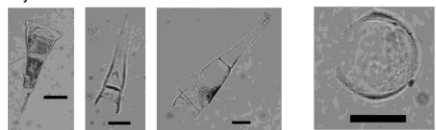
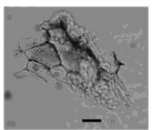
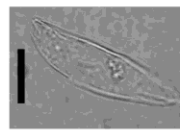
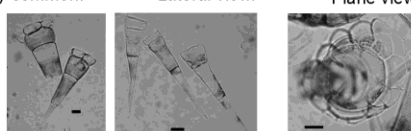
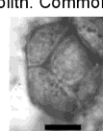
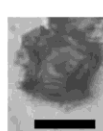
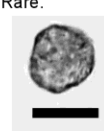
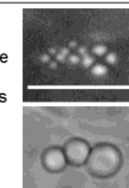
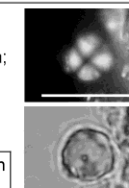



fruit

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Cucurbita moschata

Cucurbitaceae <i>Cucurbita moschata</i> "calabaza"	
Phytolith assemblage characterization	
stem	<p>Non diagnostic phytoliths:</p> <p>a) Acuminate segmented silica hairs. Very common. Lateral view. Plane view.</p>  <p>b) Silica epidermal cells. Common.</p>  <p>c) Oval silica phytolith. Rare.</p> 
	<p>References: Mentioned in Piperno et al 2000.</p>
leaf	<p>a) Acuminate segmented silica hairs. Very common. Lateral view. Plane view.</p>  <p>References: Reported in Piperno et al 2000.</p>
fruit	<p><b>Rind.</b></p> <p>a) Sub-spherical facetate silica phytolith. Common.</p>  <p>b) Polyhedral silica hair base. Common.</p>  <p>c) Round granulate silica phytolith. Rare.</p> 
	<p>References: Reported in Bozarth 1987 for the genus, Piperno et al 2000, Pearsall 2000 for the genus.</p>
Starch assemblage characterization	
fruit	<p><b>Pulp.</b></p> <p>a) Single grains, spherical or spherical with a little point projection or truncated; variable in size from 2µm to 8µm long length; not visible hilum and lamella; distinct centric cross, with four arms visible. A few linear aggregates of truncated single grains.</p>  <p><b>Rind.</b></p> <p>a) Single grains, spherical, not-well rounded; variable in size from 2µm to 12µm long length; sometimes distinct hilum and lamella; distinct centric cross, with four arms visible.</p> 
	<p>References: Partially based on Piperno and Holst 1998.</p>
seed	<p>a) Compound grains, subspherical to oval and rosette-shaped; from 10µm to 15µm long length; with crosses of each granula intersecting at several points. Granula variable in shape, irregular to bell-shaped, with rounded and truncated sides; from 2µm to 9µm long length; not visible hilum and lamella; distinct eccentric cross, with four arms visible.</p>  <p>References: Partially based on Piperno and Holst 1998.</p>

Scale bar = 20µm.

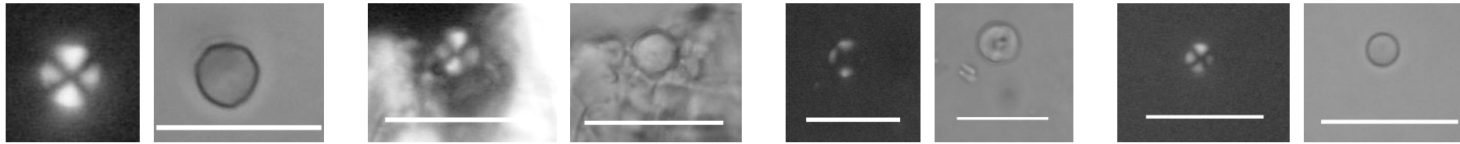
Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Cucurbita moschata

Cucurbitaceae *Cucurbita moschata* "anco"

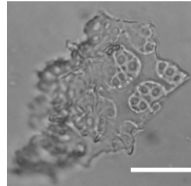
## Starch assemblage characterization

a) Single grains, spherical and polyhedral; variable in size from 3µm to 10µm long length; indistinct or distinct centric hilum as a dot or circle; not-visible lamella; distinct centric cross, with four arms visible.



seed

b) Compound grains, compounded by six or more granula. Granula are similar in size, ranging as single grains do.



**References:** Partially based on Piperno and Holst 1998.

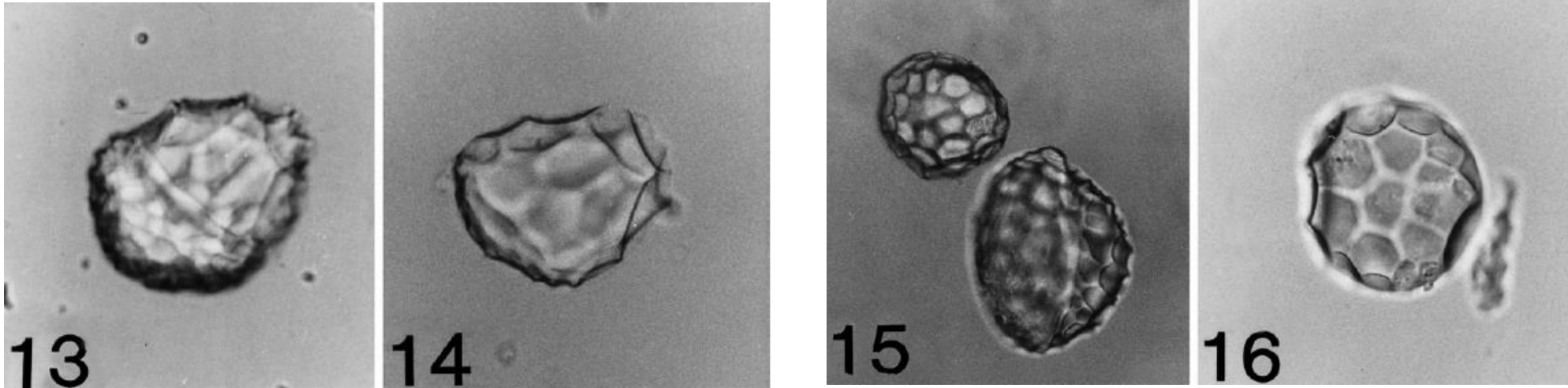
Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection



# Cucurbita moschata

## Phytolith



13. A phytolith from a Venezuelan population of *C. moschata*. It is thicker (72 m) than it is long (58 m) and possesses a clear demarcation between the two hemispheres. It also has elongated scallops on one hemisphere.

14. A scalloped phytolith from a Venezuelan population of *C. moschata*, in which the hemisphere with the smallest scallops is greatly reduced or truncated. These have only been observed thus far in *C. moschata*. It is 56 m long.

15. Scalloped phytoliths from *C. moschata* from western Ecuador. They differ from those in the Venezuelan land race of *C. moschata* (compare with Figures 13 & 14). The largest phytolith is 102 m long.

16. A scalloped phytolith from *C. moschata* from Vera Cruz, Mexico. It is 60 m long.

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in Cucurbita and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.

# Cucurbita moschata

## Phytolith

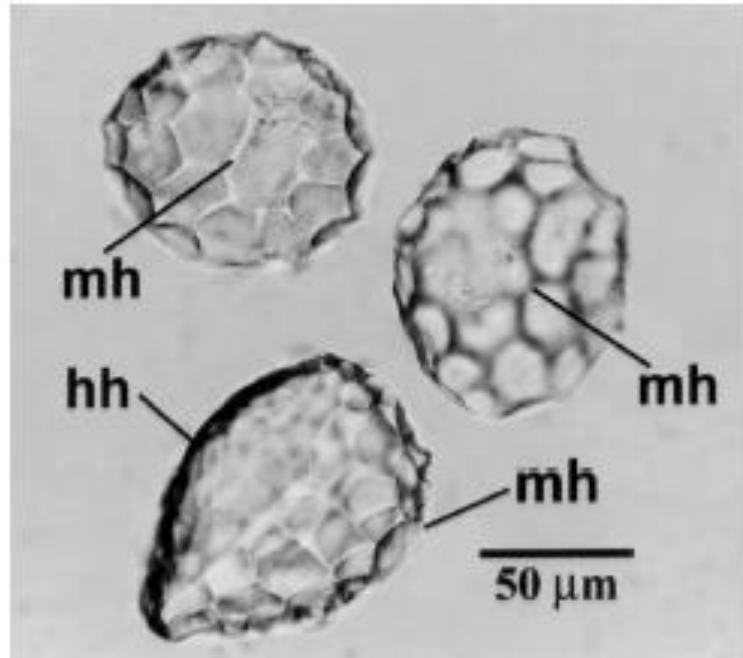


Fig. 5. Scalloped phytoliths from the domesticated species *Cucurbita moschata*. Wild squash phytoliths have the same morphology but are often much smaller than in domesticates. From Piperno, 2006

Ball, Terry B., Karol Chandler-Ezell, Ruth Dickau, Neil Duncan, Thomas C. Hart, José Iriarte, Carol Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <http://dx.doi.org/10.1016/j.jas.2015.08.010>.

# Cucurbita moschata

## Phytolith

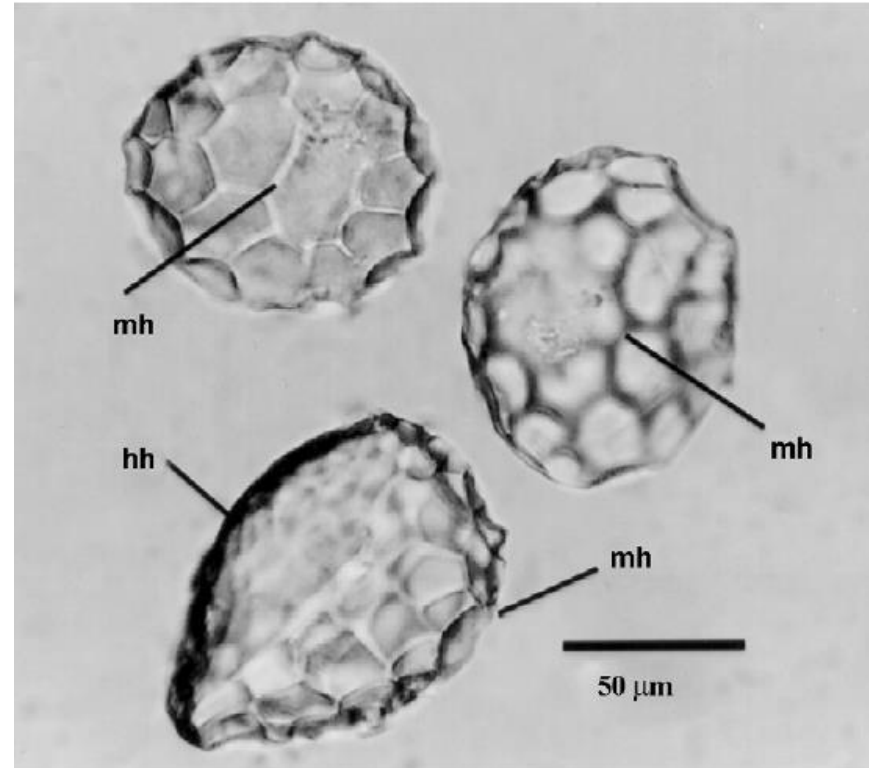
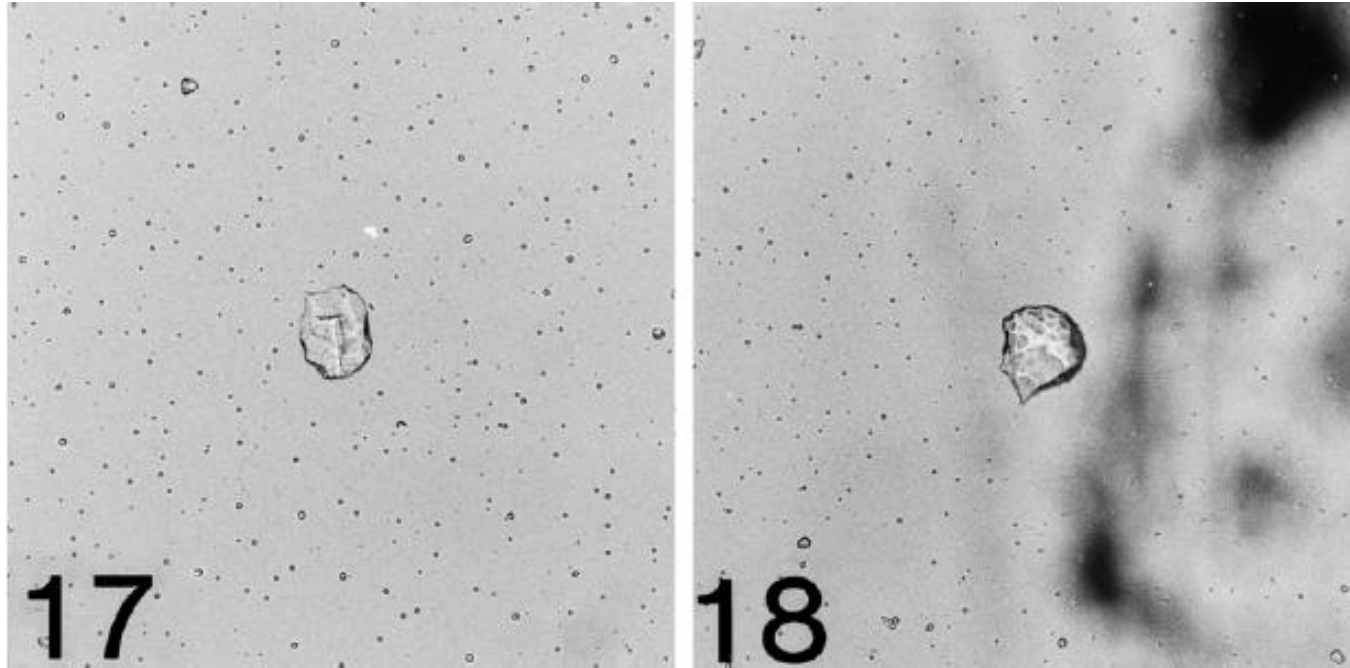


Fig. 2. Scalloped phytoliths from the domesticated species *Cucurbita moschata*. They have the same morphology as those in Fig. 1, but are larger than in *C. sororia* and other wild species. hh: hypodermal hemisphere, mh: mesocarpal hemisphere. Reprinted from Piperno et al. (2002), Copyright National Academy of Sciences USA.

Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

# Cucurbita moschata

## Phytolith



Figures 17 and 18. Irregular scalloped phytoliths from the bitter *C. moschata* from Panama. Both are about 40  $\mu$ m long.

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in Cucurbita and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.

# Cucurbita moschata

## Phytolith

Fig. 11. A spherical, scalloped phytolith from the rind of *Cucurbita moschata*. The scallops are round, deep, and regularly distributed.



Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449. <http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Cucurbita moschata

## Phytolith

Fig. 9. A phytolith from a fruit rind of *Cucurbita moschata* recovered from Huaca Prieta, Peru. It is like those found in modern fruits of the crop. The longest dimension of the phytolith measures 66 mm.



Fig. 10. A phytolith from a fruit rind of *Cucurbita moschata* from Huaca Prieta, Peru. It has attributes unlike in phytoliths from modern fruits. The longest dimension is 54mm.



Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

# Cucurbita moschata

## Starch

### APPENDIX:

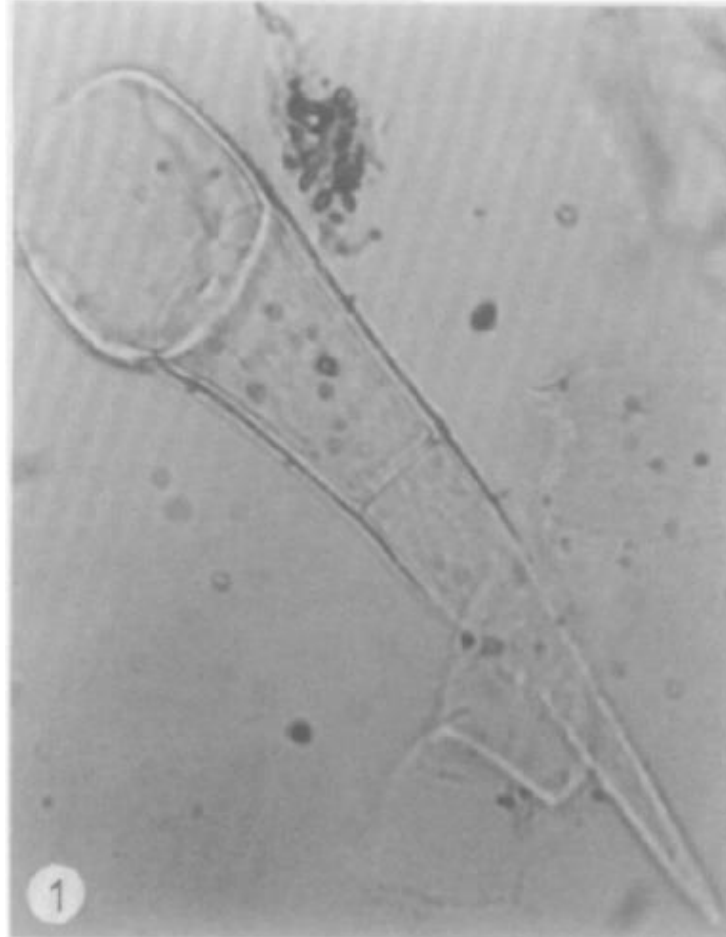
Cucurbita moschata (squash). Mostly simple grains, round to bell-shaped. When turned they may have the appearance of a hollow cone. The hilum is a closed point and is frequently surrounded by very prominent lamella. The distal end of the grains tends to be pleated. Size: 8–24 microns long.

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Cucurbita palmata

## Phytolith

1. A segmented hair from *Cucurbita palmata* (200 x ).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

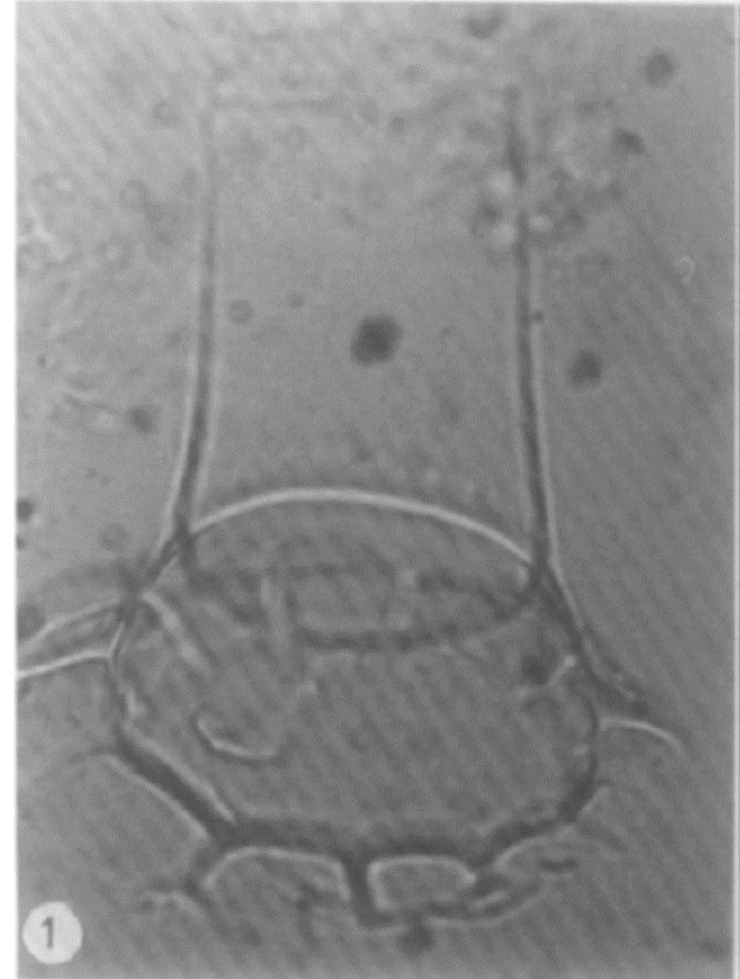


# Cucurbita pepo

## Phytolith

4. Segmented hair from *Cucurbita pepo* with two segments and a small, round apical segment (250x).

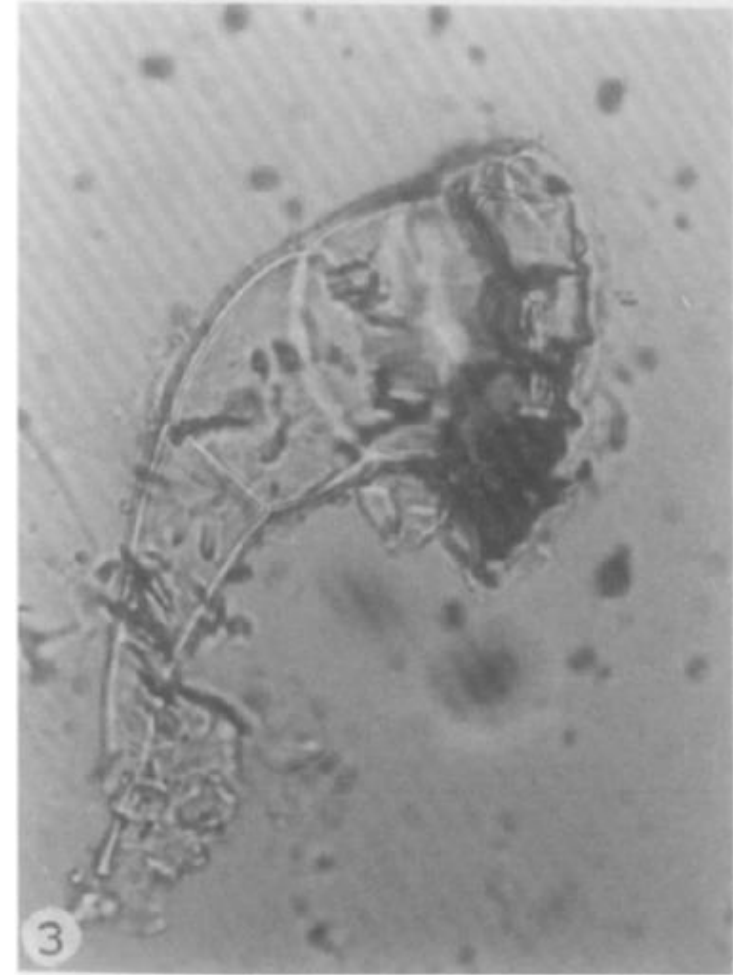
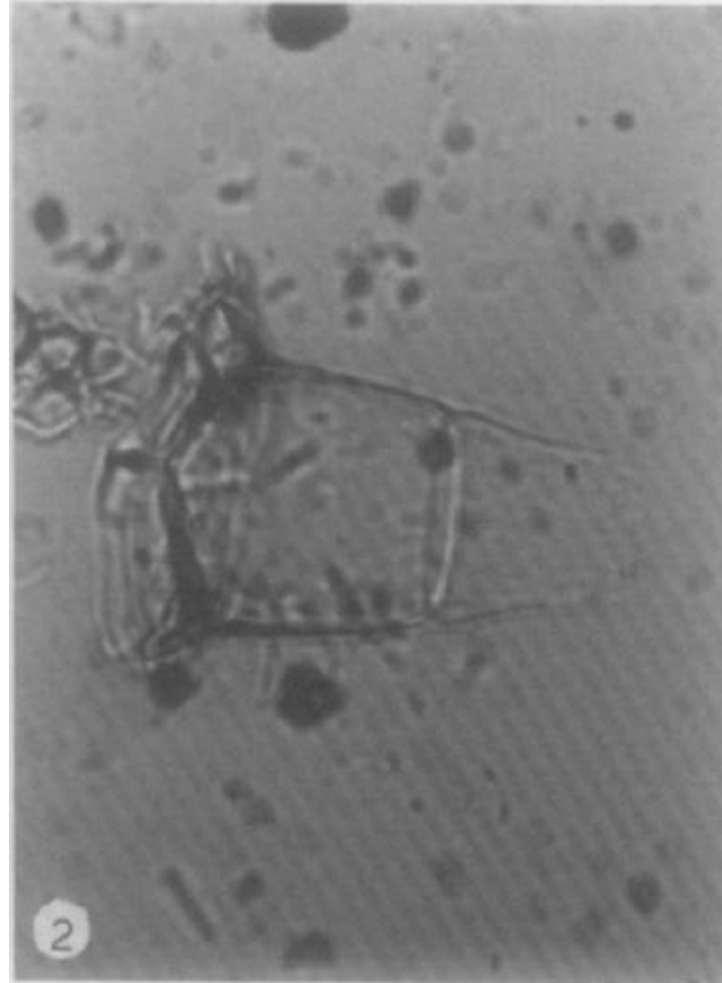
1. Segmented hair from *Cucurbita pepo* with a somewhat tapered basal and intermediate segment and a small, rounded apical segment (250 x). Many hairs of this type have less tapered basal and intermediate segments.



# Cucurbita pepo

## Phytolith

2. A broken segmented hair from *Cucurbita pepo* (250 ×).
3. A segmented hair from *Cucurbita pepo* (156 ×).



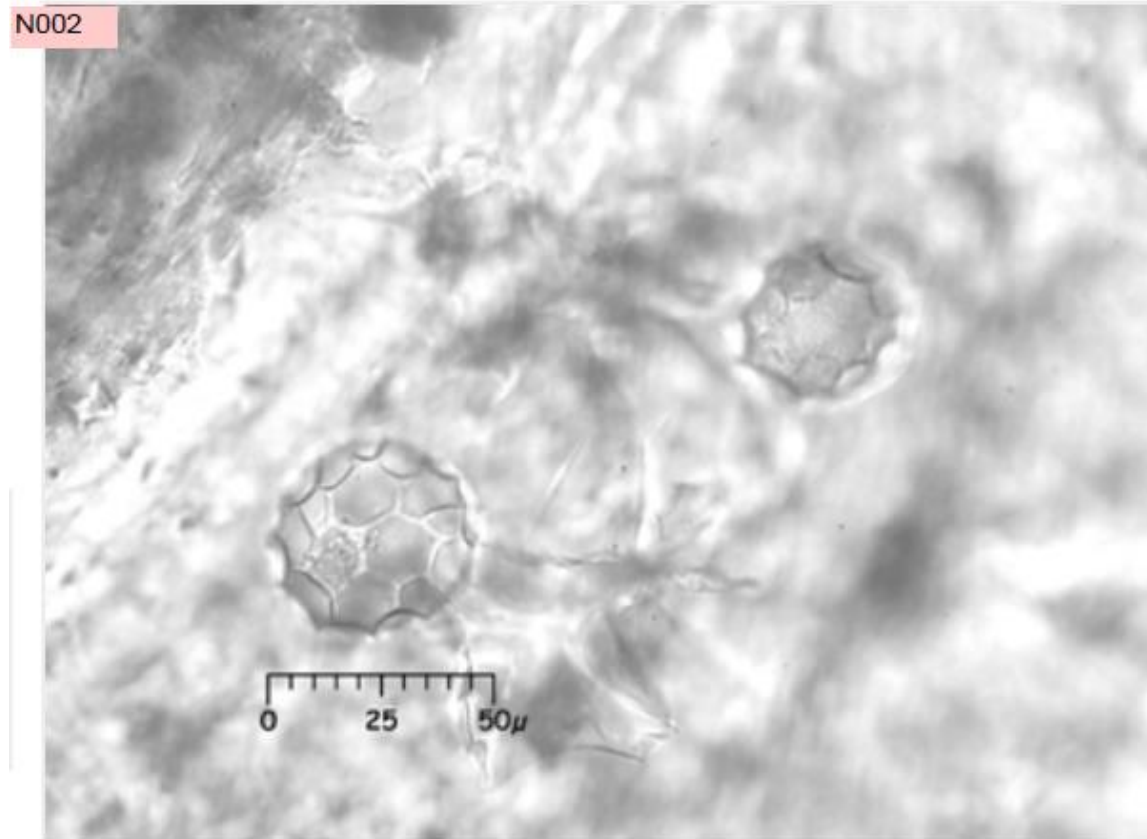
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Cucurbita pepo var. ozarkana

## Phytolith

Diagnostic level: genus, domesticated  
Larger hemisphere of spheres is visible in this view.

See Piperno's 2000 Journal Archaeological Science article: "Phytoliths in Cucurbita and other neotropical Cucurbitaceae ...." for extensive discussion of the spheres produced by this family



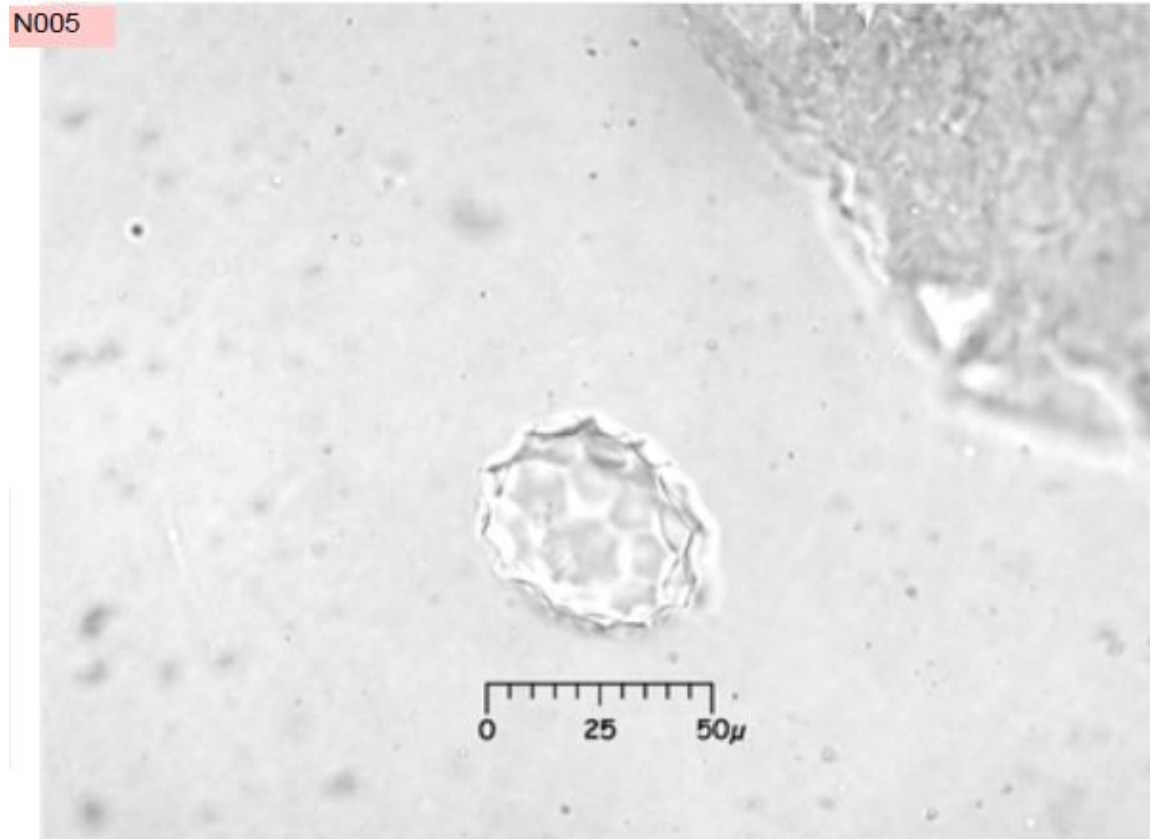
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cucurbita pepo var. ozarkana

## Phytolith

Diagnostic level: genus, domesticated In this view, you can see the difference between “large” and “small” hemispheres

See Piperno’s 2000 Journal Archaeological Science article: “Phytoliths in Cucurbita and other neotropical Cucurbitaceae ....” for extensive discussion of the spheres produced by this family

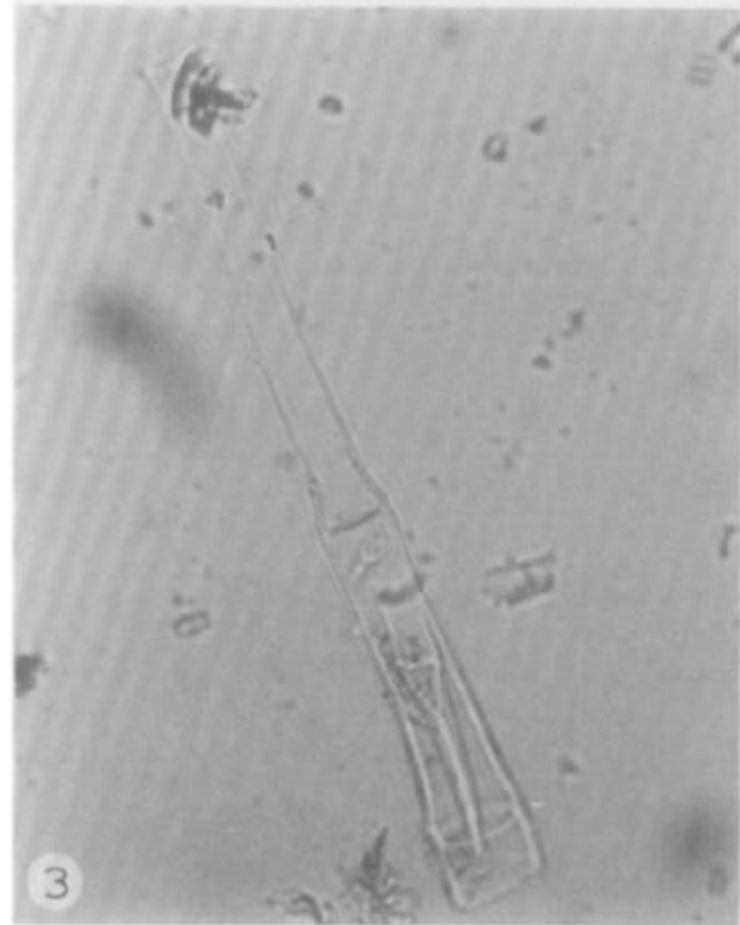
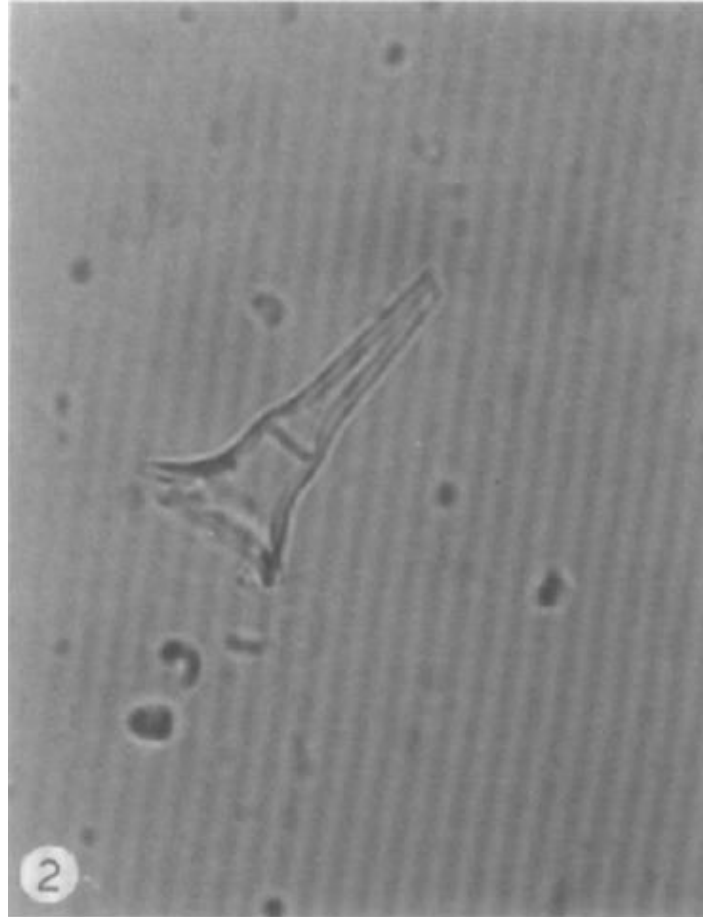


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

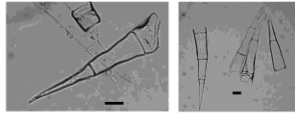
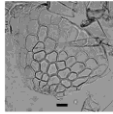
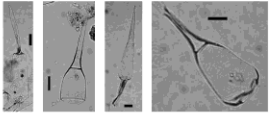
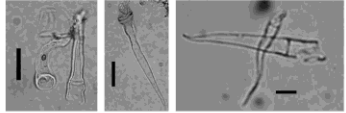
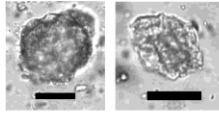
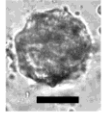
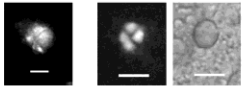
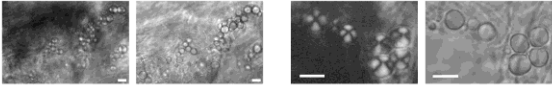
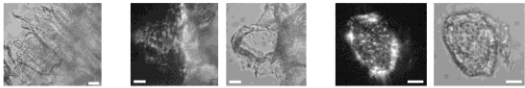
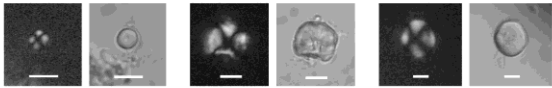
# Gurania makoyana

## Phytolith

2. A segmented hair from *Gurania makoyana* (250 x ).
3. A segmented hair with long segments and a non-tapered shaft from *Gurania makoyana* (250 X ).



# Lagenaria siceraria

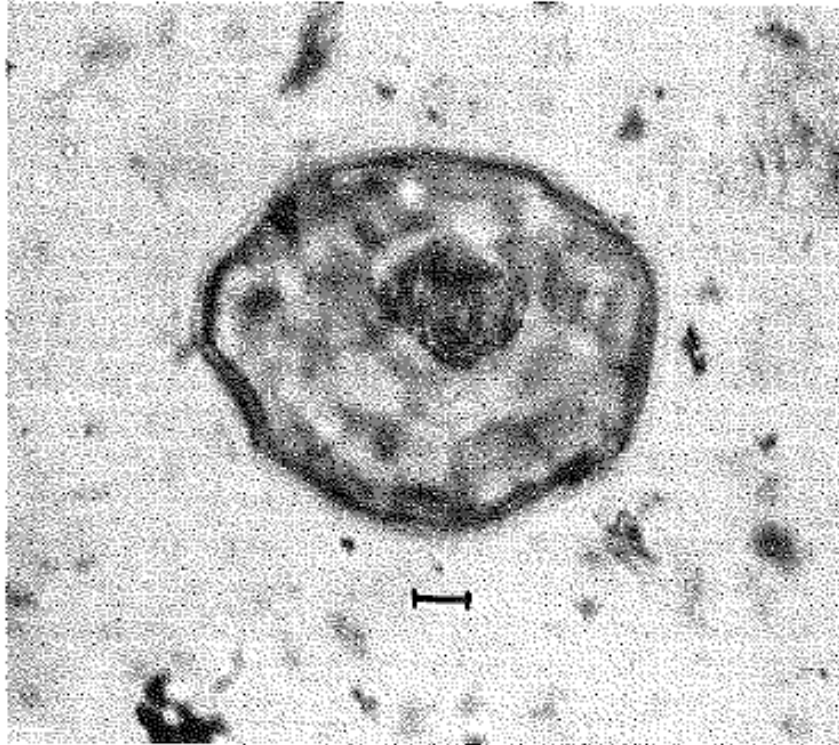
Cucurbitaceae <i>Lagenaria siceraria</i> "mate"	
Phytolith assemblage characterization	
leaf	<p>Diagnostic phytoliths:</p> <p>a) Acuminate segmented translucent silica hairs. Very common.</p>  <p>b) Silica epidermal cells. Not common.</p>  <p>c) Acuminate segmented translucent silica hairs with different ends in the hair base. Common.</p> 
	<p>References: Reported in Piperno 1988:62.</p>
stem	<p>a) Acuminate segmented silica hairs. Rare.</p>  <p>a) Semi-spherical granulate irregular facetate silica phytolith. Not common.</p>  <p>b) Semi-spherical facetate silica phytolith. Not common.</p> 
	<p>References: Reported in Bozarth 1987, Piperno 1988:62 and Piperno et al 2000.</p>
Starch assemblage characterization	
seed	<p>a) Single grains, spherical, oval and bowl-shaped; variable in size from 10µm to 20µm long length; not visible hilum and lamella; distinct centric cross, with four arms visible.</p> 
fruit	<p><b>Pulp.</b></p> <p>a) Single grains, spherical, oval, and spherical with a little point projection or truncations faceted-; variable in size from 2µm to 17µm long length; not visible hilum and lamella; distinct centric or lightly eccentric cross, with four arms visible. May occur in linear or bunch aggregates.</p> 
	<p><b>Rind.</b></p> <p>a) Compound grains, with a polyhedral package four- to five-sided, some elongated; variable in size, to 225µm long length, compounded by many granula different in size. Granula with very distinct centric hilum as a circle or oval; not visible lamella; distinct centric cross, with four arms visible.</p> 
	<p>b) Single grains, spherical and oval, sometimes faceted; variable in size from 8.5µm to 25µm long length; distinct hilum as as clear spot with a round cavity; not visible lamella; sometimes radiating fissures; distinct centric cross, with four arms visible.</p> 

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Lagenaria siceraria

## Phytolith

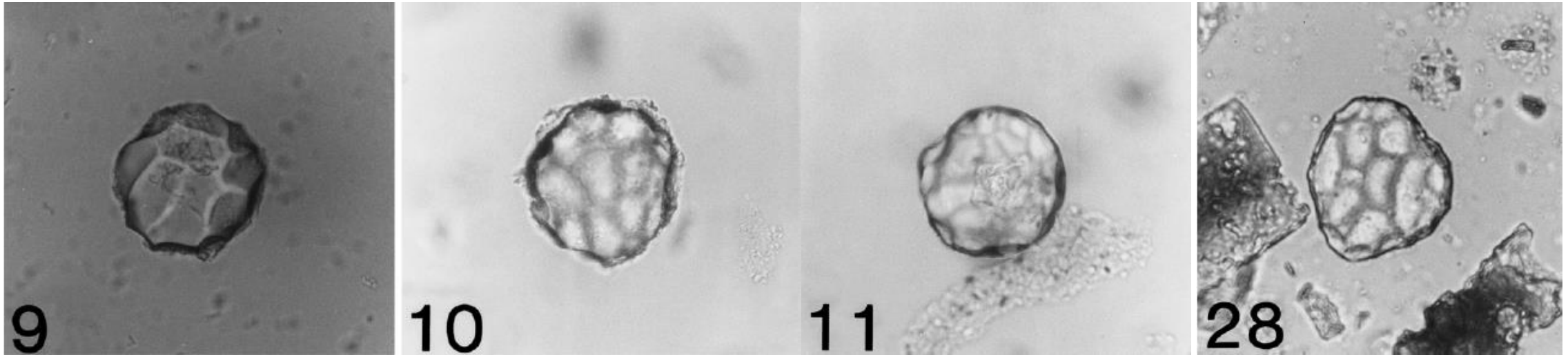


d. Scalloped sphere from *Lagenaria siceraria*.

Pearsall, Deborah Marie. 1993. Contributions of Phytolith Analysis for Reconstructing Subsistence: Examples from Research in Ecuador. *Current Research in Phytolith Analysis: Applications in Archaeology and Paleoecology*. MASCA.

# Lagenaria siceraria

## Phytolith



9. A phytolith from bottle gourd. It is hemispherical with elongated scallops.

10. A hemispherical phytolith from bottle gourd, with its undecorated flat side laying face up. The scallops are irregularly shaped.

11. A hemispherical phytolith from bottle gourd, with irregularly shaped and elongated scallops.

28. A bottle gourd phytolith from pre-7000  $\text{BP}$  contexts at the Aguadulce rock shelter. It is hemispherical and has irregular, elongated scallops (compare with Figure 10).

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in Cucurbita and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.



# Lagenaria siceraria

## Phytolith

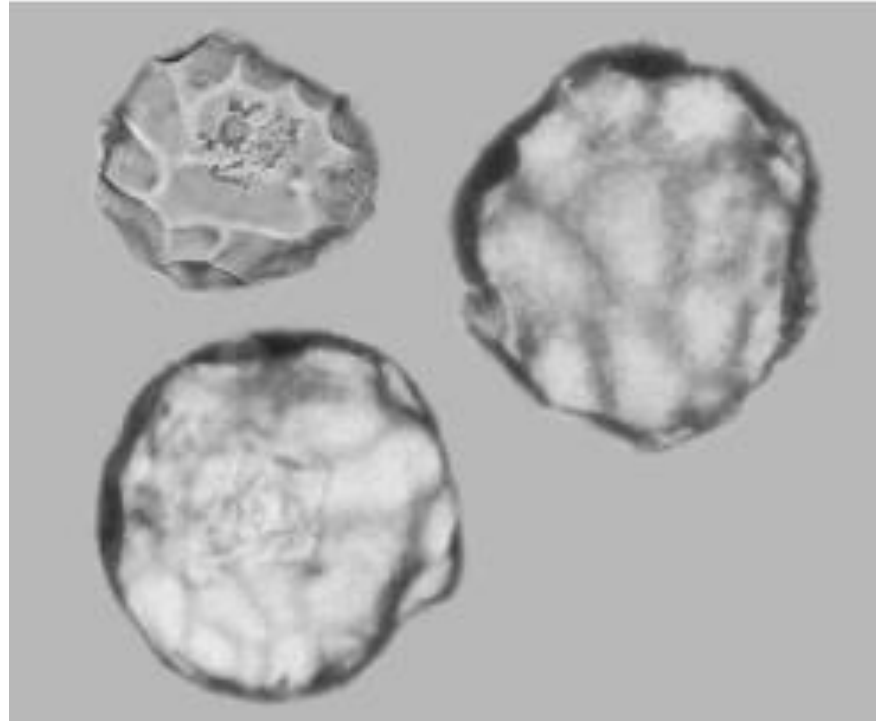


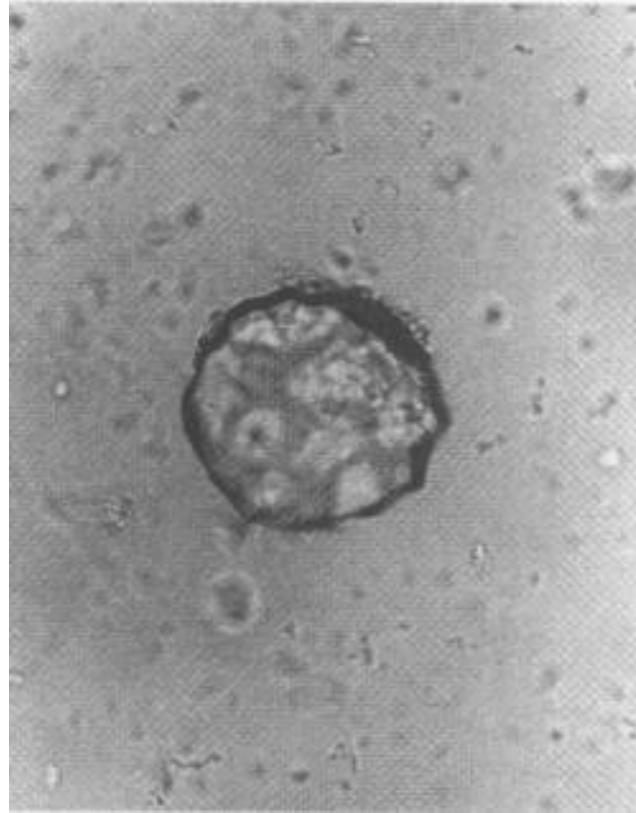
Fig. 6. Scalloped phytoliths from bottle gourd. Unlike in *Cucurbita*, scallops are irregularly-shaped and one hemisphere of the phytolith is flat and undecorated. Size ranges from 64 to 112  $\mu\text{m}$ . From Piperno, 2006

Ball, Terry B., Karol Chandler-Ezell, Ruth Dickau, Neil Duncan, Thomas C. Hart, José Iriarte, Carol Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <http://dx.doi.org/10.1016/j.jas.2015.08.010>.

# Lagenaria siceraria

## Phytolith

Fig. 13. A phytolith from *Lagenaria siceraria* (bottle gourd). It is distinctive because it has large, often elongated, and irregularly distributed scallops on one side of the phytolith, and is hemispherical.



Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449. <http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Lagenaria siceraria

## Phytolith

Fig. 4. A phytolith from bottle gourd showing how the irregular pattern of the stone cells is discernible on the phytolith surface

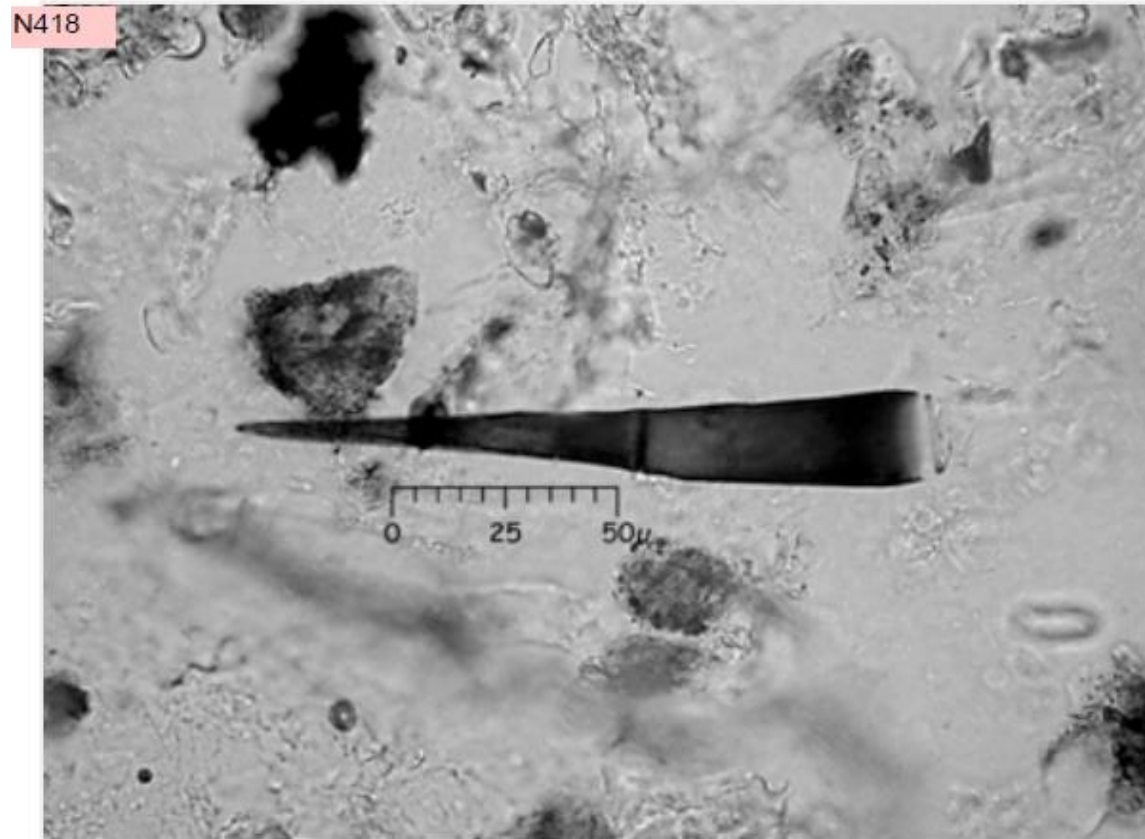


Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

# Lagenaria siceraria

## Phytolith

Diagnostic level:  
Cucurbitaceae/Asteraceae

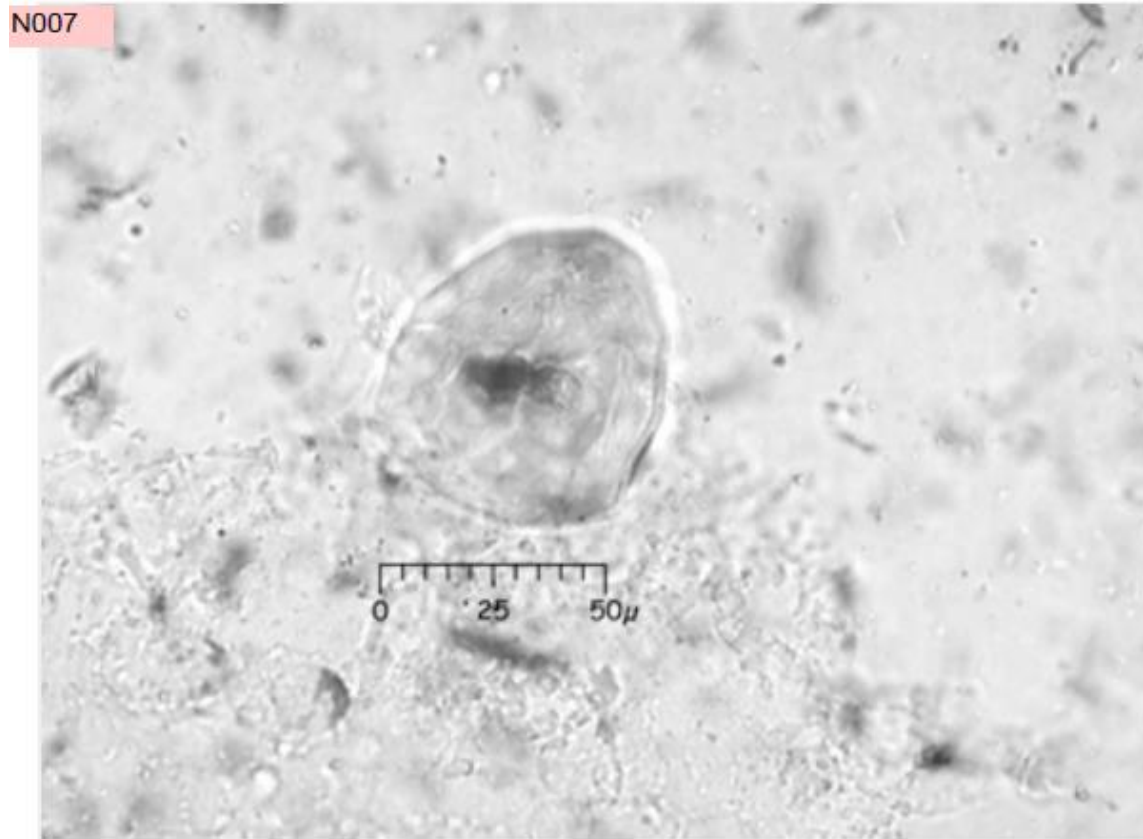


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lagenaria siceraria

## Phytolith

The presence of elongated facets/scallops, that are irregularly distributed, are the diagnostic features of gourd. See Piperno et al. 2000. Diagnostic level: species

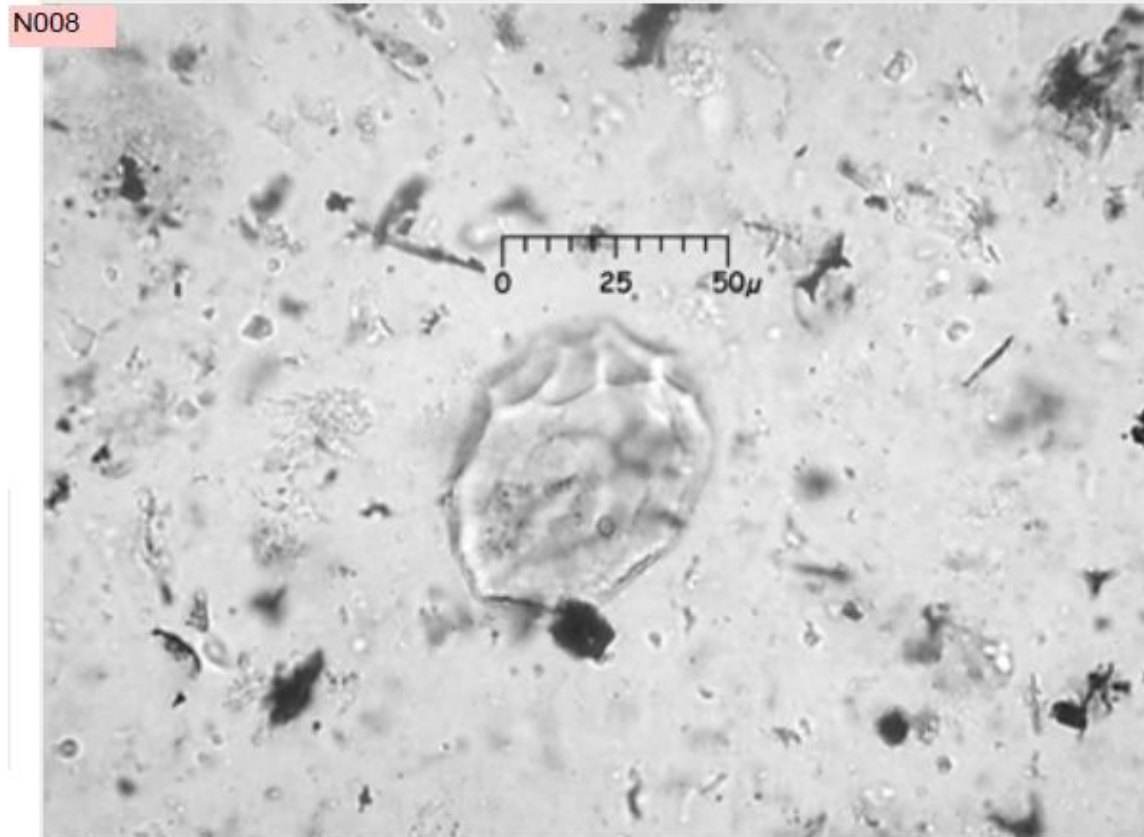


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lagenaria siceraria

## Phytolith

The presence of elongated facets/scallops, that are irregularly distributed, are the diagnostic features of gourd. See Piperno et al. 2000. Diagnostic level: species

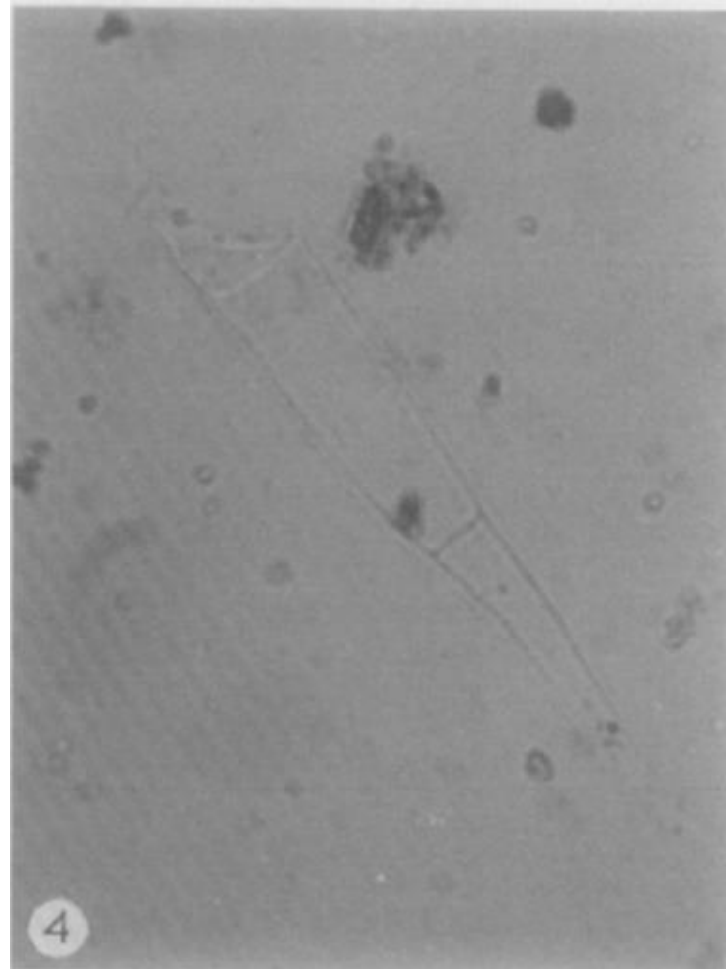


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lagenaria siceraria

## Phytolith

4. A segmented hair from *Lagenaria siceraria* (200x).

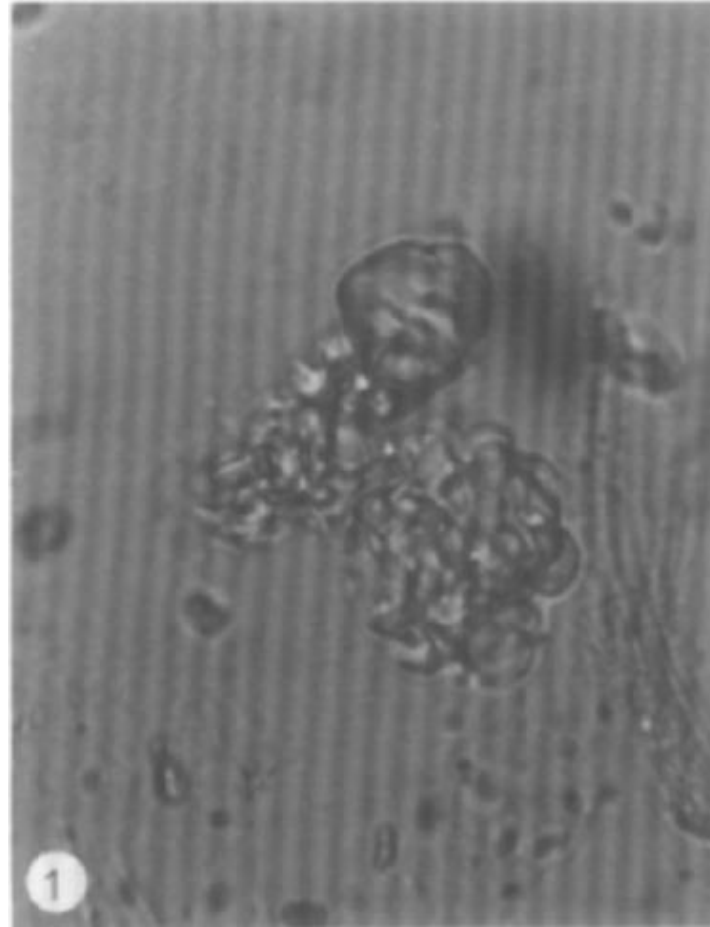


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Luffa astori

## Phytolith

1. Irregular, lumpy pieces of silica from *Luffa astori* (250 ×).



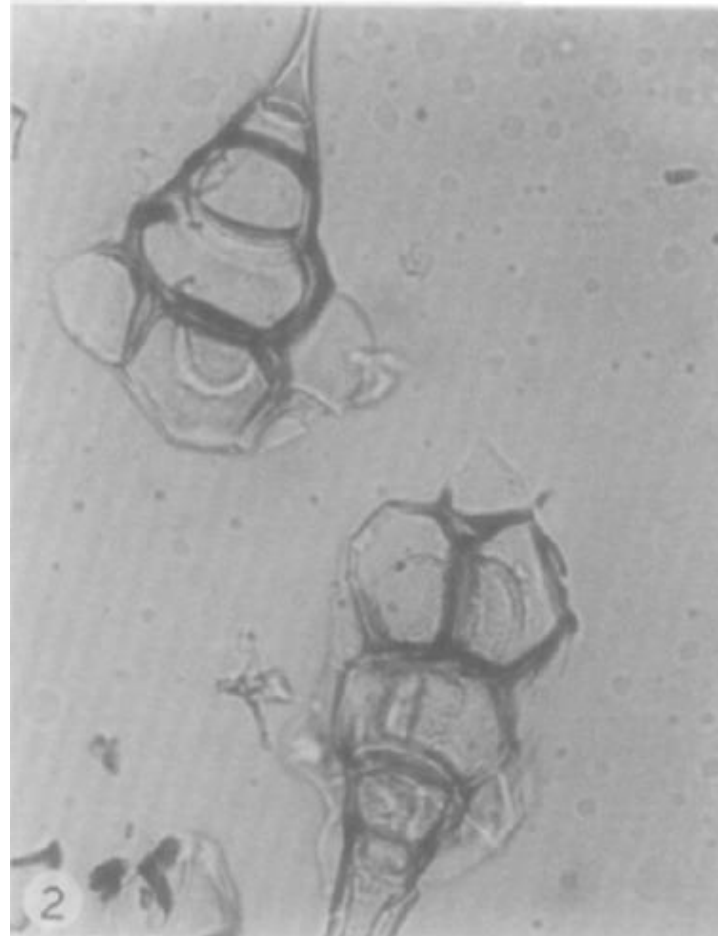
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.



# Melothria guadalupensis

## Phytolith

2. Segmented hairs with circular segments and tapered apices from *Melothria guadalupensis* (156 x).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Melothria guadalupensis

## Phytolith

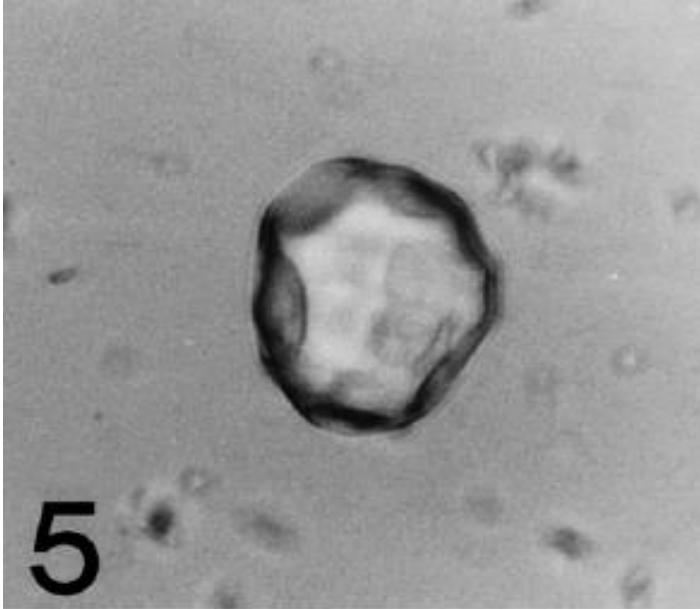
1. Segmented hairs with the surface decoration of long, fine striations from *Melothria guadalupensis* (156 x).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Peponopsis adhaerens

## Phytolith



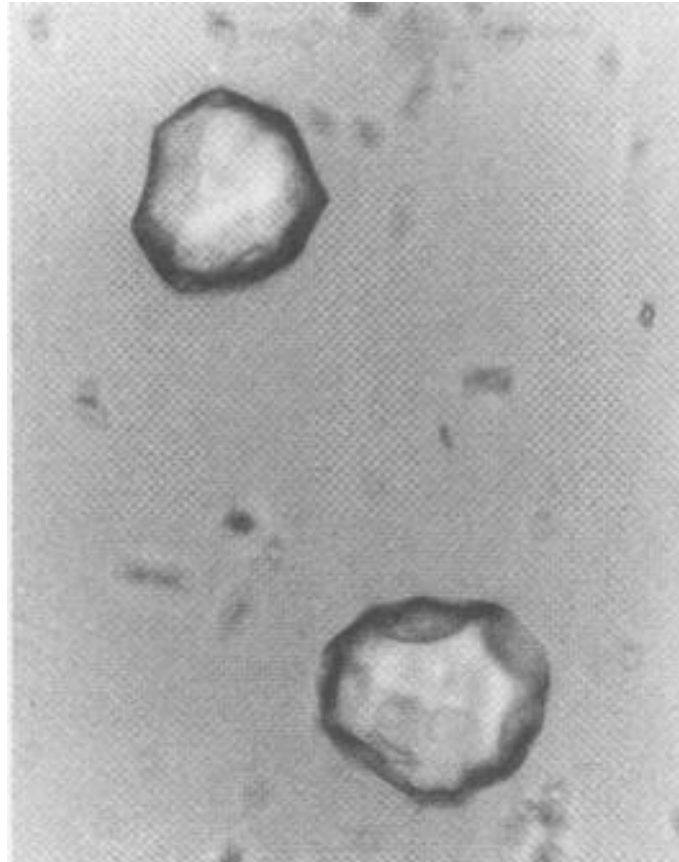
5. A scalloped phytolith from *Peponopsis adhaerens*. It has shallow scallops and possesses only one decorated hemisphere. It is 44 m long.

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in Cucurbita and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.

# Peponopsis adhaerens

## Phytolith

Fig. 15. Scalloped phytoliths from a wild species in the Cucurbitaceae, *Peponopsis adhaerens*. They differ from domesticated Cucurbitaceae in having small and indistinct scallops, little difference in the decoration of the hemispheres, and in overall size. Also, they often are not spherical, but are flattish (see also Fig. 16).

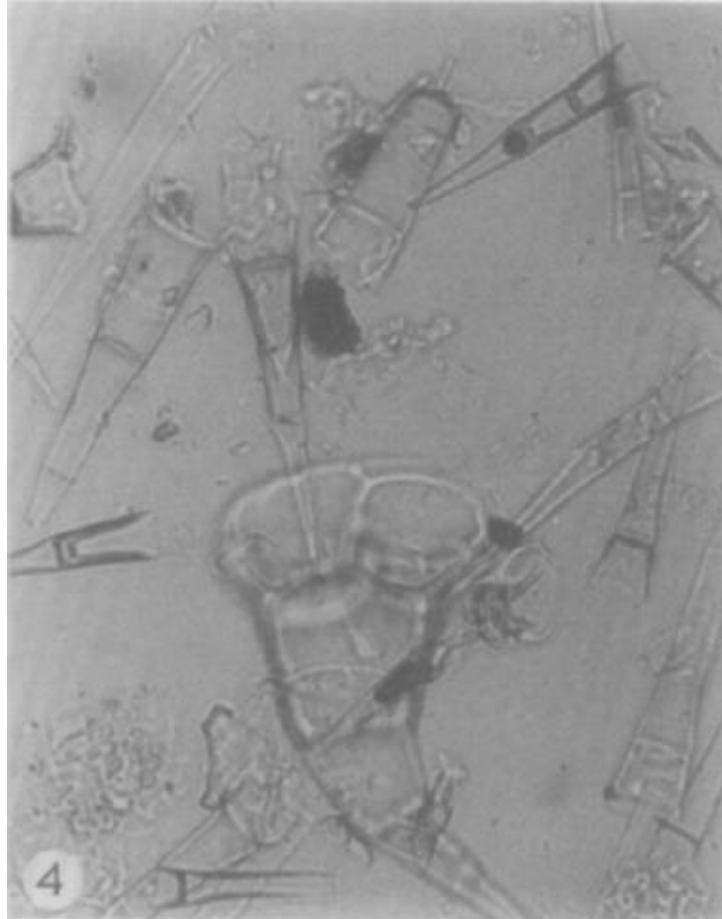


Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449. <http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Pittiera grandiflora

## Phytolith

4. Segmented hairs from *Pittiera grandiflora*. Some have blackish silica inclusions (156 x ).

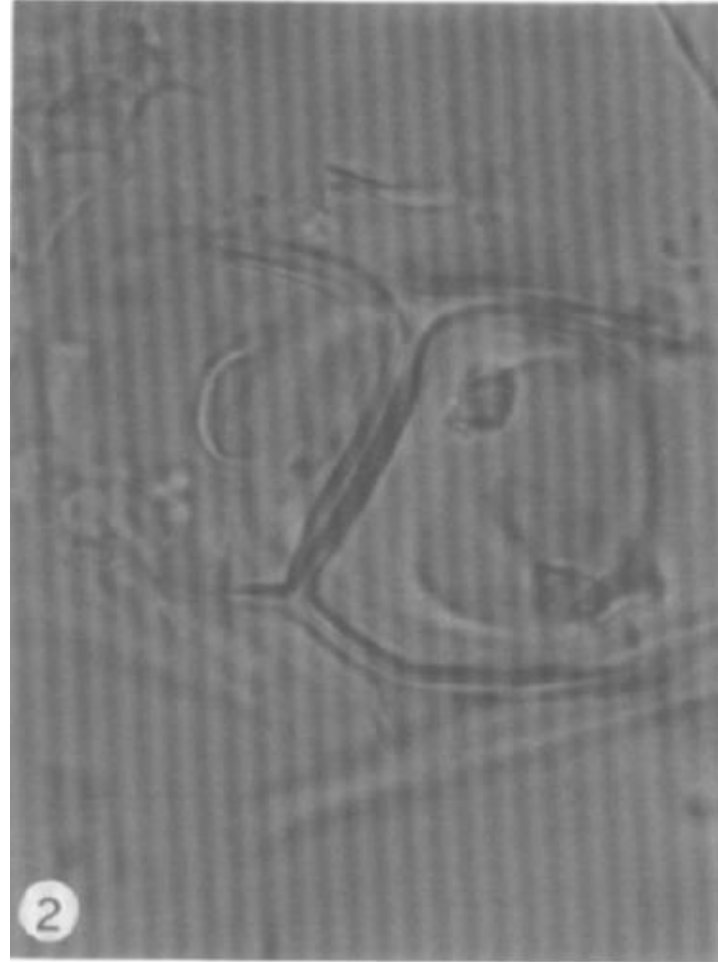


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Pittiera grandiflora

## Phytolith

2. A hair base from *Pittiera grandiflora* consisting of two half-spheres joined together (400 x).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Sechium edule

## Starch

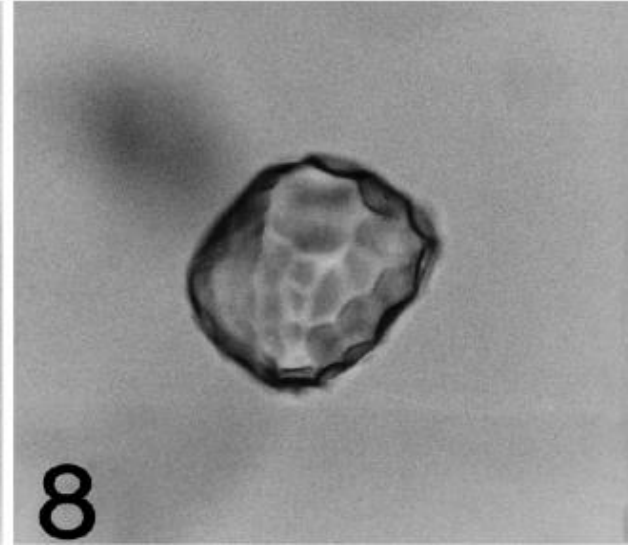
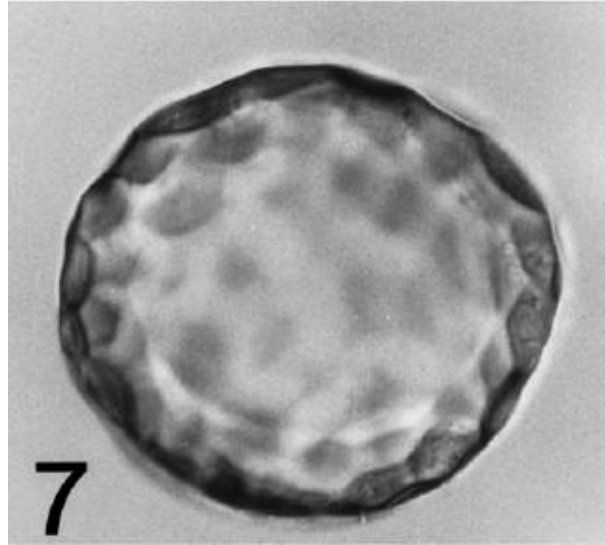
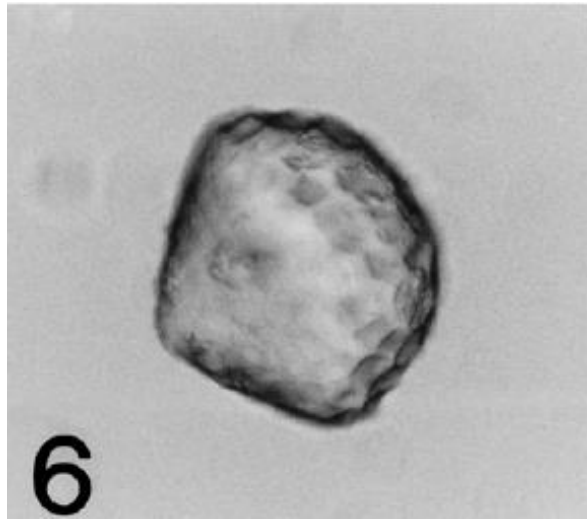
### APPENDIX:

Sechium edule (chayote). Compound and simple grains, laminated, with few distinguishing features. Size: 4–16 microns.

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Sicana odorifera

## Phytolith



6. A phytolith from *Sicana odorifera* rotated so that the differences in the shapes and decorations of the two hemispheres can be observed. The hemisphere on the left forms a cone and it also has a different surface decoration than that of *Cucurbita* (compare with Figures 1 & 2).
7. A phytolith from *Sicana odorifera*. The undecorated hemisphere is laying face up. Notice the dark margin of the phytolith (compare with Figure 1).
8. A phytolith from *Sicana odorifera* showing how the hemispheres are asymmetrical.

Piperno, Dolores R., Thomas C. Andres, and Karen E. Stothert. 2000. Phytoliths in Cucurbita and Other Neotropical Cucurbitaceae and Their Occurrence in Early Archaeological Sites from the Lowland American Tropics. *Journal of Archaeological Science* 27:193–208.



# Sicana odorifera

## Phytolith

Fig. 14. A phytolith from *Sicana odorifera*. It has one hemisphere that is markedly conical and faintly decorated (compare with *Cucurbita* and *Lagenaria*).

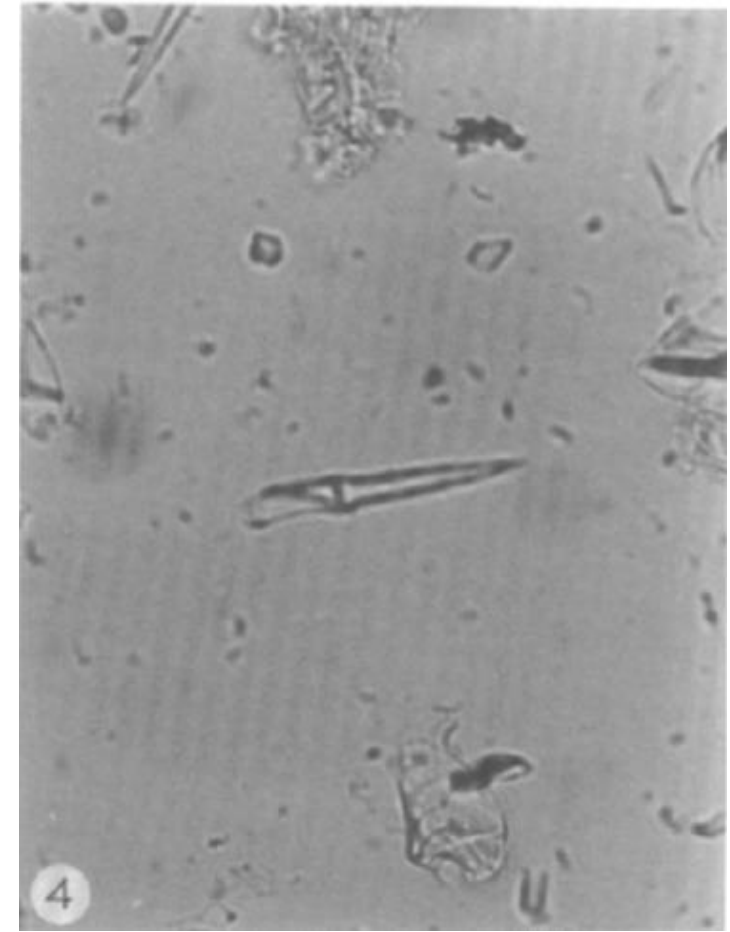
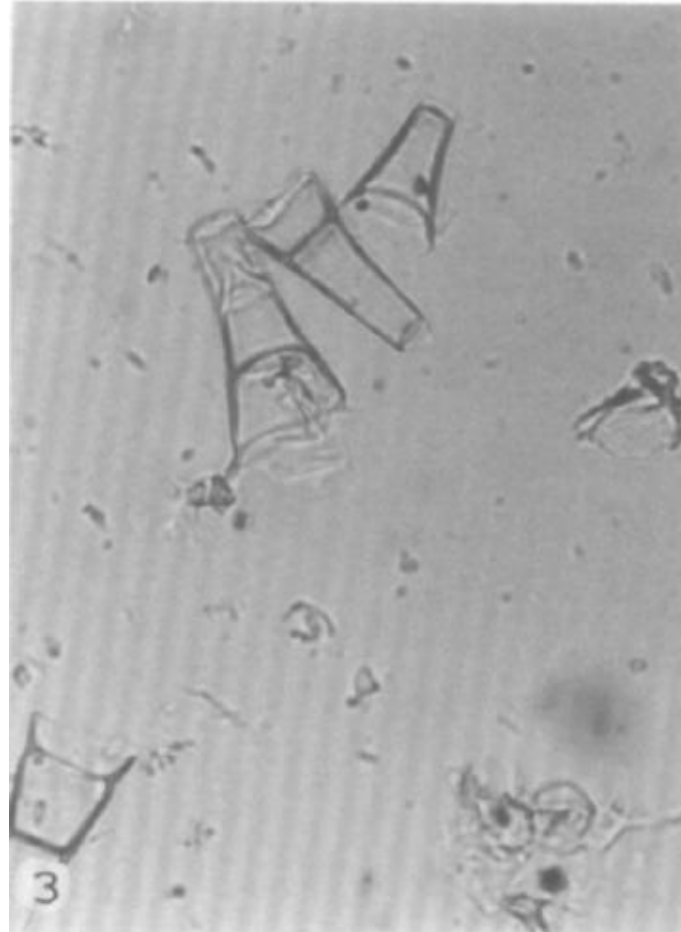


Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449. <http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Sicyos echinocystoides

## Phytolith

- 3. Segmented hairs from *Sicyos echinocystoides* (156 ×).
- 4. A segmented hair from *Sicyos echinocystoides* (156 ×).



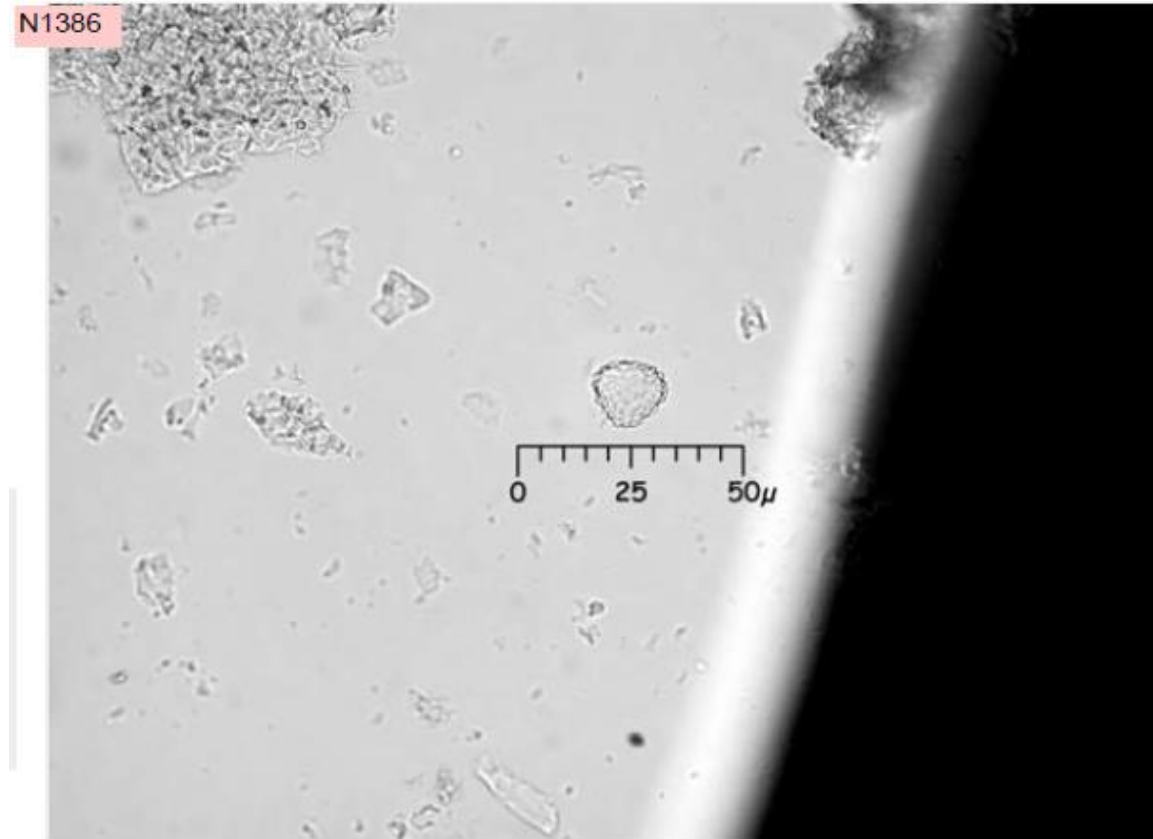
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

CYATHEACEAE

# Cyathea pallescens

## Phytolith

Slide 2229a. Leaf

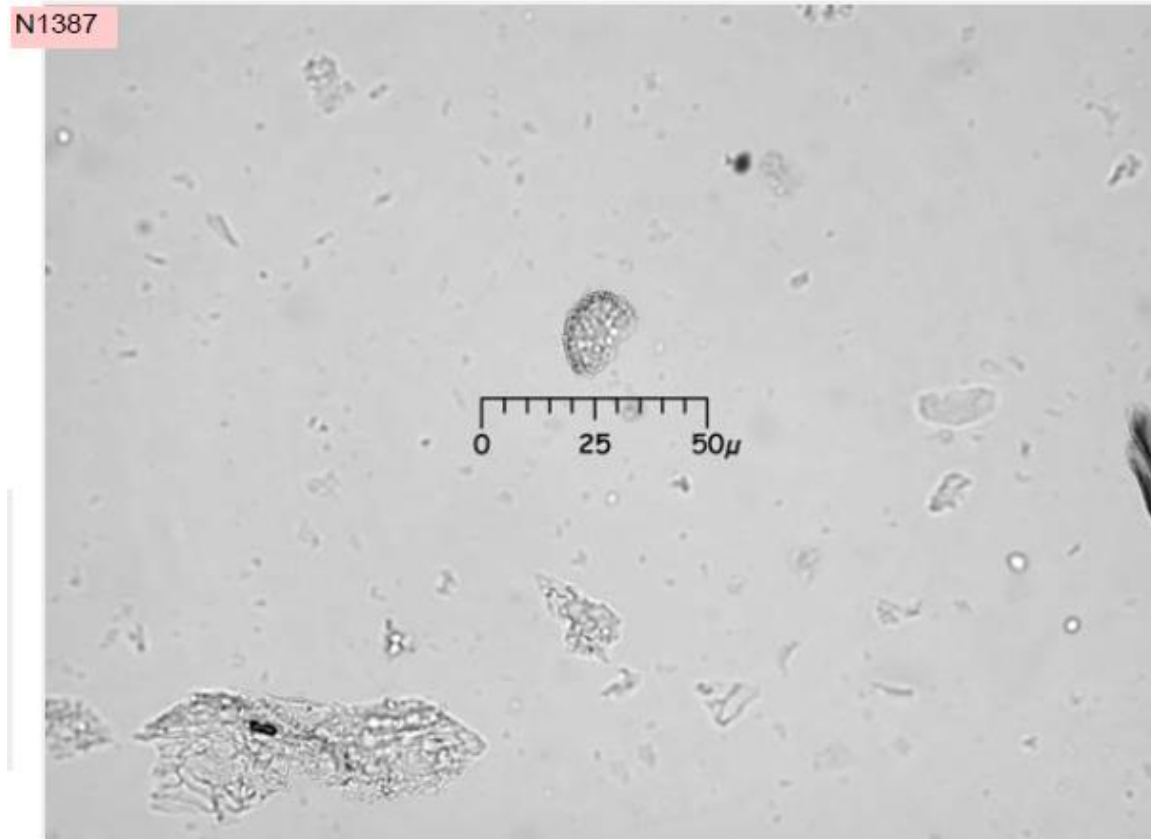


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyathea pallescens

## Phytolith

Slide 2229a. Leaf

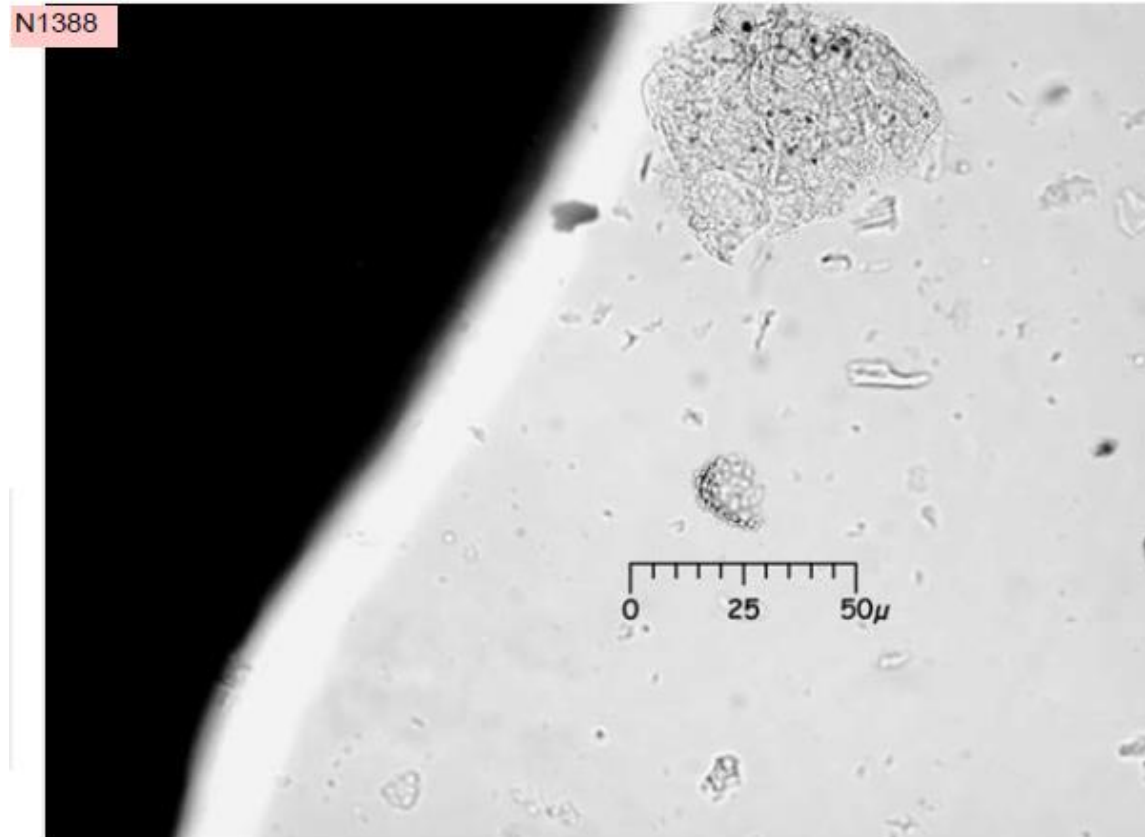


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyathea pallescens

## Phytolith

Slide 2229a. Leaf

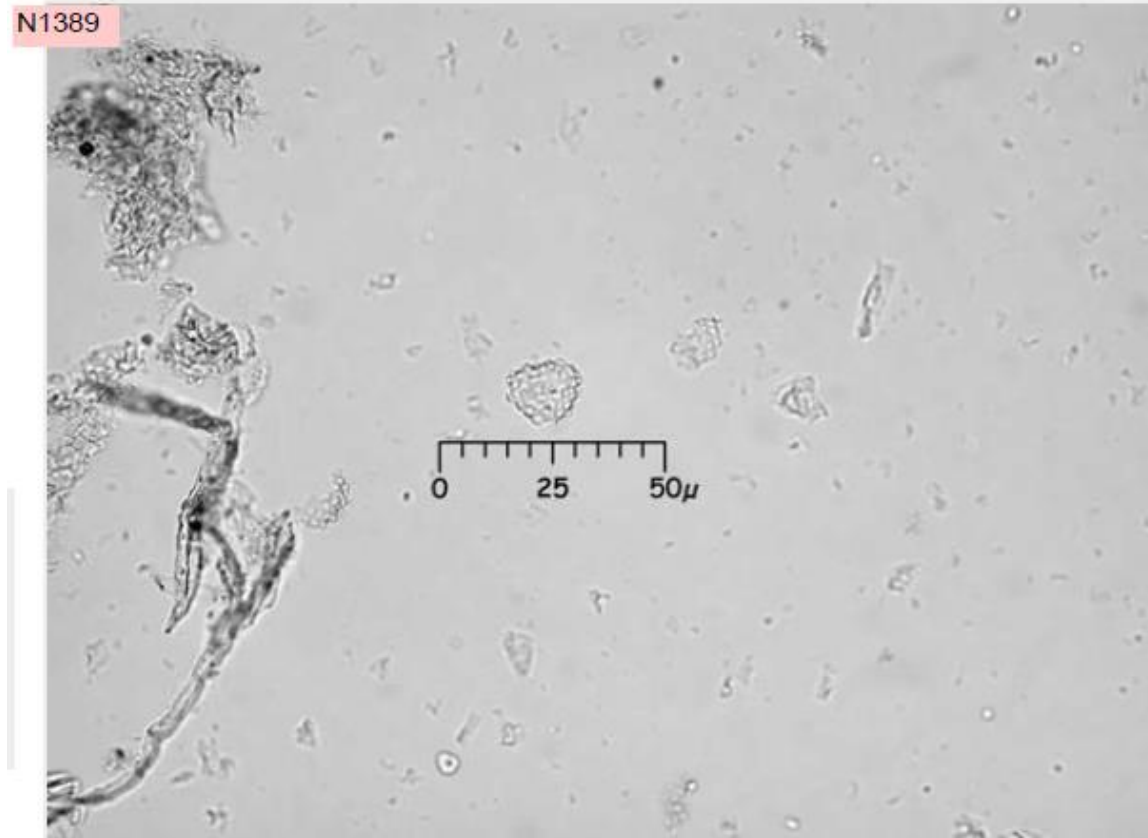


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyathea pallescens

## Phytolith

Slide 2229a. Leaf

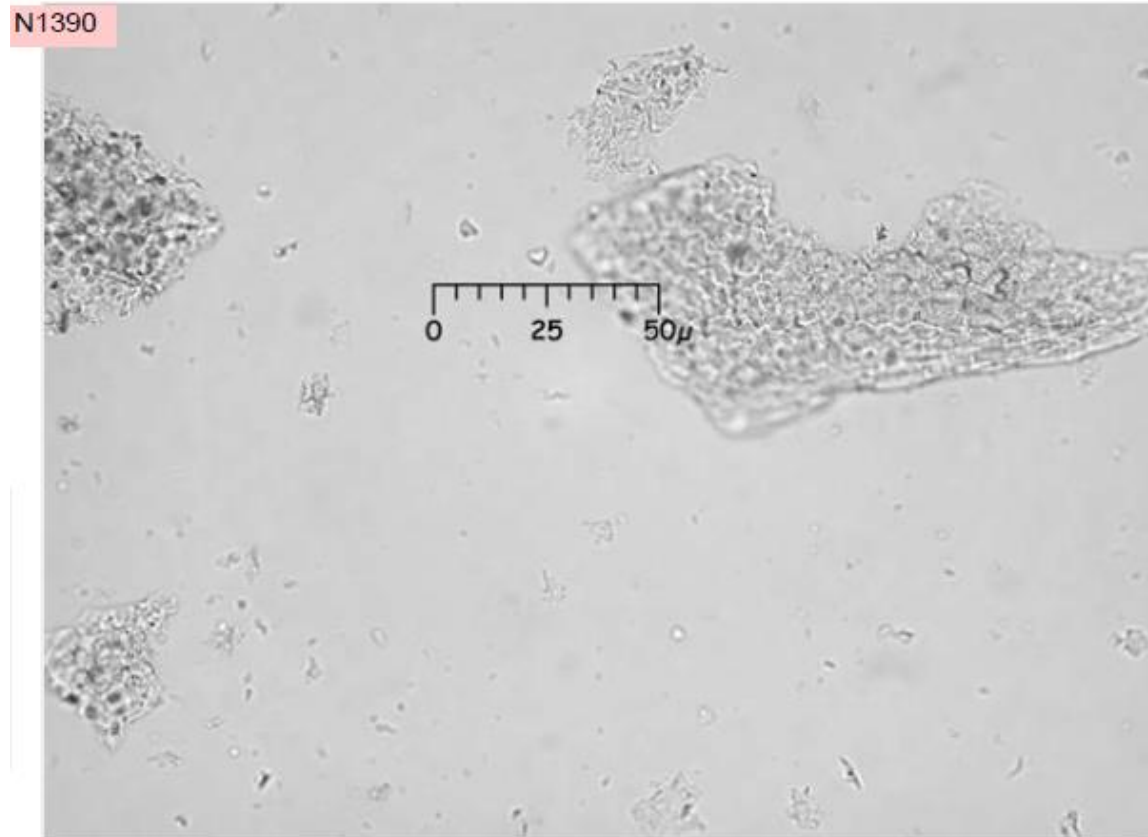


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyathea pallescens

## Phytolith

Slide 2229a. Leaf



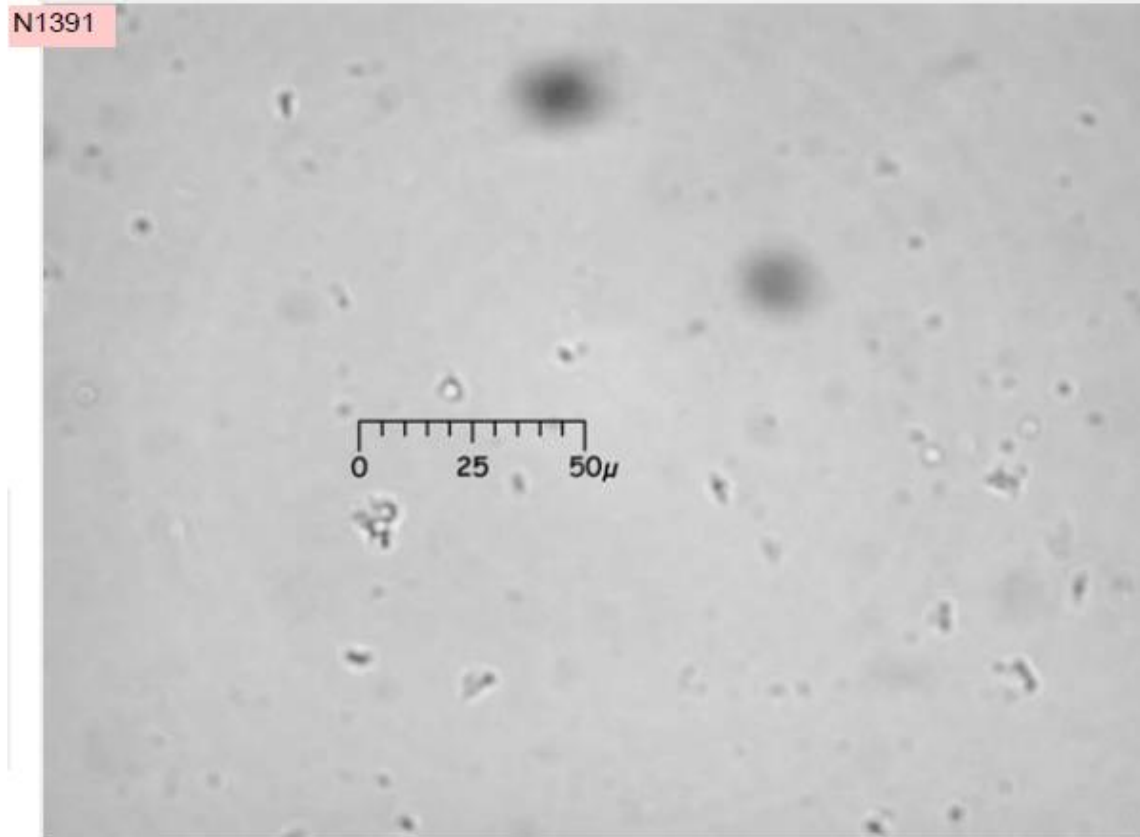
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Cyathea pallescens

## Phytolith

Slide 2229a. Leaf

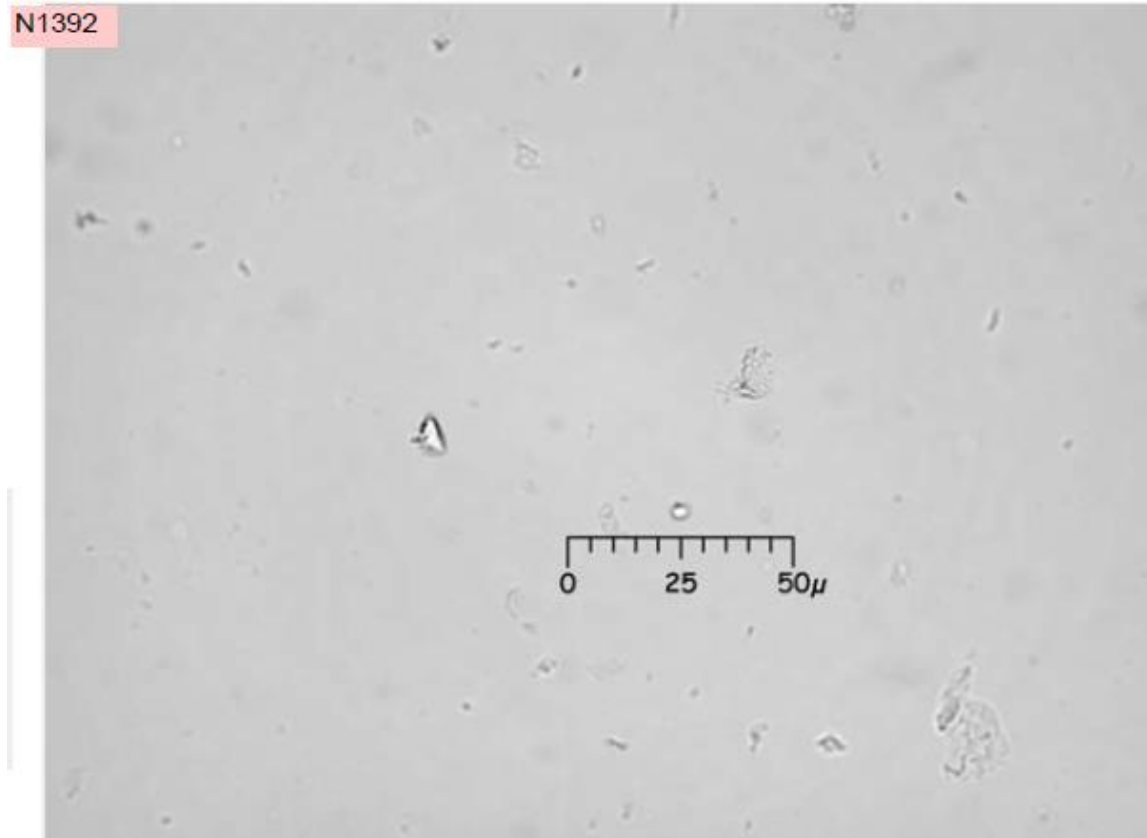


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyathea pallescens

## Phytolith

Slide 2229a. Leaf

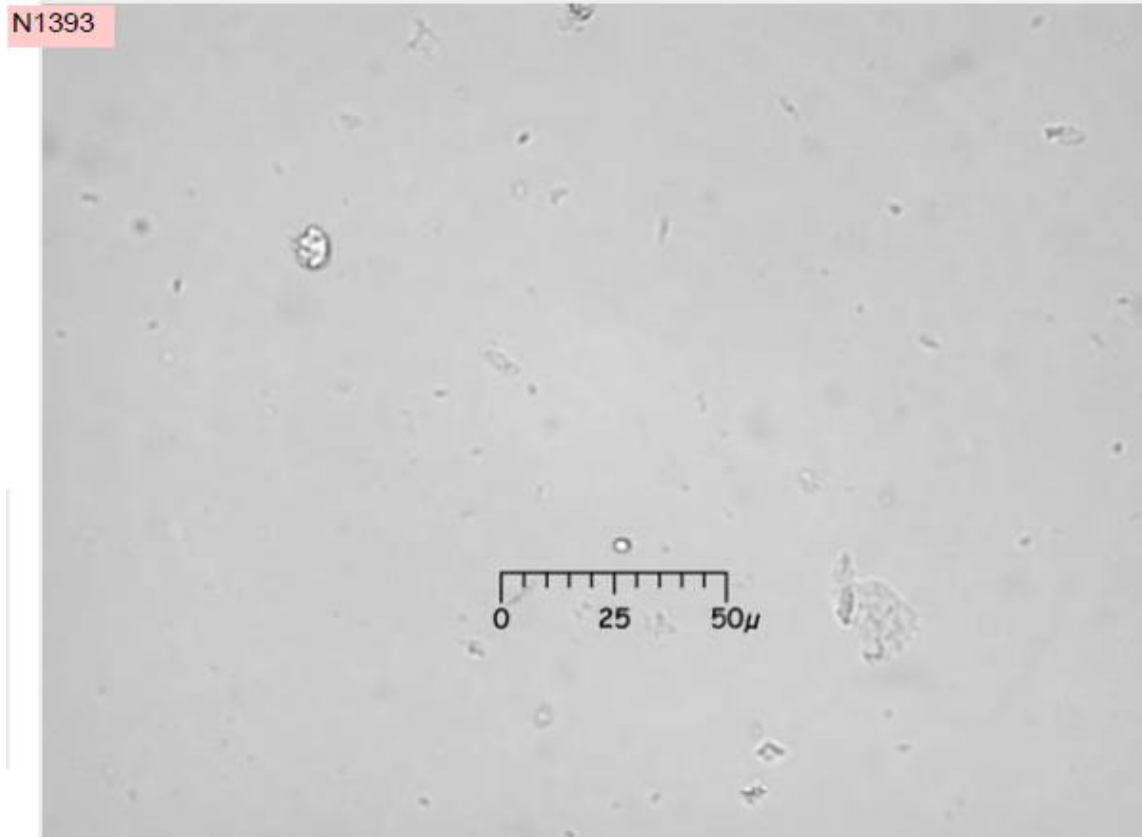


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyathea pallescens

## Phytolith

Slide 2229a. Leaf

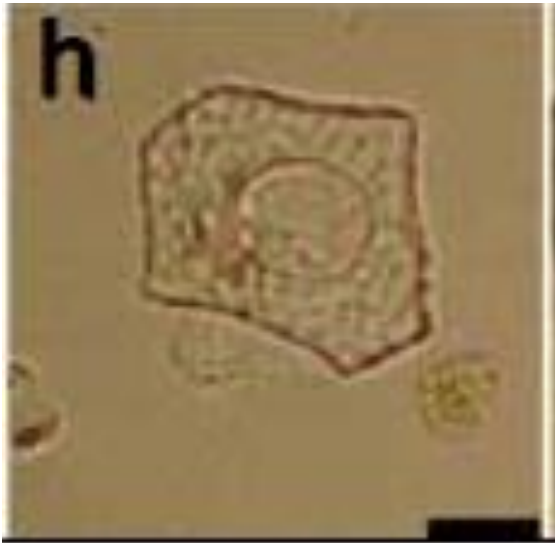


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

CYPERACEAE

# Cyperaceae

## Phytolith



h. Achene phytolith highly distinctive, and possibly diagnostic of the Cyperaceae genera *Kyllinga* and *Cyperus*.

Abramiuk, Marc A., Peter S. Dunham, Linda Scott Cummings, Chad Yost, and Todd J. Pesek. 2011. Linking Past and Present: A Preliminary Paleoethnobotanical Study of Maya Nutritional and Medicinal Plant Use and Sustainable Cultivation in the Southern Maya Mountains, Belize. *Ethnobotany Research and Applications* 9:257–73.

# Cyperaceae

## Phytolith

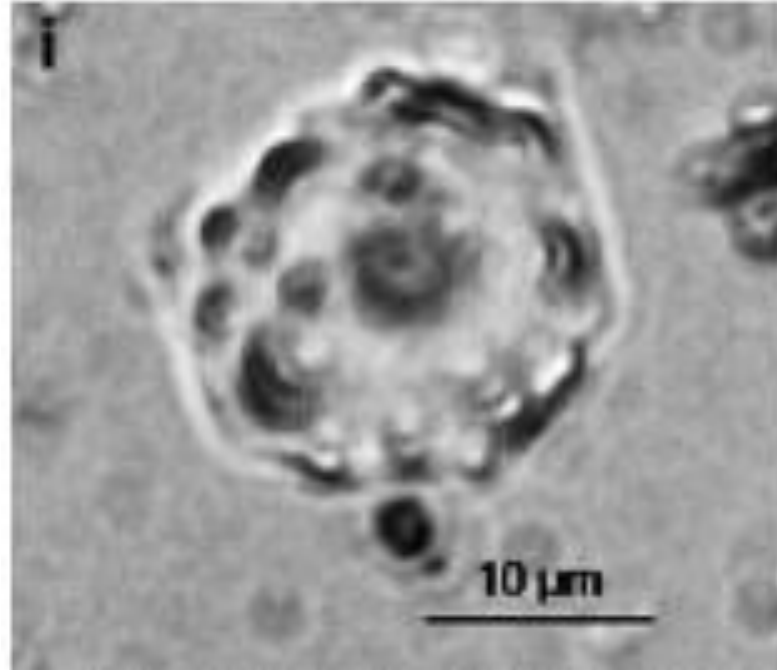


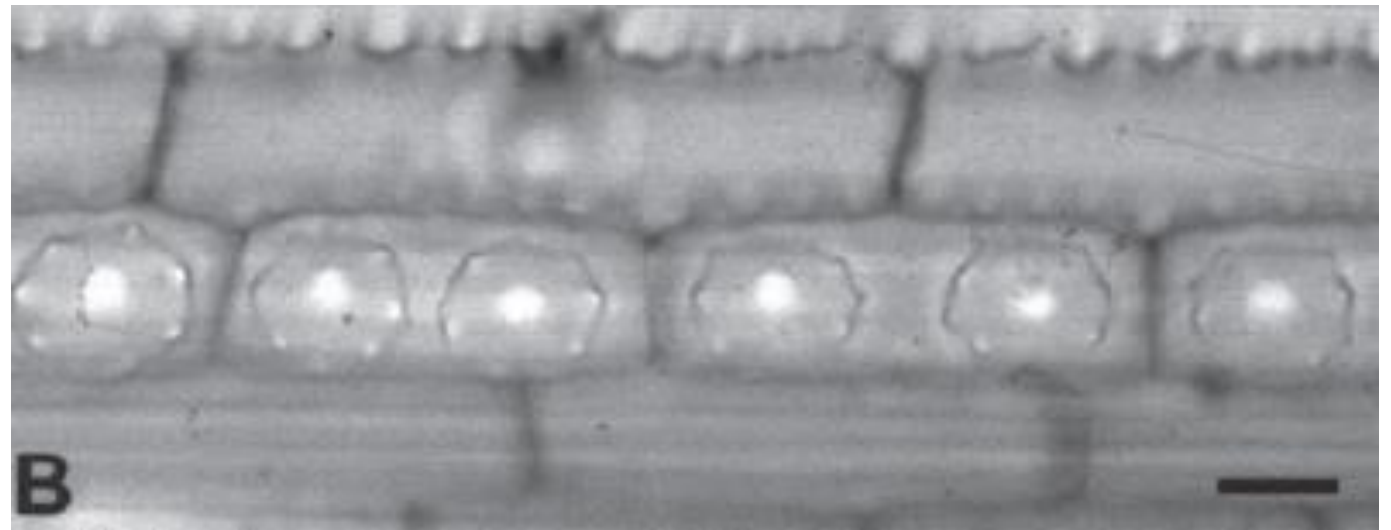
Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. i) Cyperaceae hat-shaped phytolith with satellites (BD M1, 20-30 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Abildgaardia monostachya

## Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. B. *Abildgaardia monostachya* (Cyperaceae), conical bodies with satellites in epidermis (bar = 10  $\mu\text{m}$ ).

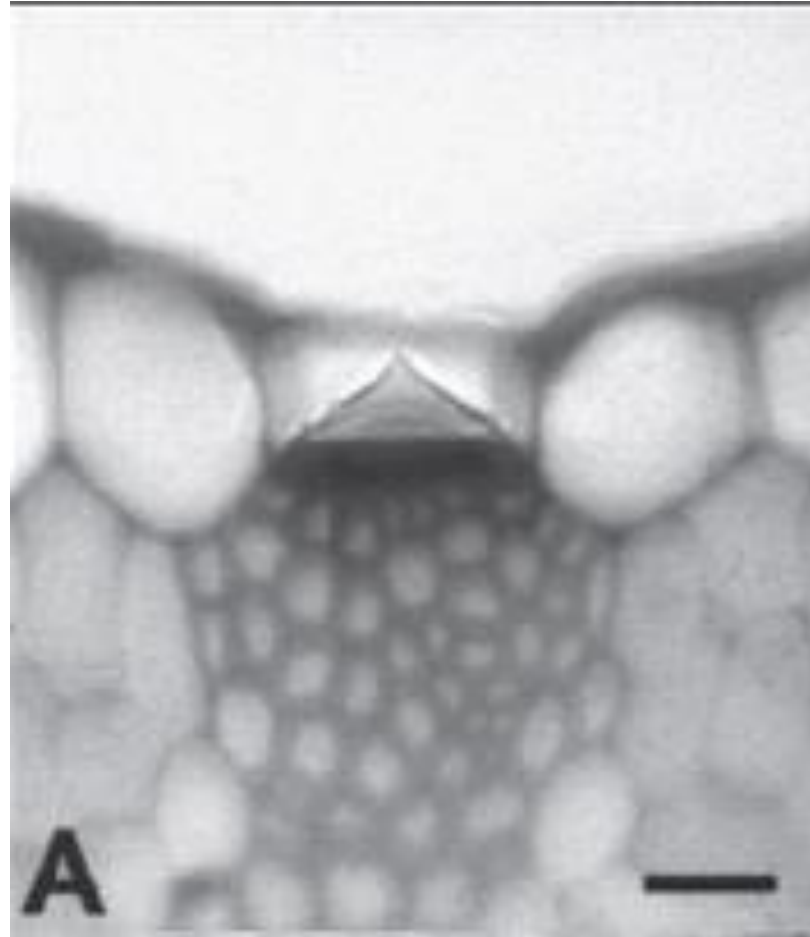


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Carex intermedia

## Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. A. *Carex intermedia* (Cyperaceae), lateral view of a conical silica body with tiny spines projecting near the base (bar = 10  $\mu\text{m}$ ).



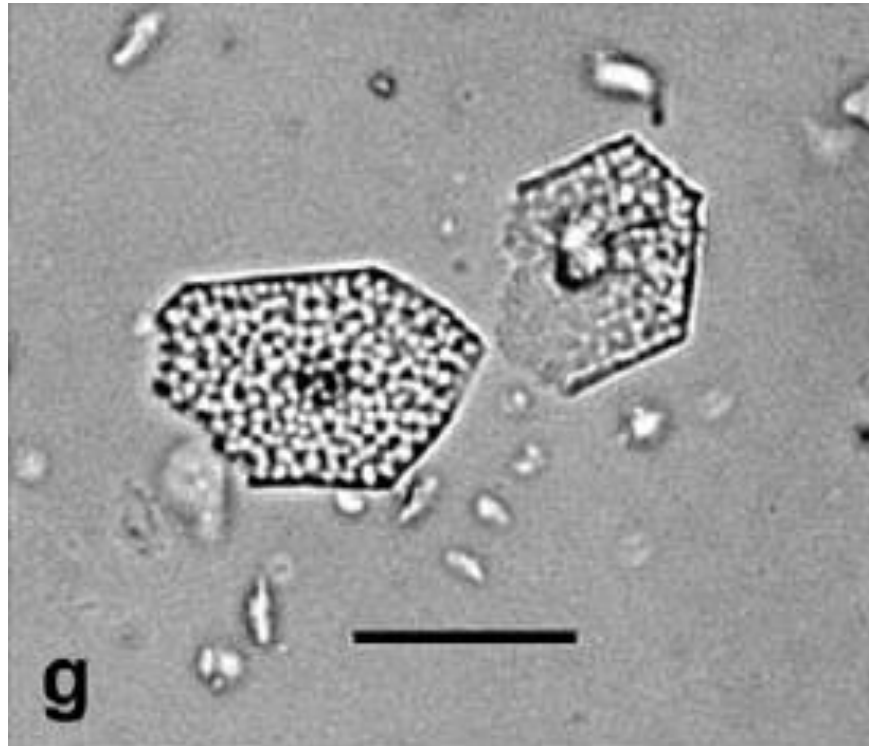
Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.



# Cyperus articulatus

## Phytolith

Fig. 3. Phytoliths from non-grass monocots. g) Polygonal cone from *Cyperus articulatus* achene

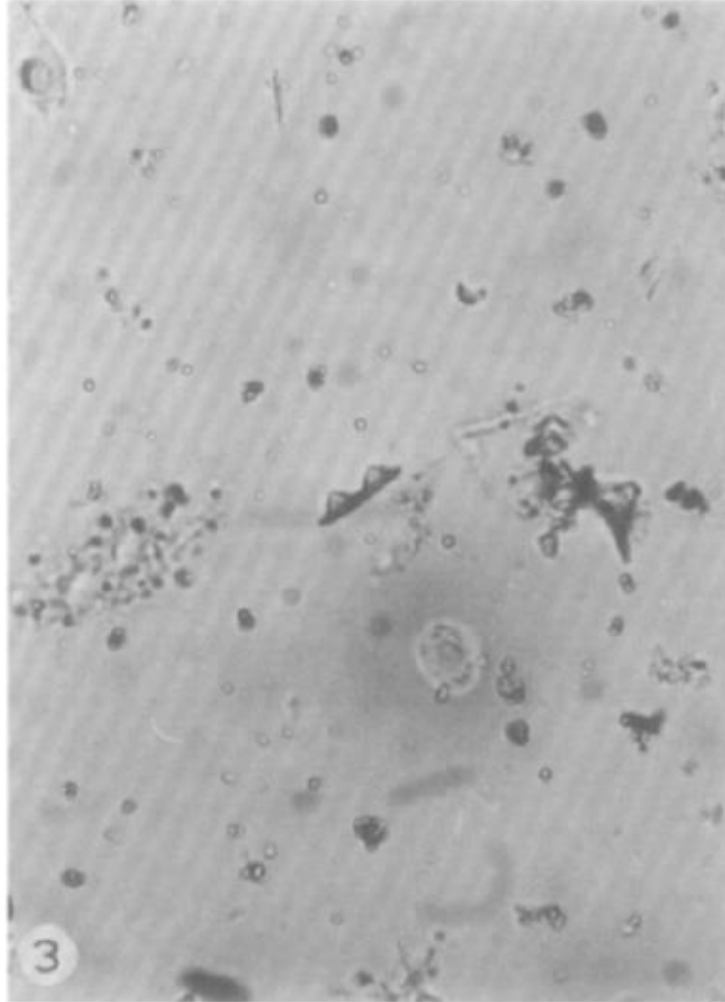


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Cyperus chorizanthus

## Phytolith

3. Conical-shaped phytoliths from *Cyperus chorizanthus* (400×).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Cyperus esculentus

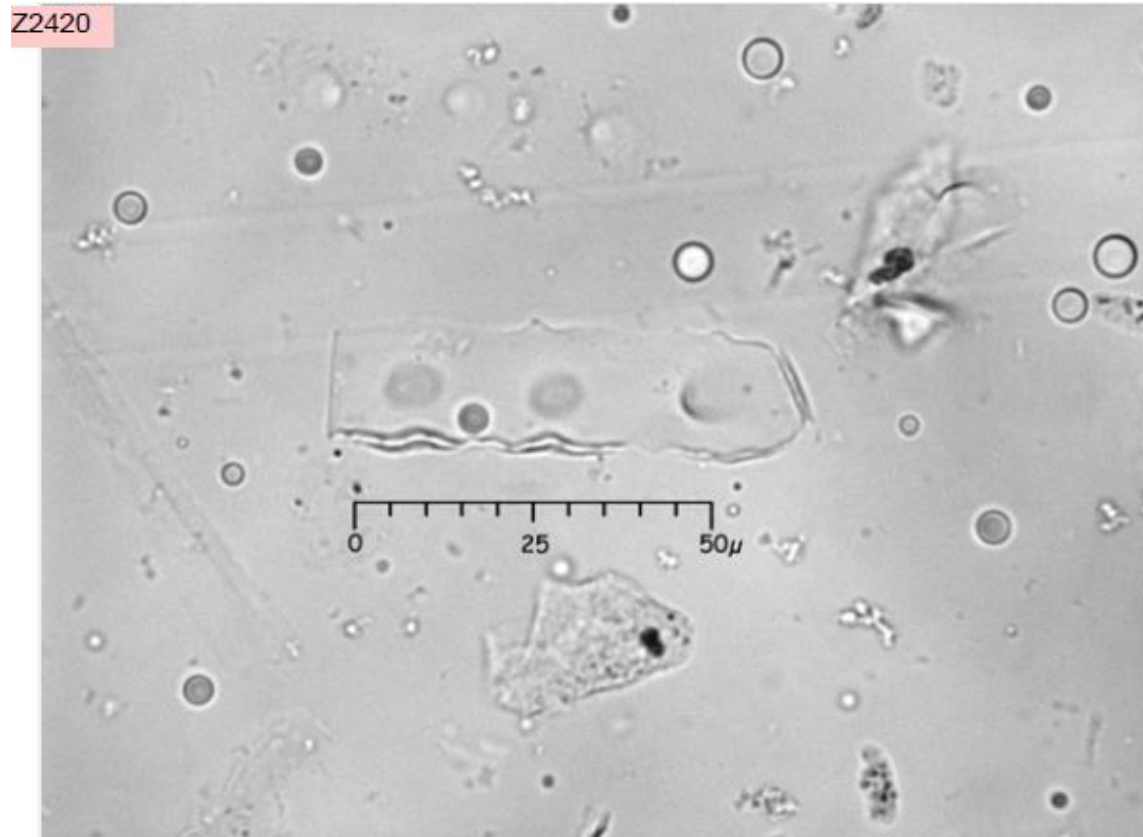
## Phytolith

PC628, leaf

Often occur in lines or ranks. Often conical in top view, but non-quadrilateral in side view.

In side view, conical projections with “shoulders”.

Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus esculentus

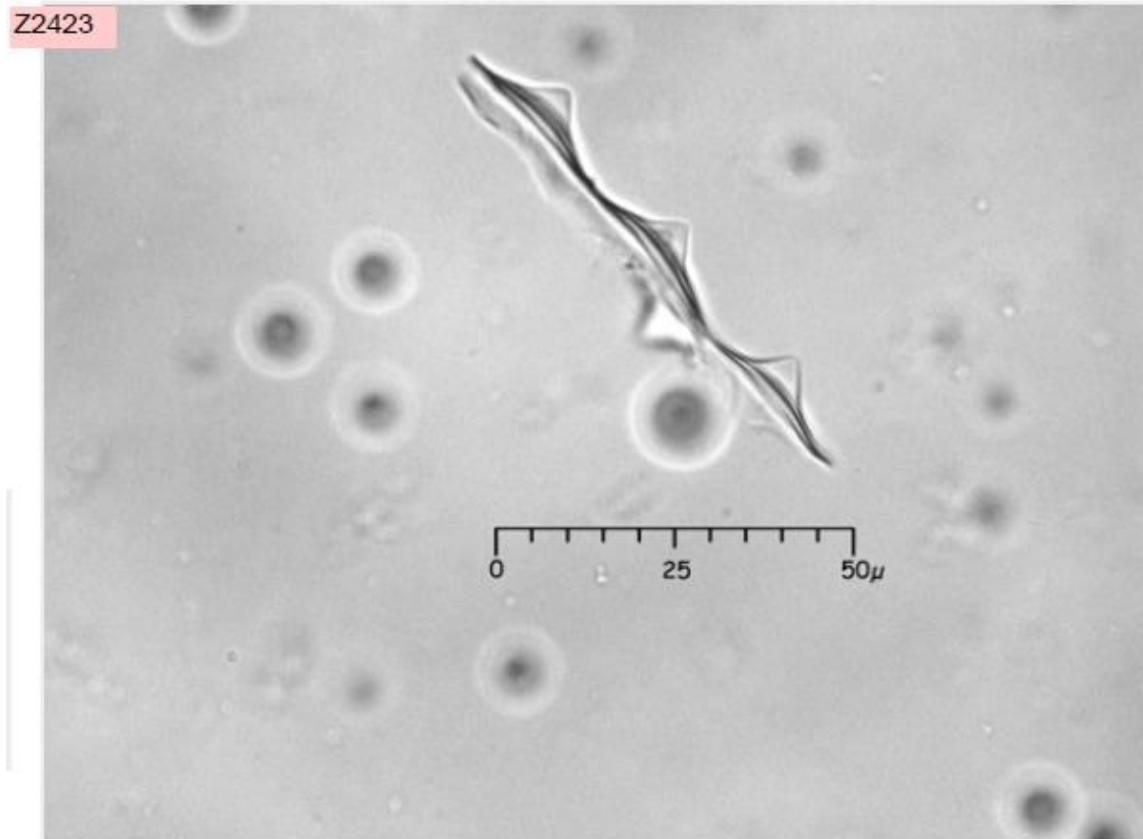
## Phytolith

PC628, leaf

Often occur in lines or ranks. Often conical in top view, but non-quadrilateral in side view.

In side view, conical projections with "shoulders".

Diagnostic level: family

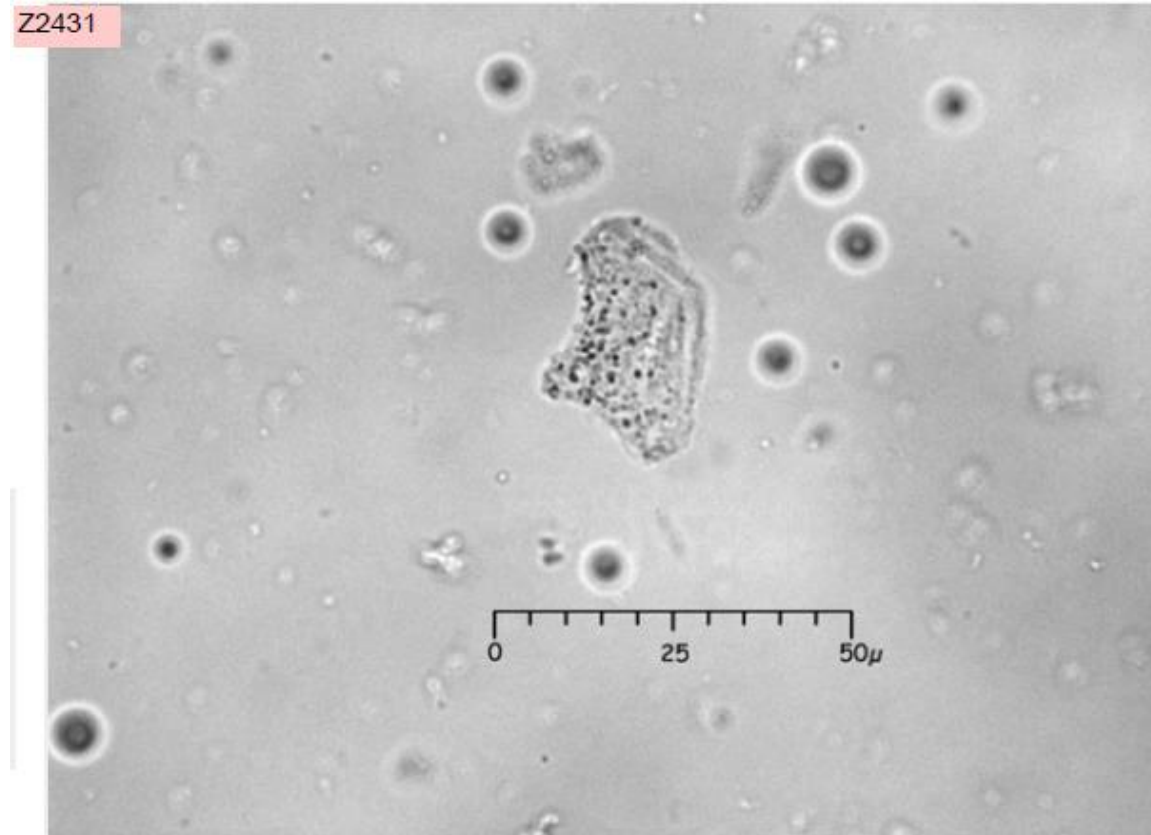


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus esculentus

## Phytolith

PC629 inflorescence  
Some examples have edge  
projections Diagnostic level: under  
study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus esculentus

## Phytolith

PC629 inflorescence  
Some examples have edge  
projections This photo shows a side  
view  
Diagnostic level: under study

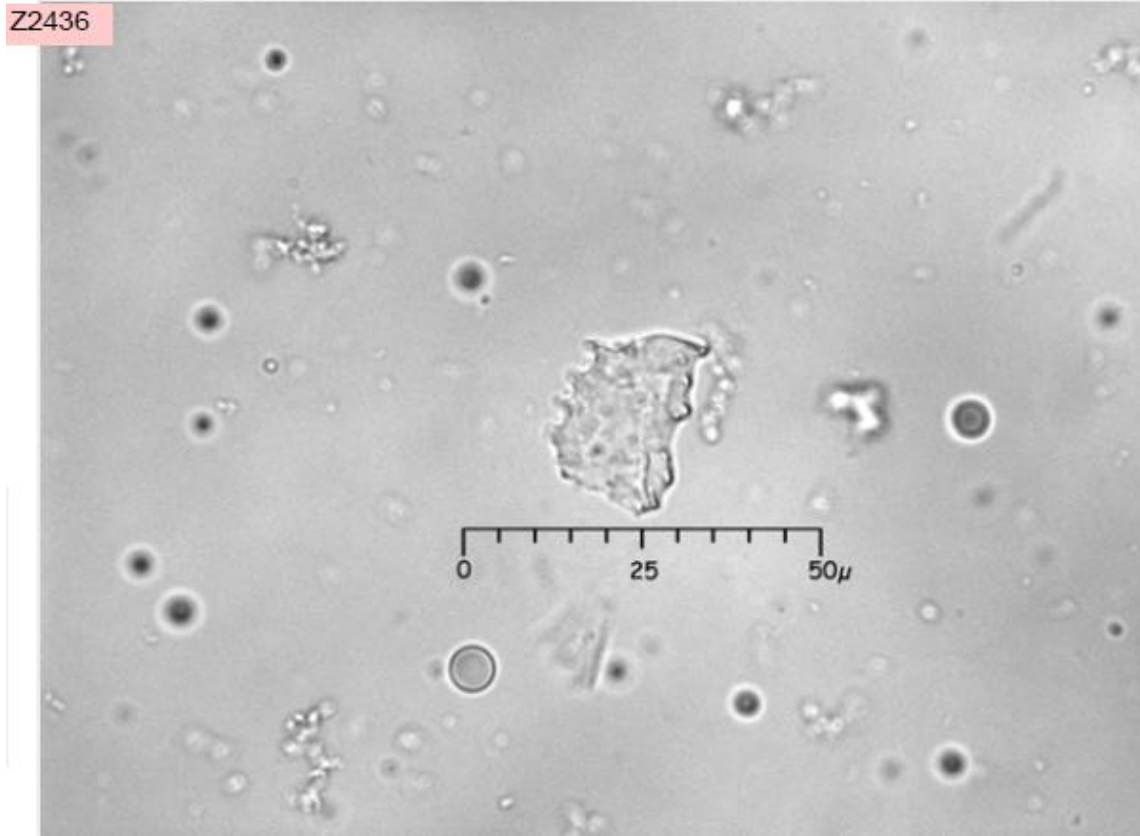


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus esculentus

## Phytolith

PC629 inflorescence  
Some examples have edge  
projections This photo shows edge  
projections.  
Diagnostic level: under study

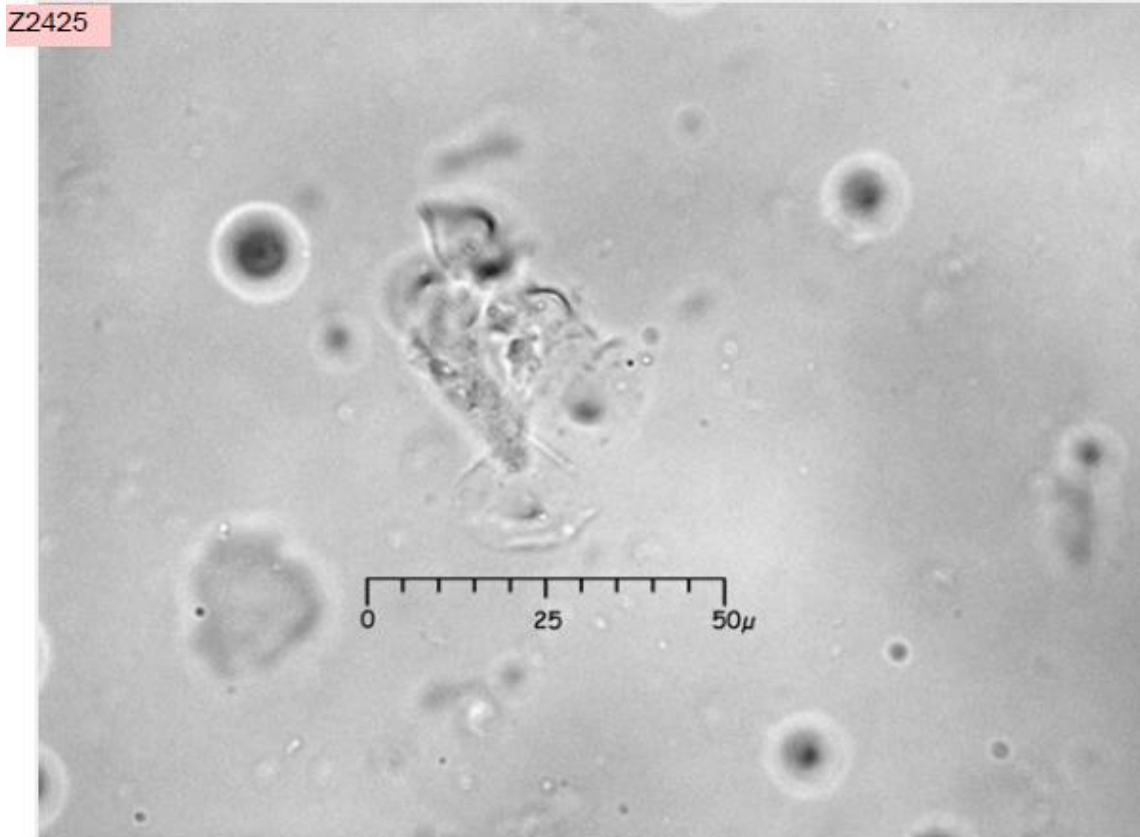


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus esculentus

## Phytolith

PC629 inflorescence Diagnostic level:  
under study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Cyperus esculentus

## Phytolith

PC629 inflorescence

This example (viewed from the bottom) has edge decoration/projections

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus esculentus

## Phytolith

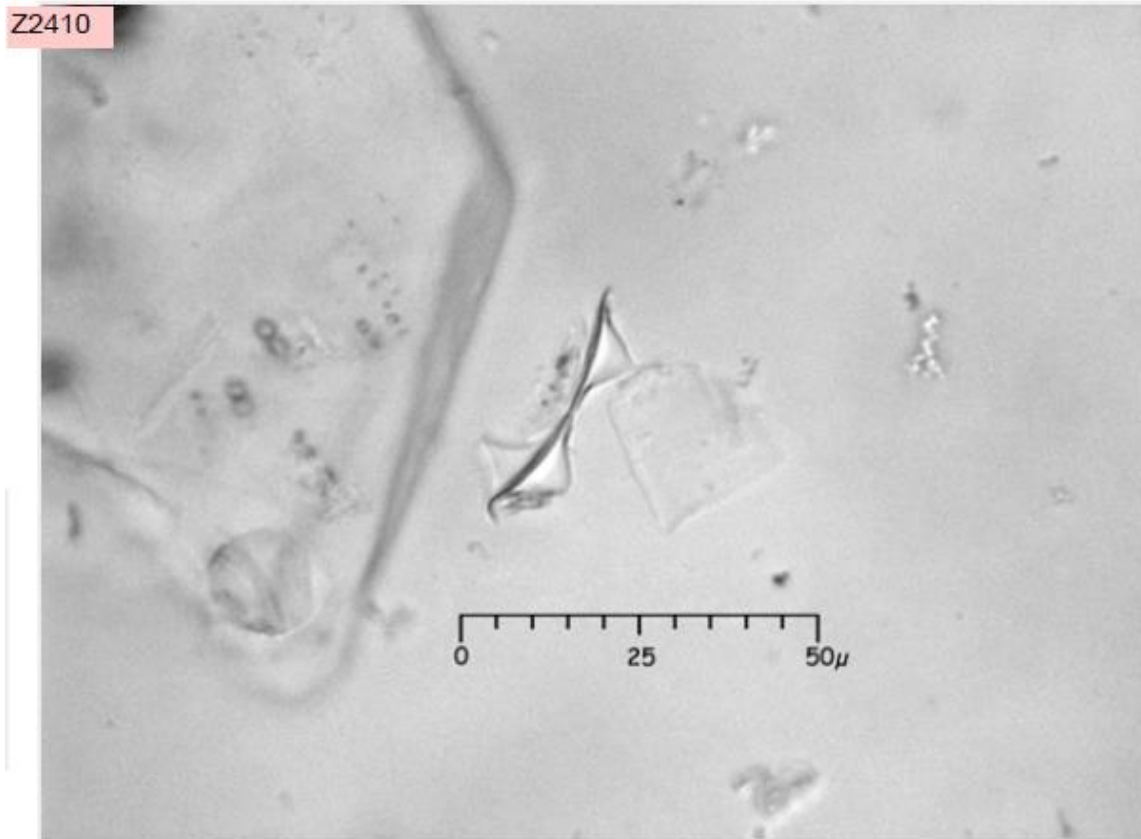
PC626, leaf

Often occur in lines or ranks.

Often conical in top view, but non-quadrilateral in side view.

In side view, conical projections with “shoulders”.

Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus esculentus

## Phytolith

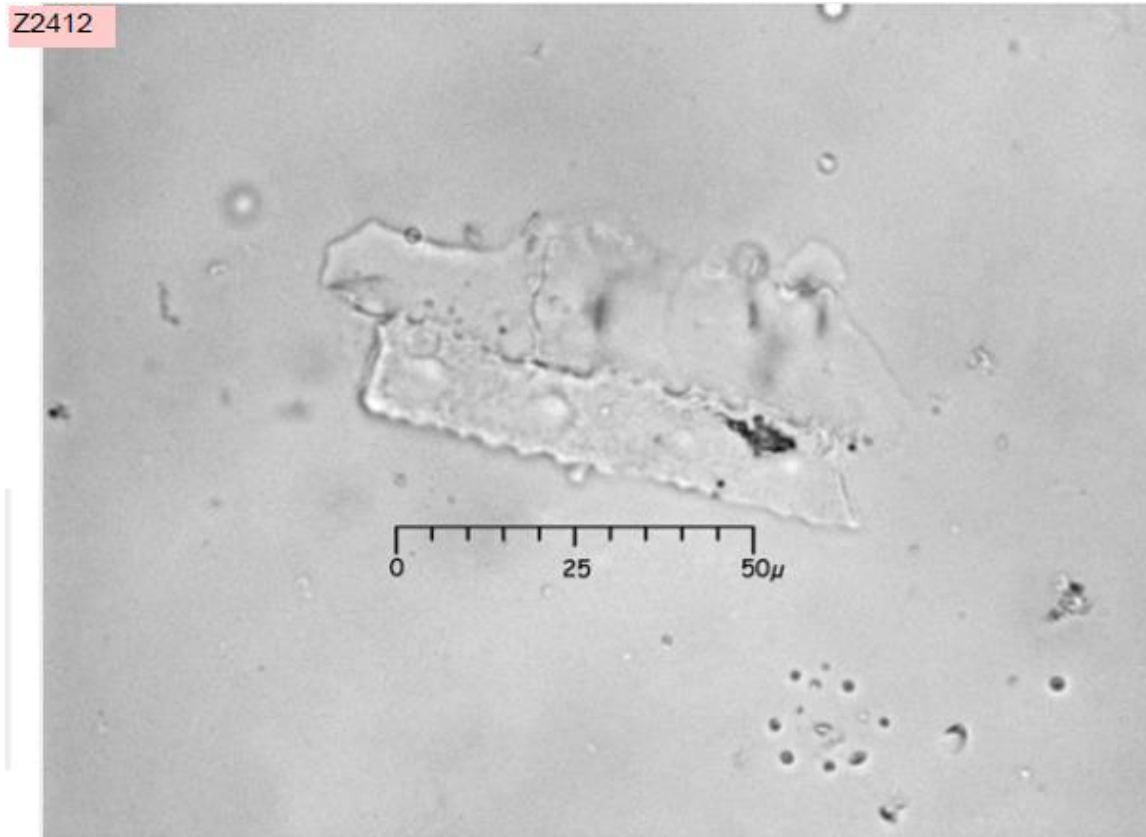
PC626, leaf

Often occur in lines or ranks.

Often conical in top view, but non-quadrilateral in side view.

In side view, conical projections with "shoulders".

Diagnostic level: family

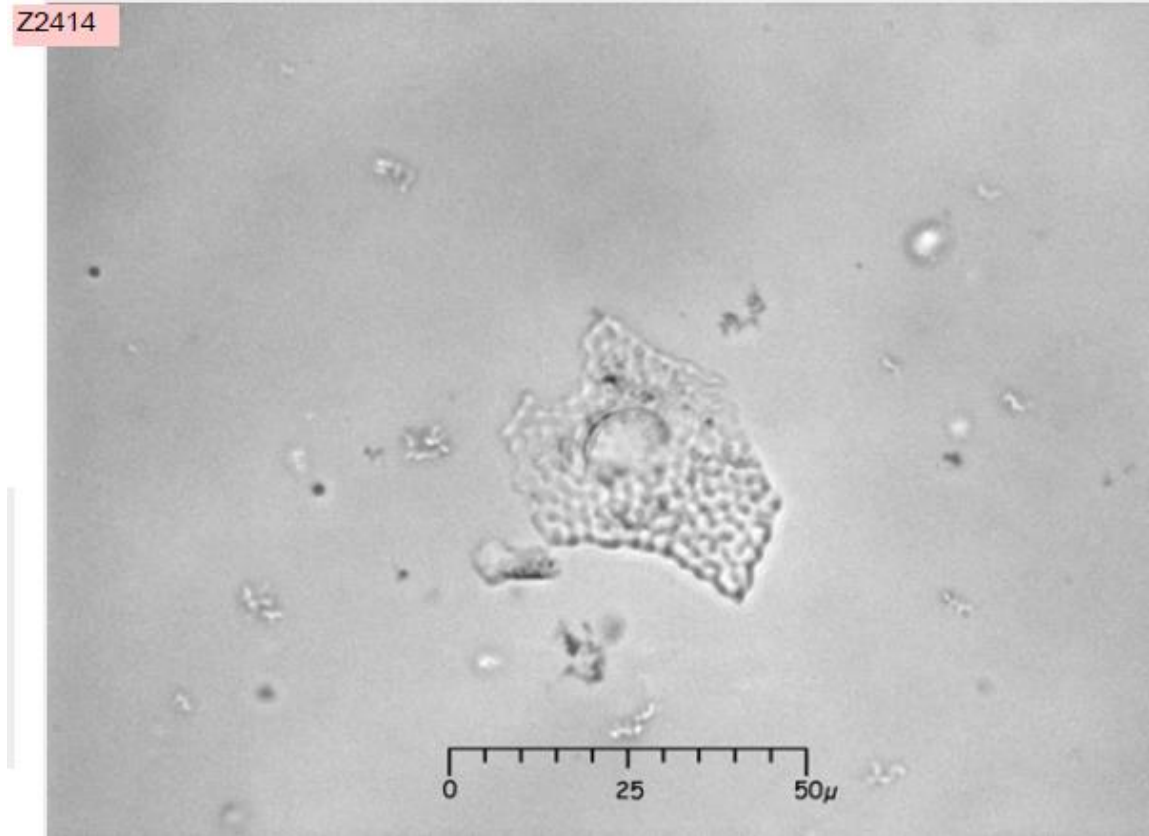


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus esculentus

## Phytolith

PC627 inflorescence  
Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus esculentus

## Phytolith

PC627 inflorescence  
Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus esculentus

## Phytolith

PC627 inflorescence  
Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus hermaphroditus

## Phytolith

PC2996 leaf

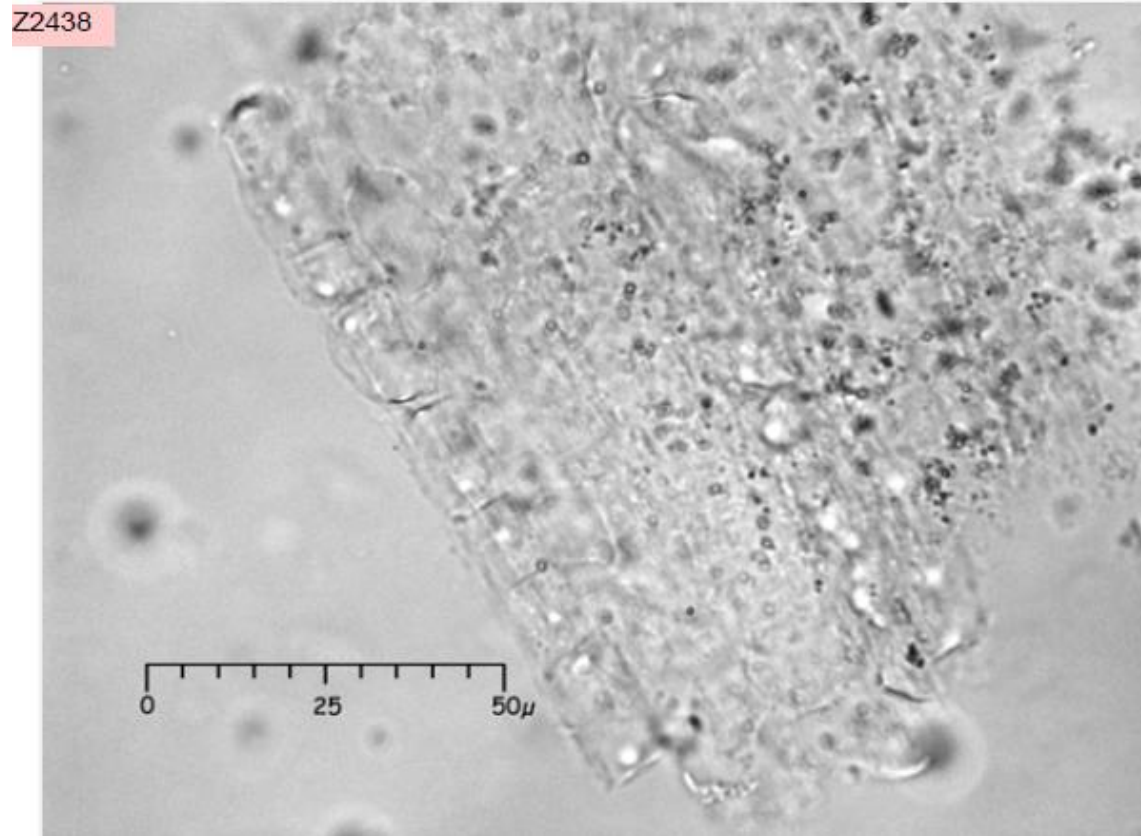
Epidermal sheet with 20VA in situ

Often occur in lines or ranks.

Often conical in top view, but non-quadrilateral in side view.

In side view, conical projections with "shoulders".

Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus hermaphroditus

## Phytolith

PC2996 leaf

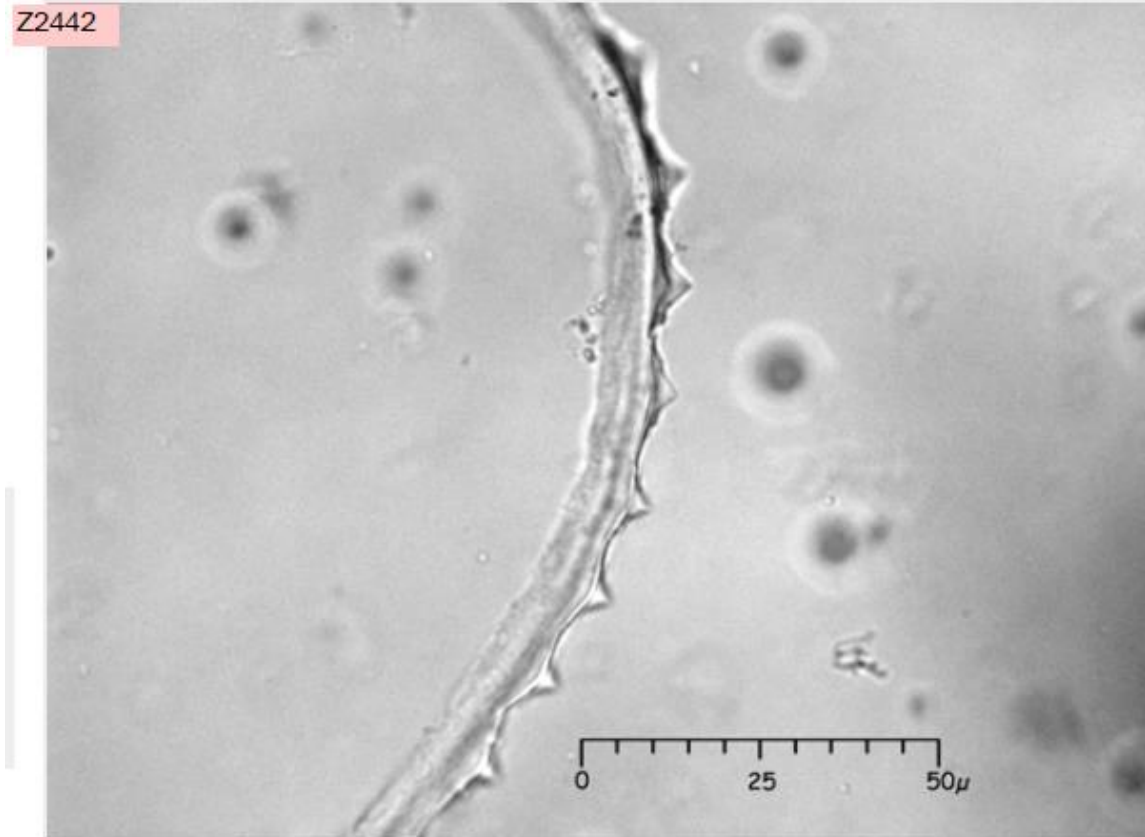
Side view of group of 20VA

Often occur in lines or ranks.

Often conical in top view, but non-quadrilateral in side view.

In side view, conical projections with "shoulders".

Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Cyperus hermaphroditus

## Phytolith

PC2997

This variant has flat-topped rather than conical projections. Both flat and conical are present in the specimen; flat tend to occur in epidermal sheets

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

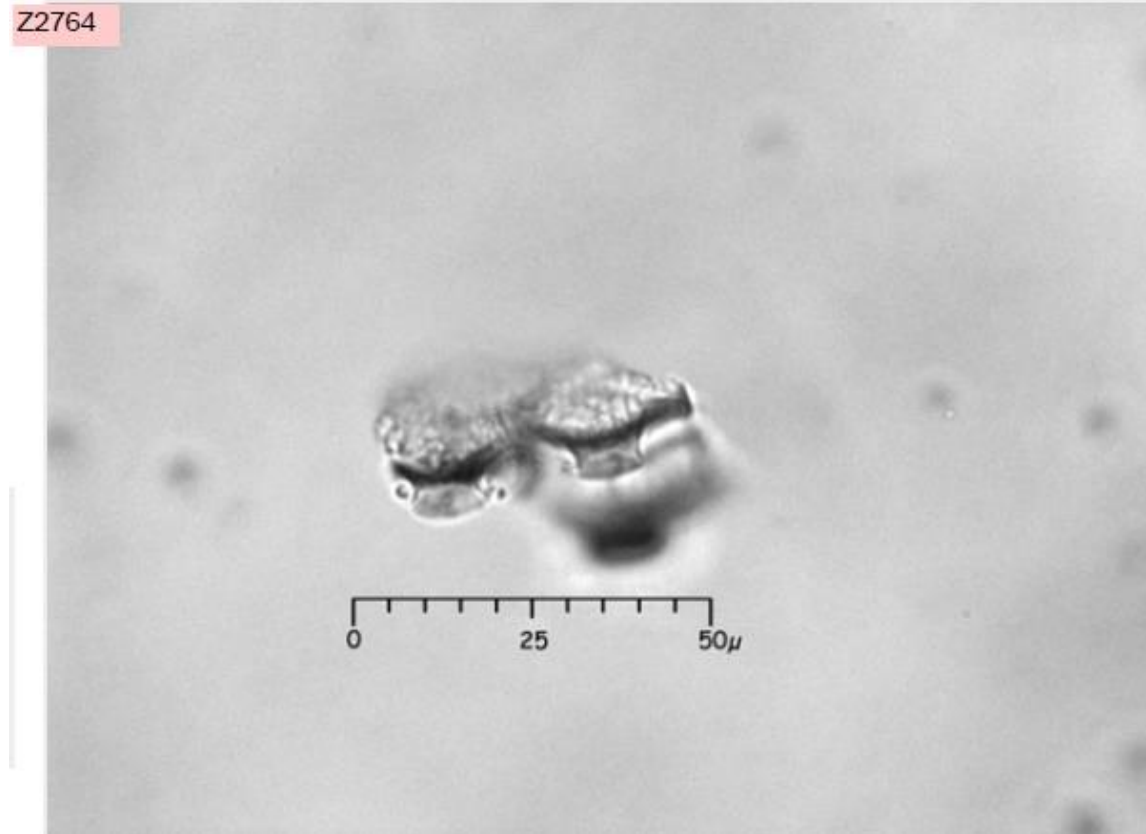
# Cyperus hermaphroditus

## Phytolith

PC2997

This variant has flat-topped rather than conical projections. Both flat and conical are present in the specimen; flat tend to occur in epidermal sheets

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

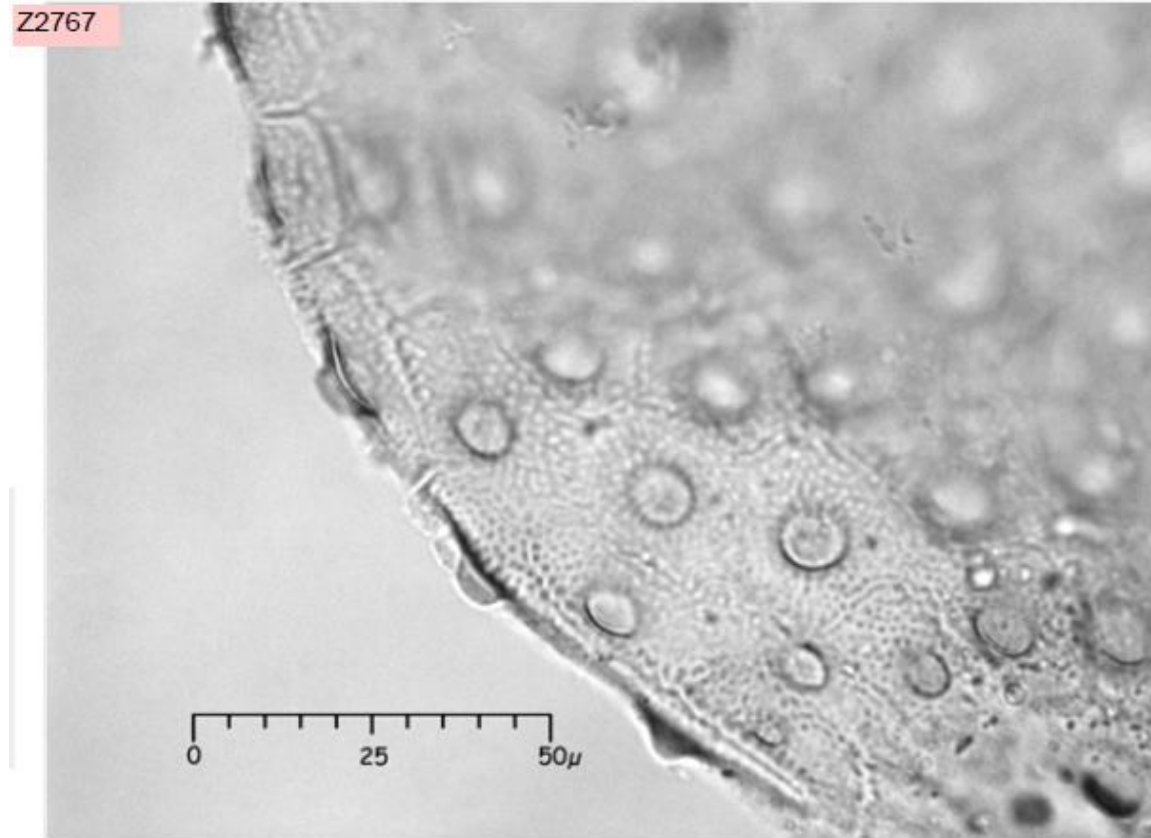
# Cyperus hermaphroditus

## Phytolith

PC2997

This variant has flat-topped rather than conical projections. Both flat and conical are present in the specimen; flat tend to occur in epidermal sheets

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus hermaphroditus

## Phytolith

PC2996, leaf  
double-outline trichome  
Not diagnostic

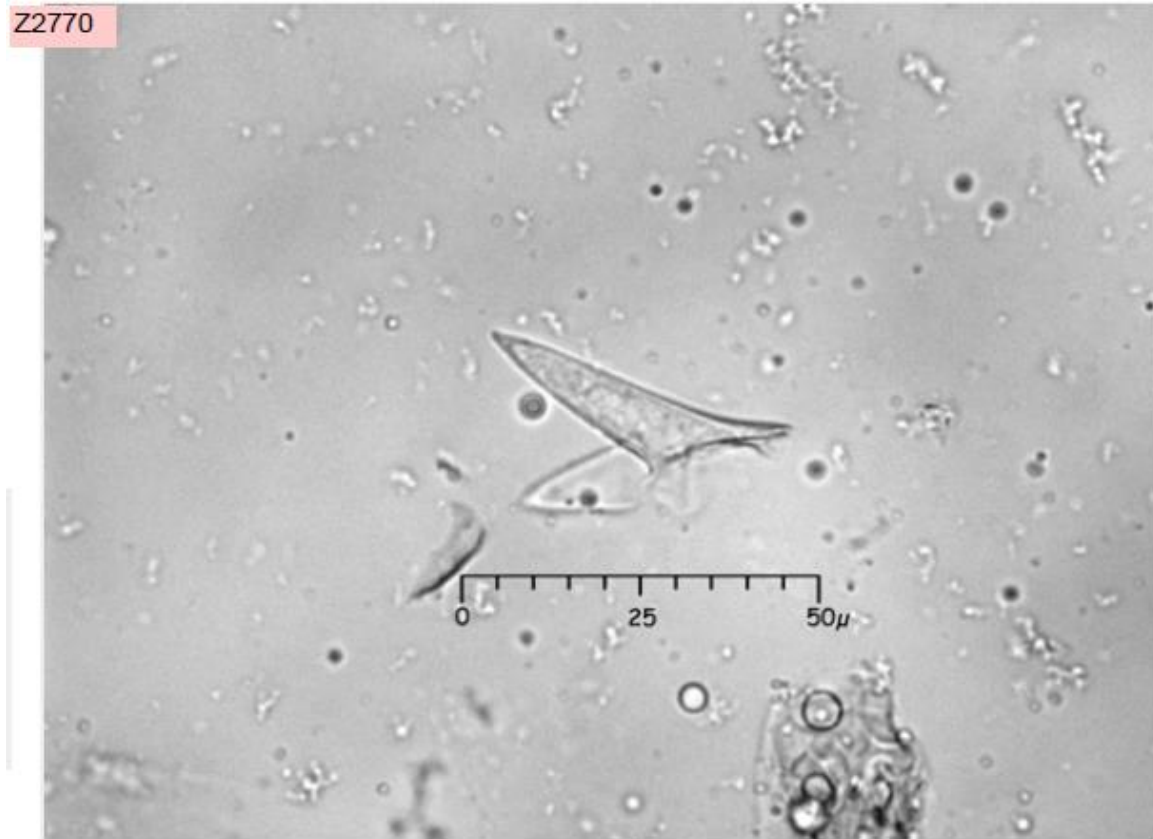


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus hermaphroditus

## Phytolith

PC2997, inflorescence  
double-outline trichome  
Not diagnostic



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Cyperus/Kyllinga sp.

## Phytolith

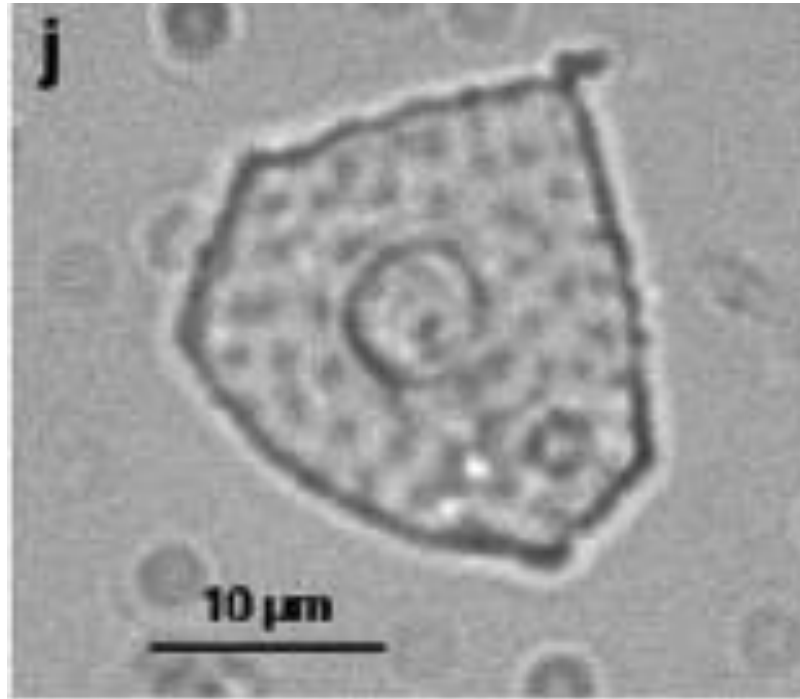


Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. j) *Cyperus/Kyllinga* achene body (BD M1, 10-20 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Cyperus/Kyllinga sp.

Phytolith

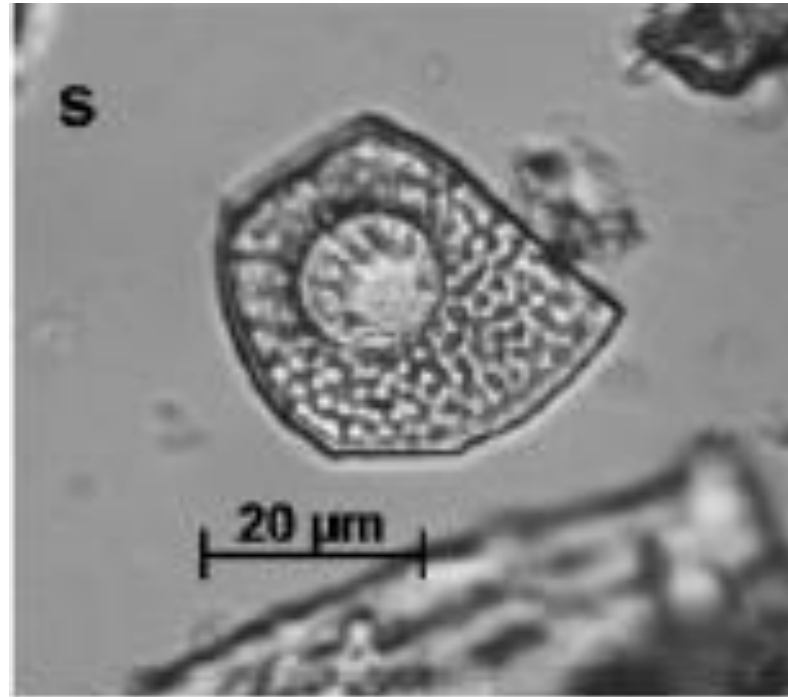


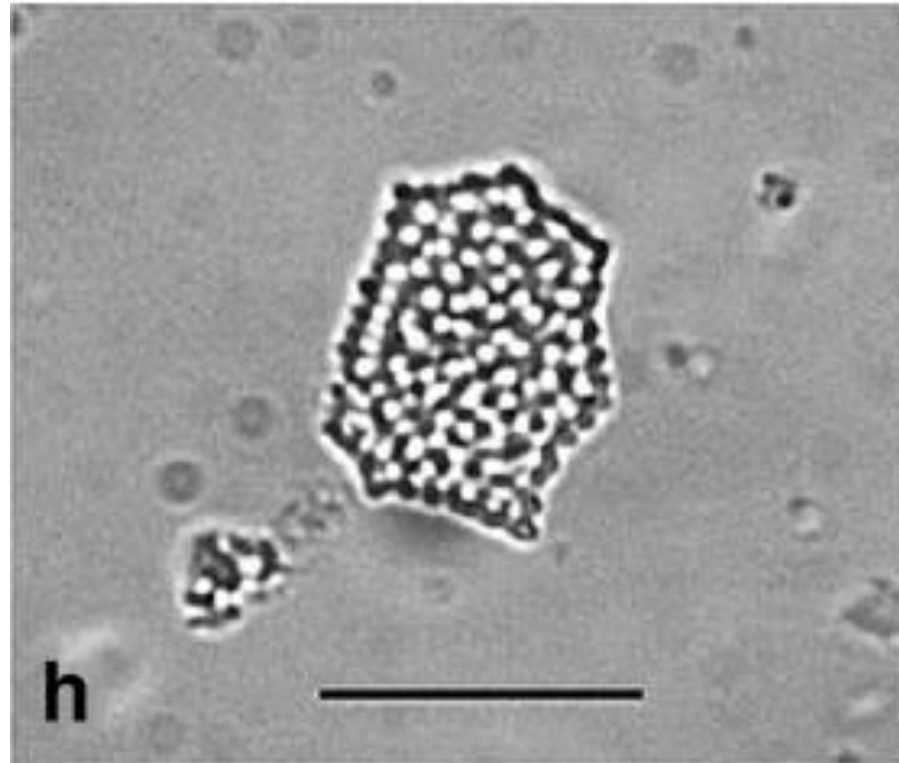
Fig. 5. Selected microbotanical remains. Phytoliths: s) Cyperus/Kyllinga achene (Sed. Sample 3)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Kyllinga brevifolia

## Phytolith

Fig. 3. Phytoliths from non-grass monocots. h) Polygonal cone from *Kyllinga brevifolia* achene



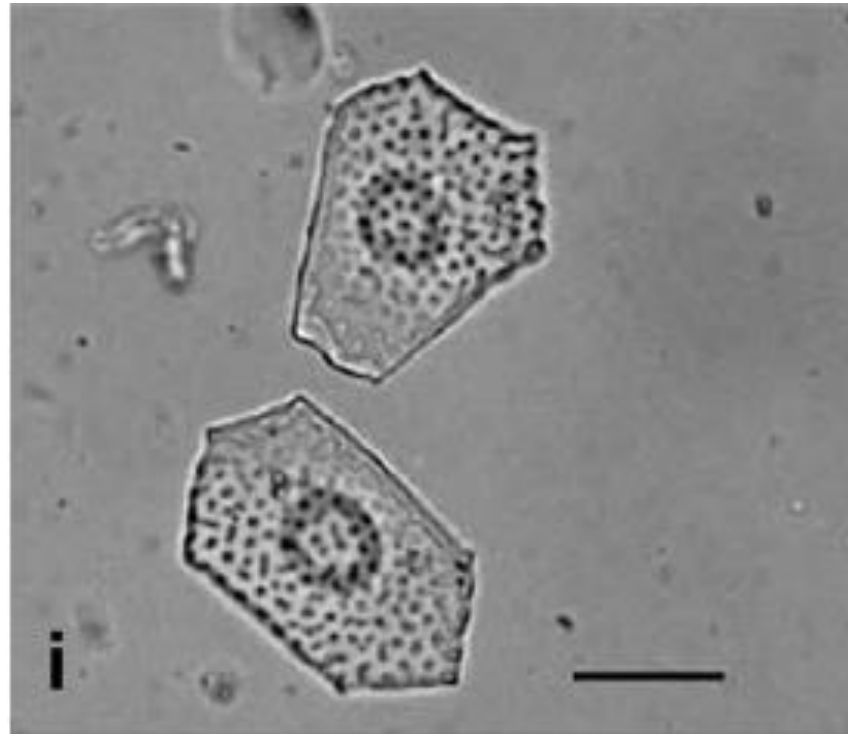
Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.



# Remirea maritima

## Phytolith

Fig. 3. Phytoliths from non-grass monocots. i) Polygonal cone from *Remirea maritima* achene

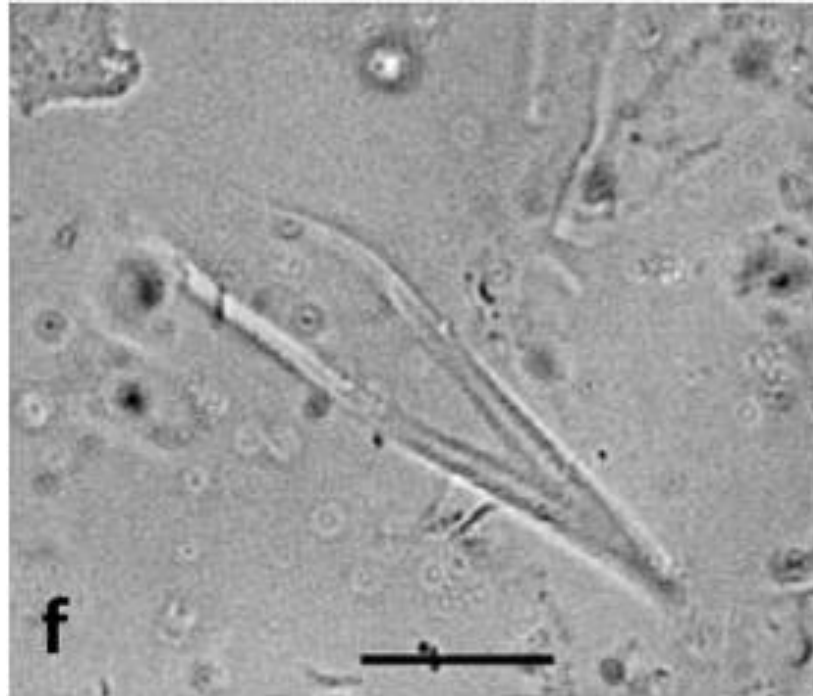


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Rhynchospora gigantea

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. f) Trichome from *Rhynchospora gigantea* inflo

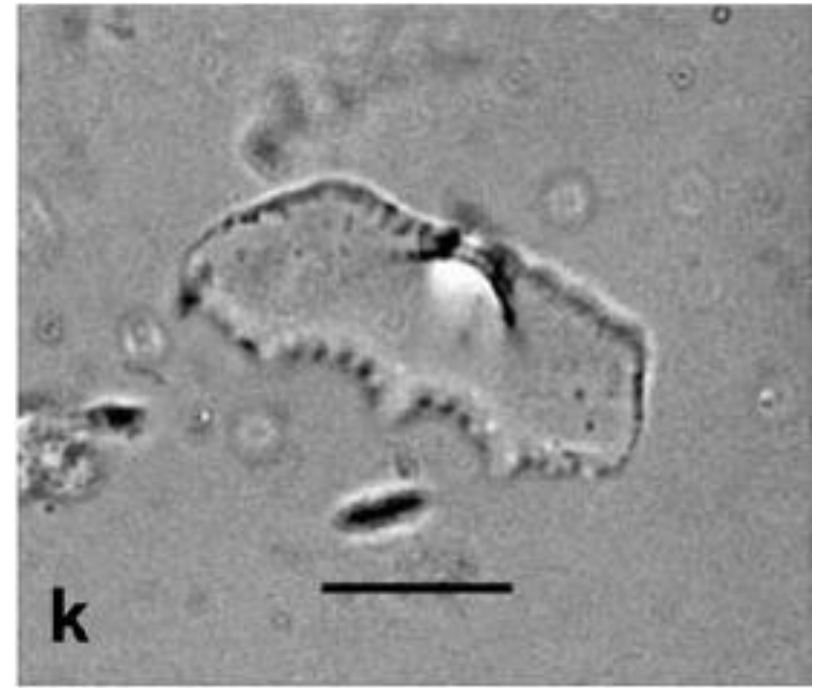


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Rhynchospora gigantea

## Phytolith

Fig. 3. Phytoliths from non-grass monocots. f) Cones from *Rhynchospora gigantea* inflo, k) Polygonal cone from *R. gigantea* achene



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Scirpus sp.

## Phytolith

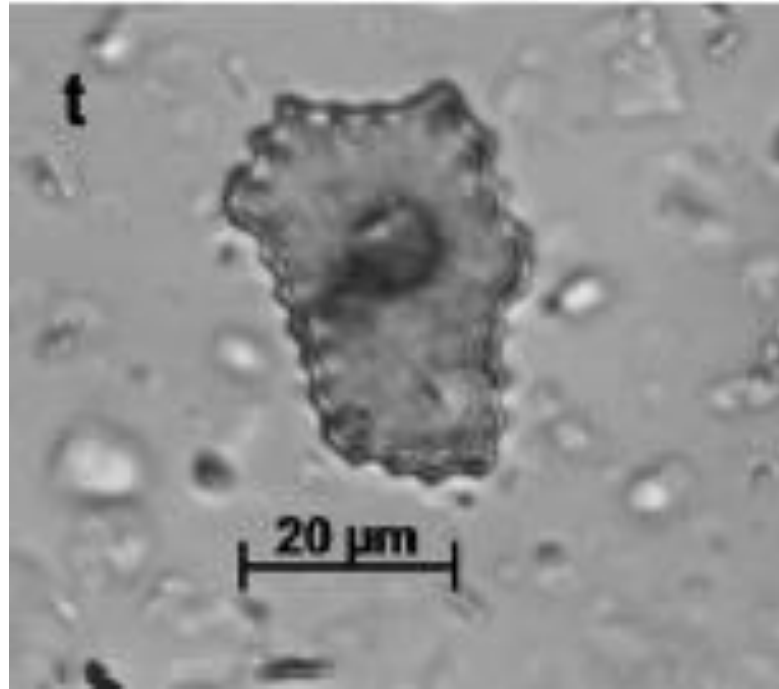


Fig. 5. Selected microbotanical remains. Phytoliths: t) *Scirpus achene* (LM 99-1864).

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

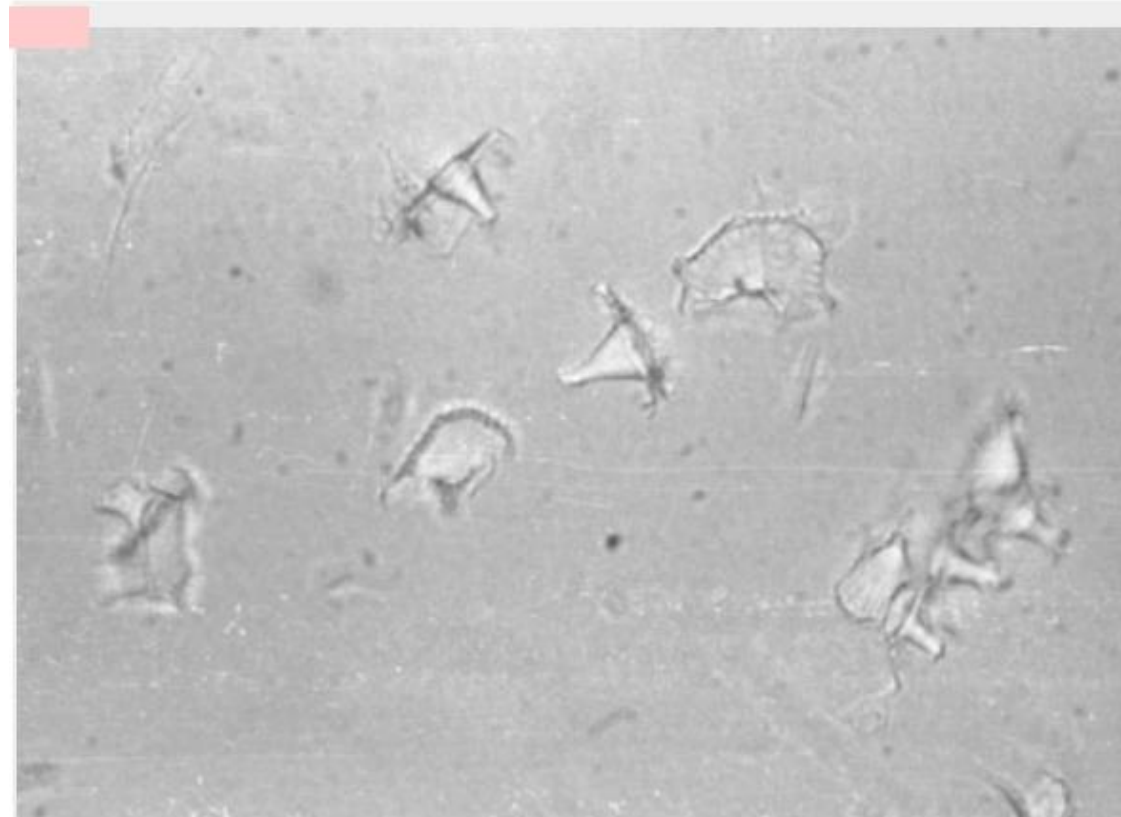
# Scirpus sp.

## Phytolith

Epidermal seed phytolith

The genus *Scirpus* is distinct for its very tall conical projection and tall, pointed “sombbrero” appearance.

Diagnostic level: genus

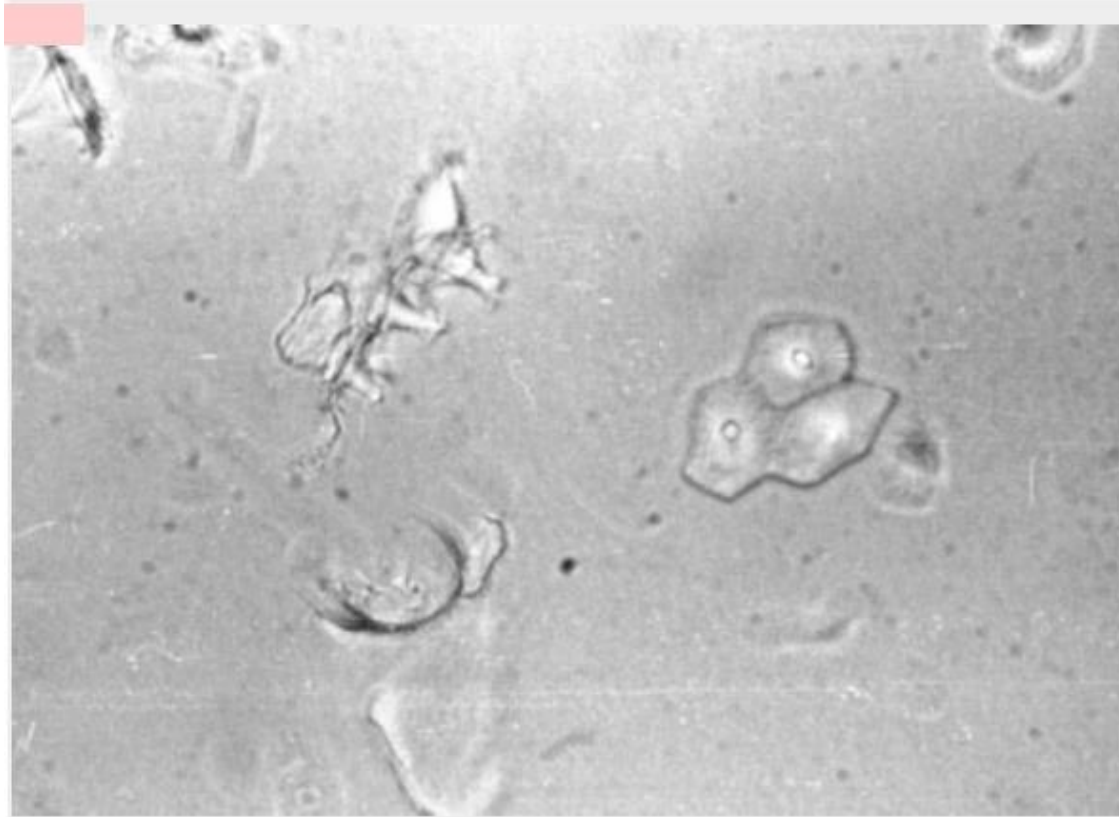


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Scirpus sp.

## Phytolith

The genus *Scirpus* is distinct for its very tall conical projection and tall, pointed “sombbrero” appearance. Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Scirpus-type sp.

## Phytolith



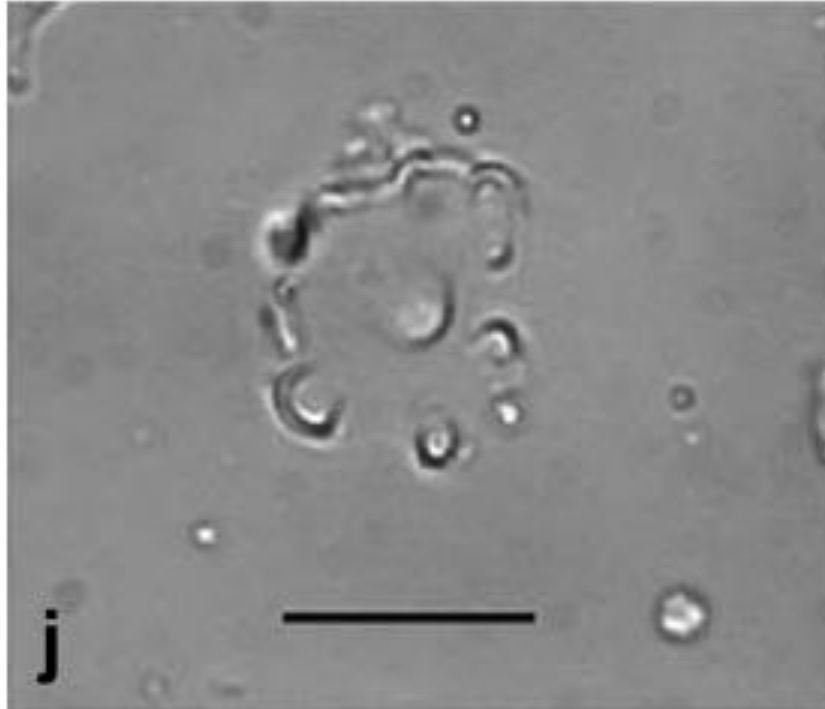
Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. k) Scirpus-type achene body (BD M1, 0-10 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Scirpus asper

## Phytolith

Fig. 3. Phytoliths from non-grass monocots. j) Polygonal cone from *Scirpus asper* achene



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.



# Scirpus totora

## Phytolith

PC644 leaf

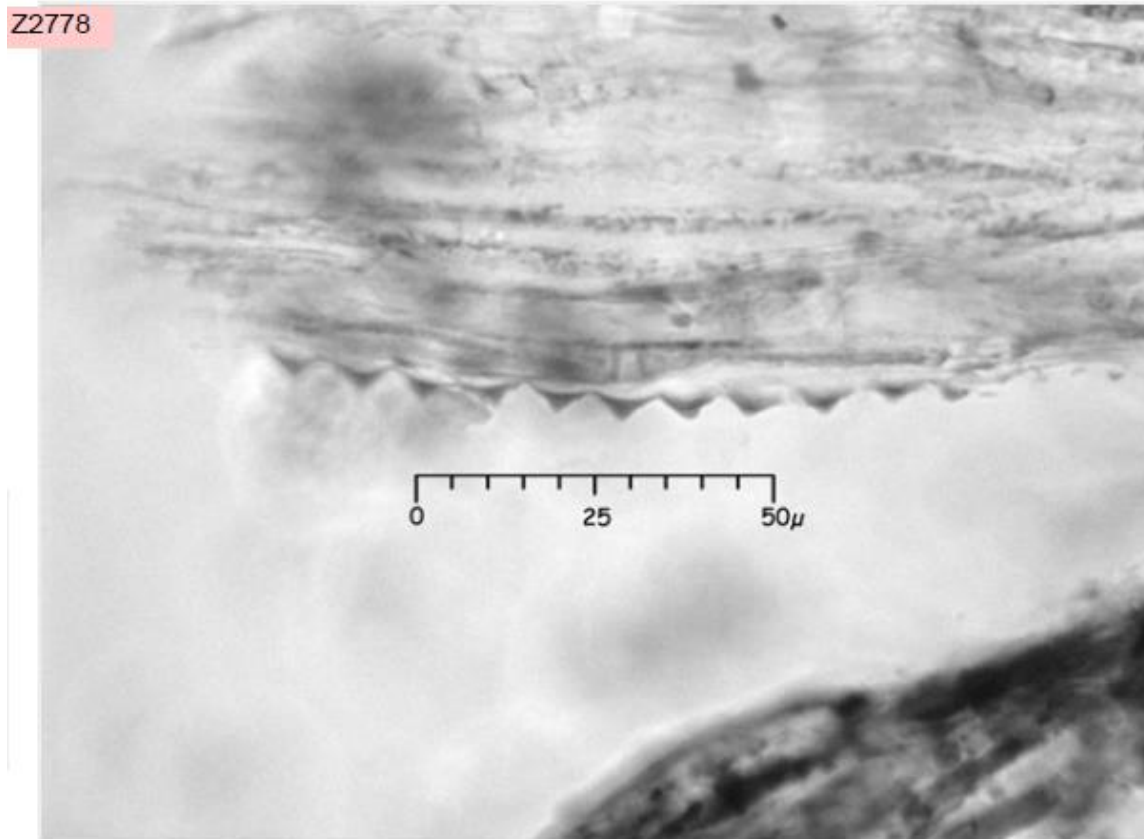
Epidermal sheet with 20VA in situ

Often occur in lines or ranks.

Often conical in top view, but non-quadrilateral in side view.

In side view, conical projections with "shoulders".

Diagnostic level: family

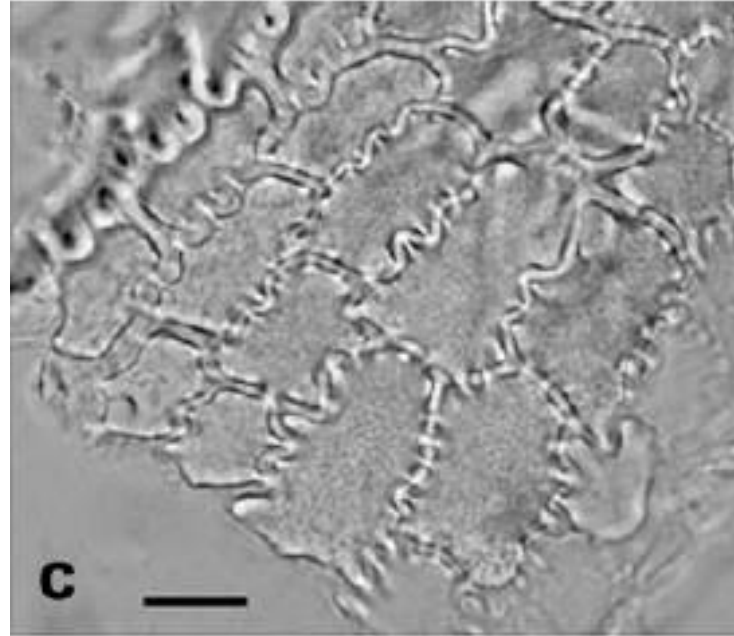


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Scleria eggersiana

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. c) Anticlinal epidermis from *Scleria eggersiana* inflo

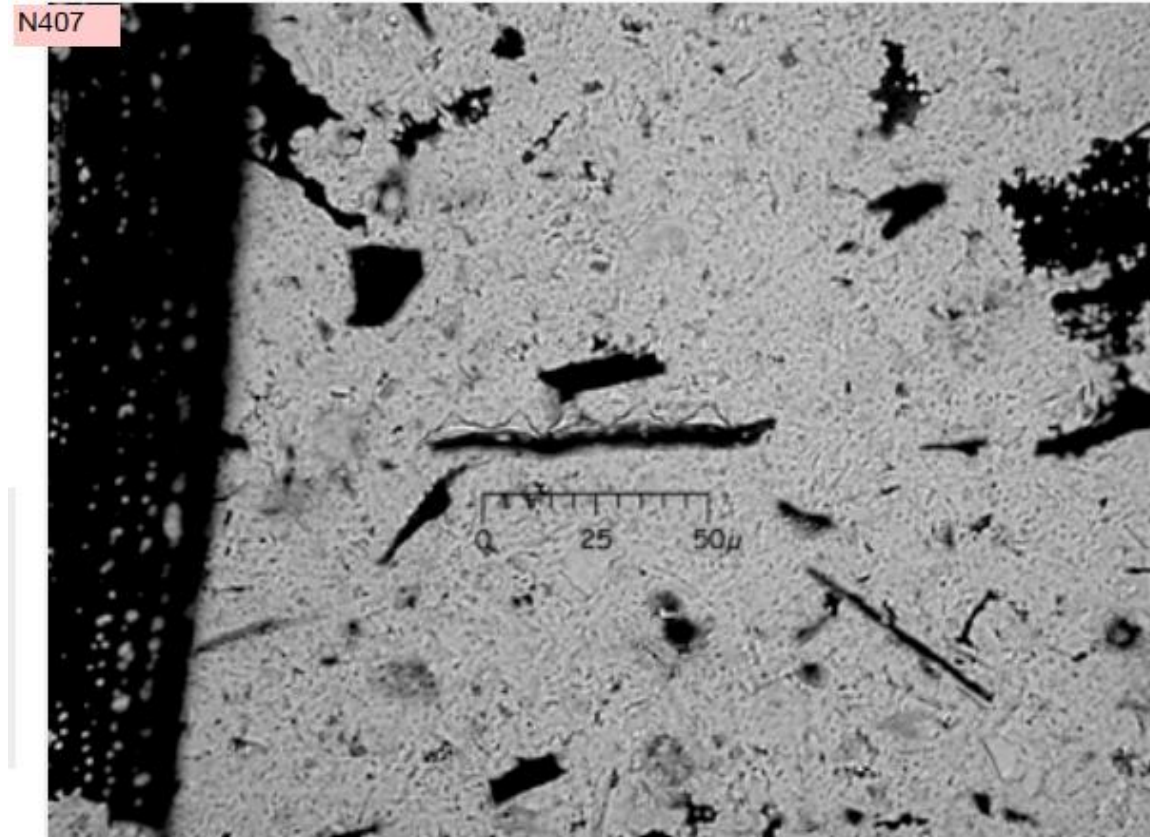


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Torulium odoratum

## Phytolith

Often occur in lines or ranks.  
Often conical in top view, but non-  
quadrilateral in side view.  
In side view, conical projections with  
“shoulders”.  
Diagnostic level: family

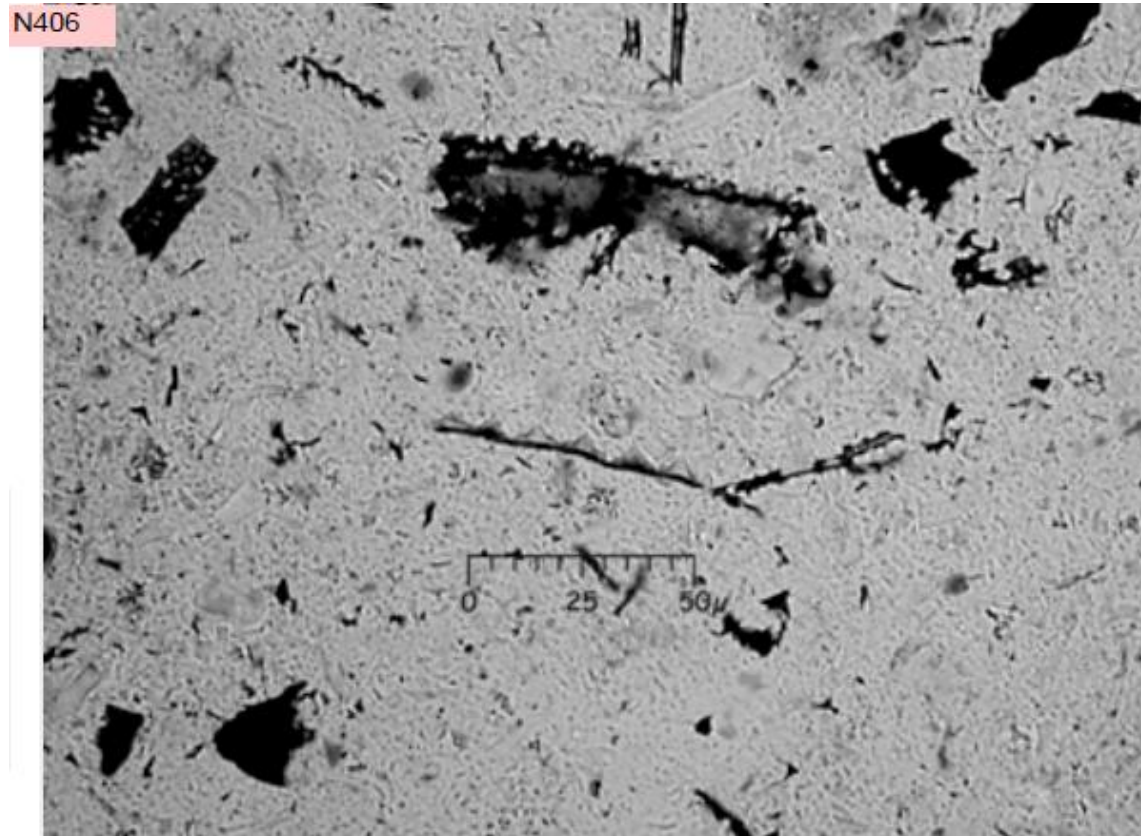


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Torulium odoratum

## Phytolith

Often occur in lines or ranks.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

DASYPOGONACEAE

# Dasypogon bromeliifolius

## Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. J. *Dasypogon bromeliifolius* (Dasypogonaceae), epidermal silica sand (bar = 20  $\mu\text{m}$ ).



Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Kingia australis

## Phytolith

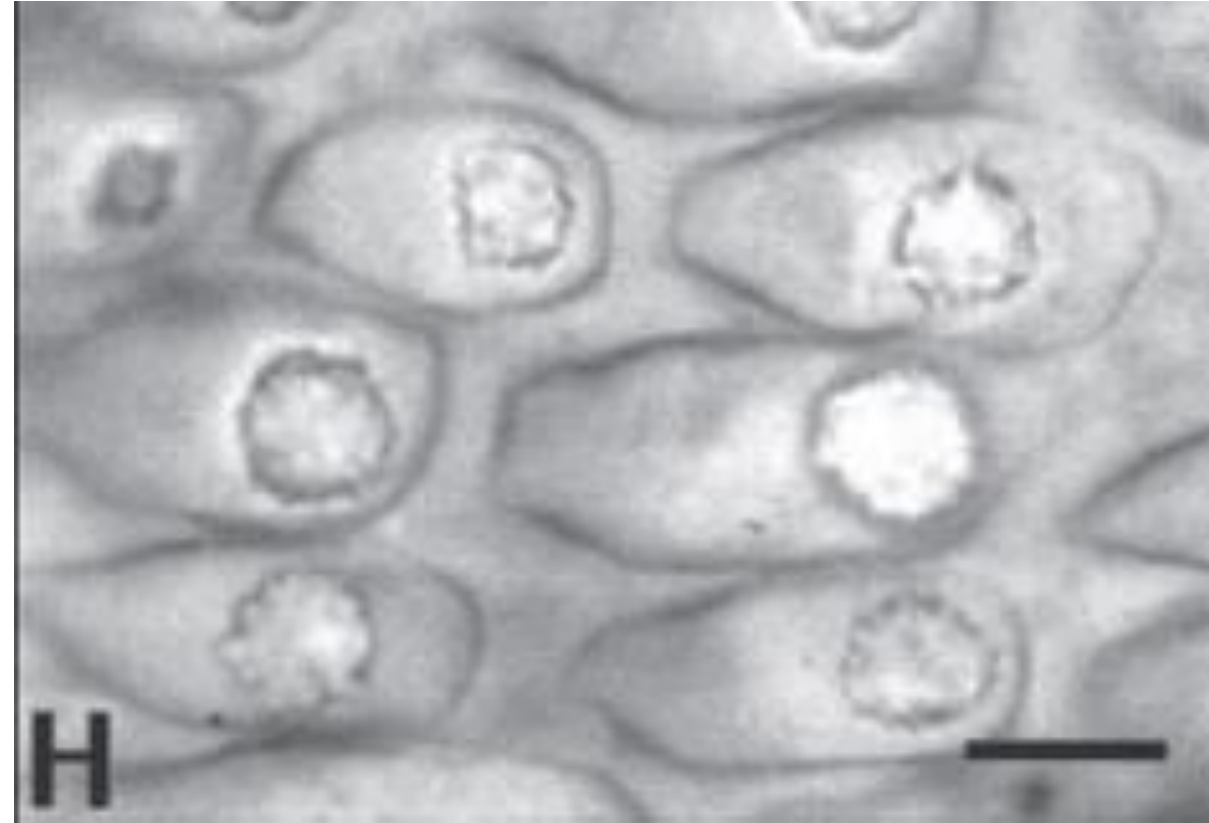


Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. H. *Kingia australis* (Dasypogonaceae), spherical silica bodies with a rugose surface in epidermal cells (bar = 10  $\mu\text{m}$ ).

Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

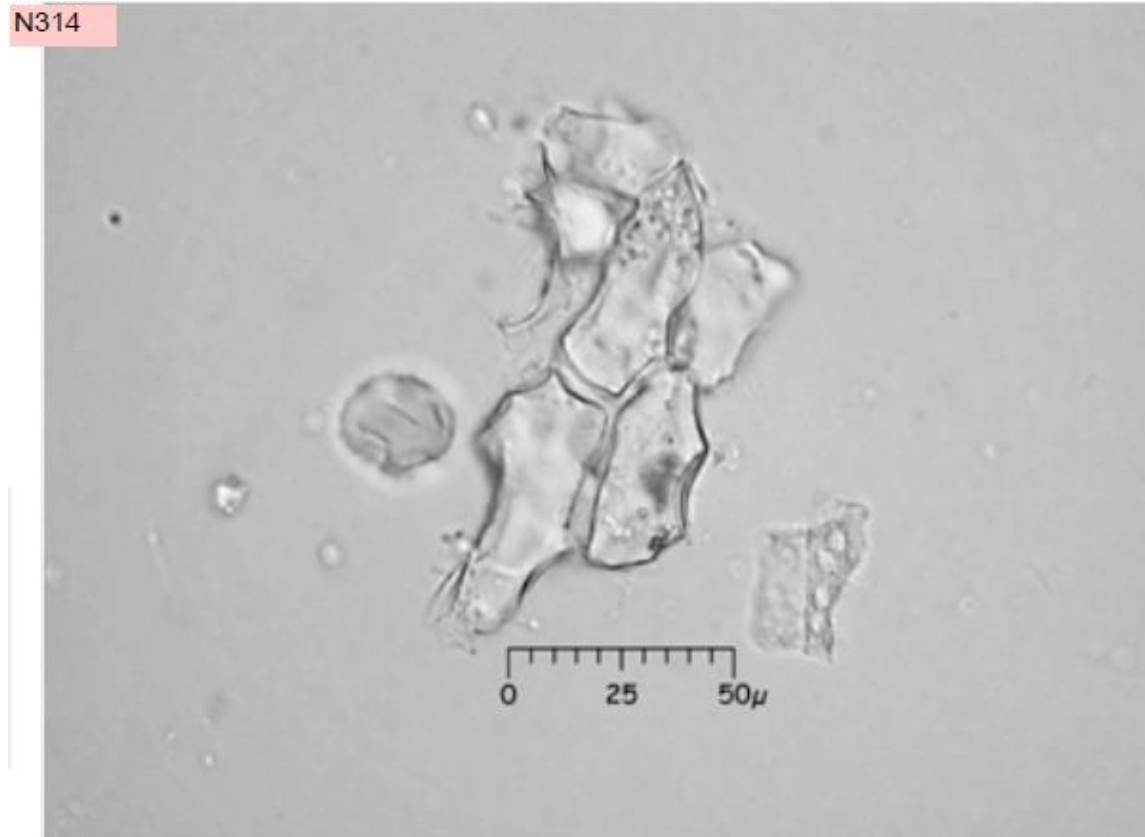
DICHAPETALACEAE



# Stephanopodium longipedicellatum

## Phytolith

Very variable in appearance,  
recognizable by the twisted appearance  
with smooth concave curves next to  
angular plate junctions.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stephanopodium longipedicellatum

## Phytolith

Dichapetalaceae family diagnostic type.  
Surfaces angled, platelike, yet curving.  
Dichapetalaceae type has 3 broad  
branches, surface grainy while other  
types have thin or pointed branches.  
Diagnostic level: family

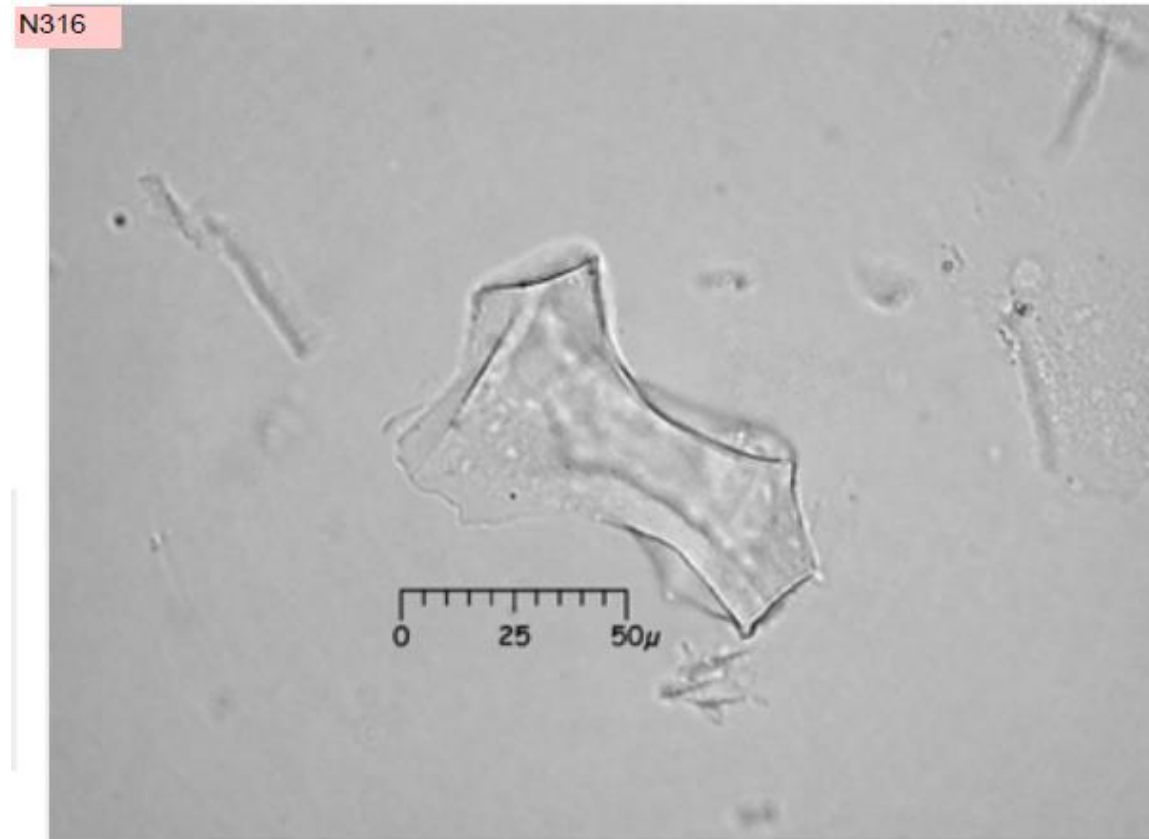


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stephanopodium longipedicellatum

## Phytolith

Dichapetalaceae family diagnostic type.  
Surfaces angled, platelike, yet curving.  
Dichapetalaceae type has 3 broad  
branches, surface grainy while other  
types have thin or pointed branches.  
Diagnostic level: family

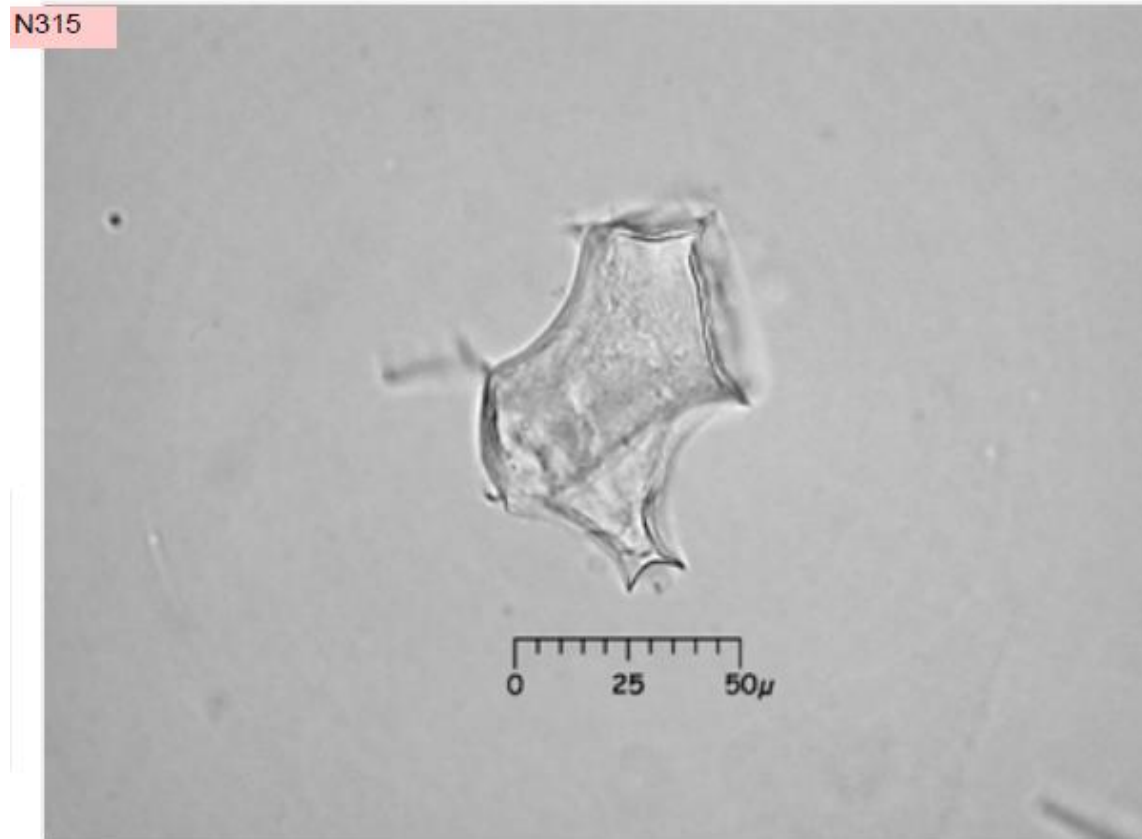


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stephanopodium peruvianum

## Phytolith

Very variable in appearance,  
recognizable by the twisted appearance  
with smooth concave curves next to  
angular plate junctions.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Tapura peruviana

## Phytolith

Very variable in appearance,  
recognizable by the twisted appearance  
with smooth concave curves next to  
angular plate junctions.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

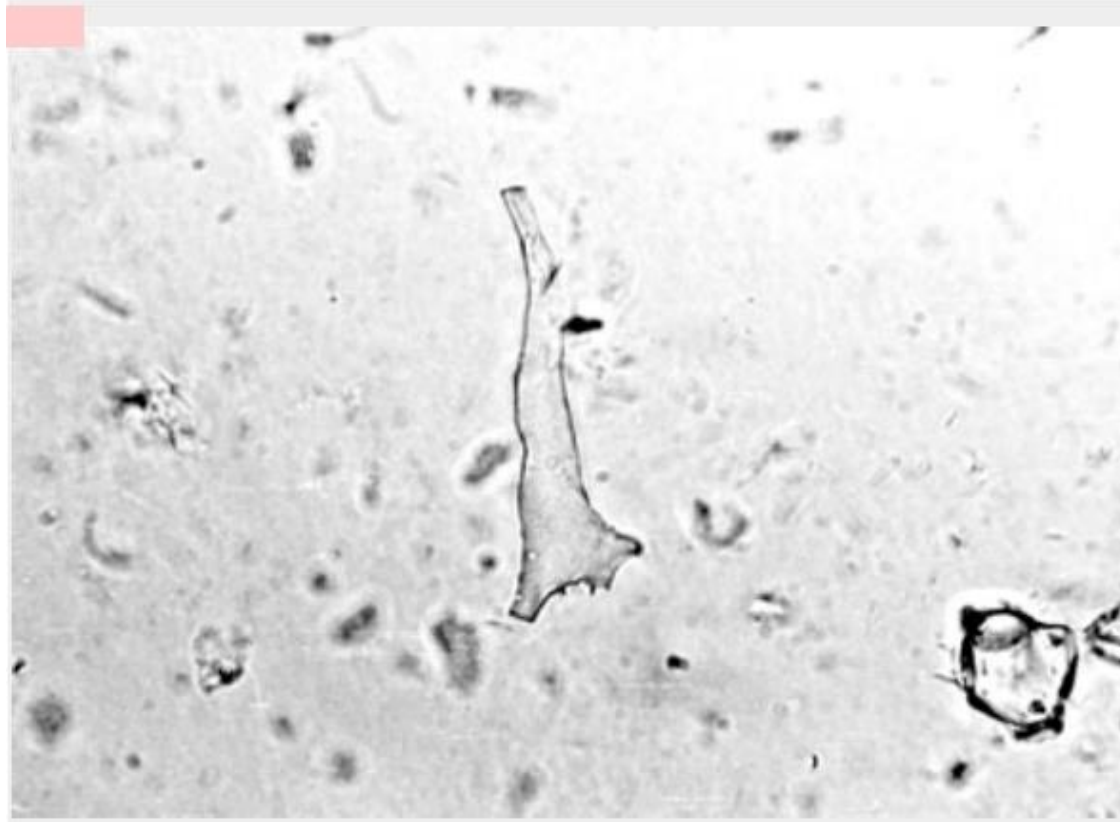
# Tapura peruviana

## Phytolith

schlerid

This shows a typical elongate schlerid.

Diagnostic level: generalized arboreal



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

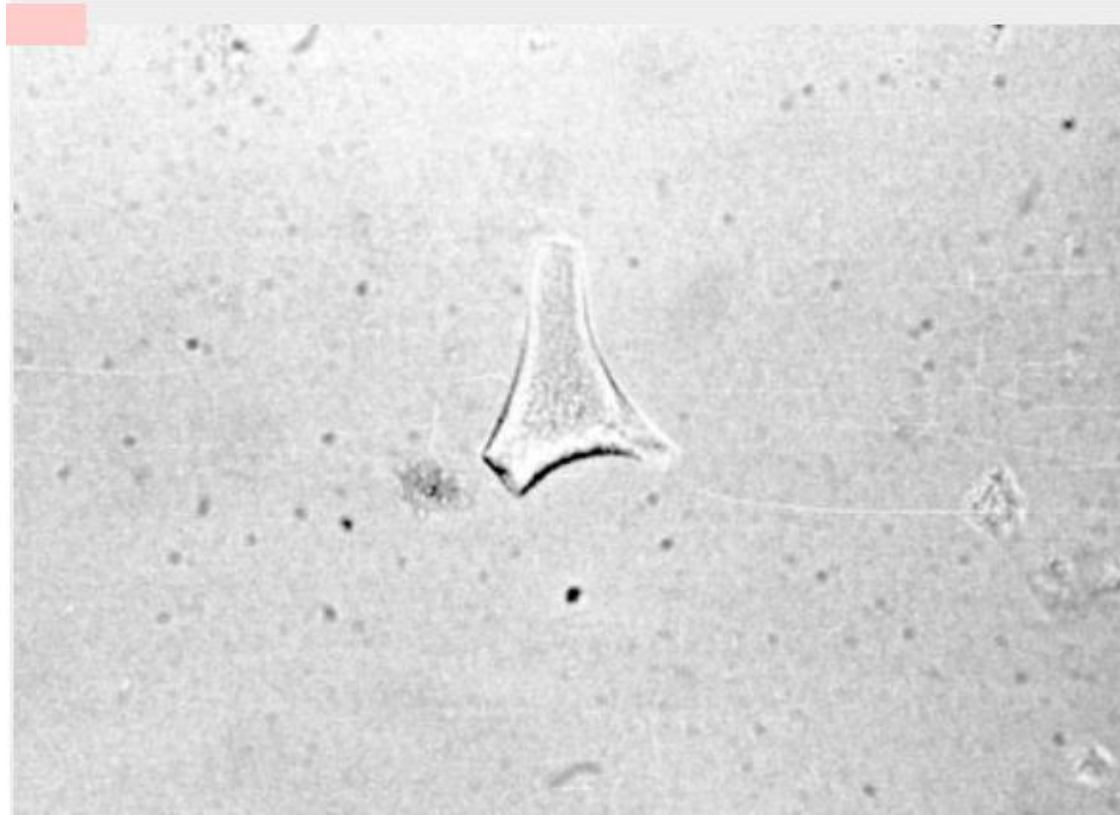
# Tapura peruviana

## Phytolith

schlerid

This shows a very short, broad, curved example.

Diagnostic level: generalized arboreal



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

DILLENIAACEAE



# Dilleniaceae

## Phytolith



Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. r) Dilleniaceae-type hair base phytoliths (GM RP, 0-15 cm)

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Curatella americana

## Phytolith

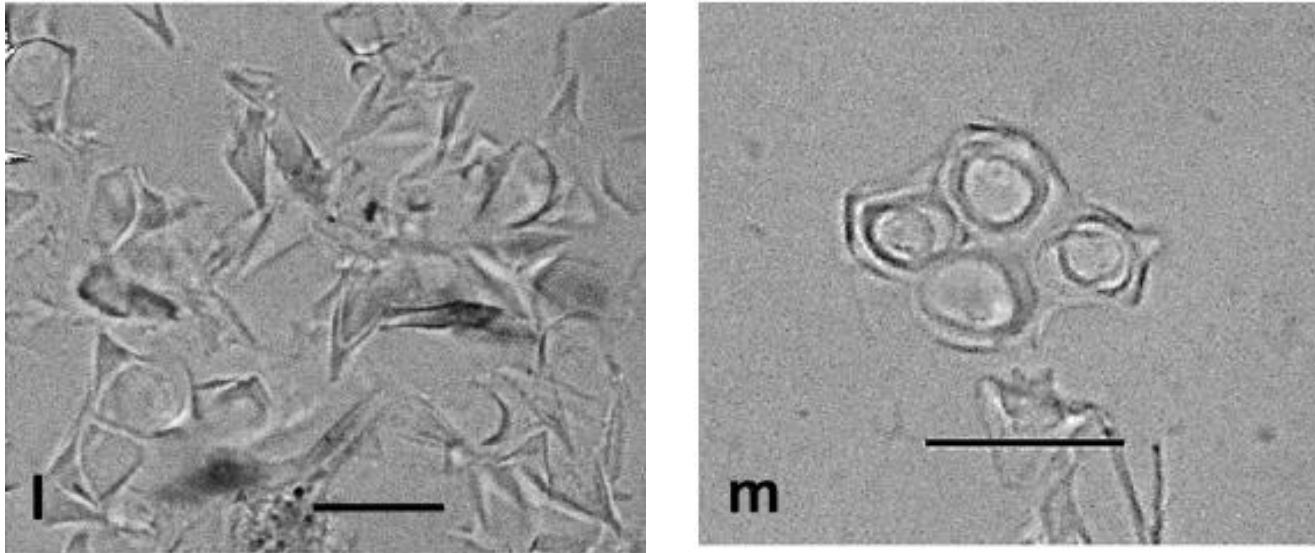


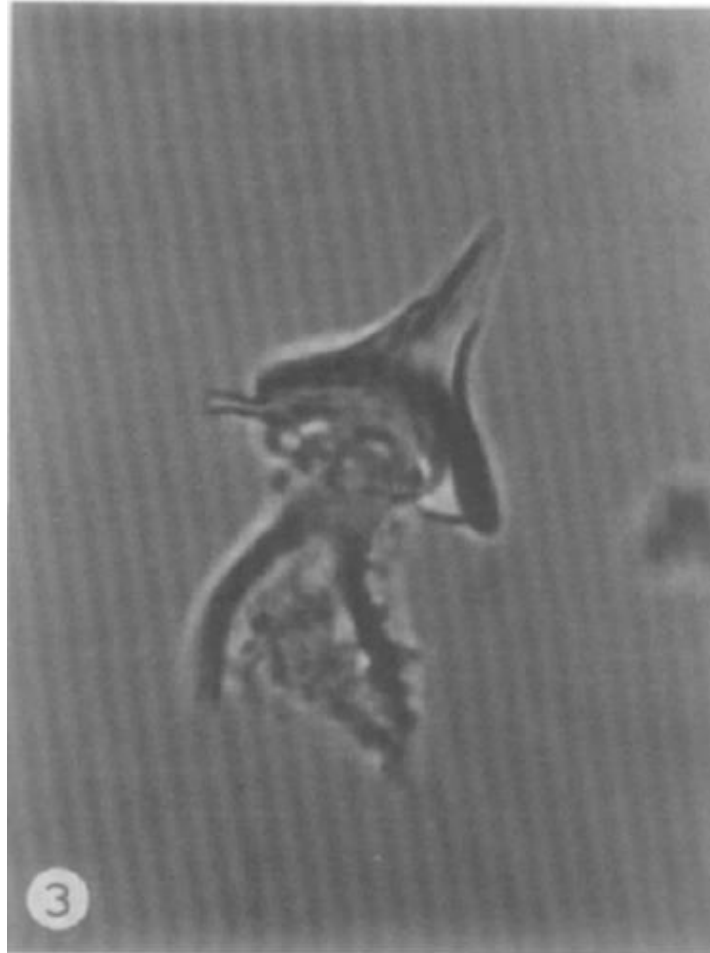
Fig. 5. Phytoliths from dicotyledons. l) Trichomes from *Curatella americana*, m) Hair base from *C. americana*

Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Curatella americana

## Phytolith

3. A short, deltoid hair cell phytolith with prongs from *Curatella americana* (400 x)

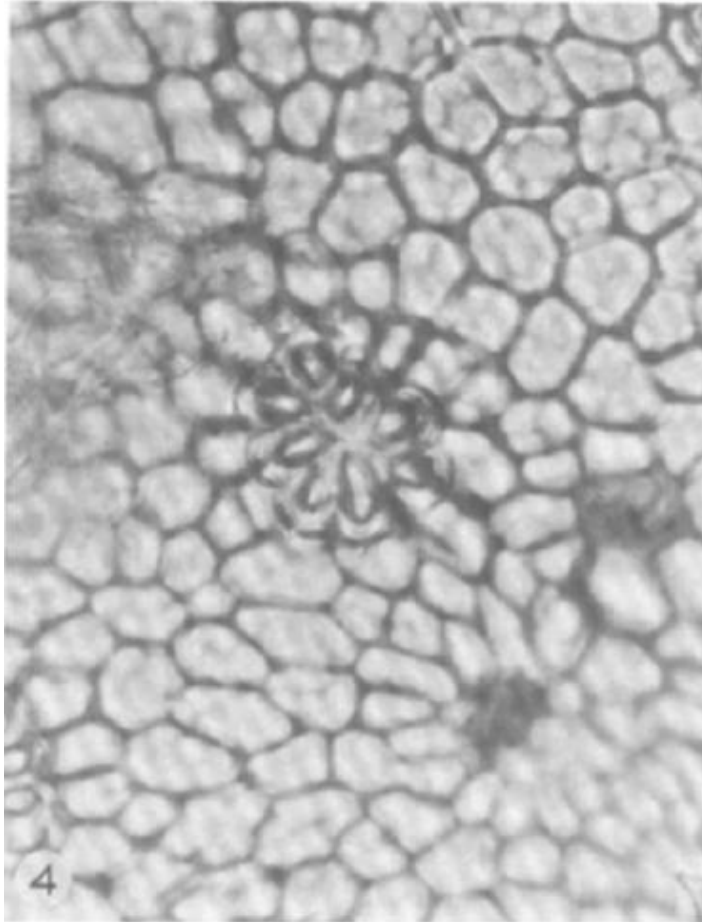


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Curatella americana

## Phytolith

4. Silicified multicelled hair bases from *Curatella americana*. They are attached to silicified polyhedral epidermis (250 x).

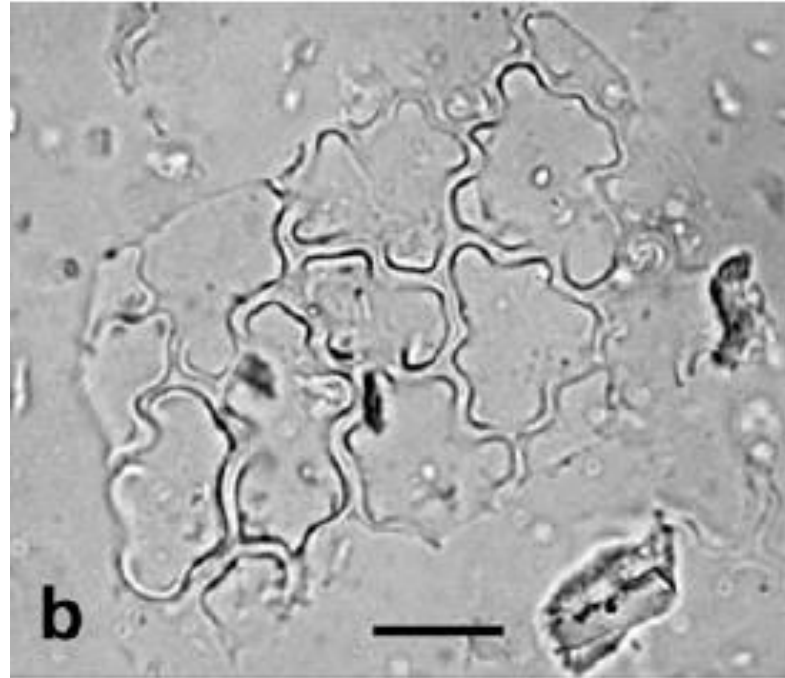


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Davilla alata

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. b) Anticlinal epidermis from *Davilla alata* leaf

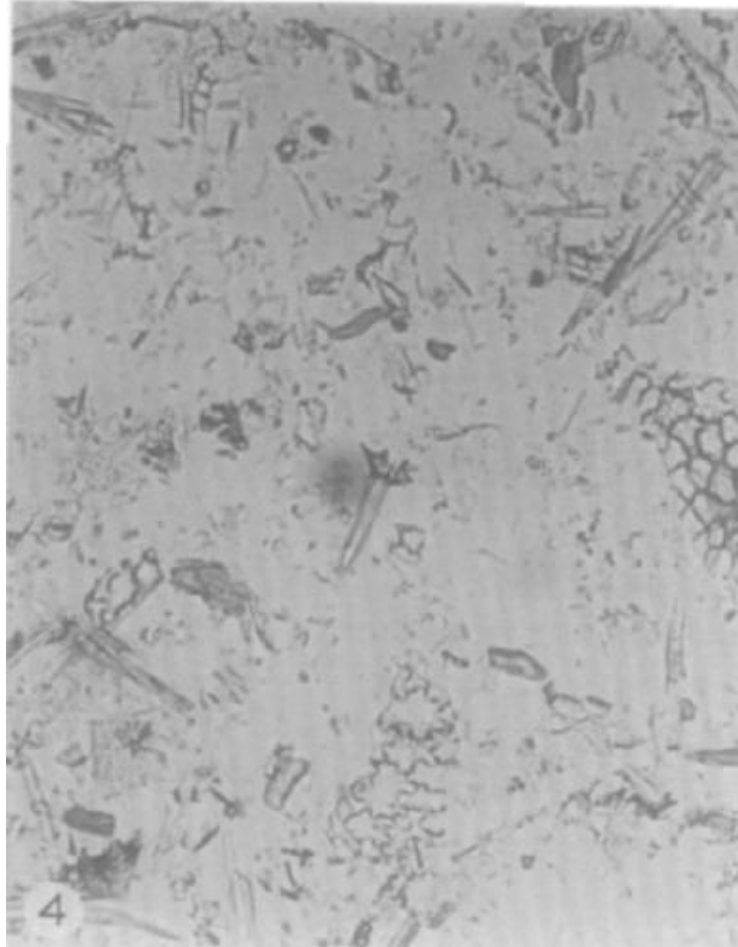


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Davilla aspera

## Phytolith

4. Non-segmented hair cell phytoliths from *Davilla aspera*. The hair in the center has prongs and lateral projections at the base (125 x).

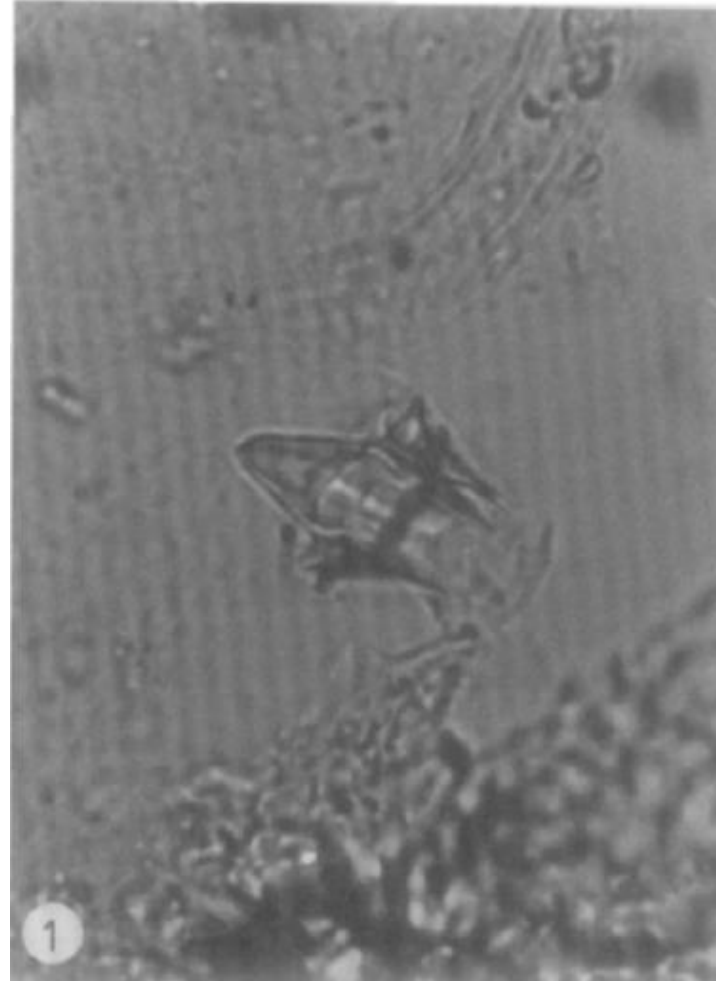


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Davilla rugosa

## Phytolith

1. Non-segmented hair cell phytolith with prongs and lateral projections from *Davilla rugosa* (250 X ).

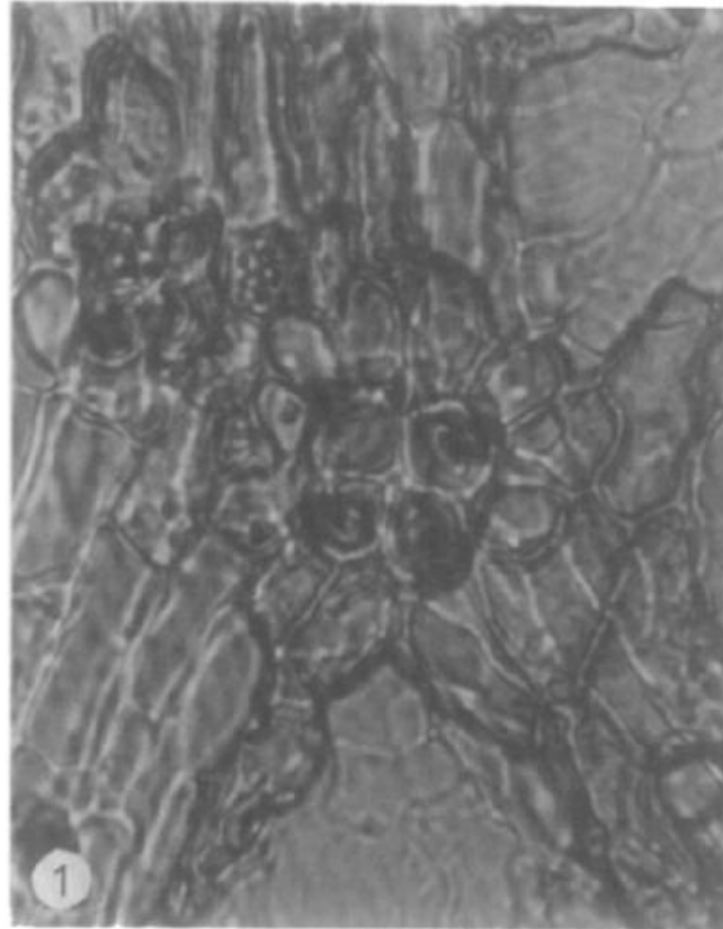


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Tetracera volubilis

## Phytolith

1. Silicified multicelled hair base with 4 cells from *Tetracera volubilis* (250 ×).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.



DIOSCOREACEAE

# Dioscoreaceae cf.

## Starch

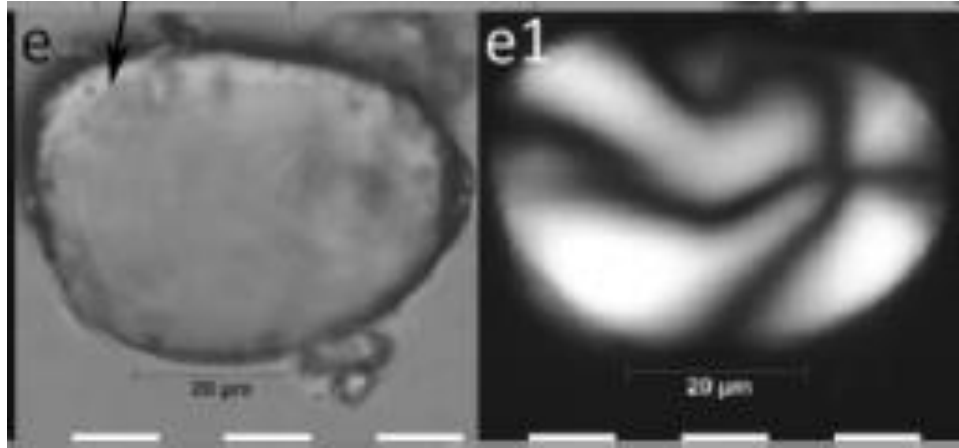
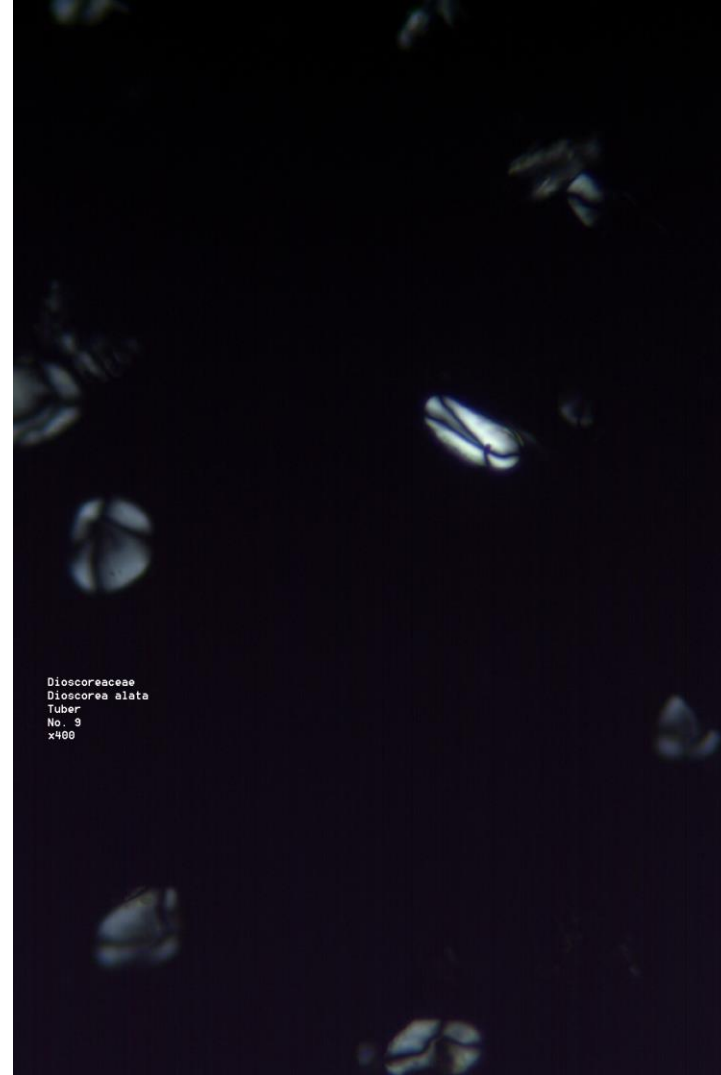
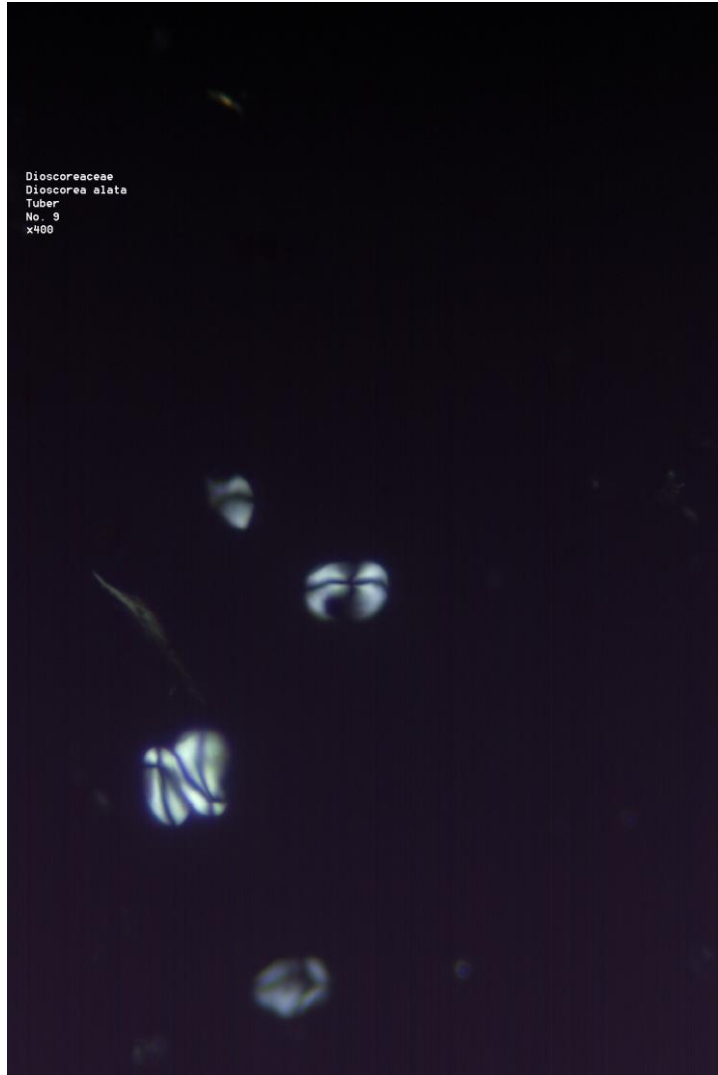


Fig. 9. Other ancient starch grains (a-g) recovered at St. John and Eva 2. e, cf. Dioscoreaceae starch with various concentric rings or lamellae around the hilum and with concentric layers or lamellae (“L”) going down to the distal end; e1, the same starch showing its extinction cross.

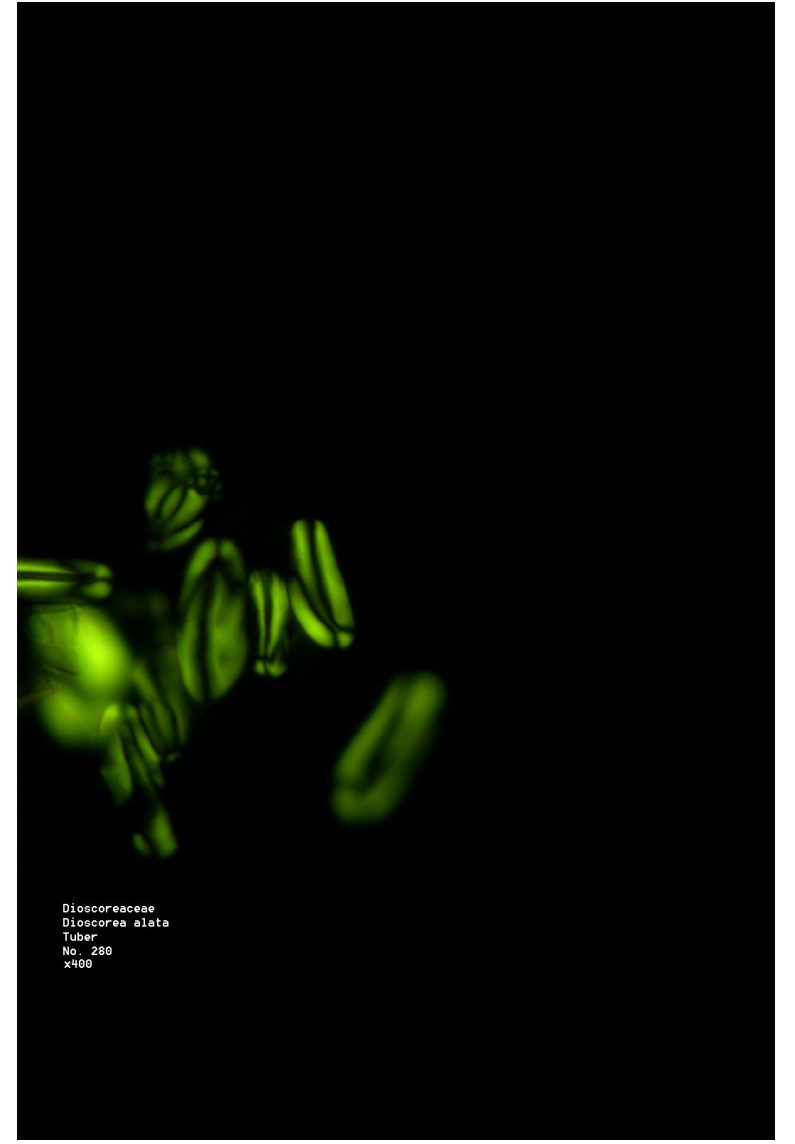
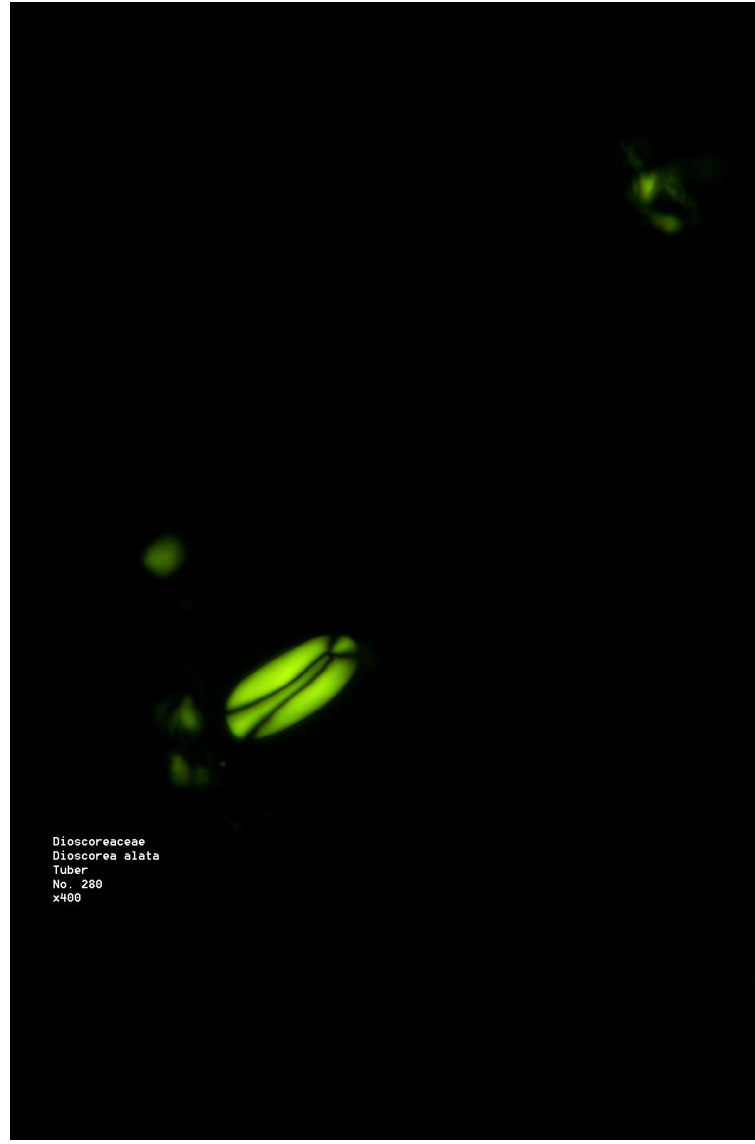
# Dioscorea alata

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



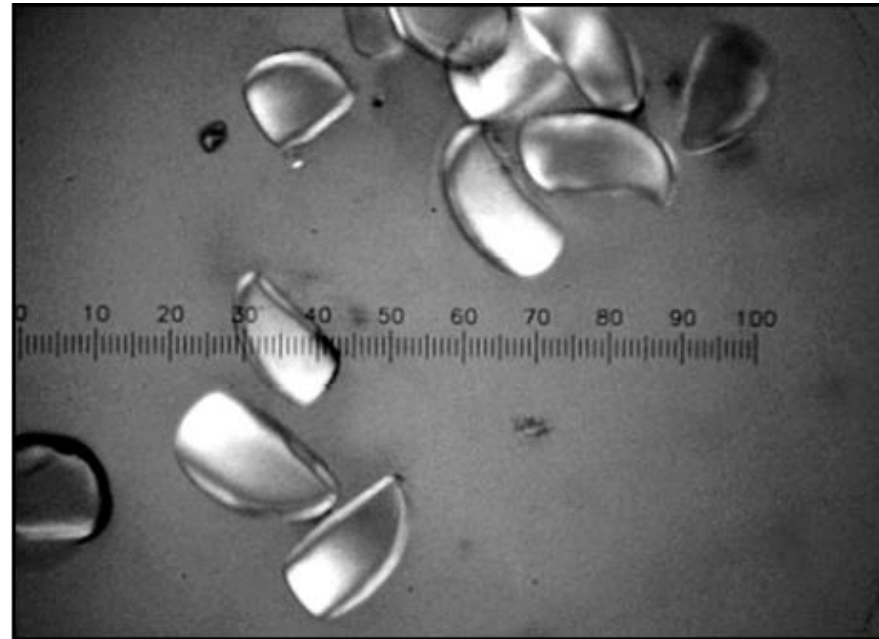
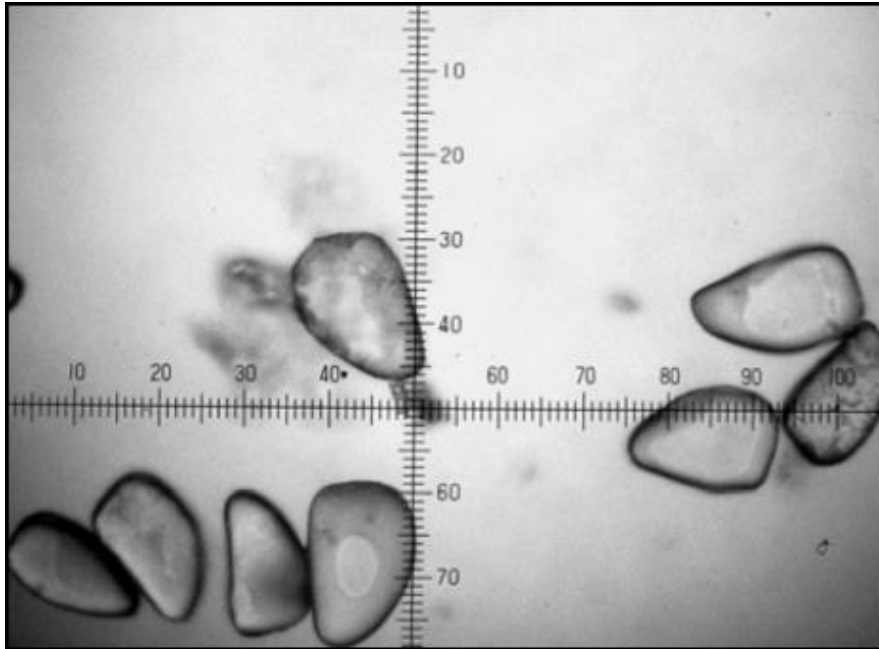
# Dioscorea alata

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Dioscorea alata

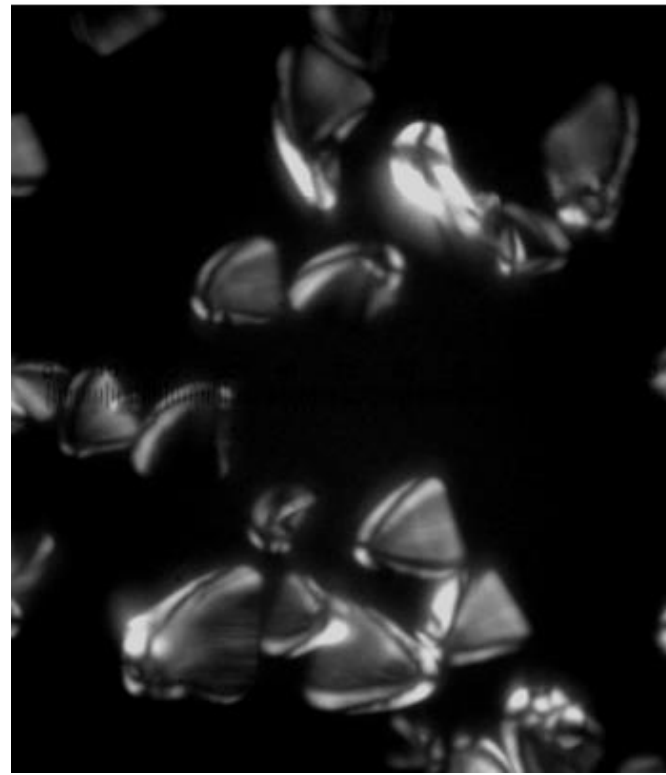
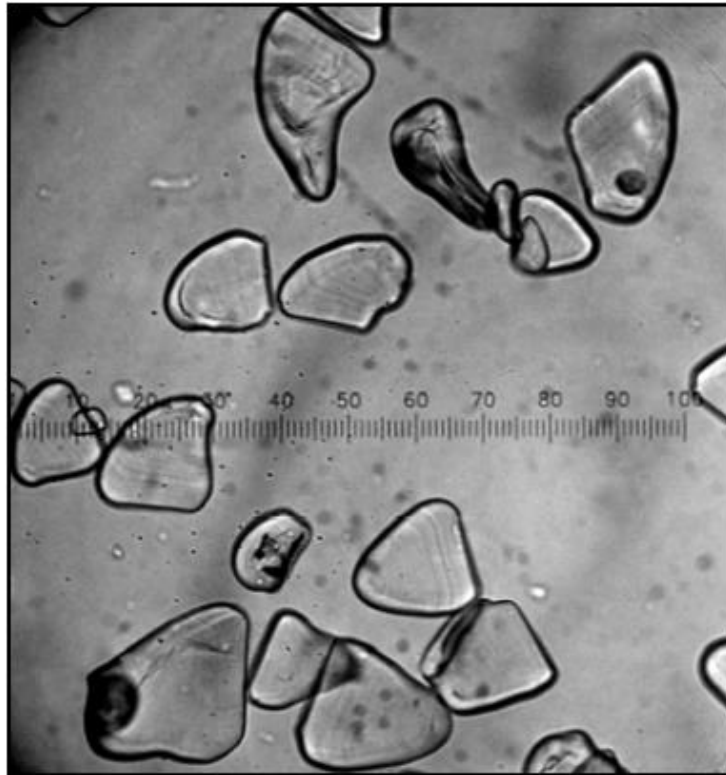
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Dioscorea altissima

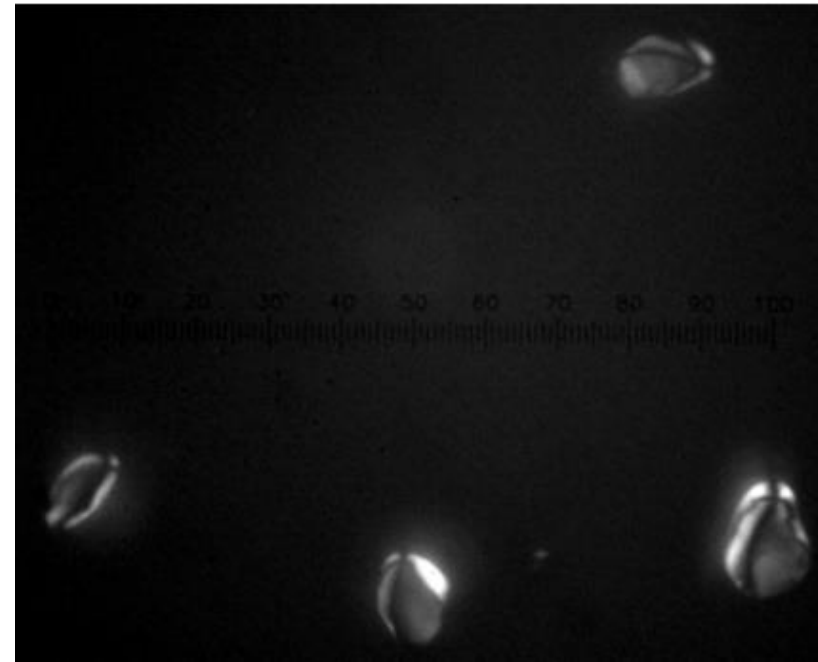
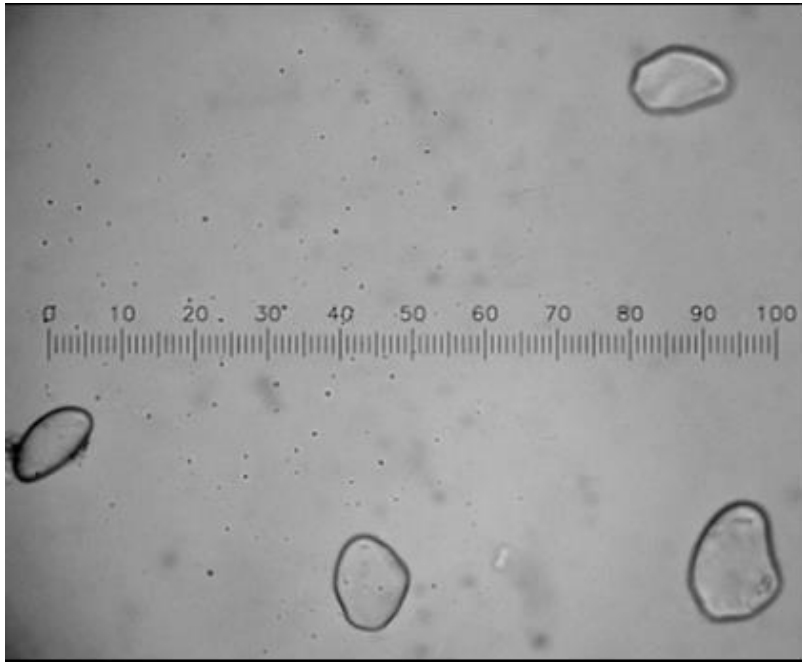
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Dioscorea altissima

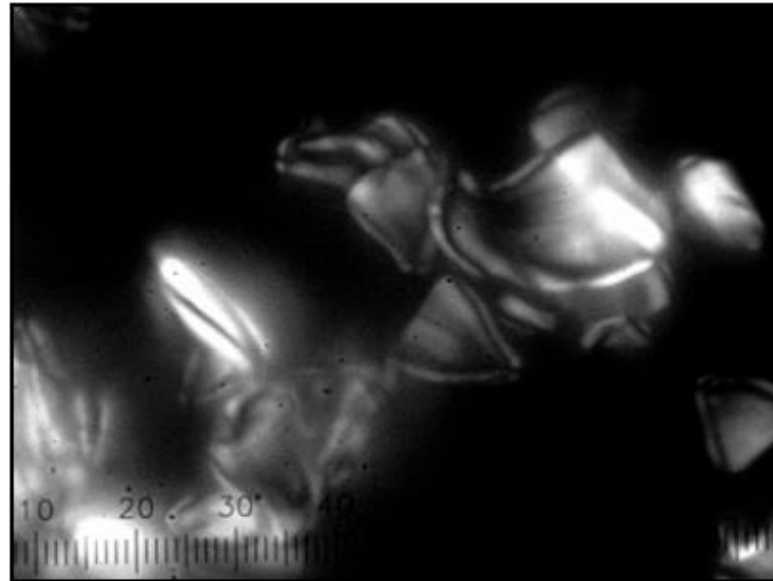
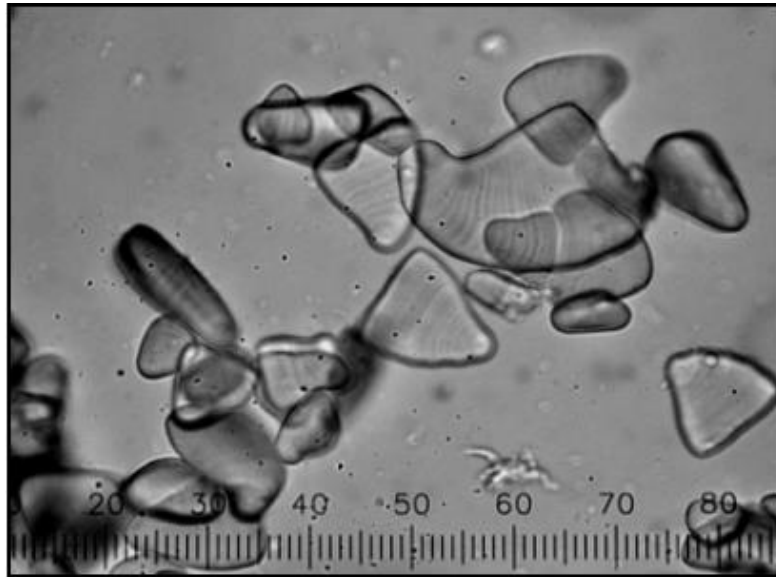
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Dioscorea bulbifera

## Starch

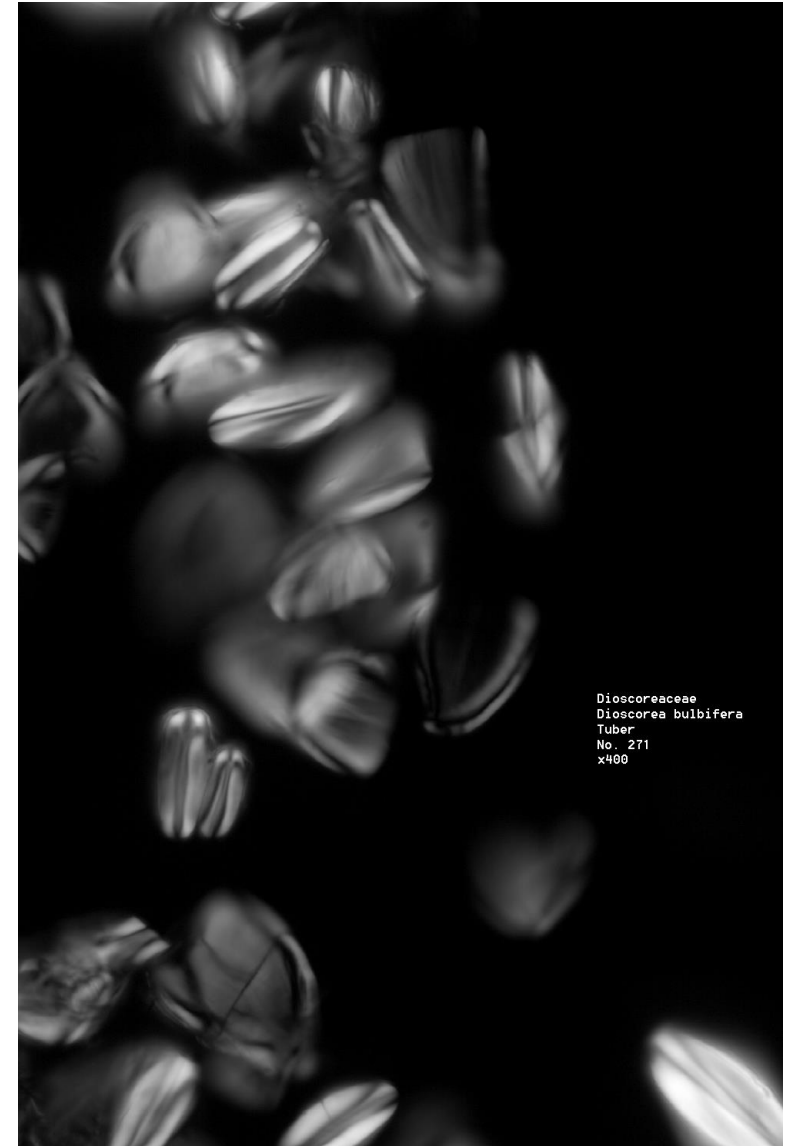


Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.



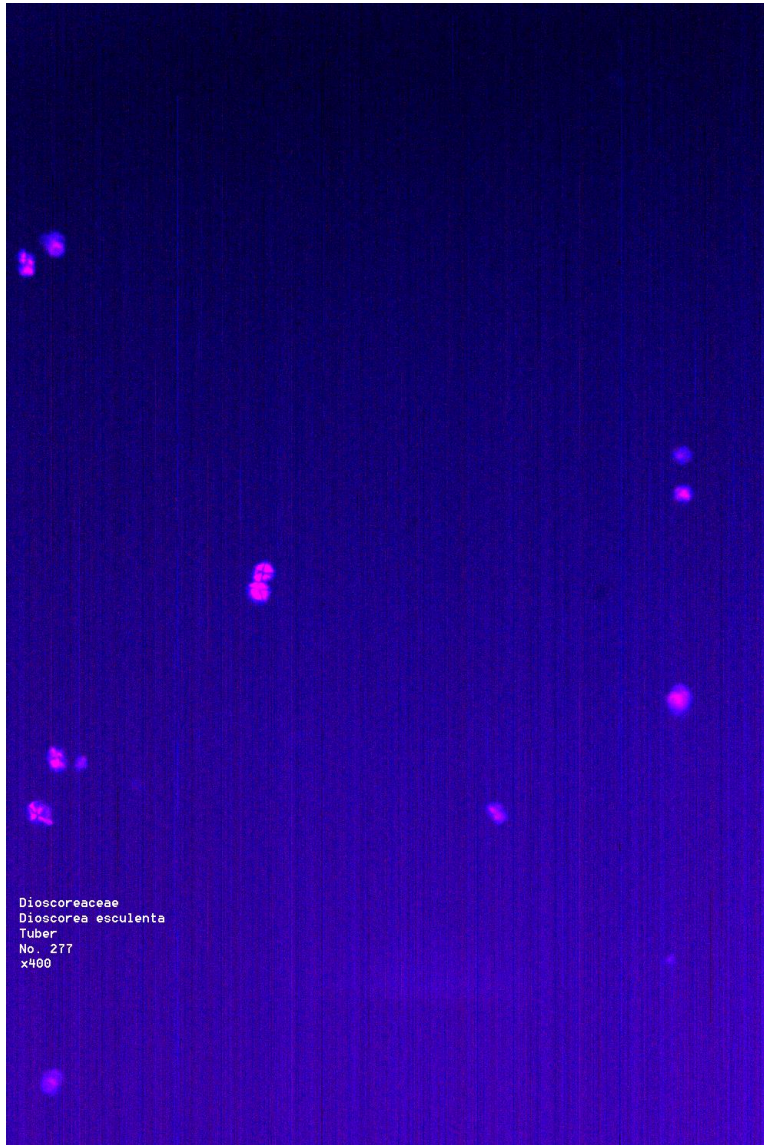
# Dioscorea bulbifera

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



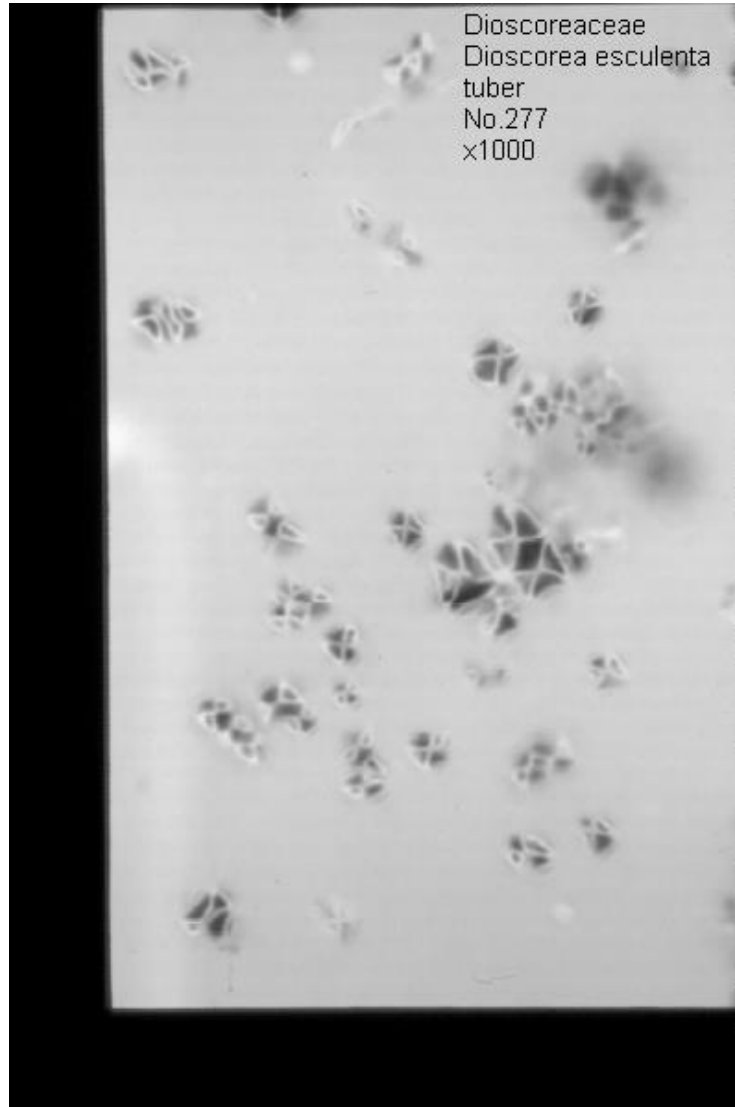
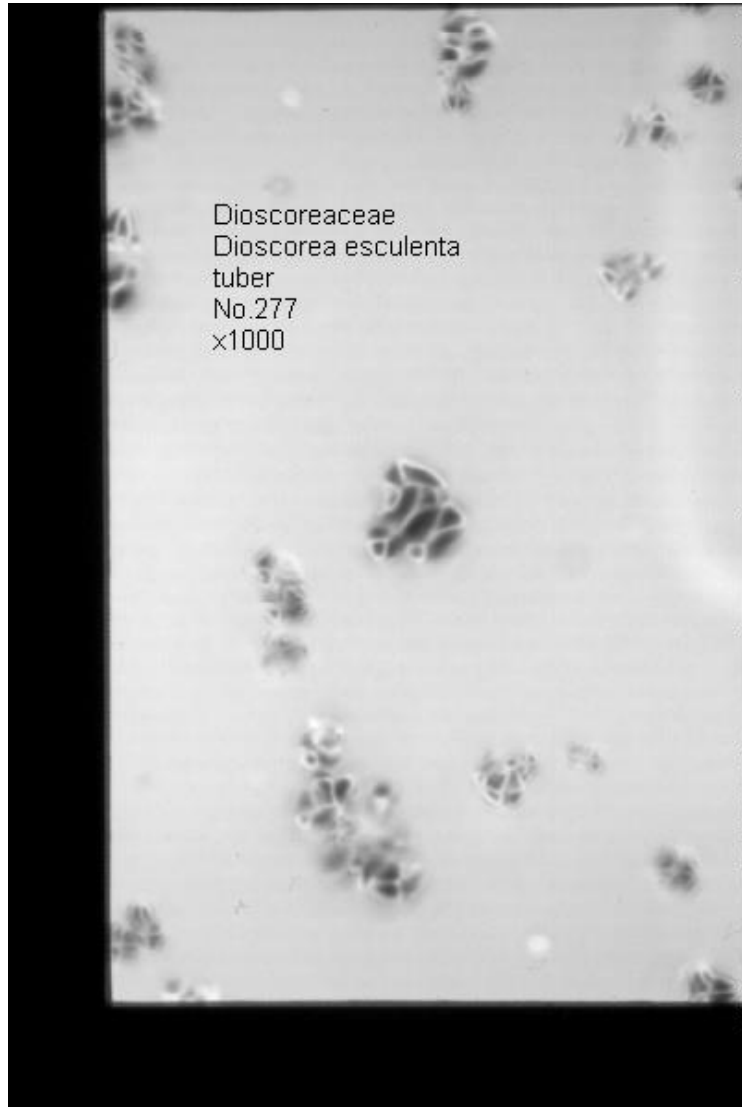
# Dioscorea esculenta

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



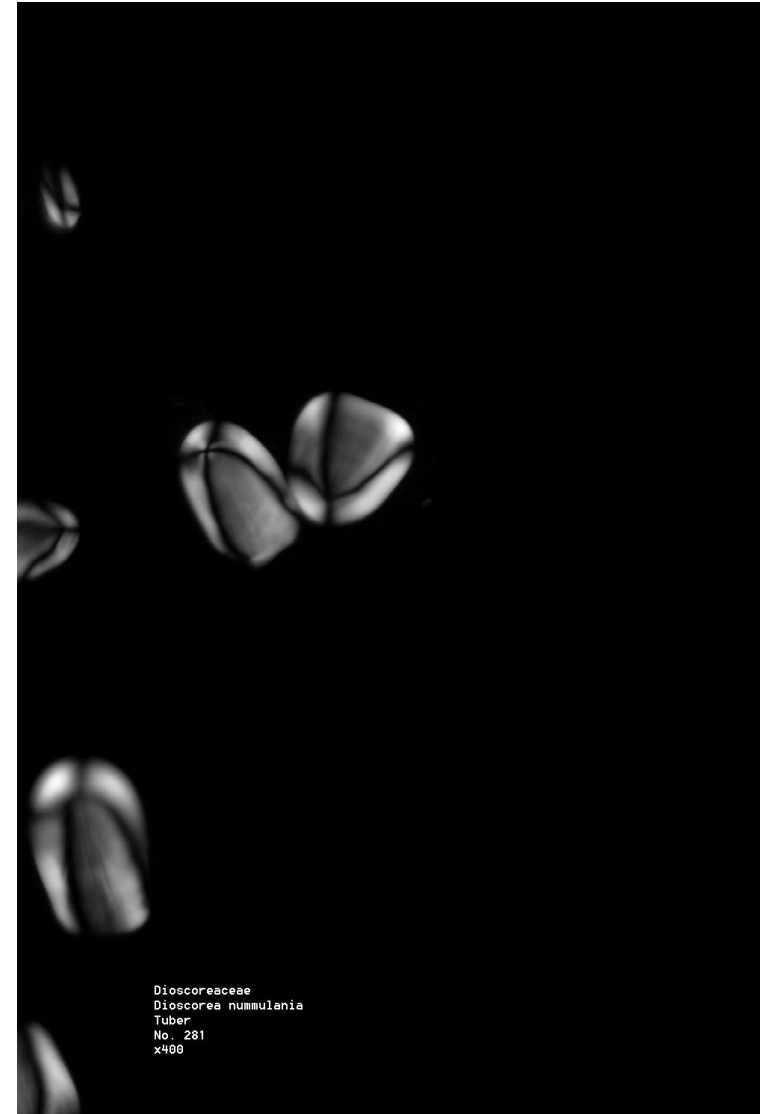
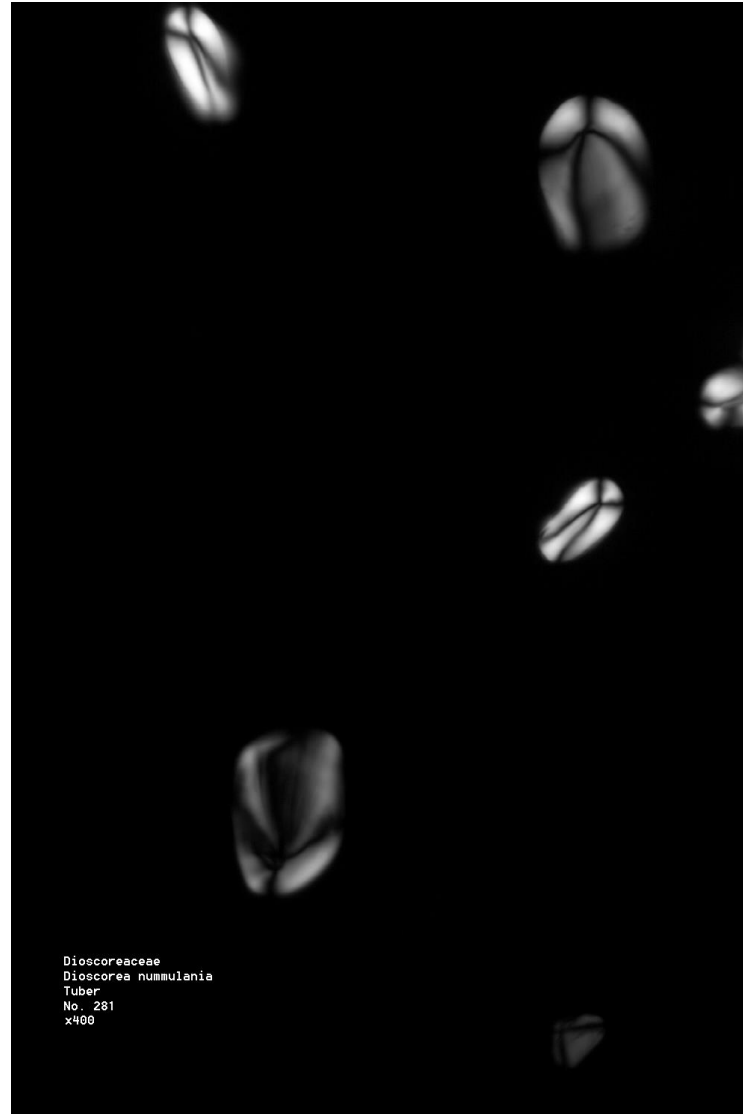
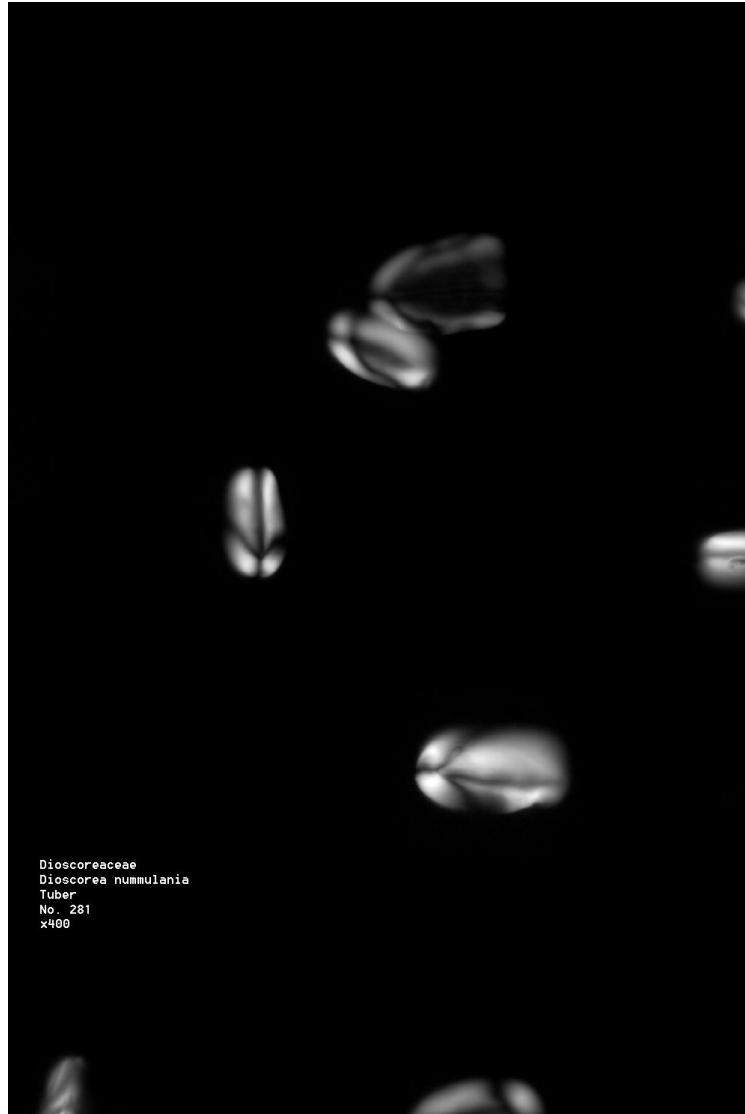
# Dioscorea esculenta

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



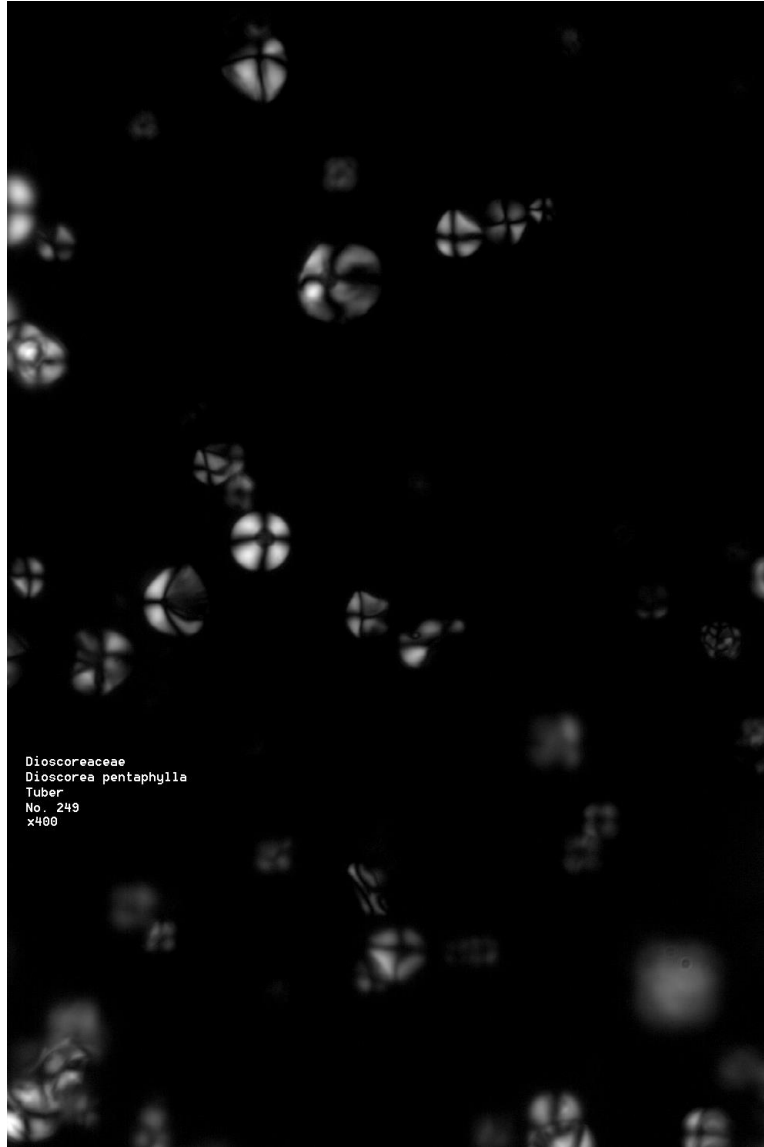
# Dioscorea nummularia

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Dioscorea pentaphylla

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



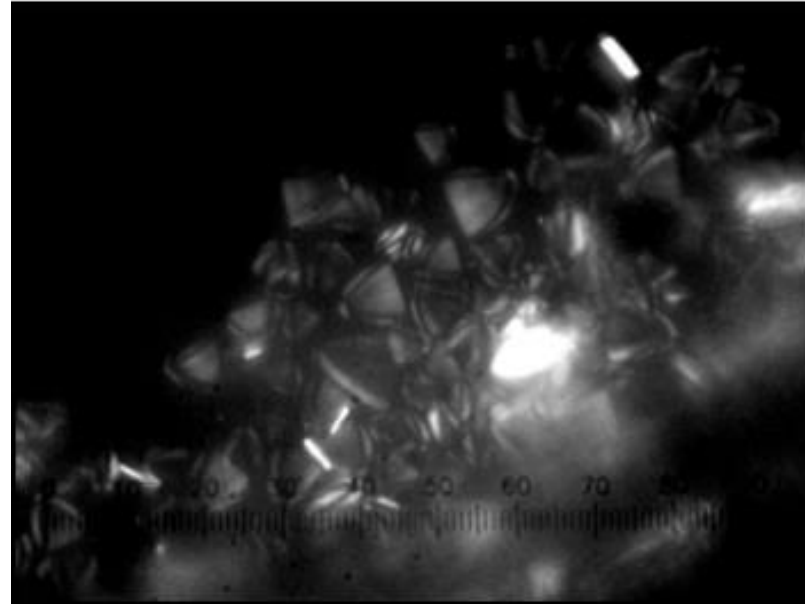
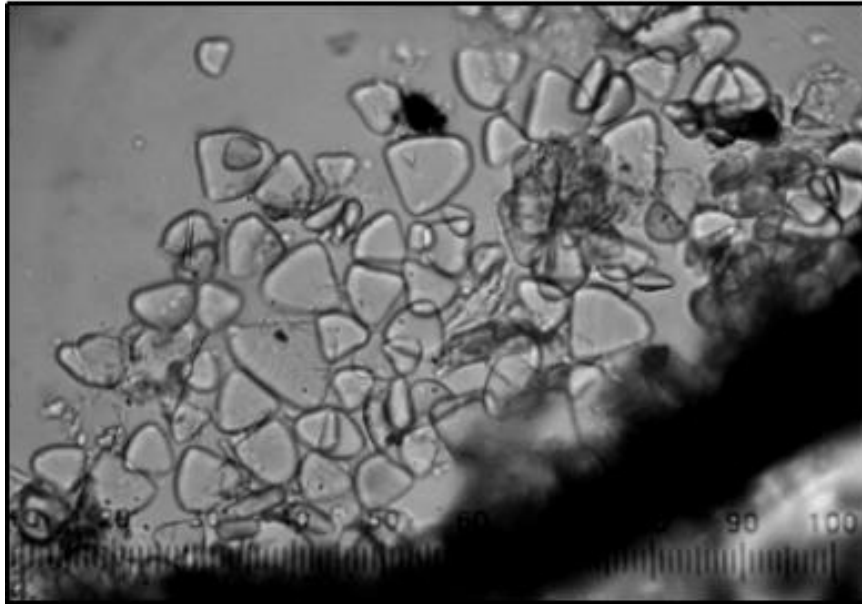
# Dioscorea pentaphylla

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Dioscorea polygonoides

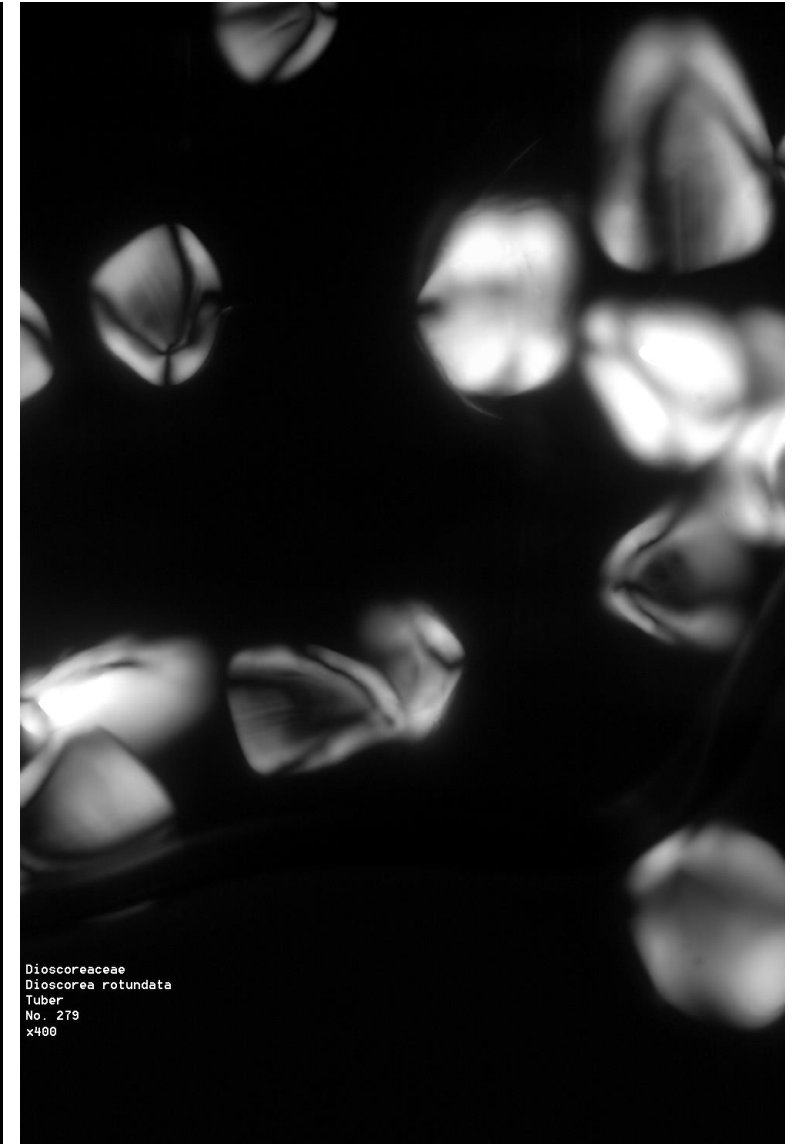
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Dioscorea rotundata

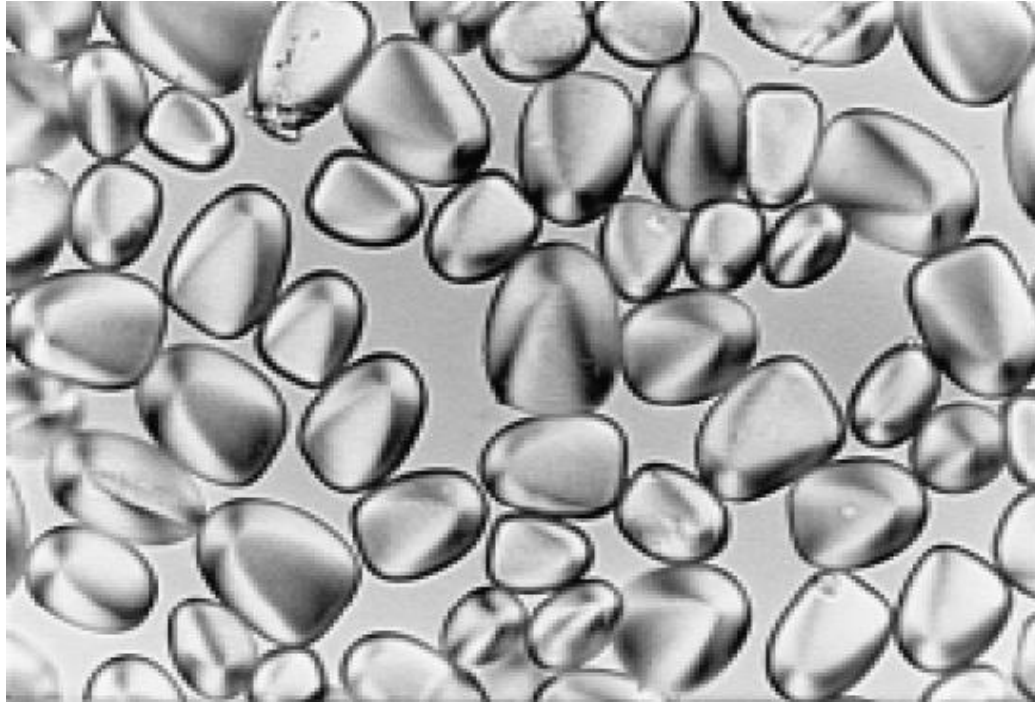
Australian Museum,  
McCown Archaeobotany  
Laboratory Collection





# Dioscorea trifida

## Starch



Starch grains from a modern tuber of *Dioscorea trifida*.

80x

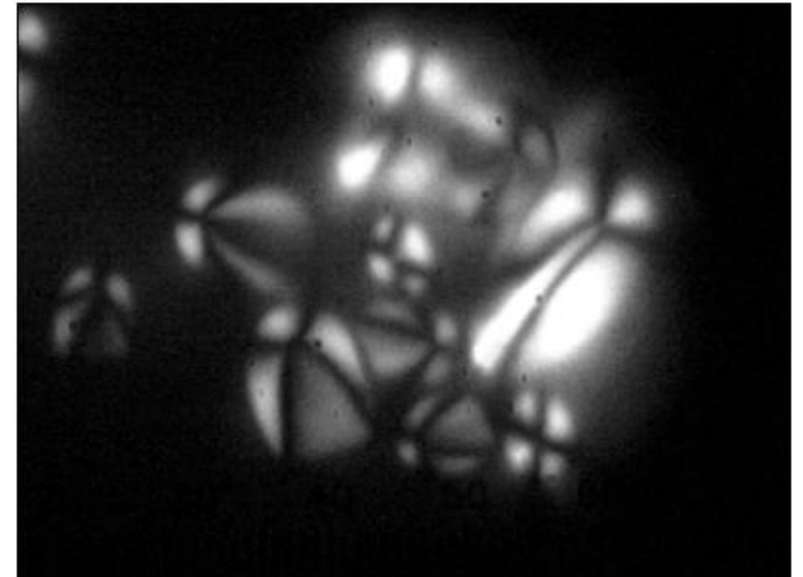
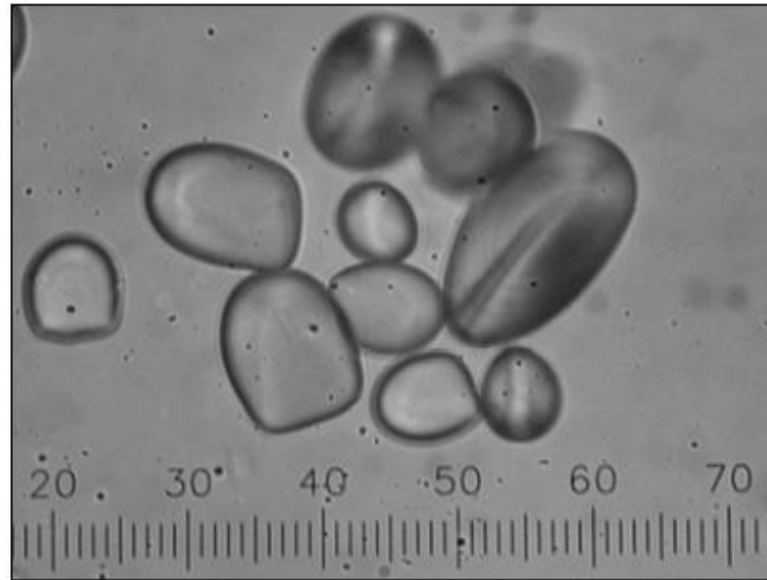
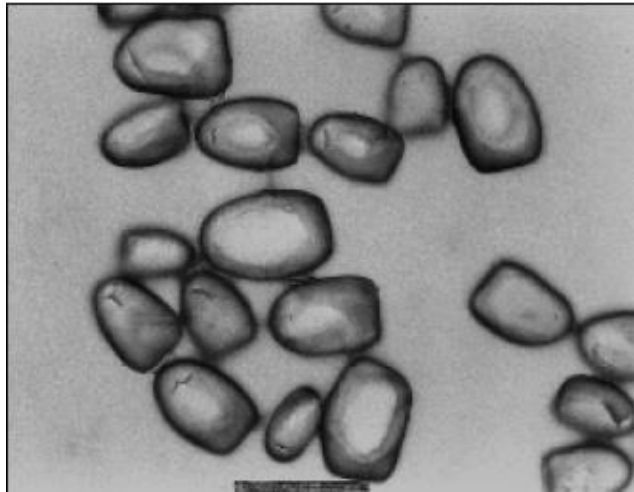
### APPENDIX:

*Dioscorea trifida* (yampi´) (Figure 3). Simple grains, laminated, with a more or less distinct point where the hilum is located. They possess a cuneiform-shaped depression extending from the hilum to the bottom of the grain, and a straight distal edge. Size: 24– 84 microns long

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Dioscorea trifida

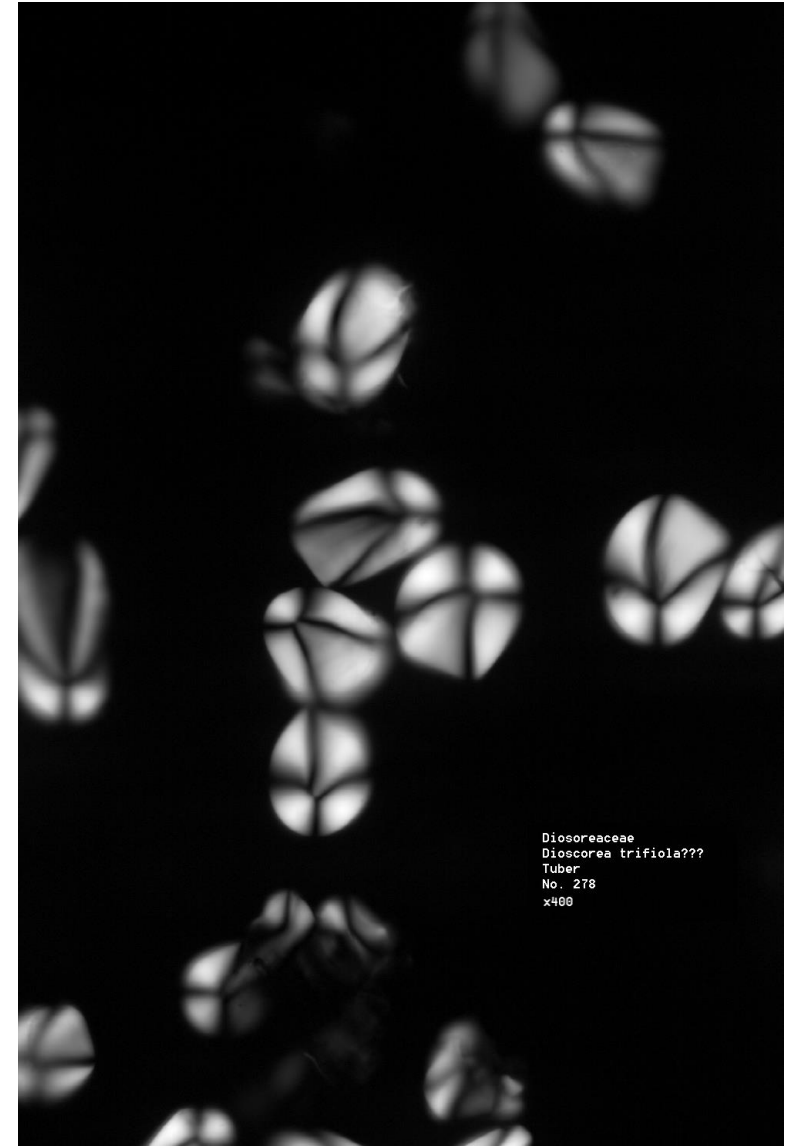
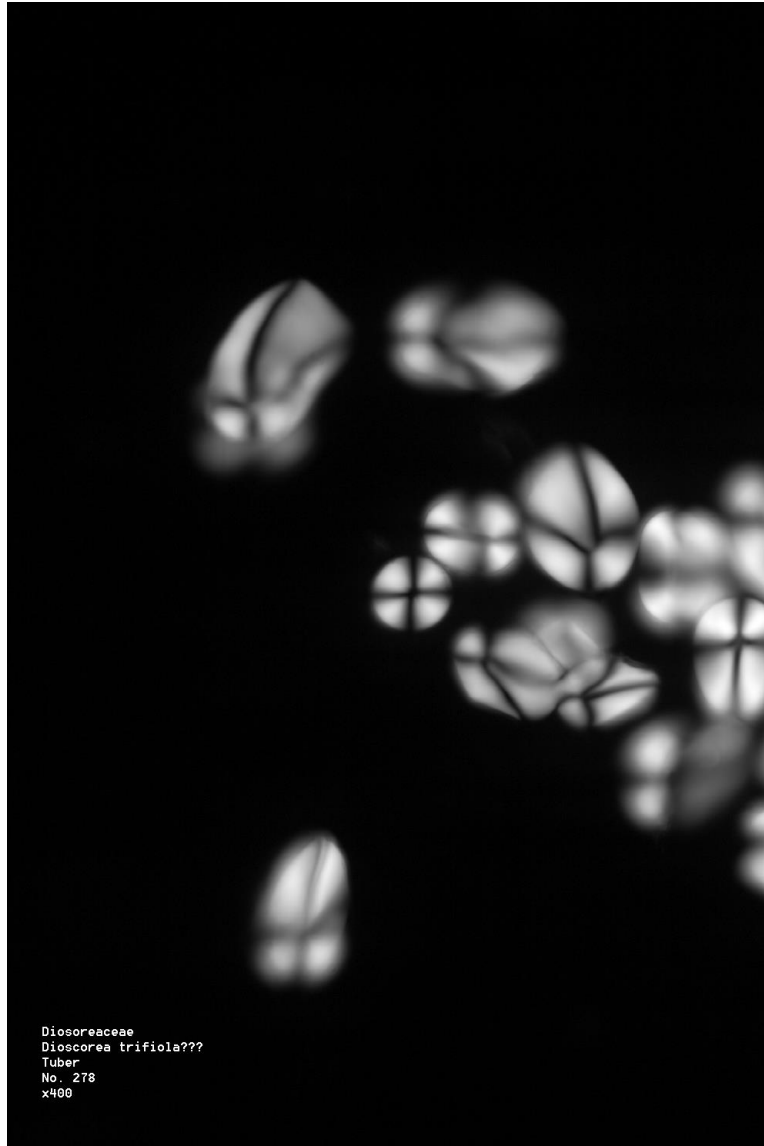
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Dioscorea trifoliola?

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Dioscorea sp.

## Starch

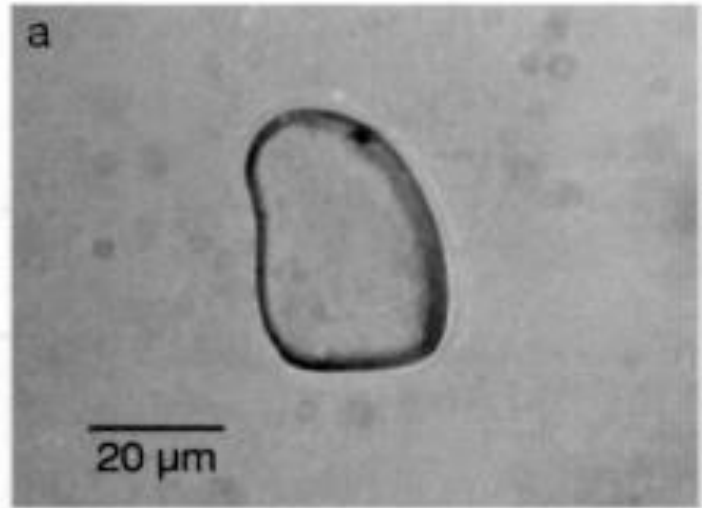


Figure 3. Light micrographs of archaeological starch granules representative of the recovered assemblage. a: Starch granule of *Dioscorea* sp. recovered from flake 3.

Perry, Linda. 2002. Starch Analyses Reveal Multiple Functions of quartz “manioc” Grater Flakes from the Orinoco Basin, Venezuela. *Interciencia* 27 (11):635–39.

# Dioscorea sp.

## Starch

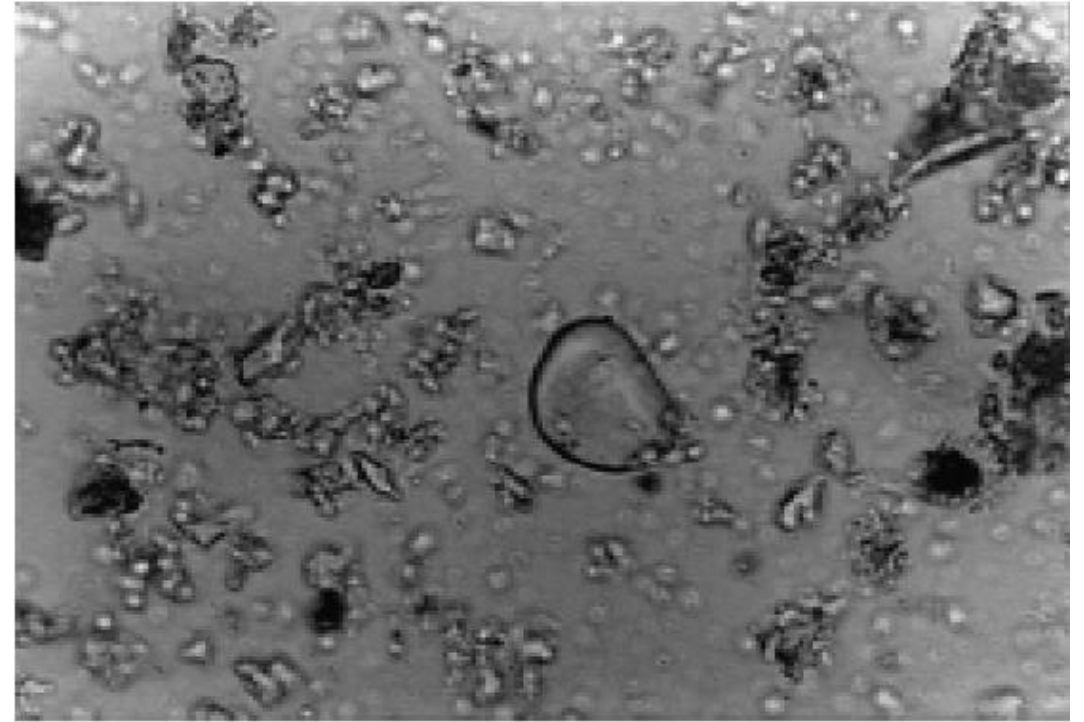
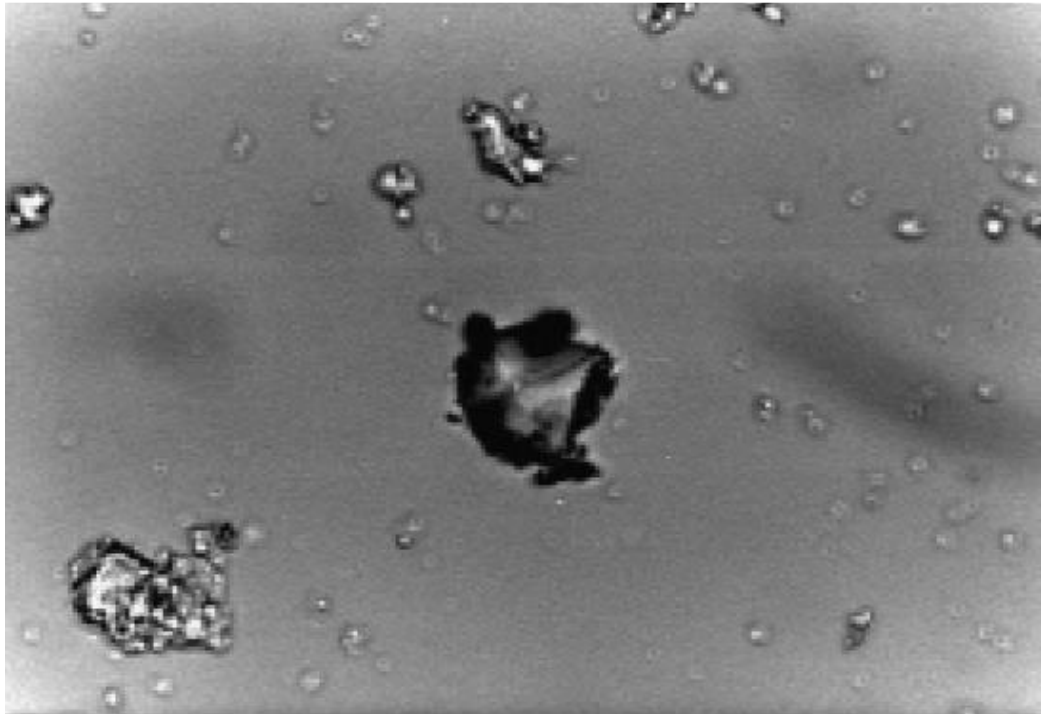


Starch grains from the tuber  
of a wild *Dioscorea* species  
from Panama. 80x

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Dioscorea sp.

## Starch



A *Dioscorea* sp. starch grain from La Mula. 160x. The grain measures 20 microns by 16 microns.

A *Dioscorea* sp. starch grain from the Aguadulce shelter. 320x. The grain measures 16 microns by 16 microns.

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Dioscorea sp.

Starch



Fig. 5. Selected microbotanical remains. Starch grains: c) Dioscorea sp. (SAL 04-2-7447)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Dioscorea sp.

## Starch



Figure 1. Various starch grains. c, A starch grain from a species of *Dioscorea* recovered from milling stone 350. Scale bar 10  $\mu\text{m}$

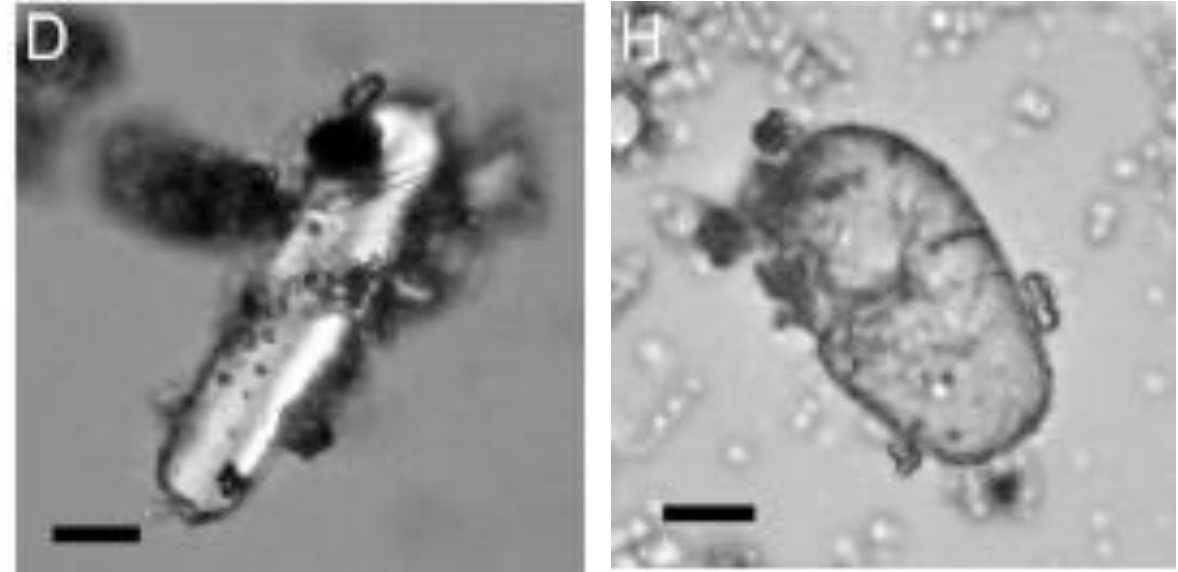
Piperno, Dolores R., Anthony J. Ranere, Irene Holst, and Patricia Hansell. 2000. Starch Grains Reveal Early Root Crop Horticulture in the Panamanian Tropical Forest. *Nature* 407:894–97.



# Dioscorea sp.

## Starch

Fig. 2. Selected archaeological starch grains. (D) *Dioscorea* cf. *urophylla* starch from Trapiche, chopper 147/10, ?4300 cal BP (under cross-polarized light). (H) *Dioscorea* sp. starch from Ladrones, handstone CL-68/1, ?7500 cal BP. (Scale bar: 10  $\mu$ m.) Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8

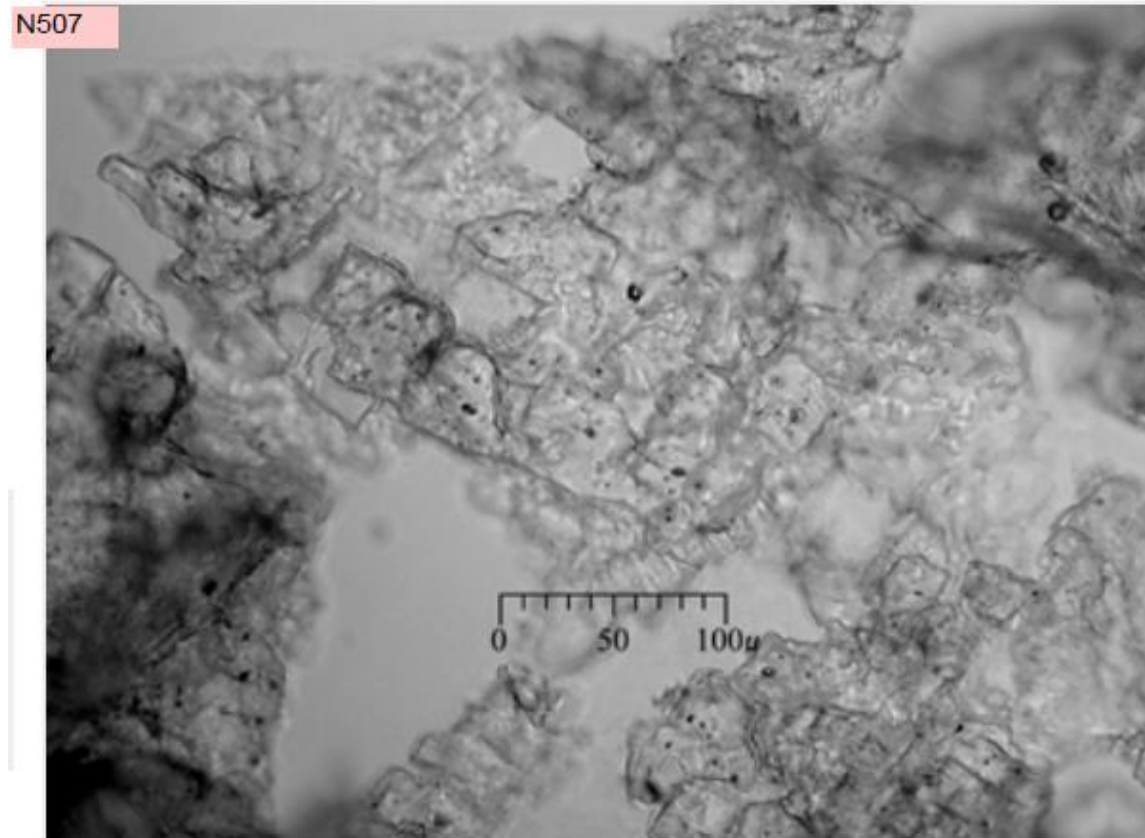


Dickau, Ruth, Anthony J. Ranere, and Richard G. Cooke. 2007. Starch Grain Evidence for the Preceramic Dispersals of Maize and Root Crops into Tropical Dry and Humid Forests of Panama. *Proceedings of the National Academy of Sciences of the United States of America* 104 (9):3651–56.

# Dioscorea sp.

## Phytolith

Type established by Karol Chandler-Ezell,  
2004. Cultivated tuber.  
Diagnostic level: root/tuber



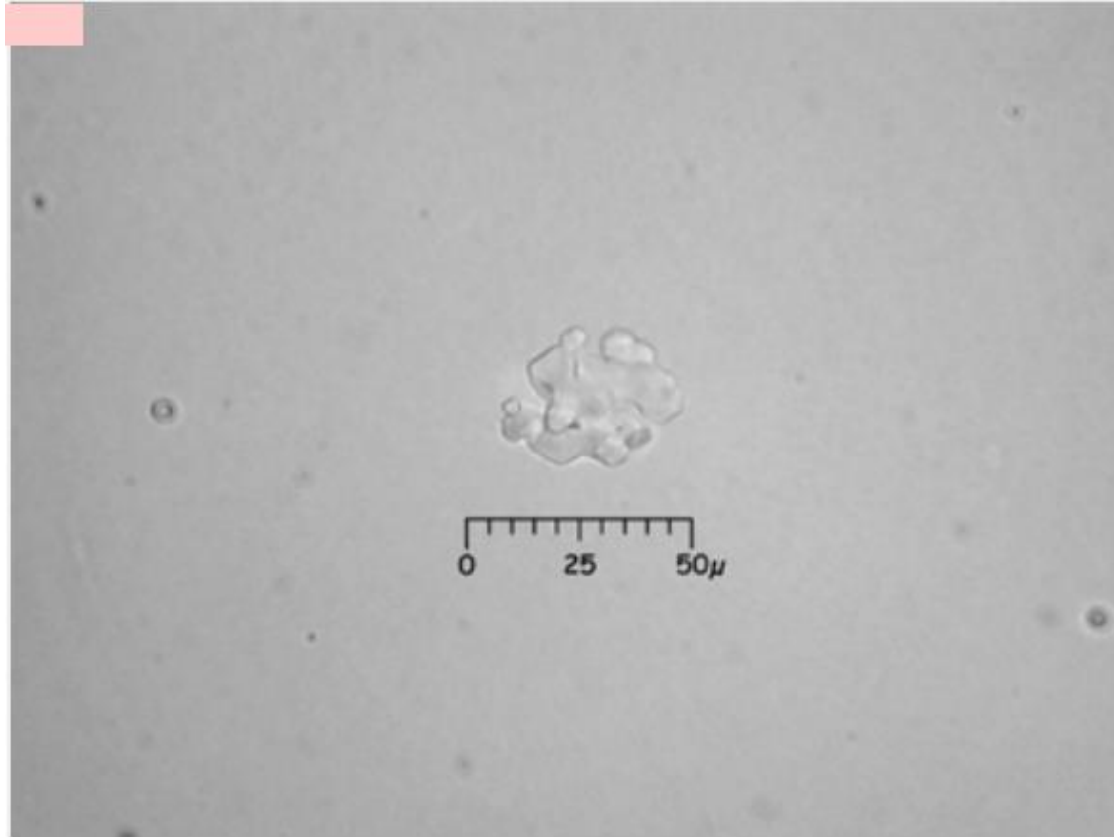
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Dioscorea sp.

## Phytolith

Type established by Karol Chandler-Ezell,  
2004. Cultivated tuber.

Diagnostic level: root/tuber



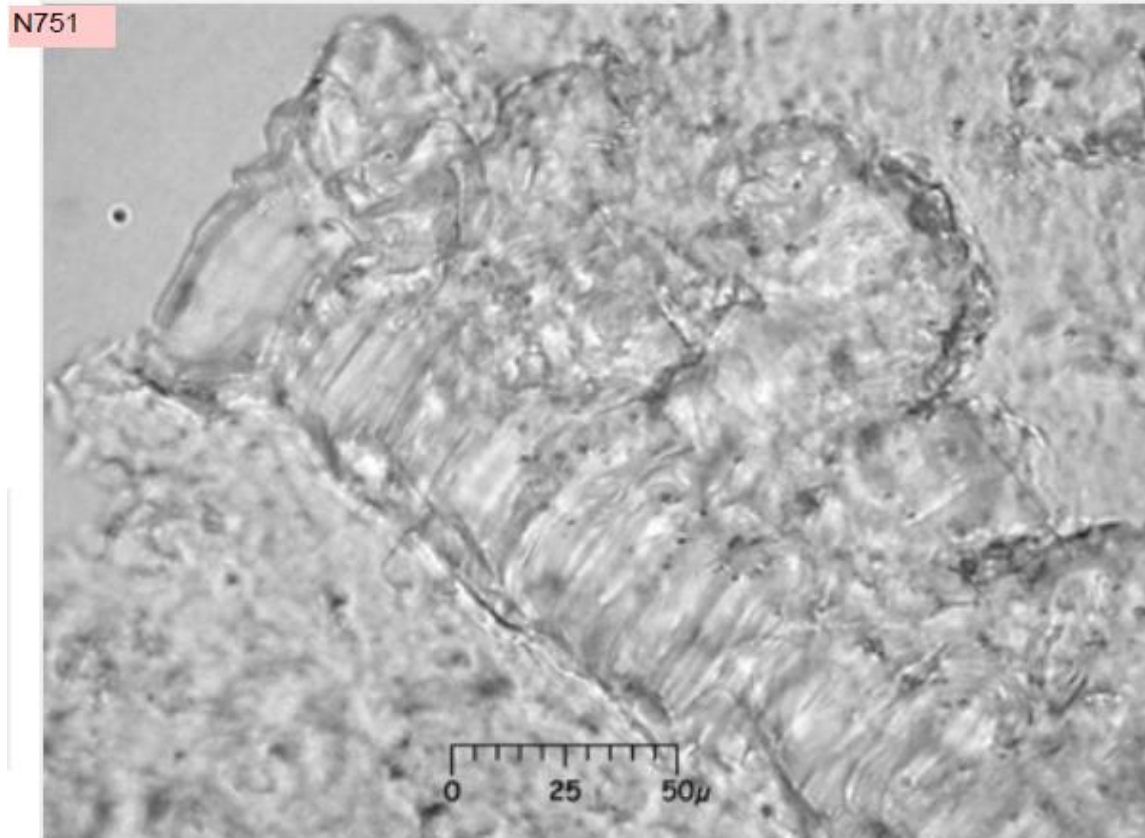
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Dioscorea sp.

## Phytolith

Type established by Karol Chandler-Ezell,  
2004. Cultivated tuber.

Diagnostic level: not diagnostic



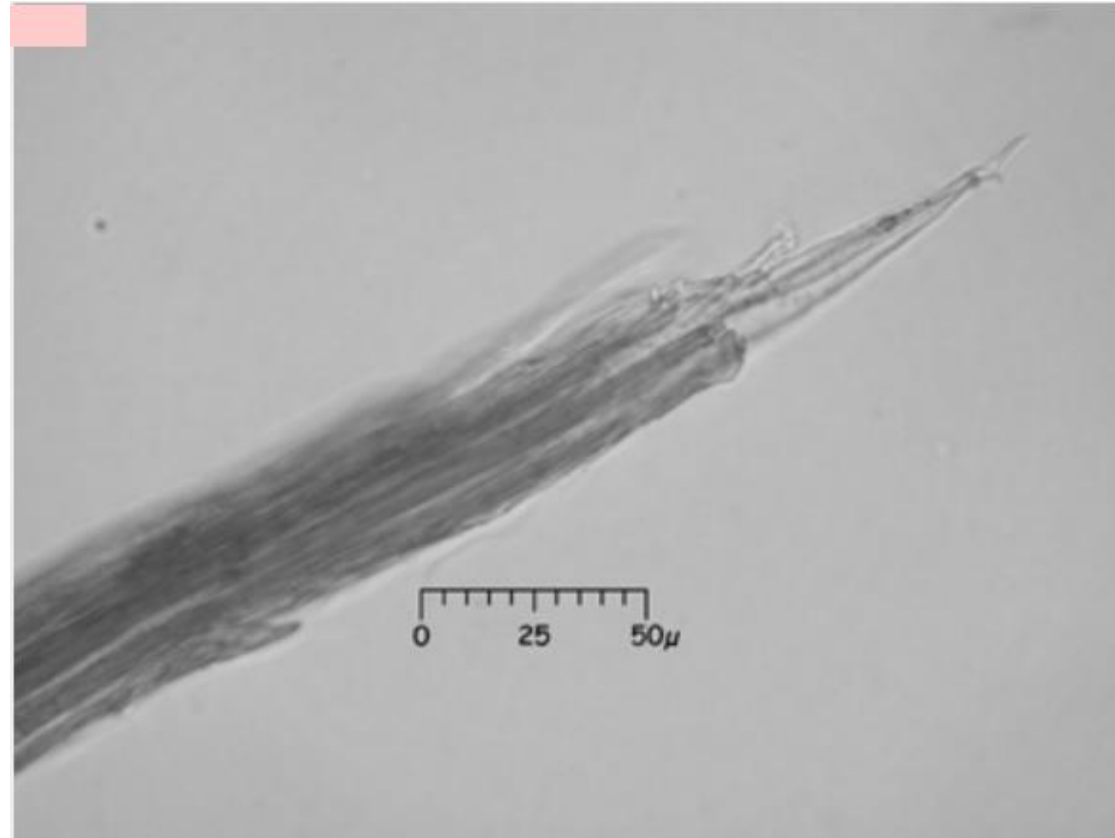
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Dioscorea sp.

## Phytolith

Type established by Karol Chandler-Ezell,  
2004. Cultivated tuber.

Diagnostic level: root/tuber



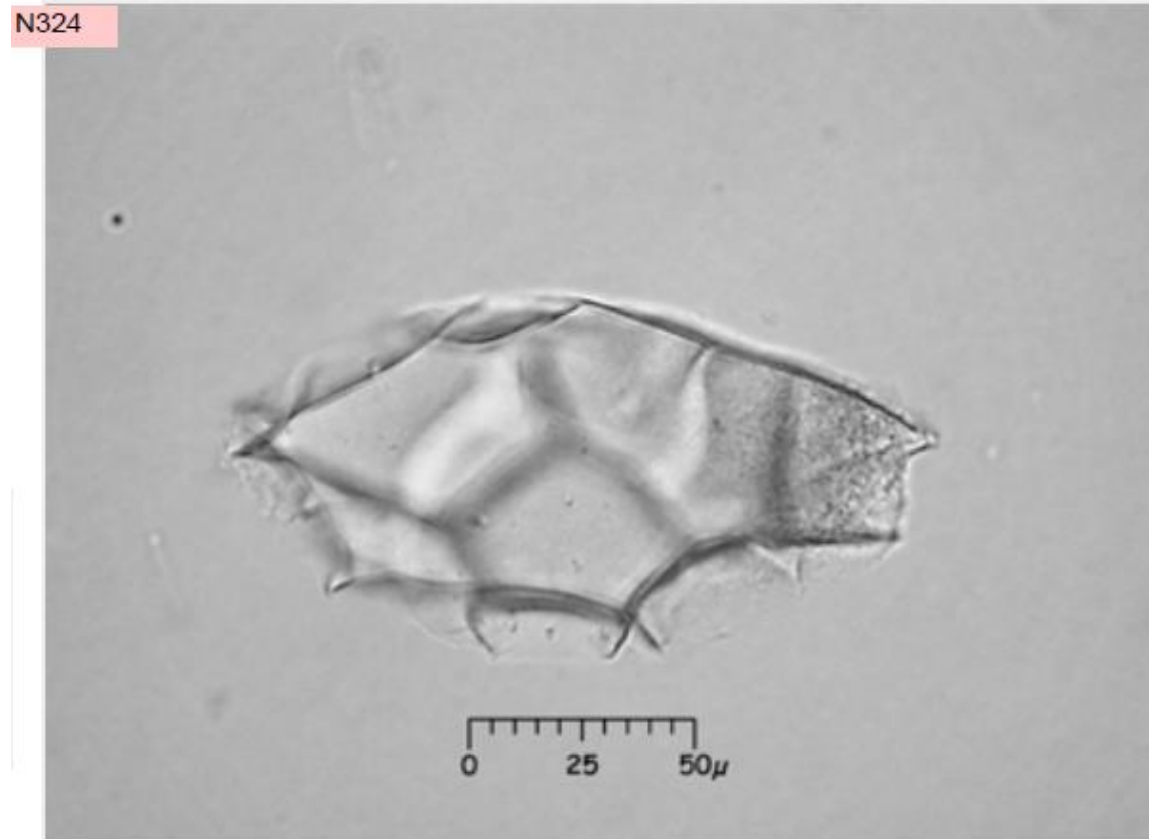
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

EBENACEAE

# Diospyros virginiana

## Phytolith

Faceted hemisphere, side view (see Record #177 for top view).  
Diagnostic level: family

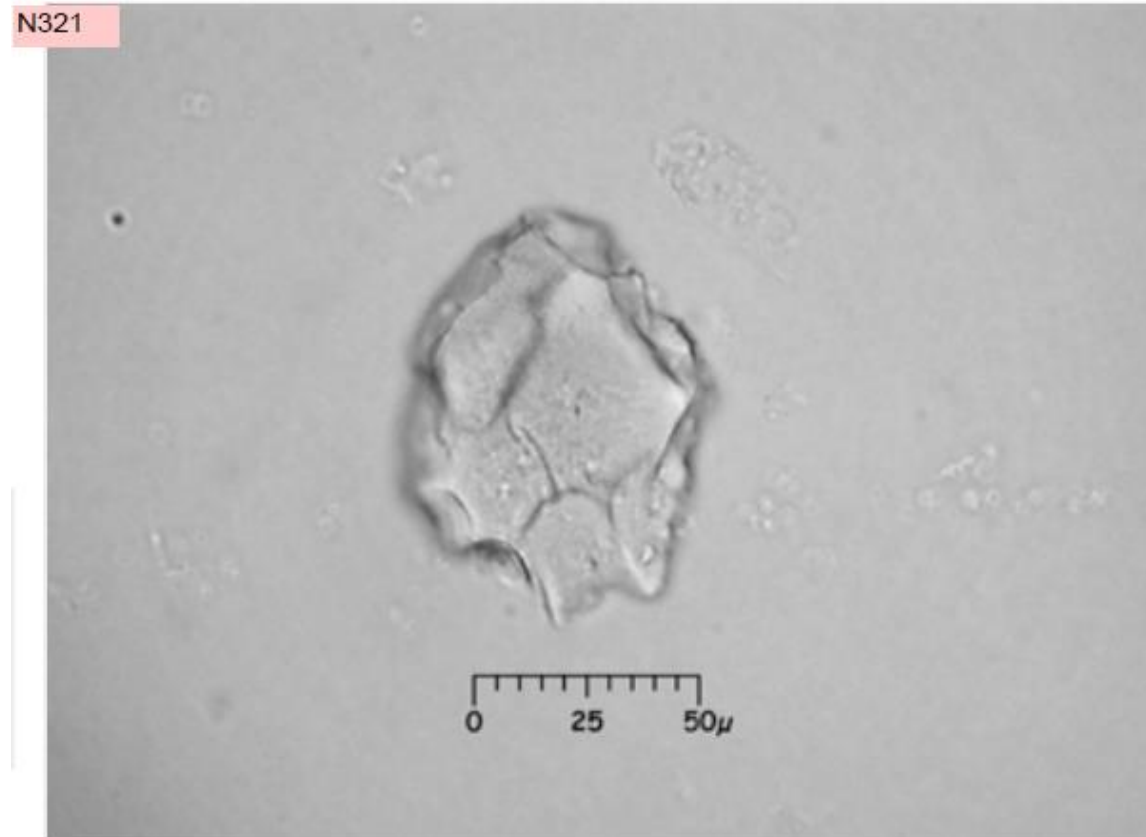


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Diospyros virginiana

## Phytolith

Faceted hemisphere, top view (see Record #176 for side view).  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

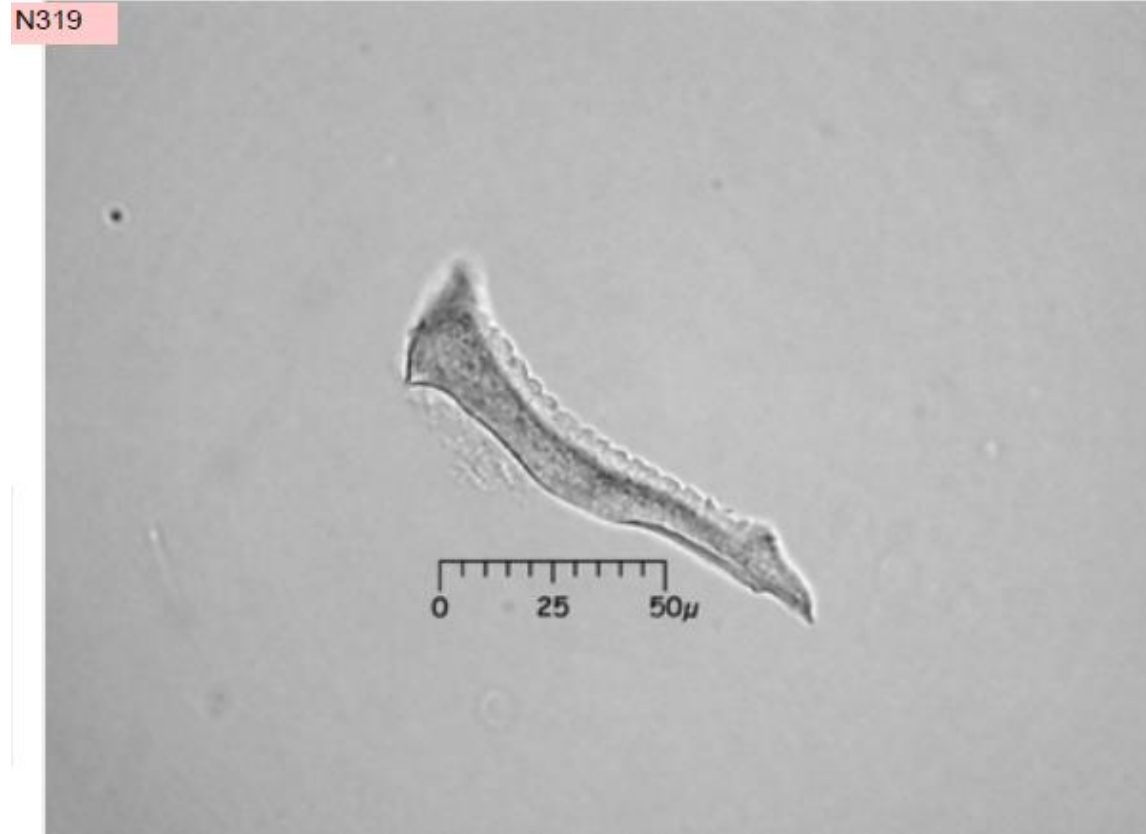


# Diospyros virginiana

## Phytolith

Note interesting "ridge" of bumps gives it a scalloped appearance on the dorsal ridge.

Diagnostic level: generalized arboreal



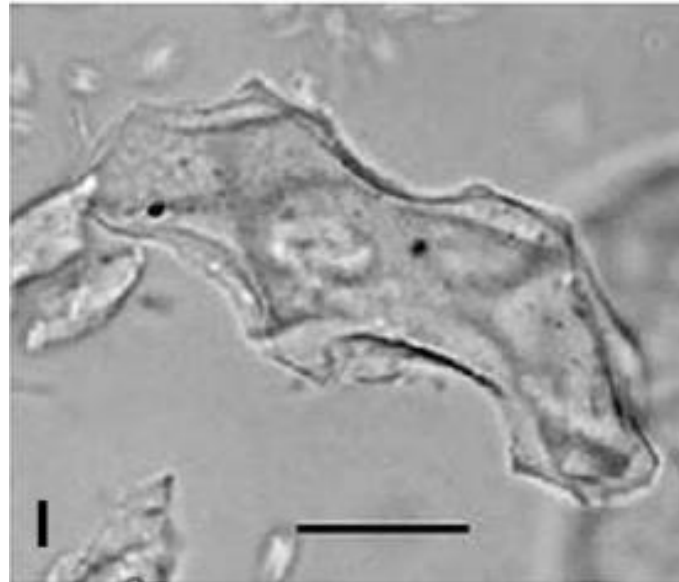
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

ELAEOCARPACEAE

# Sloanea grandiflora

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. I) MFB from *Sloanea grandiflora* leaf



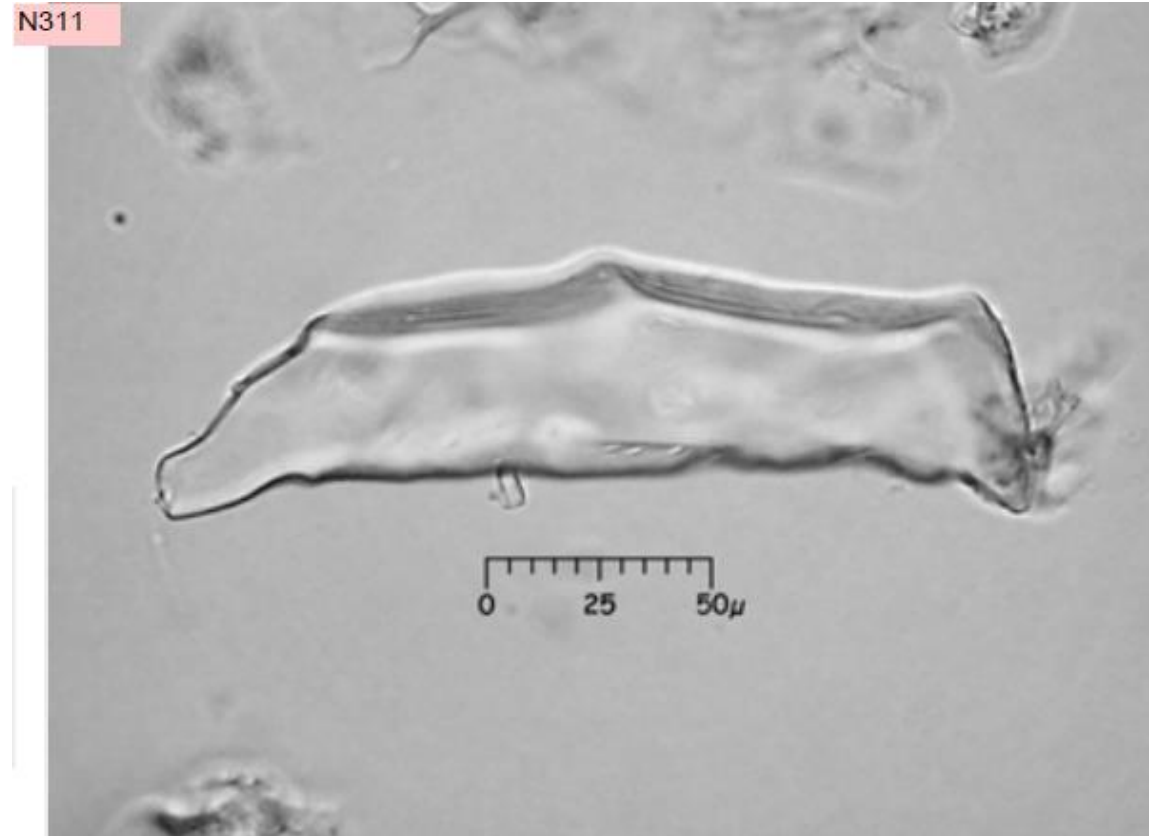
Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

ERICACEAE

# Macleania sp.

## Phytolith

Very large schlerid.  
Diagnostic level: generalized arboreal



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Macleania sp.

## Phytolith

Very large schlerid.  
Diagnostic level: generalized arboreal



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

ERITHROXELACEAE

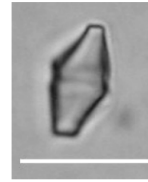
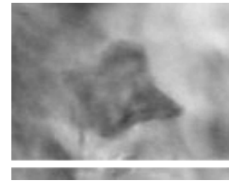
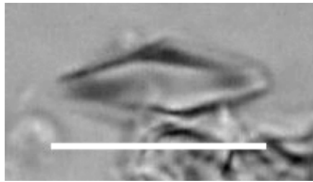
# Erythroxylum coca

Erithroxelaceae *Erythroxylum coca* "coca"

## Phytolith assemblage characterization

a) Tetracuneiform calcium oxalates phytoliths. Very common.

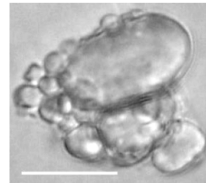
leaf



## Starch assemblage characterization

a) Single grains, oval to spherical, well rounded; variable in size from 10µm to 30µm long length; not-visible hilum and lamella. Some bunch aggregates.

leaf



Scale bar = 20µm.

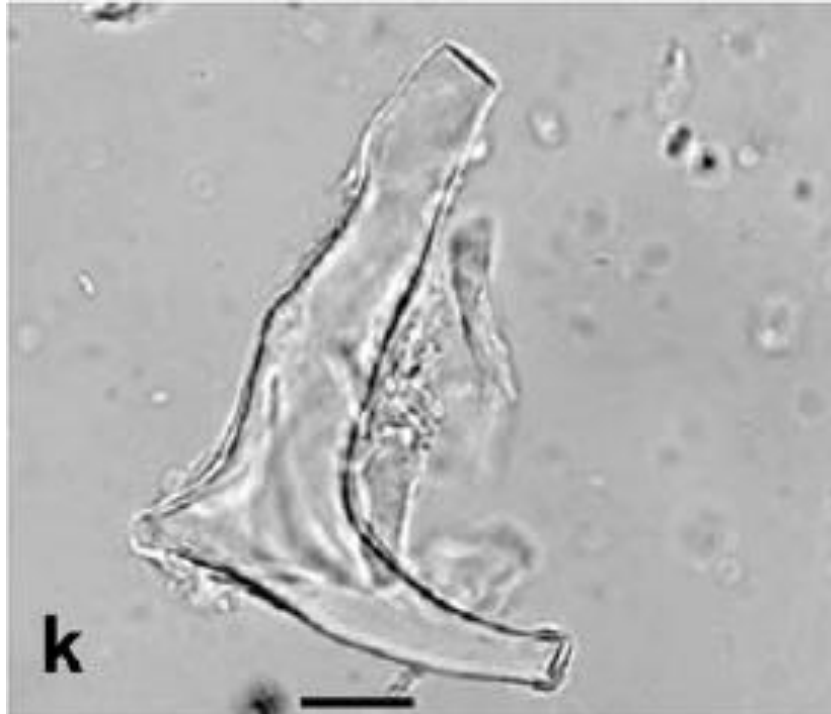
Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection



# Erythroxyllum mucronatum

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. k) Sclereid from *Erythroxyllum mucronatum*



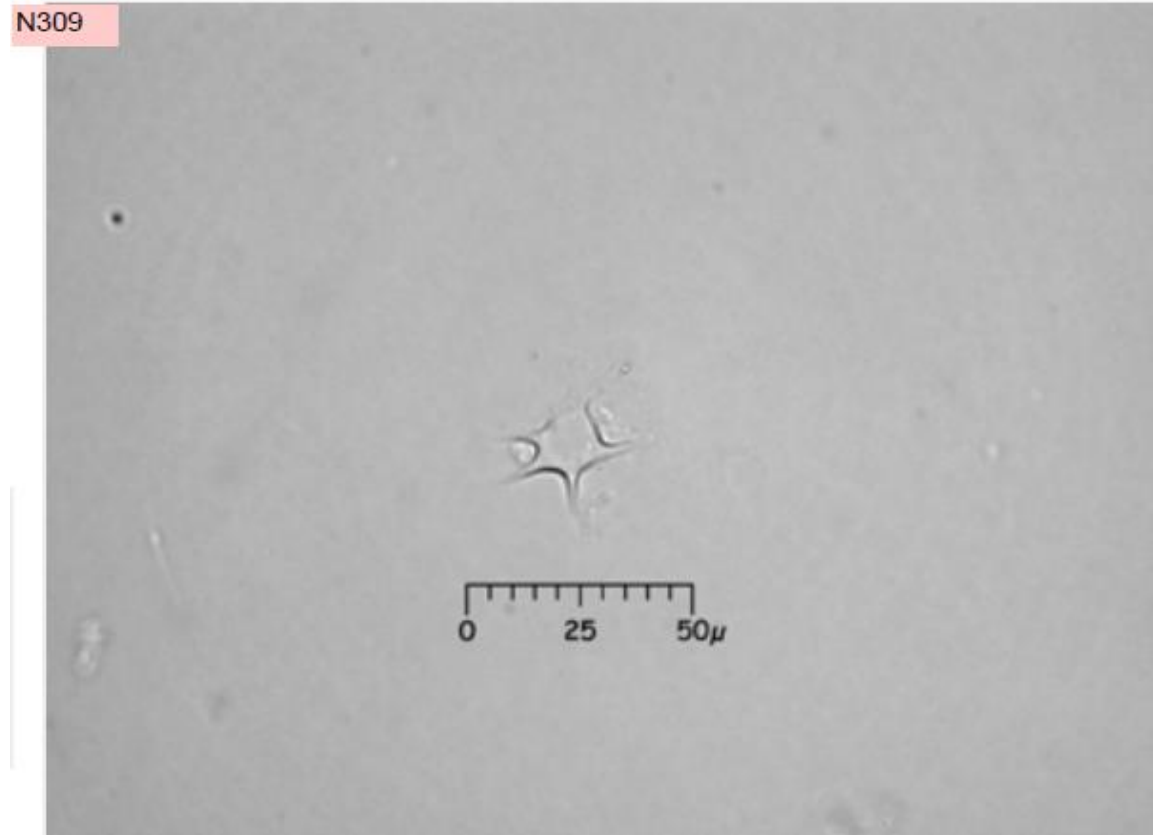
Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

EUPHORBIACEAE

# Acalypha diversifolia

## Phytolith

Diagnostic level: not diagnostic

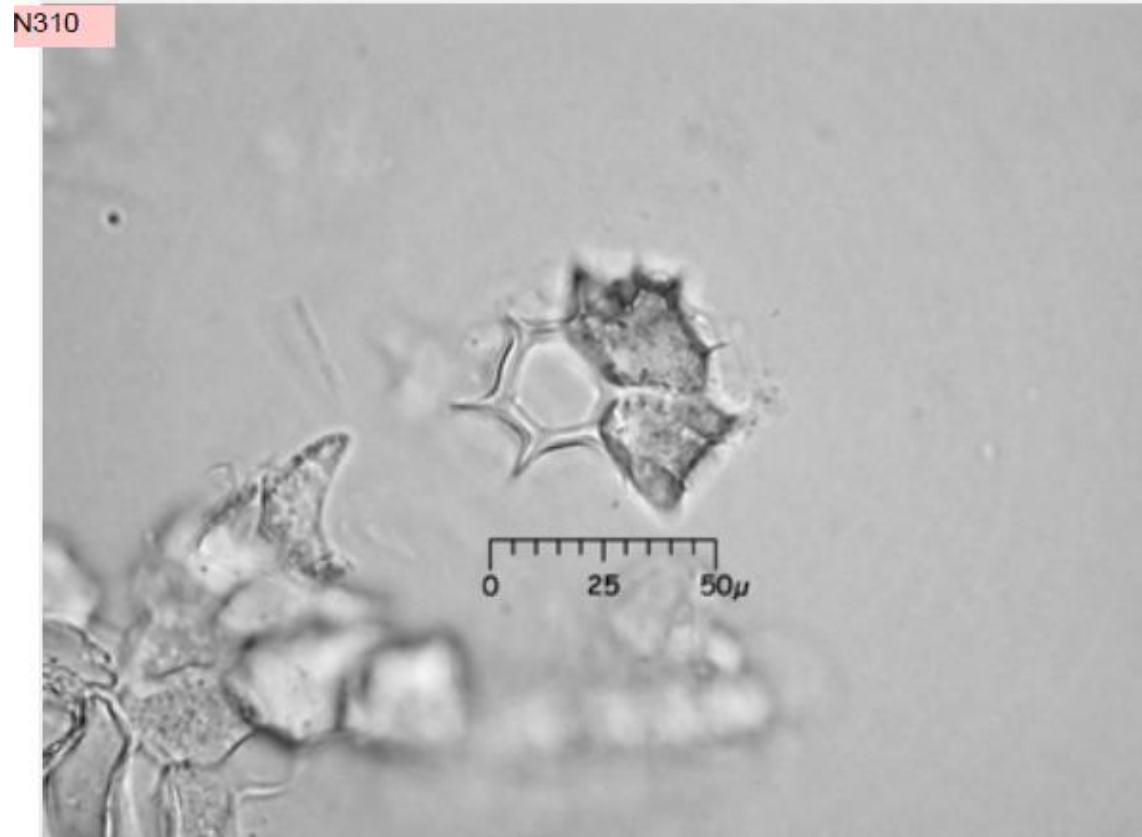


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Acalypha diversifolia

## Phytolith

Diagnostic level: not diagnostic



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Amanoa anomala

## Phytolith

Be sure to rotate blocky quadrilaterals to see the distinct nature of the projections in this type.

See other Euphorbiaceae taxa to see range of variation of this type across the family.

Diagnostic level: family

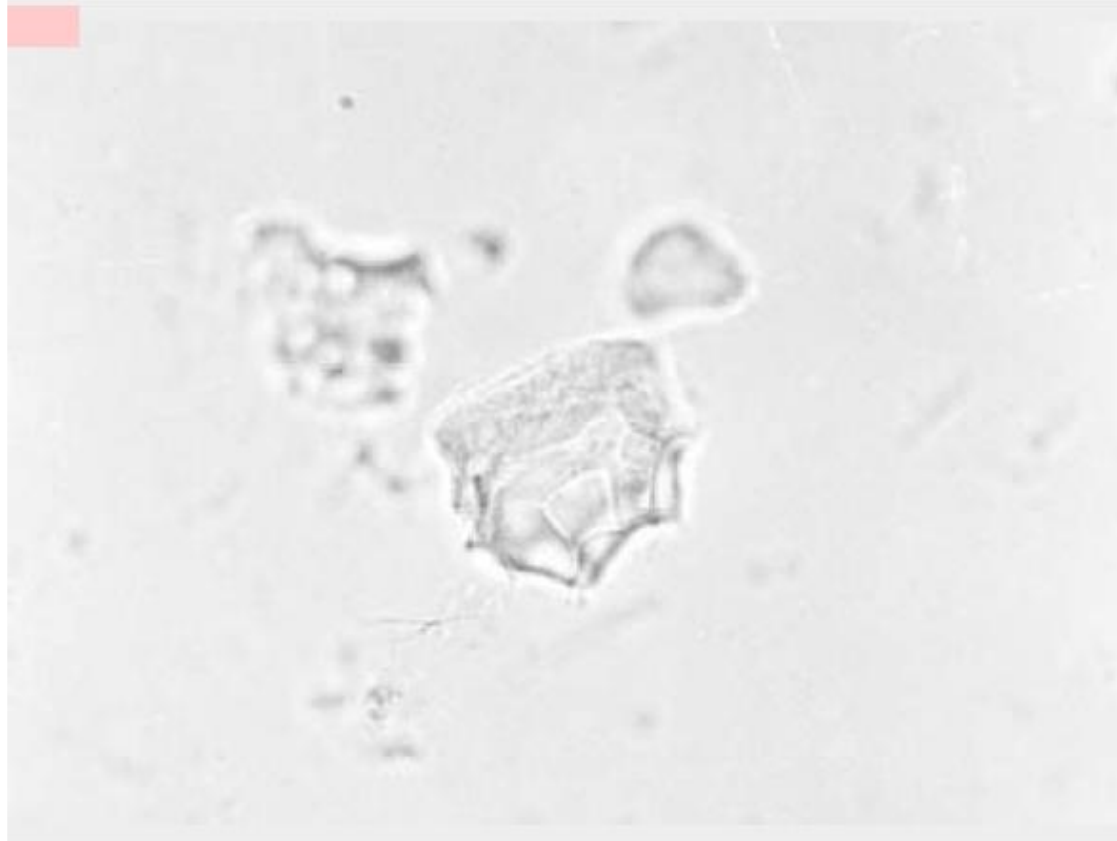


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Amanoa anomala

## Phytolith

Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Amanoa anomala

## Phytolith

View of rounded side... projections not visible, facets not distinct in this view.  
Be sure to rotate to see both views.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Croton fraseri

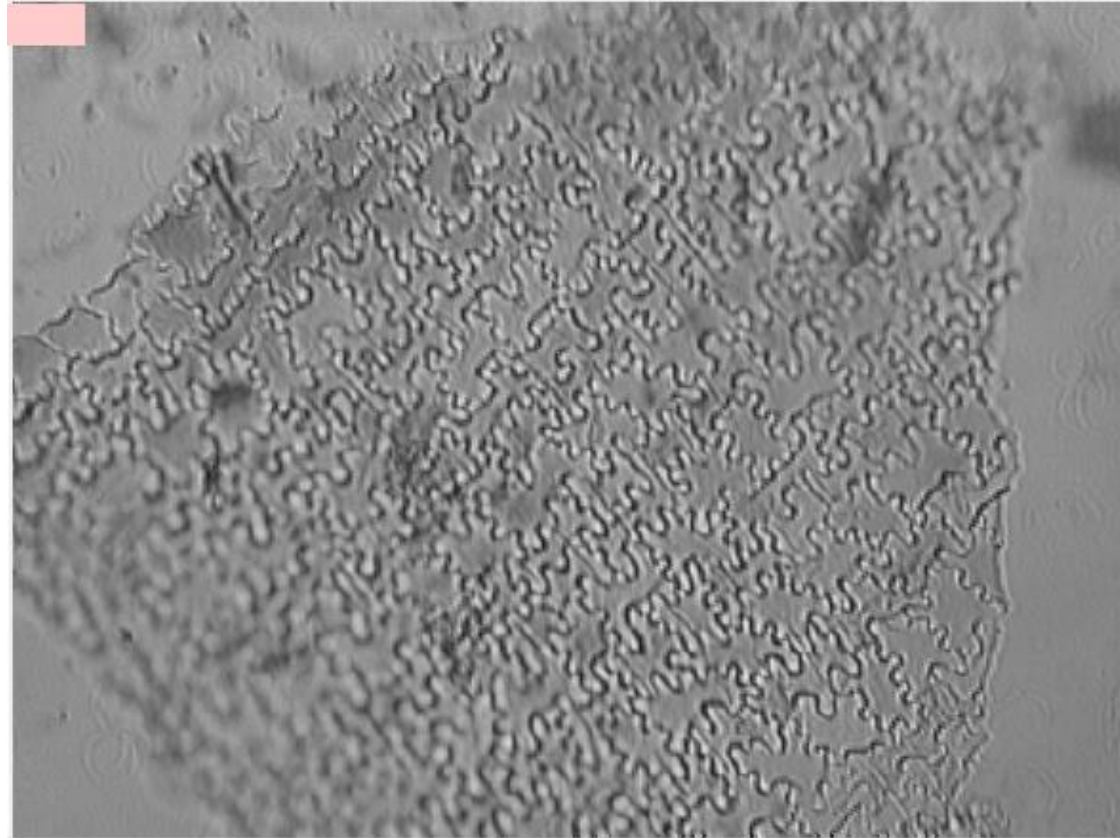
## Phytolith

This type is not diagnostic of Euphorbiaceae. It is produced in a number of dicots.

May occur singly or in sheets of different sizes. This is a particularly large sheet.

May be occluded.

Diagnostic level: not diagnostic



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Croton fraseri

## Phytolith

Blocky quadrilateral epidermal tissue.  
In profile, projections and facets on  
multifaceted face give crown-like  
appearance. Rotate to spot  
multifaceted space and distinguish from  
non-diagnostic 3D epidermal blocks.  
Diagnostic level: family

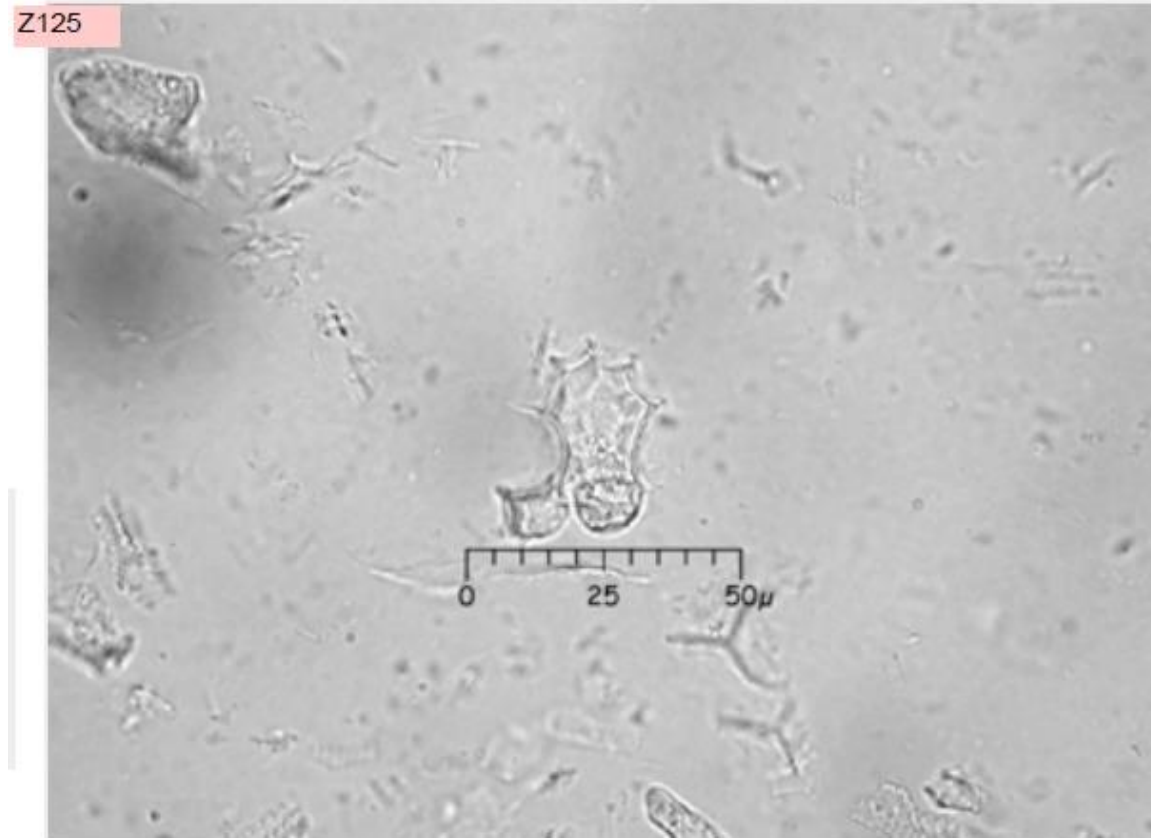


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Croton fraseri

## Phytolith

Blocky quadrilateral. This example is more flattened than usual, showing range of the type.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Croton fraseri

## Phytolith

Can have roughened edges, but many examples are smooth.

Diagnostic level: species



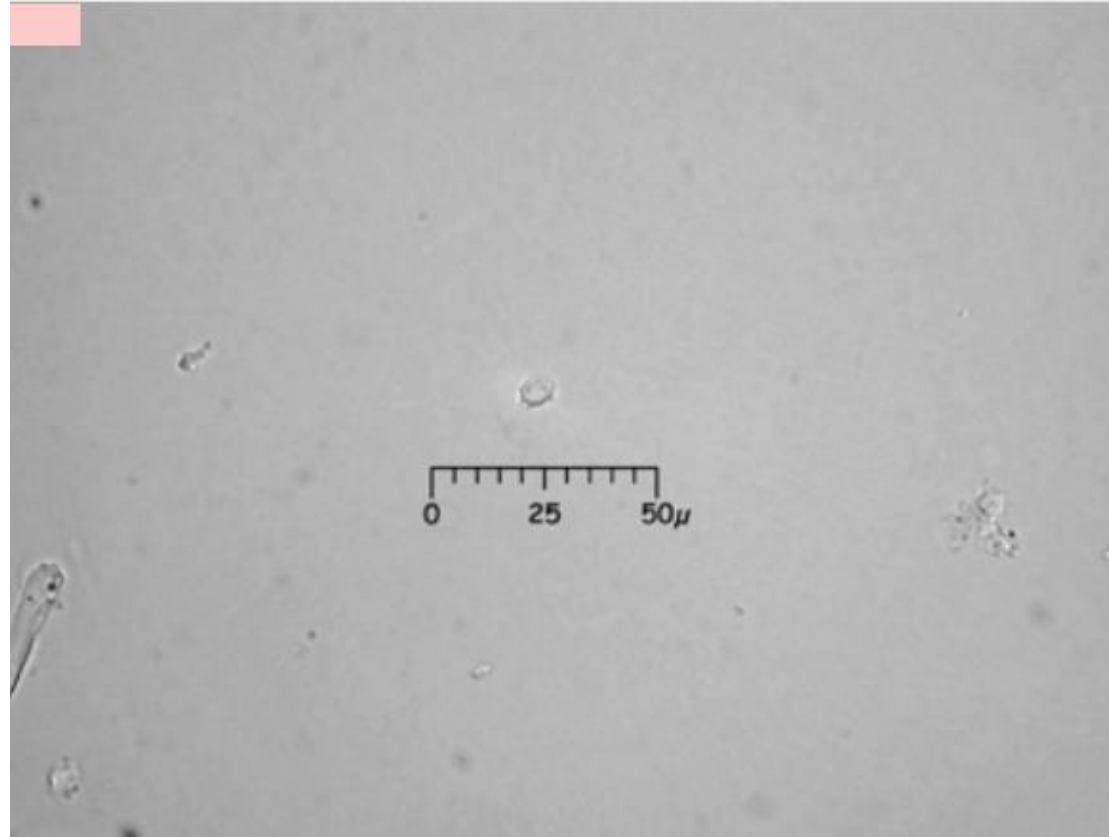
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Manihot esculenta

## Phytolith

Type established by Karol Chandler-Ezell,  
2004

Diagnostic level: genus



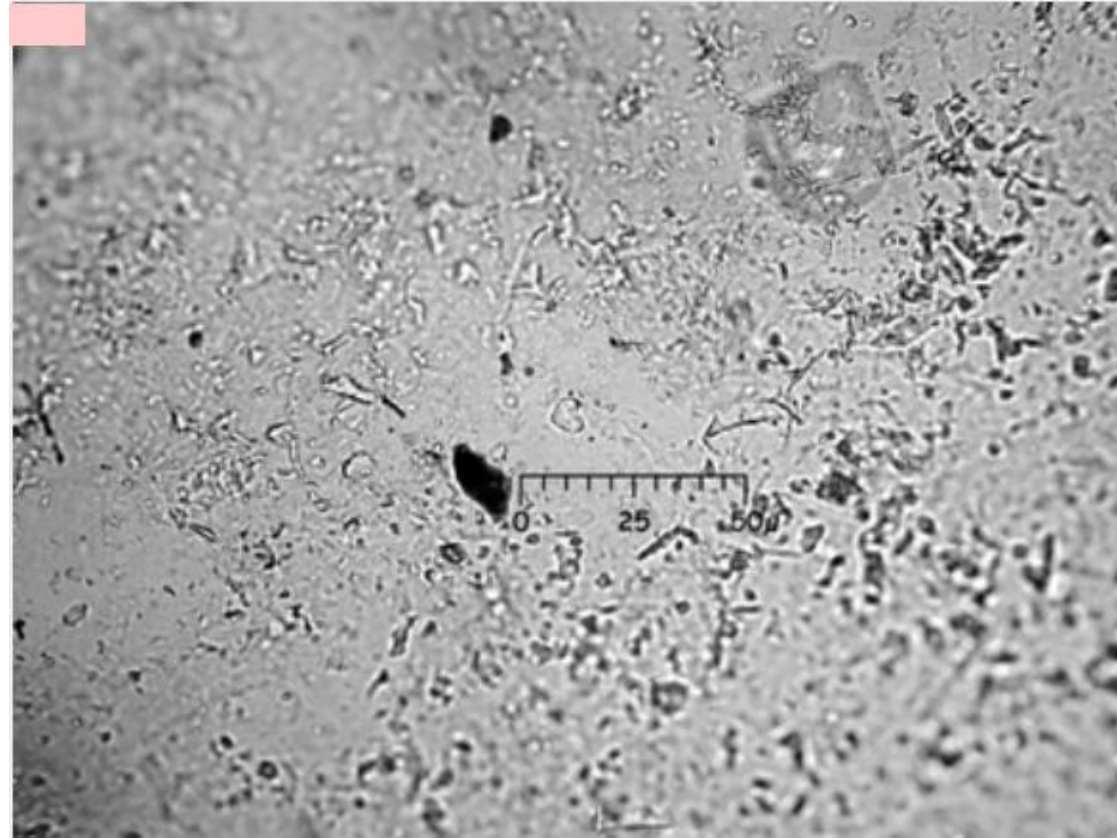
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Manihot esculenta

## Phytolith

Type established by Karol Chandler-Ezell,  
2004

Diagnostic level: genus



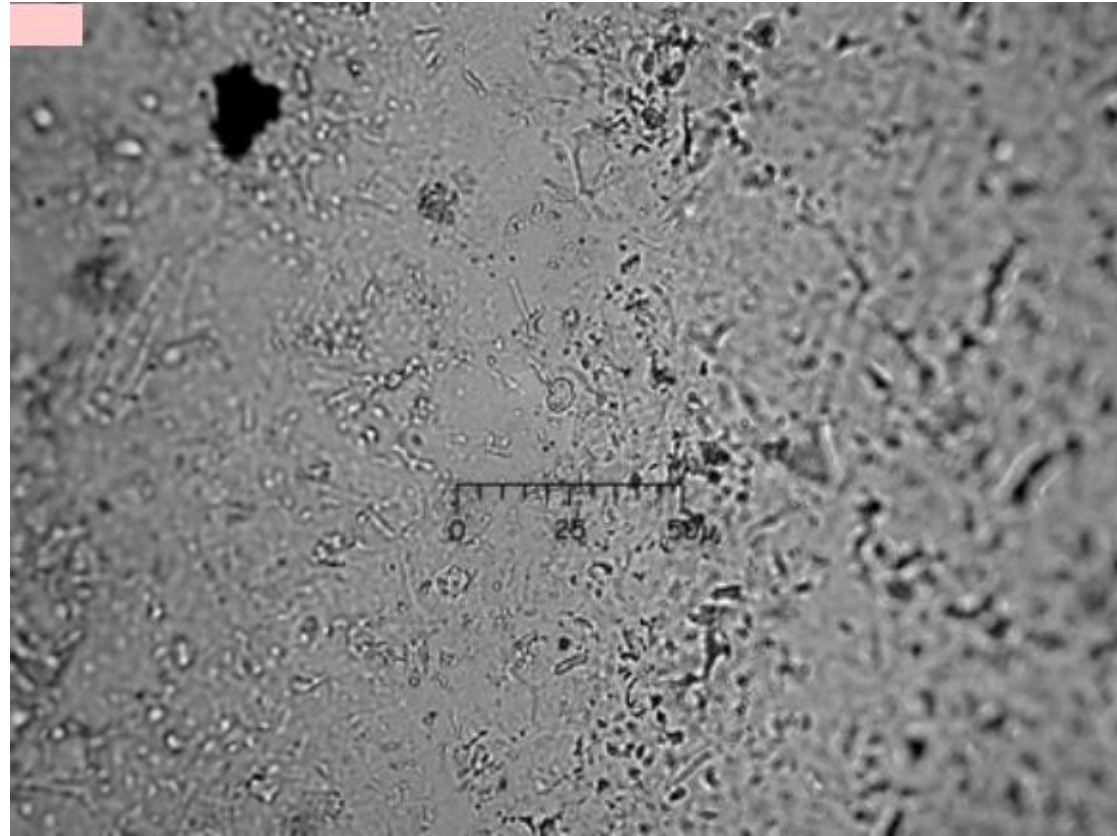
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Manihot esculenta

## Phytolith

Type established by Karol Chandler-Ezell,  
2004

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Manihot esculenta

## Phytolith

Type established by Karol Chandler-Ezell,  
2004

Diagnostic level: genus

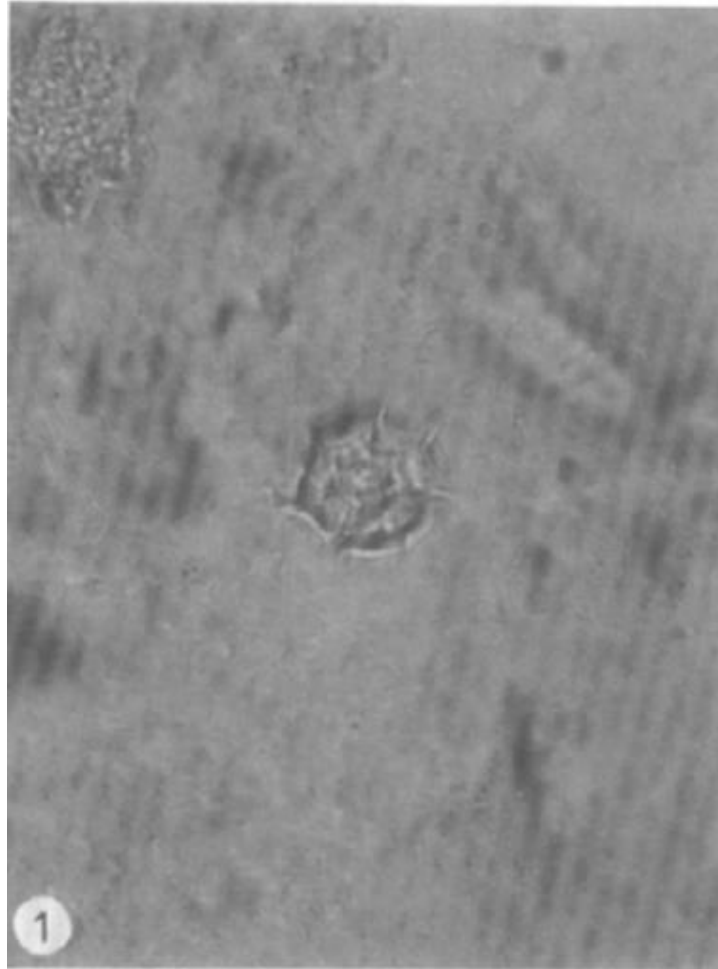


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Manihot esculenta

## Phytolith

1. A stellate hair cell from *Manihot esculenta* (250 x ).

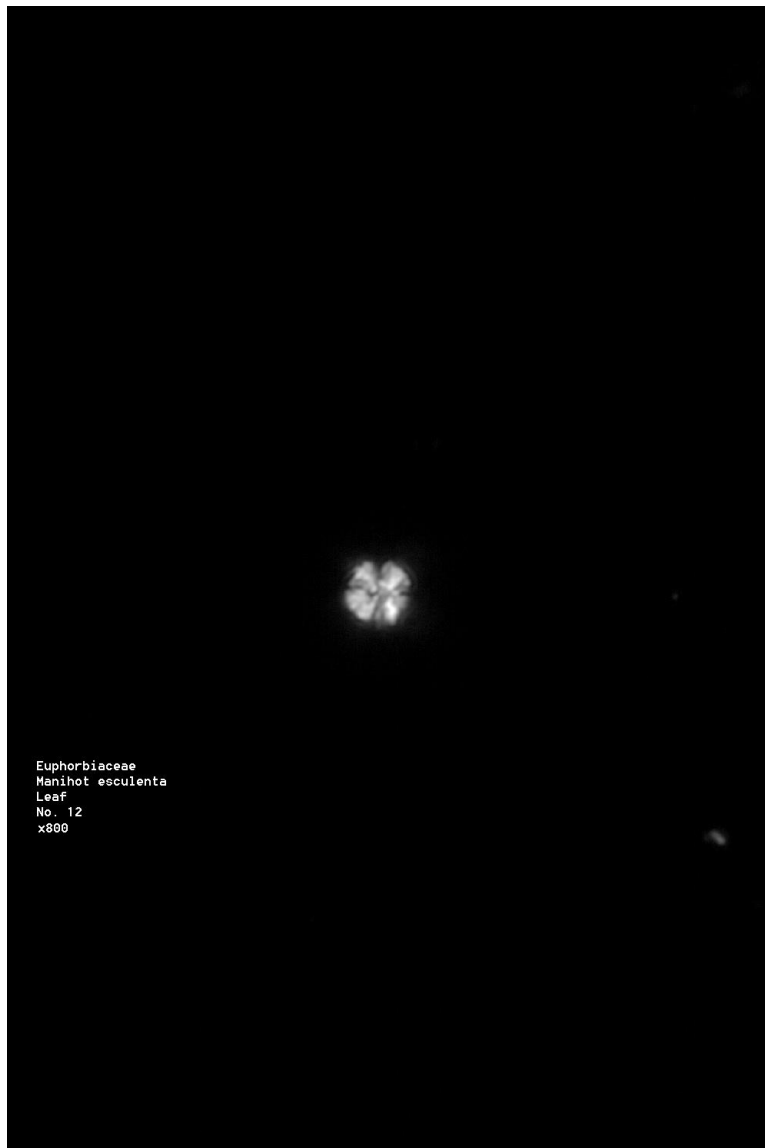


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.



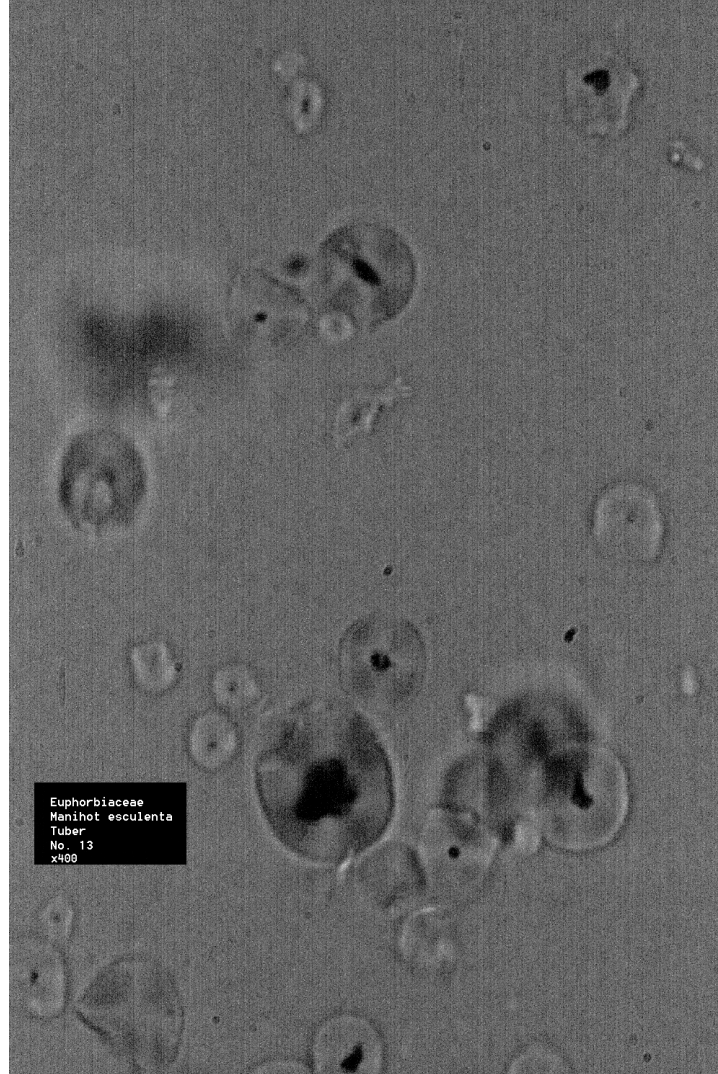
# Manihot esculenta

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Manihot esculenta

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection

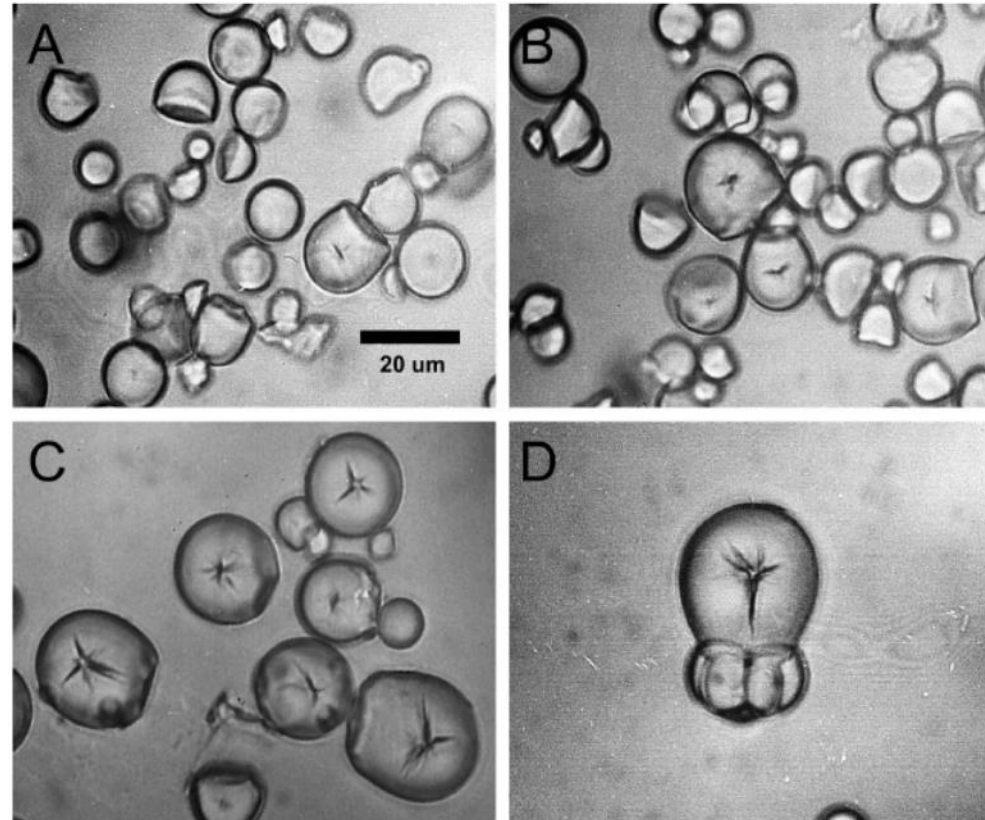


# Manihot esculenta

## Starch

PERRY: STARCH SIZE IN MANIOC AND SWEET POTATO

345



**Fig. 1.** Light micrographs of coastal Peruvian (A, B) and lowland (C, D) types of manioc starch granules showing distinctive and diagnostic features of each. All photographs are at the same magnification.

**A.** Starch granules of manioc roots from Chimu Sur. Note the typical hemispherical forms with linear central fissuring.

**B.** Coastal Peruvian starch granules from modern manioc roots with typical Peruvian form. Note the smaller overall size and less “inflated” quality of hemispherical granules compared to lowland types.

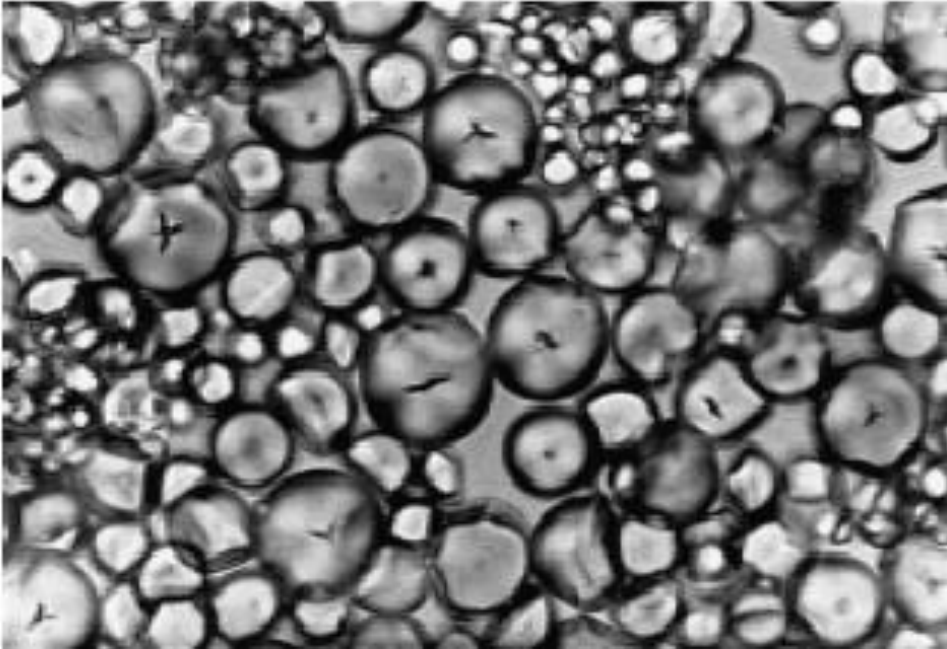
**C.** Modern manioc starch granules from roots from the Upper Rio Negro region of Venezuela. Note the large, central stellate fissure and hollow hilum.

**D.** Compound starch grain of lowland manioc showing how basal faceting occurs during development as small granules form with the larger granule. Note the inflated quality of the large, diagnostic granule.

Perry, Linda. 2002. Starch Granule Size and the Domestication of Manioc (*Manihot Esculenta*) and Sweet Potato (*Ipomoea Batatas*). *Economic Botany* 56 (4):335–49.

# Manihot esculenta

## Starch



Starch grains from a modern manioc tuber. 80x.

### APPENDIX:

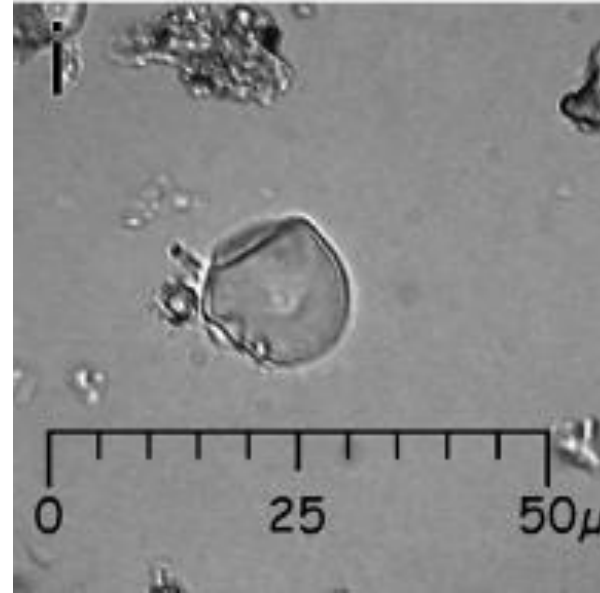
*Manihot esculenta* (manioc, yuca). Mostly compound grains, with very characteristic bell shapes and smooth surfaces. They are not demonstrably laminated. They often possess a diagnostic central fissure that is deep and stellate. Size: 5–20 microns long

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Manihot esculenta

## Starch

Fig. 5. Selected phytoliths and starch granules recovered from tools. See MU Phytolith website (<http://www.missouri.edu/~phyto>) for other photographs. i. *Manihot esculenta* starch granule, SS42 FS3294-B.



Chandler-Ezell, Karol, Deborah Marie Pearsall, and James A. Zeidler. 2006. Root and Tuber Phytoliths and Starch Grains Document Manioc (*Manihot Esculenta*), Arrowroot (*Maranta Arundinacea*), and Llerén (*Calathea Sp.*) at the Real Alto Site, Ecuador. *Economic Botany* 60 (2):103–20.

[http://www.bioone.org/doi/abs/10.1663/0013-0001\(2006\)60%5B103:RATPAS%5D2.0.CO%3B2](http://www.bioone.org/doi/abs/10.1663/0013-0001(2006)60%5B103:RATPAS%5D2.0.CO%3B2).

# Manihot esculenta

## Starch

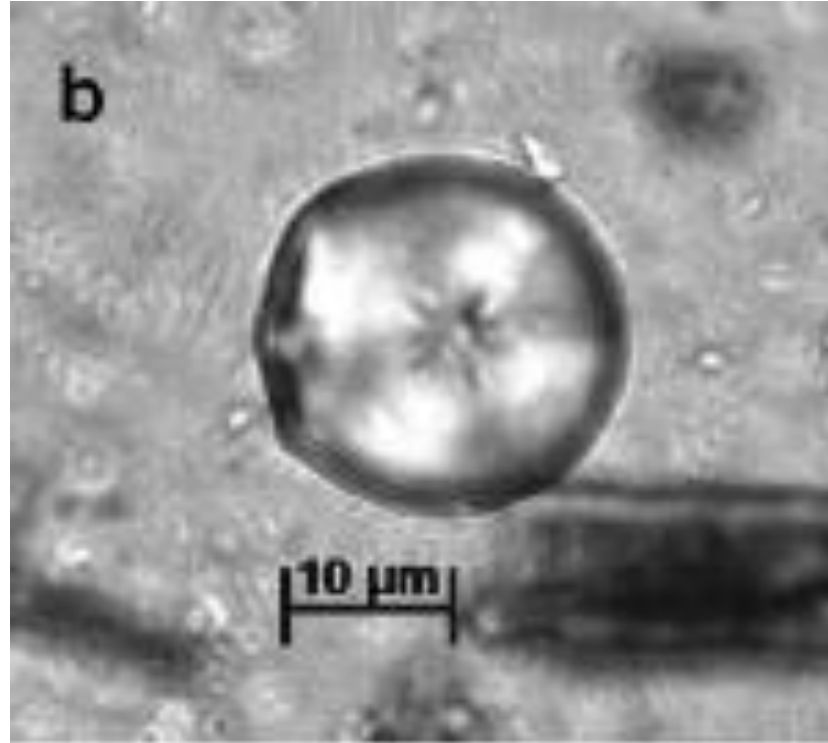


Fig. 5. Selected microbotanical remains. Starch grains: b) *Manihot esculenta* (SAL 04-4-3597)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Manihot esculenta

## Starch

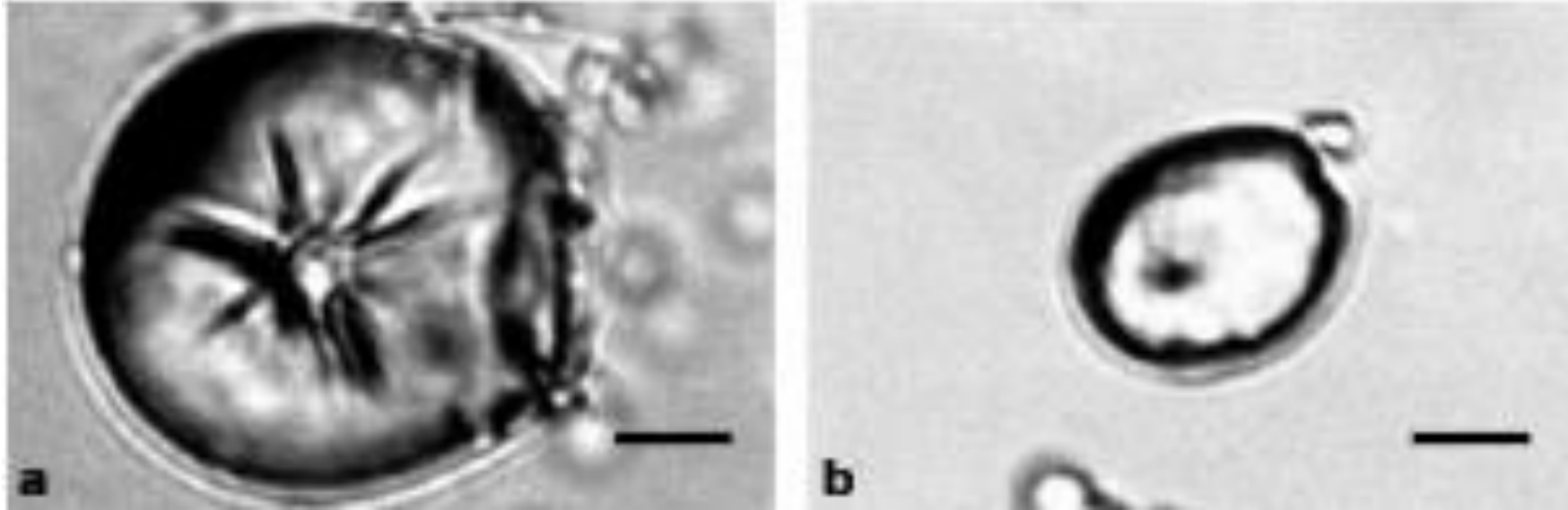


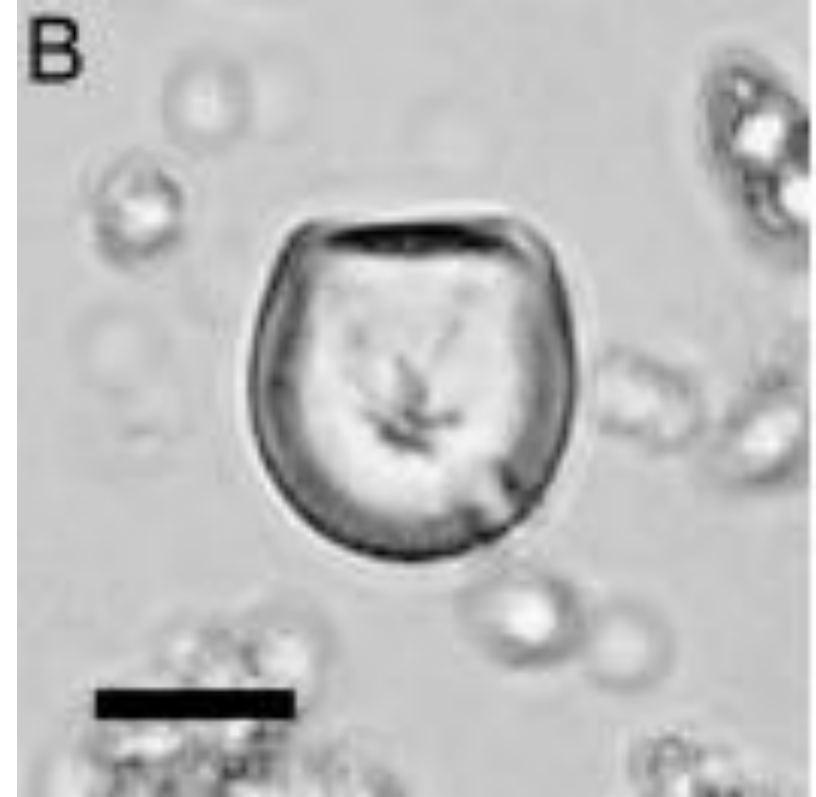
Figure 1. Various starch grains. a, A starch grain from manioc recovered from milling stone 42. b, A starch grain from the putative wild ancestor of manioc, *Manihot esculenta* spp. *flabellifolia*. Scale bar 5  $\mu\text{m}$

Piperno, Dolores R., Anthony J. Ranere, Irene Holst, and Patricia Hansell. 2000. Starch Grains Reveal Early Root Crop Horticulture in the Panamanian Tropical Forest. *Nature* 407:894–97.

# Manihot esculenta

## Starch

Fig. 2. Selected archaeological starch grains. (B) Manioc (Manihot esculenta) starch from Casita de Piedra, grinding-stone base 69/18, ?3600 cal BP. (Scale bar: 10  $\mu$ m) Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8.

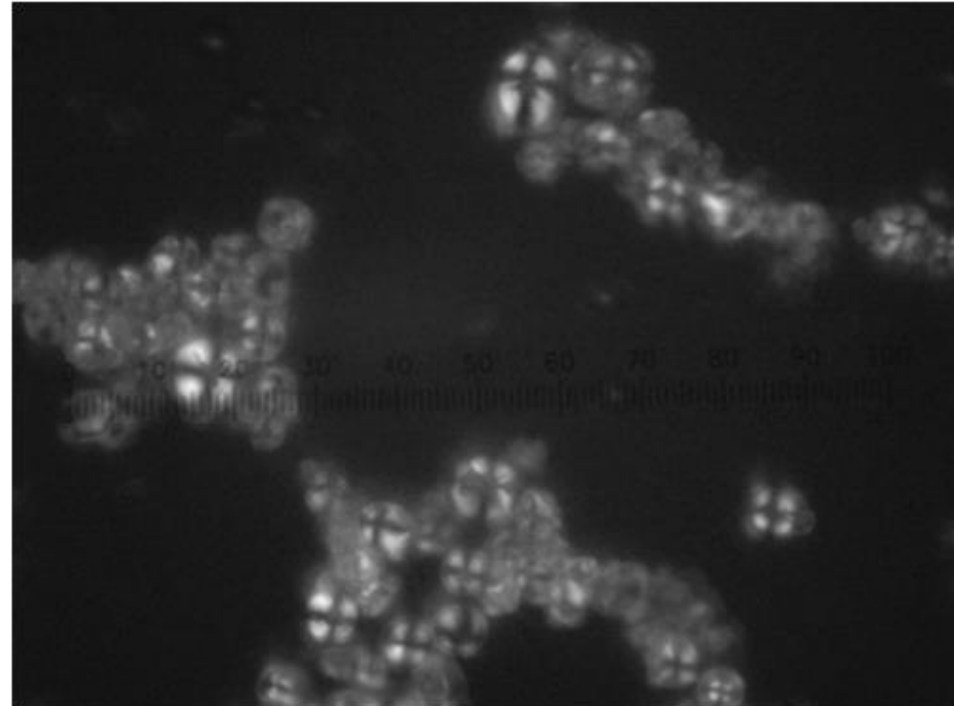
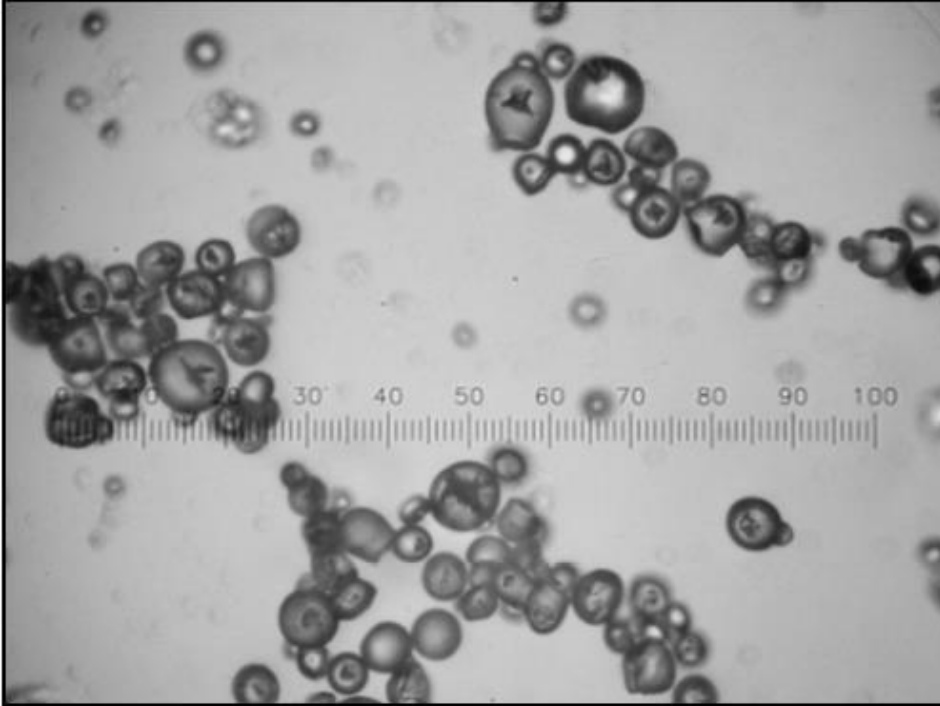


Dickau, Ruth, Anthony J. Ranere, and Richard G. Cooke. 2007. Starch Grain Evidence for the Preceramic Dispersals of Maize and Root Crops into Tropical Dry and Humid Forests of Panama. *Proceedings of the National Academy of Sciences of the United States of America* 104 (9):3651–56.



# Manihot esculenta

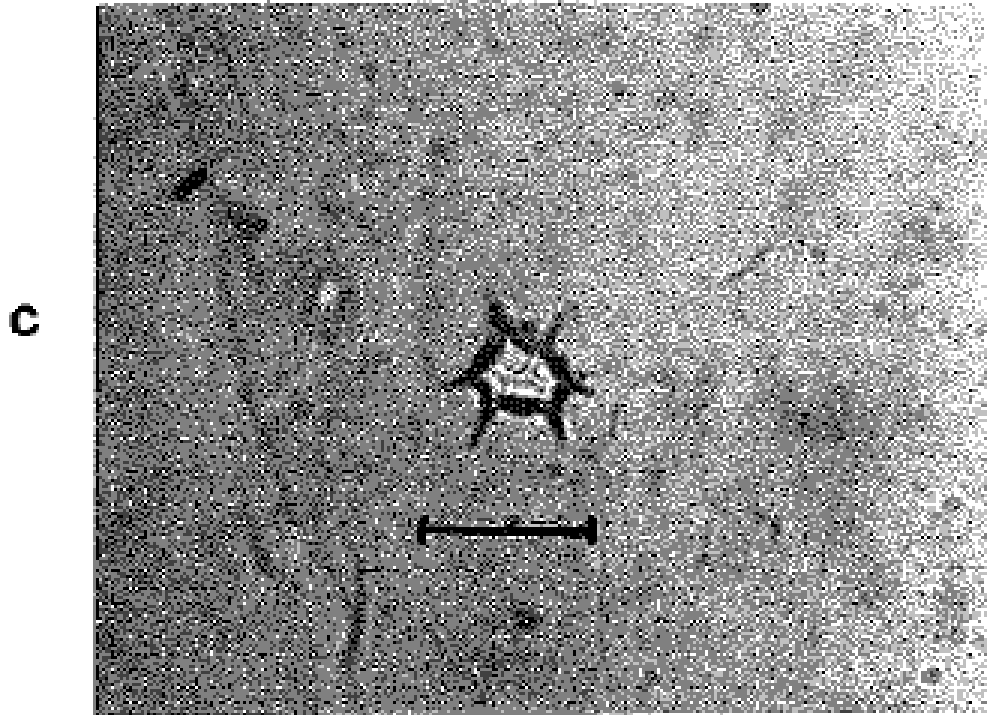
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Manihot esculenta

## Phytolith



c. Hair cell base from manioc, *Manihot esculenta*

Pearsall, Deborah Marie. 1993. Contributions of Phytolith Analysis for Reconstructing Subsistence: Examples from Research in Ecuador. *Current Research in Phytolith Analysis: Applications in Archaeology and Paleoecology*. MASCA.

# Manihot sp.

## Phytolith

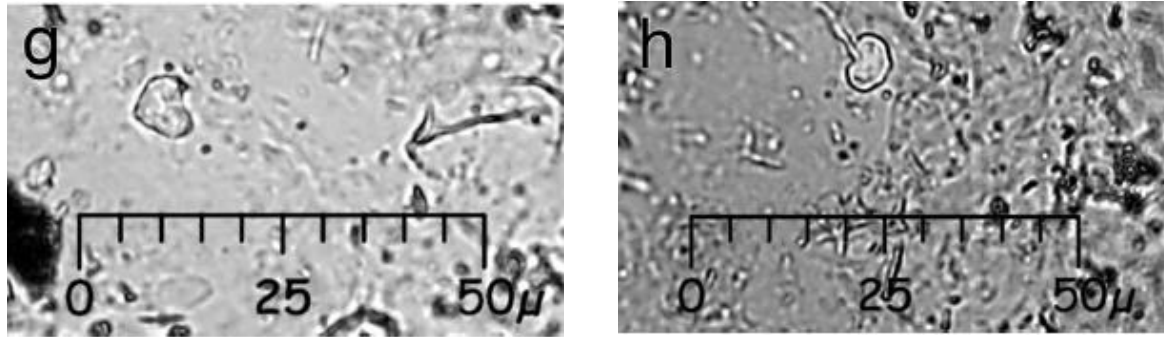


Fig. 1. Selected new diagnostic phytoliths. See MU Phytolith website (<http://www.missouri.edu/~phyto>) for photographs of all types. g, h. 160l Manihot (Euphorbiaceae) secretory cell

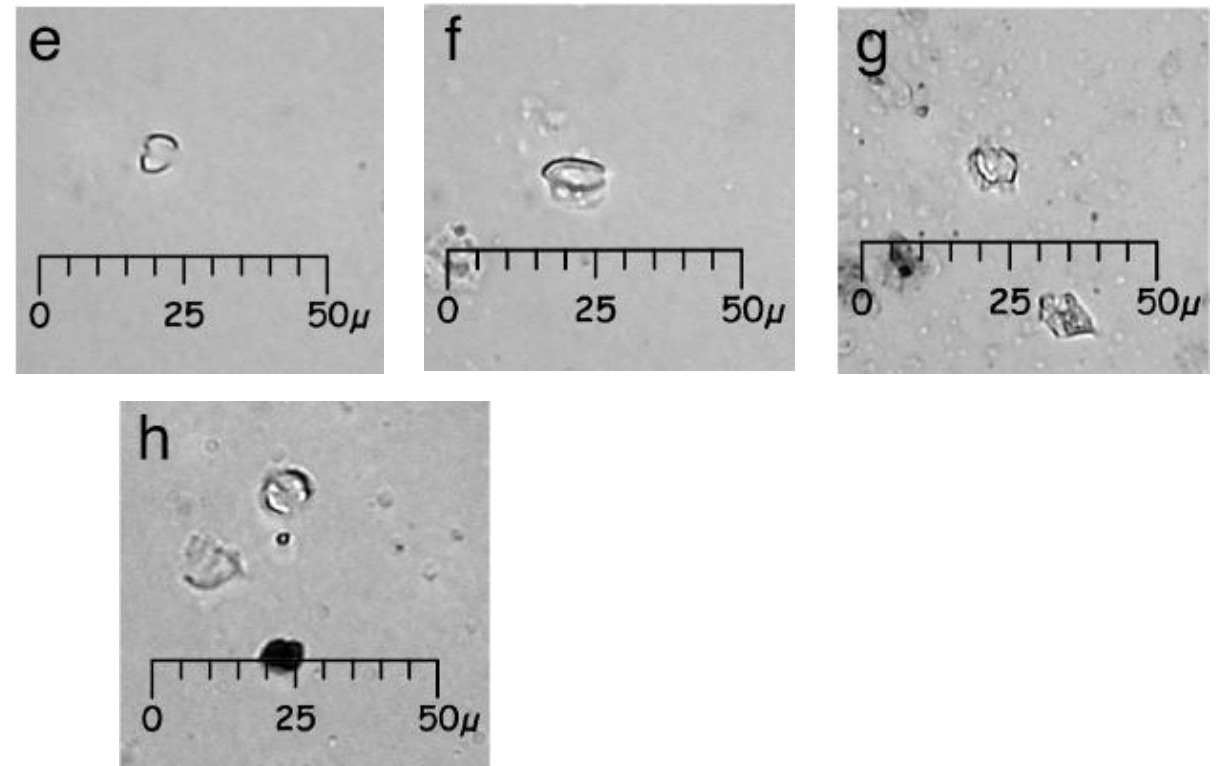
Chandler-Ezell, Karol, Deborah Marie Pearsall, and James A. Zeidler. 2006. Root and Tuber Phytoliths and Starch Grains Document Manioc (*Manihot Esculenta*), Arrowroot (*Maranta Arundinacea*), and Llerén (*Calathea Sp.*) at the Real Alto Site, Ecuador. *Economic Botany* 60 (2):103–20.

[http://www.bioone.org/doi/abs/10.1663/0013-0001\(2006\)60%5B103:RATPAS%5D2.0.CO%3B2](http://www.bioone.org/doi/abs/10.1663/0013-0001(2006)60%5B103:RATPAS%5D2.0.CO%3B2).

# Manihot sp.

## Phytolith

Fig. 5. Selected phytoliths and starch granules recovered from tools. See MU Phytolith website (<http://www.missouri.edu/~phyto>) for other photographs e. 160I Manihot secretory cell, PS1804FS 3294-B. f. 160I Manihot secretory cell, PS1804FS 3294-B. g. 160I Manihot secretory cell, PS3, Structure 20 floor sediment. h. 160I Manihot secretory cell, PS1804 FS3294-B.



Chandler-Ezell, Karol, Deborah Marie Pearsall, and James A. Zeidler. 2006. Root and Tuber Phytoliths and Starch Grains Document Manioc (*Manihot Esculenta*), Arrowroot (*Maranta Arundinacea*), and Llerén (*Calathea Sp.*) at the Real Alto Site, Ecuador. *Economic Botany* 60 (2):103–20.

[http://www.bioone.org/doi/abs/10.1663/0013-0001\(2006\)60%5B103:RATPAS%5D2.0.CO%3B2](http://www.bioone.org/doi/abs/10.1663/0013-0001(2006)60%5B103:RATPAS%5D2.0.CO%3B2).

FABACEAE

# Fabaceae

## Starch

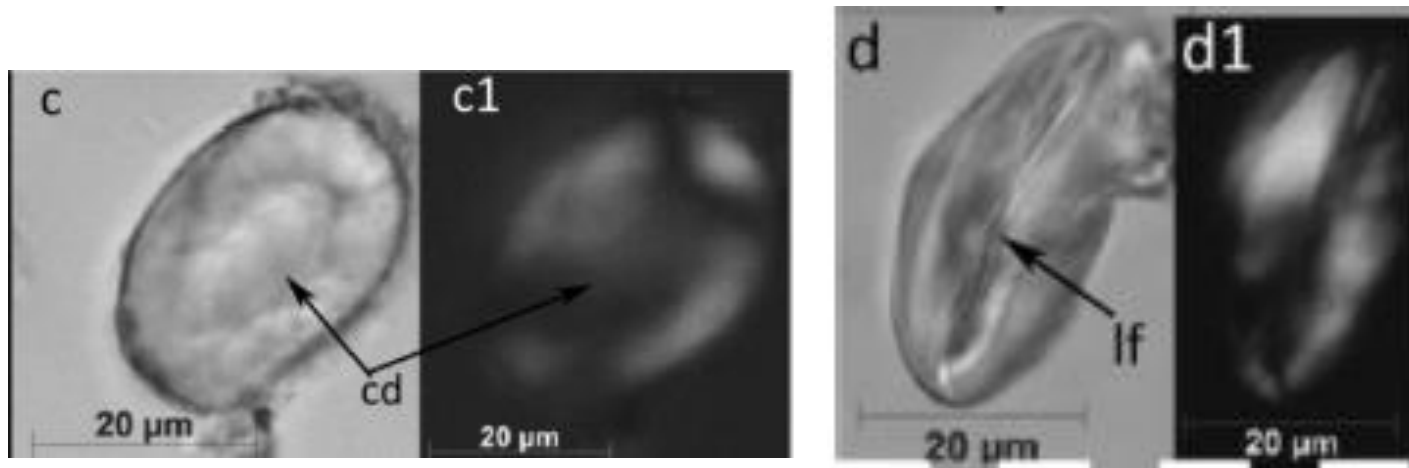


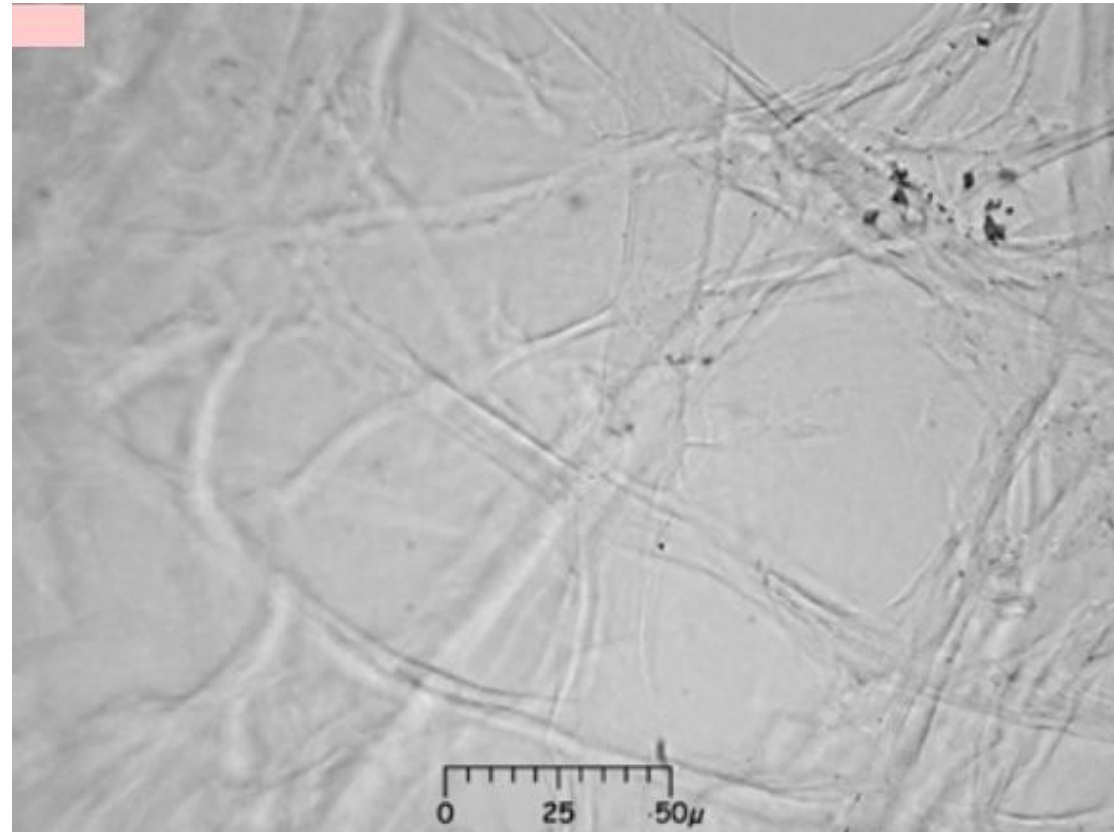
Fig. 9. Other ancient starch grains (a-g) recovered at St. John and Eva 2. c, Fabaceae starch with central depression (“cd”), c1, the same starch reflecting damaging signs at the center as noted by the extinction cross; d, Fabaceae starch in lateral (eccentric) view with a longitudinal fissure (“lf”); d1, the same starch projecting the extinction cross.

# Acacia macrocantha

## Phytolith

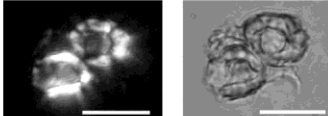
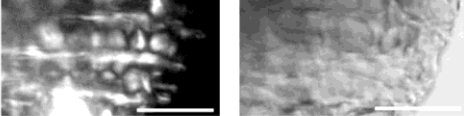
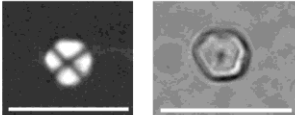
Type established by Karol Chandler-Ezell, 2004

Diagnostic level: family, seeds/pods



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Acacia visco

Leguminosae <i>Acacia visco</i> "visco"	
<b>Phytolith assemblage characterization</b>	
pod	<b>References:</b> Reported as rare in Piperno 1988:37 for <i>Acacia farnesiana</i> epidermis.
seed and seminal coverig	No diagnostic phytoliths (*).  <b>References:</b> Reported as rare in Piperno 1988:37 for <i>Acacia farnesiana</i> epidermis.
<b>Starch assemblage characterization</b>	
pod	<p>a) Single grains, oval to spherical; variable in size, from 18µm to 25µm long length; not visible hilum and lamella; a centric hollow with a similar shape to the contour of the grain; distinct centric cross, with four arms visible, meeting at a dark oval or circular hollow.</p>  <p>b) Compound grains, with a single external package elongated, variable in shape, size, and number of granula. Granula; uncertain shaped; ca. 10µm; not-visible hilum and lamella; distinct centric cross, with four arms visible, intersecting at a line or a dark center.</p> 
seed and seminal coverig	<p>a) Single grains, polyhedral, six-sided; ca. 8µm long length; distinct centric hilum as a dot; not visible lamella; distinct centric cross, with four arms visible.</p> 

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection



# Anadenanthera colubrina

Leguminosae *Anadenanthera colubrina* "cebil or vilca"

**Phytolith assemblage characterization**

Non diagnostic phytoliths (\*):

a) Round planar silica phytolith. Rare.

b) Sub-spherical central depressed silica phytolith. Not common.

c) Polyhedral central depressed silica phytolith. Rare.

d) Irregular silica phytoliths. Rare.

**Starch assemblage characterization**

a) Single grains, oval and spherical; variable in size, from 6µm to 10µm long length; not visible hilum and lamella; a centric circular, oval or elliptical hollow with a similar shape to the contour of the grain; distinct centric cross, with four arms visible, meeting at a dark oval or circular hollow. May occur in bunch aggregates.

b) Typically, compound grains; spindle-shaped; regular size, from 80µm to 85µm long length, without a single external packing, compounded by a variable number or granula. Granula with distinct cross.

c) Another compound grains, fiber-like, with a single external package; variable in size and number of granula. Granula; uncertain shaped; ranging in size from 10µm to 17µm long length; very distinct centric hilum as a line or v-shaped; distinct centric cross, with four arms visible.

fruit

seed and seminal covering

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Anadenanthera peregrina

## Starch

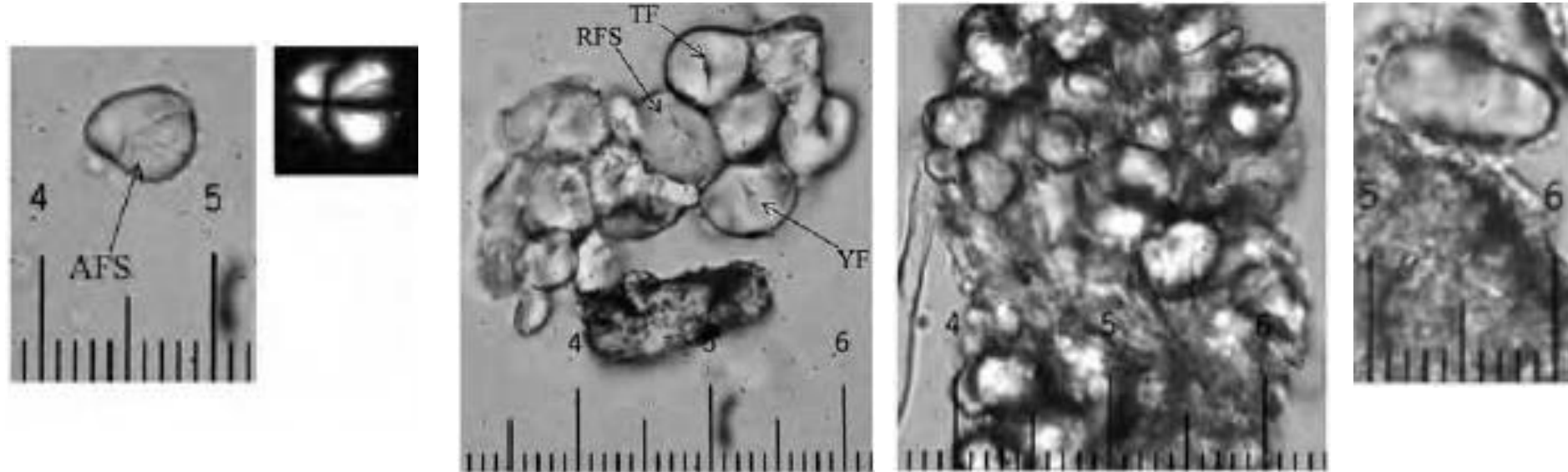


Figure 6. Modern starch grains from *Anadenanthera peregrina*. Starch grain from mature seeds and starch grain cluster showing shapes, dimensions, and types of fissures that are common in *A. peregrina*. AFS = asymmetrical fissures and striations; RFS = radial fissure and striations; TF = transversal fissure; YF = “Y” shaped fissure. Note: oval starch grain at the extreme right; transovate-obtuse starch grain at the extreme left. Scale for all microphotographs: space between major units (numbers) = 37.5  $\mu\text{m}$ .

Pagán-Jiménez, Jaime R., and Lisabeth A. Carlson. 2014. Recent Archaeobotanical Findings of the Hallucinogenic Snuff Cojoba (*Anadenanthera Peregrina* (L.) Speg.) in Precolonial Puerto Rico. *Latin American Antiquity* 25 (1):101–16.

# Anadenanthera peregrina

## Starch

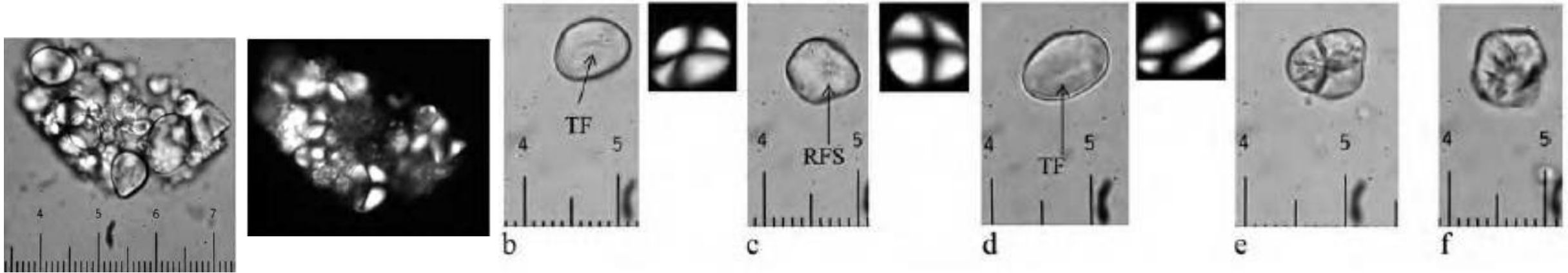


Figure 7. Starch grains recovered from the coral milling base from CE-11: (a) starch grain cluster from cojoba or *A. peregrina* (to the right is the same cluster cross-polarized in dark field); (b) oval starch grain with a transversal fissure (the same cross-polarized); (c) transovate-obtuse starch grain with thin striations and radial fissure that are typical of *A. peregrina* (the same cross-polarized); (d) oval starch grain (the same cross-polarized); (e) and (f) broken starch grains, probably broken by the grinding process. TF = transversal fissure; RFS = radial fissure and striations. Scale for all microphotographs: space between major units (numbers) = 37.5  $\mu\text{m}$

# Anadenanthera peregrina

## Starch

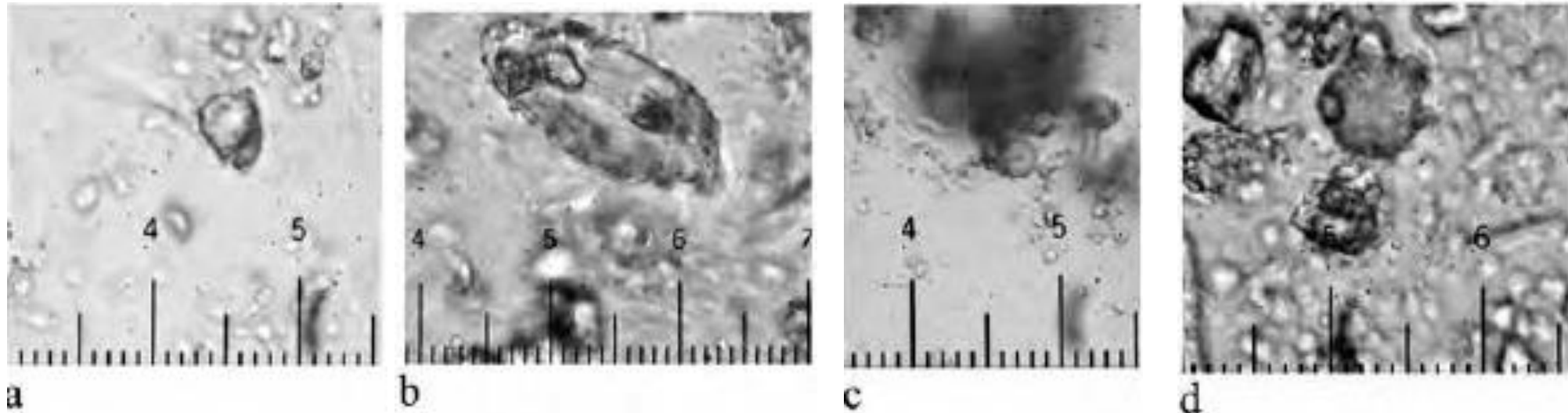


Figure 8. Modified and/or damaged starch grains from modern *Anadenanthera peregrina* (cojoba) seeds after parching (toasting). All the starches lost their extinction crosses, some of them (b) quadrupled their size due to the gelatinization process, and others (c) revealed a small circumscribed central depression (“scoop”). Scale for all microphotographs: space between major units (numbers) = 37.5  $\mu\text{m}$ .

Pagán-Jiménez, Jaime R., and Lisabeth A. Carlson. 2014. Recent Archaeobotanical Findings of the Hallucinogenic Snuff Cojoba (*Anadenanthera Peregrina* (L.) Speg.) in Precolonial Puerto Rico. *Latin American Antiquity* 25 (1):101–16.

# Arachis hypogaea

Leguminosae *Arachis hypogaea* "mani"

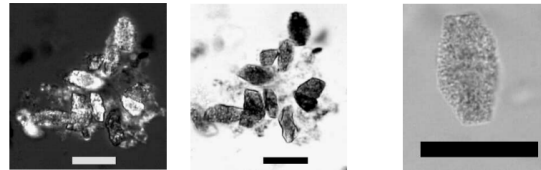
## Phytolith assemblage characterization

### Pod and seed.

Non diagnostic phytoliths (\*):

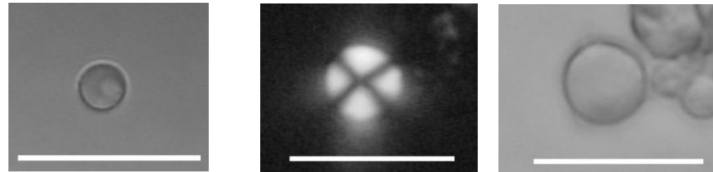
- a) Polyhedral calcium oxalate phytolith.  
Common.

fruit



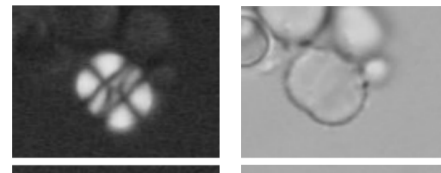
## Starch assemblage characterization

- a) Single grains, spherical and subspherical; variable in size, from 4µm to 10µm long length; distinct centric hilum as clear spot with a round cavity; distinct fine lamella; generally an elongated central cleft with short radiating fissures extends the length of the grain; distinct centric cross, with four arms visible, intersecting at a dark oval or line.



seed

- b) Some compound grains, without a single external package, compounded by two granula. Granula similar in size and shape; bowl-shaped with wavy truncation; ca. 7µm long length; distinct eccentric cross, to the truncate end, with four arms visible.



**References:** Partially based on Cortella and Pochettino 1994, Piperno and Holst 1998, Reichert 1913.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

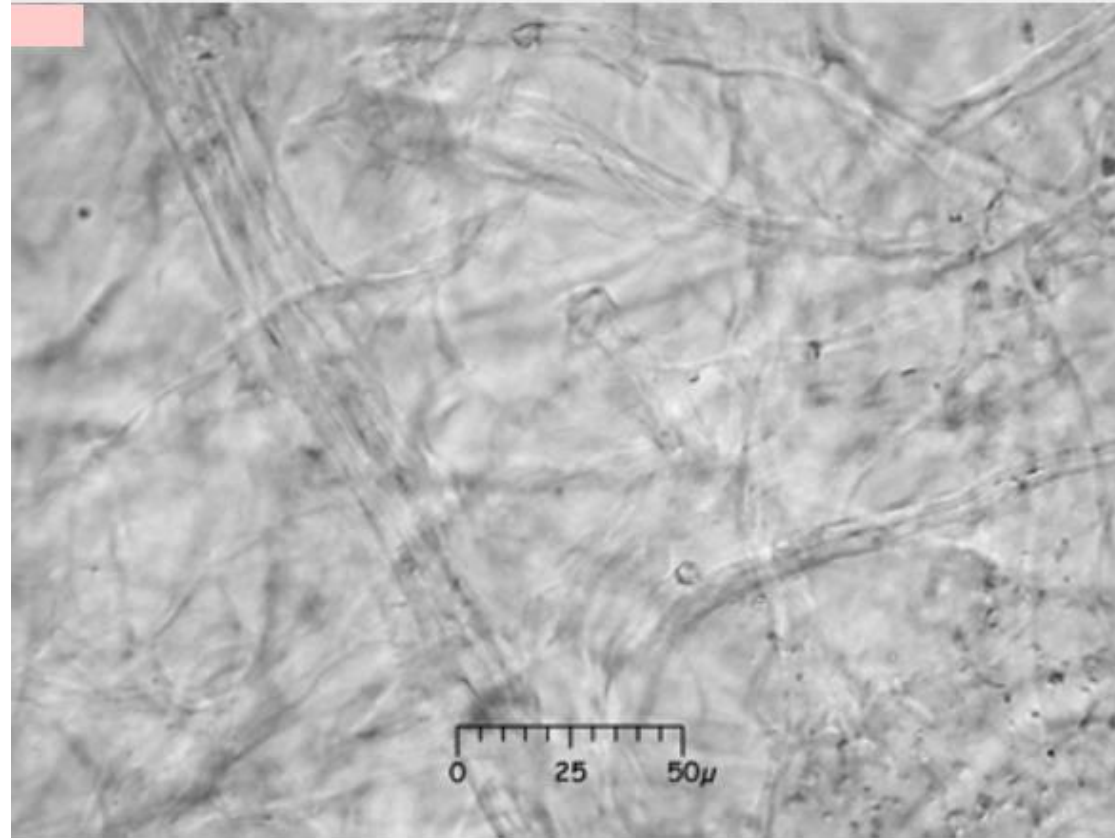
Scale bar = 20µm.

# Arachis hypogaea

## Phytolith

Type established by Karol Chandler- Ezell,  
2004

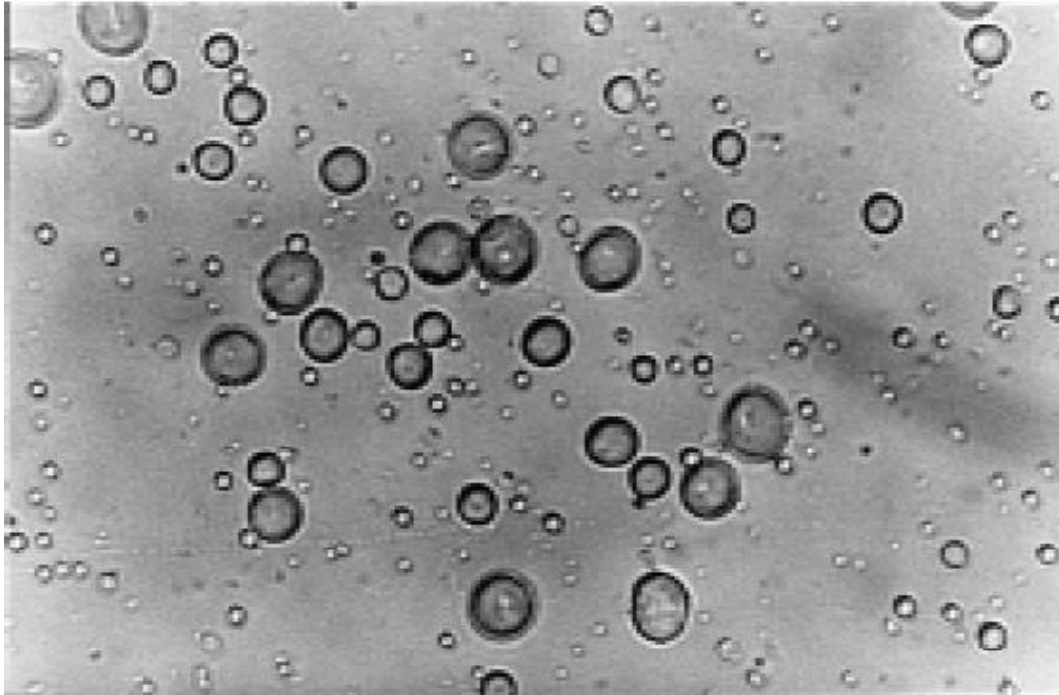
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Arachis hypogaea

## Starch



Starch grains from modern peanuts. 160x

### APPENDIX:

Arachis hypogaea (peanut) (Figure 7). Simple grains with fine laminations. The hilum appears as a clear spot with a round cavity. An elongated central cleft with short radiating fissures extends the length of the grain. Size: 4–10 microns long

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

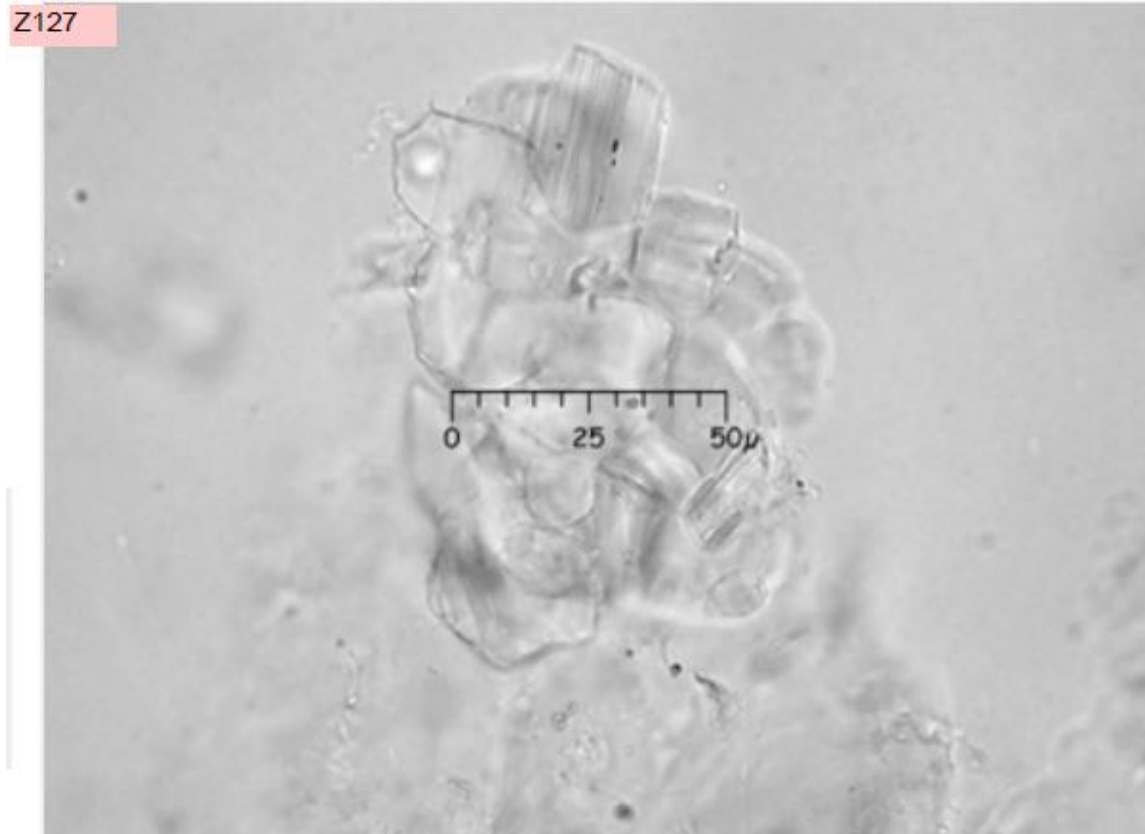
# Brownea grandiceps

## Phytolith

probably calcium carbonate ( $\text{CaCO}_3$ ) crystals.

Appear in many of the genera of the Fabaceae, but also present in Musaceae, Flacourtiaceae and Bombacaceae.

Diagnostic level: not diagnostic



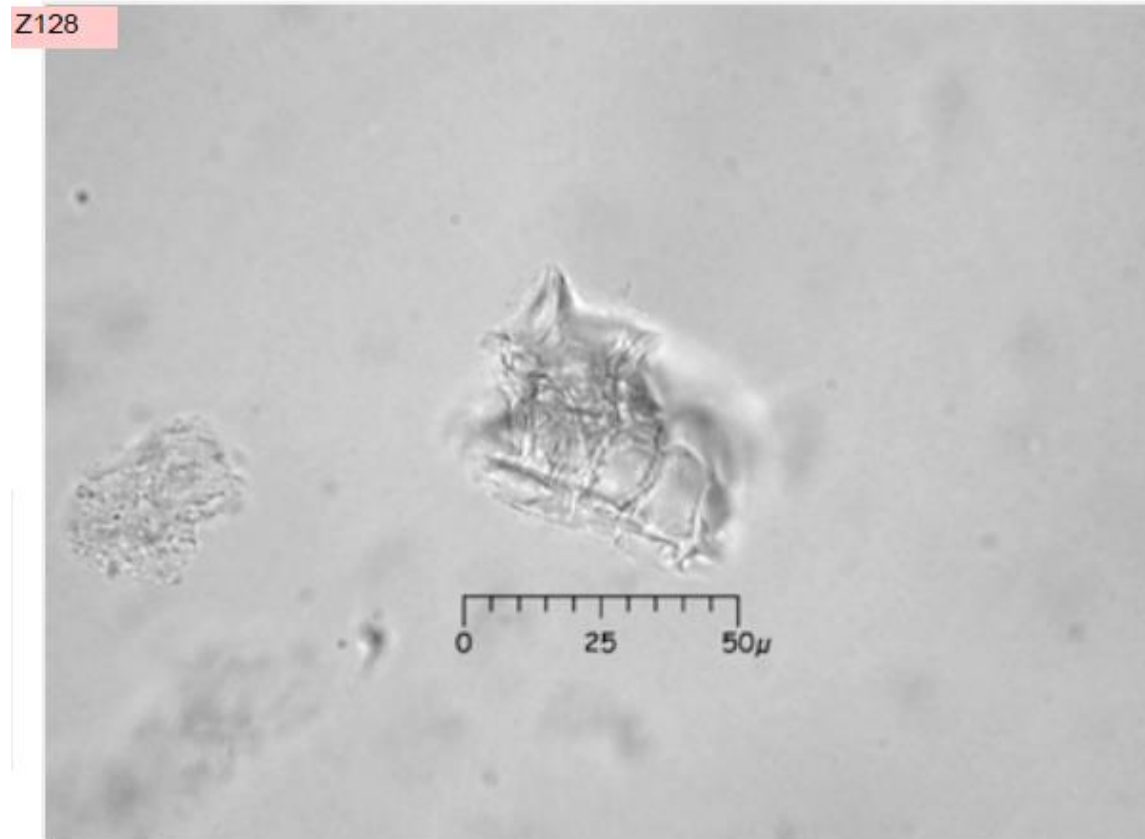
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Brownea ucayalina

## Phytolith

From the top, this hair base may be confused with a diagnostic produced by *Dalium guianense* (also of the Fabaceae family). Rotate to see the thickness of the hair base. Slide 1772a leaf. Type defined by Shawn Collins 01/1999.  
Diagnostic level: genus

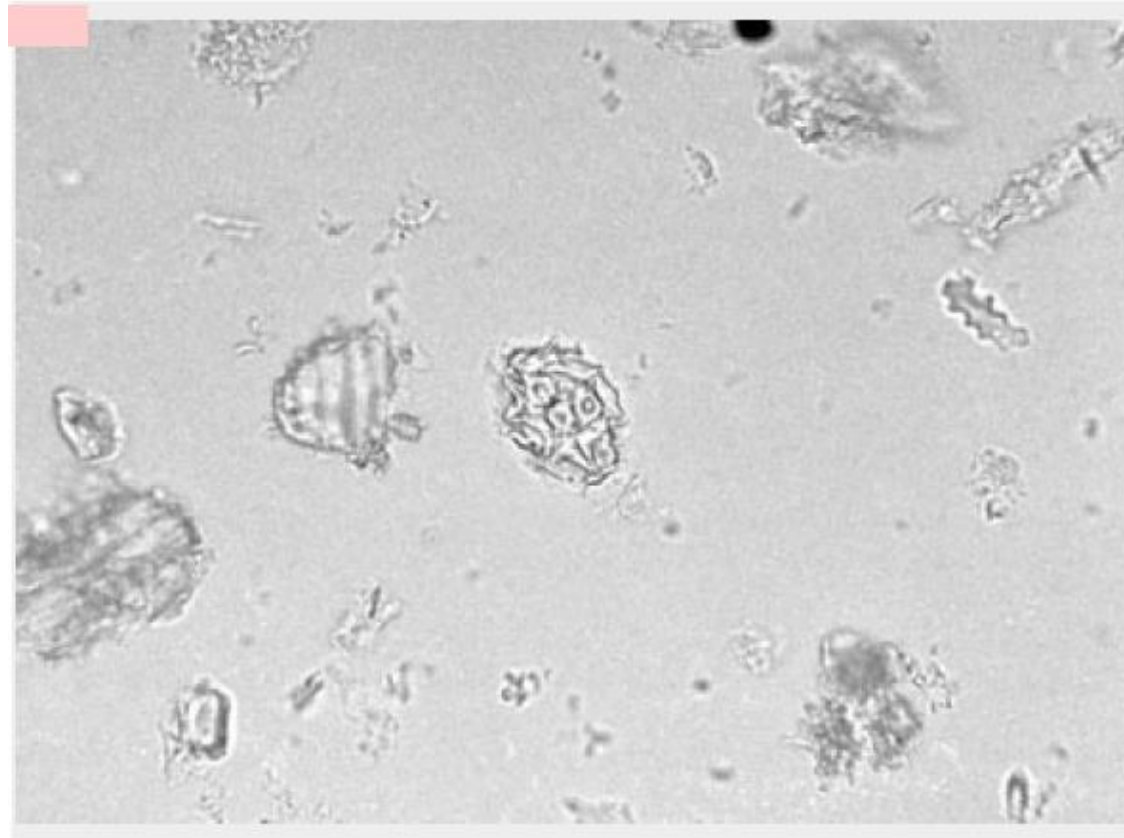


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Brownea ucayalina

## Phytolith

Slide 1772a leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

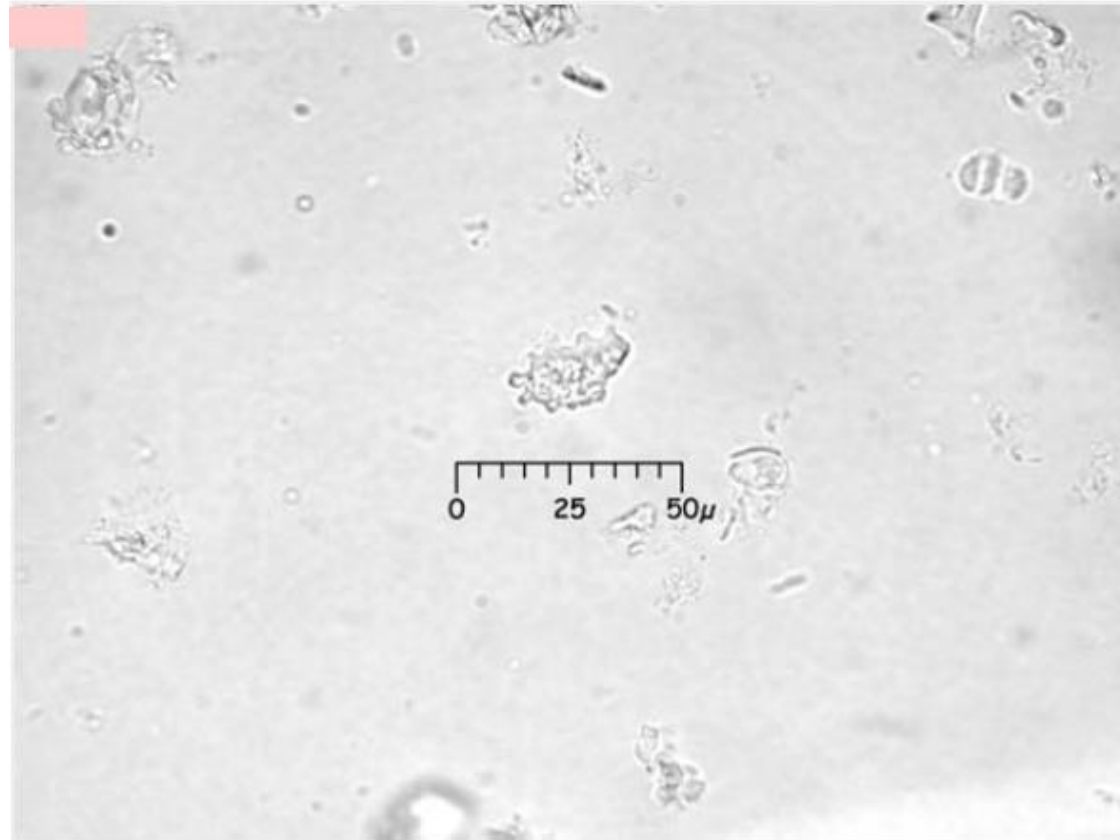


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Brownea ucayalina

## Phytolith

Slide 1772a leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Canavalia spp.

## Starch

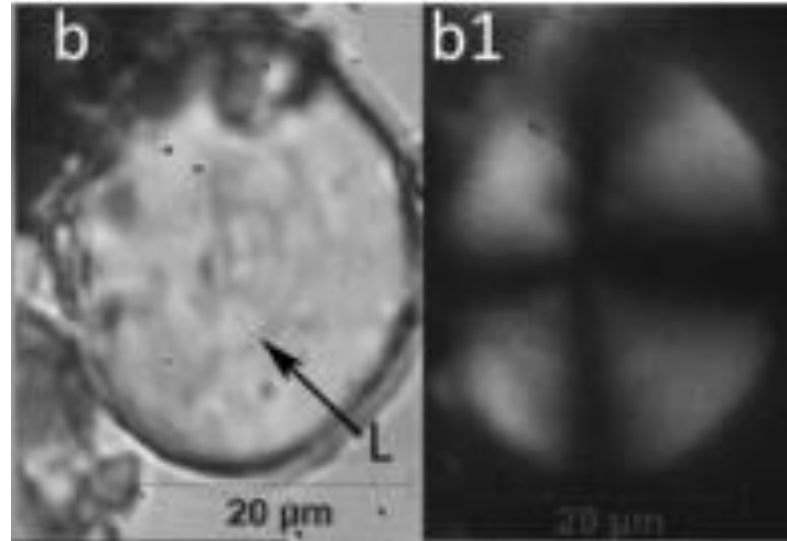
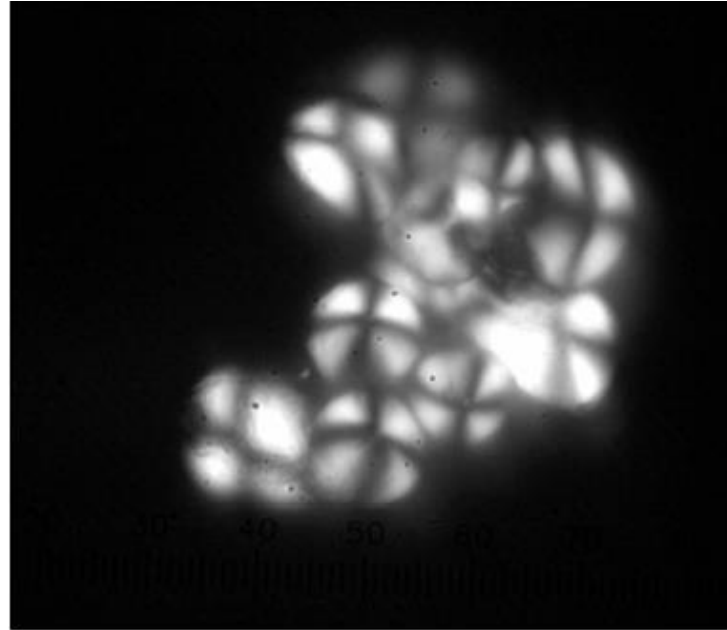
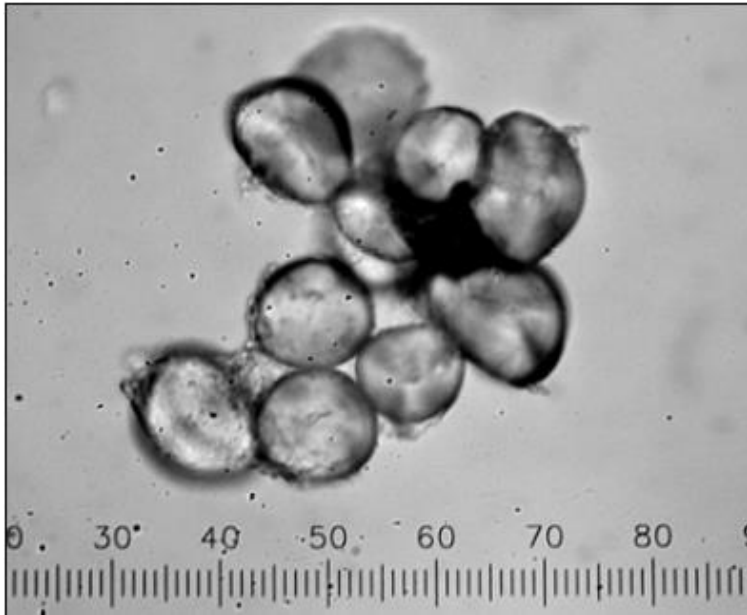


Fig. 9. Other ancient starch grains (a-g) recovered at St. John and Eva 2. b, *Canavalia* spp. oval starch showing partial lamellae (“L”); b1, the same starch with extinction cross

# Canavalia rosea

## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Cicer arietinum

## Starch

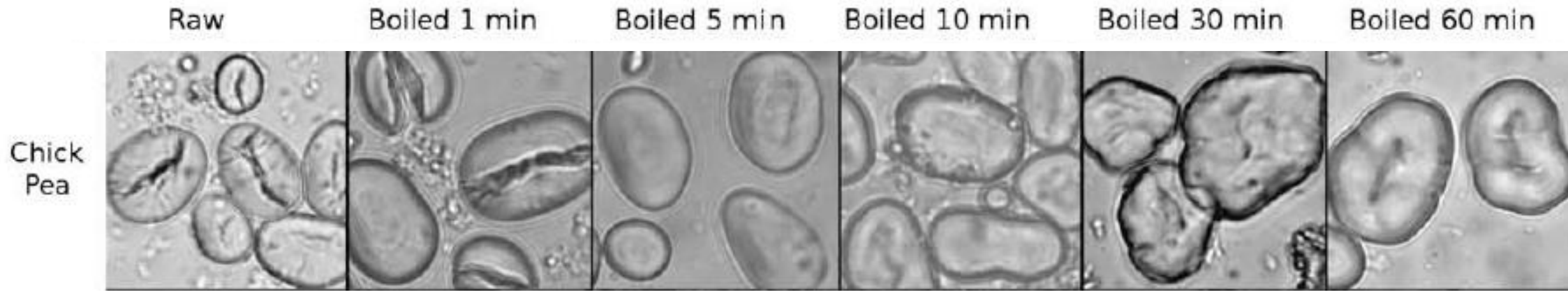


Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Cicer arietinum

## Starch

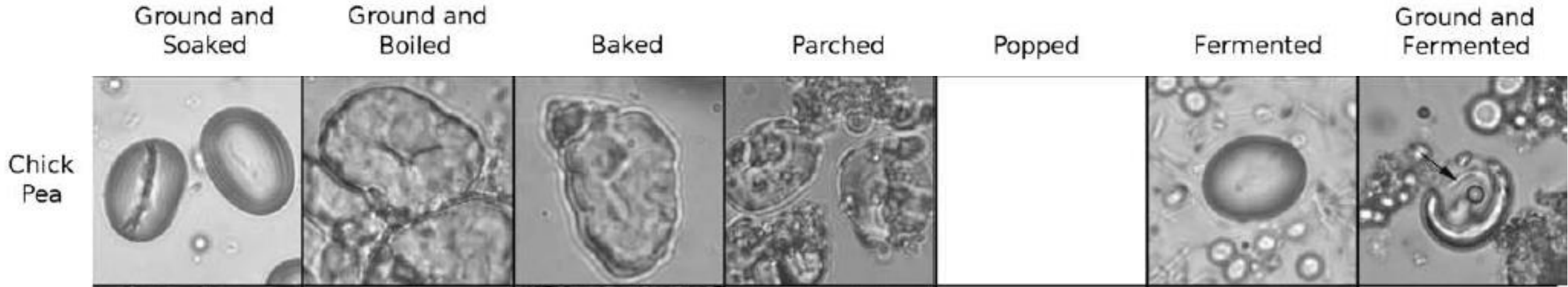


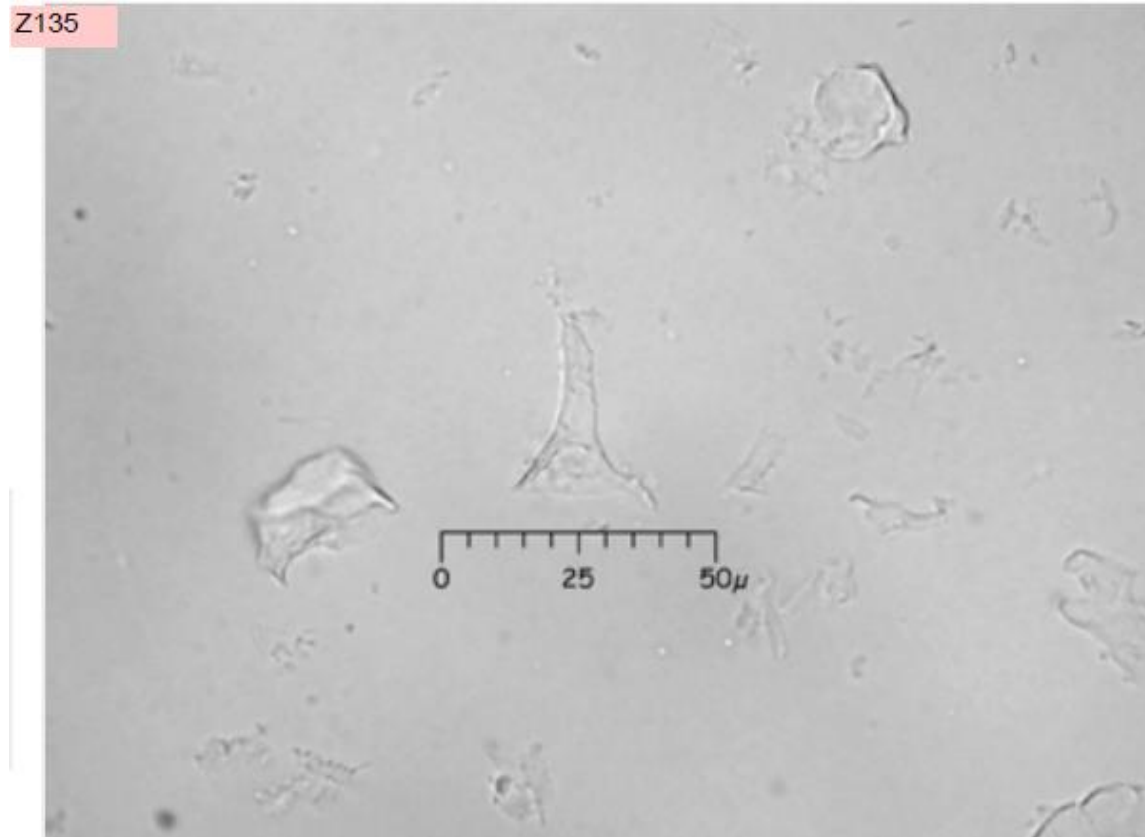
Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Dalium guianense

## Phytolith

Slide 1766e leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus



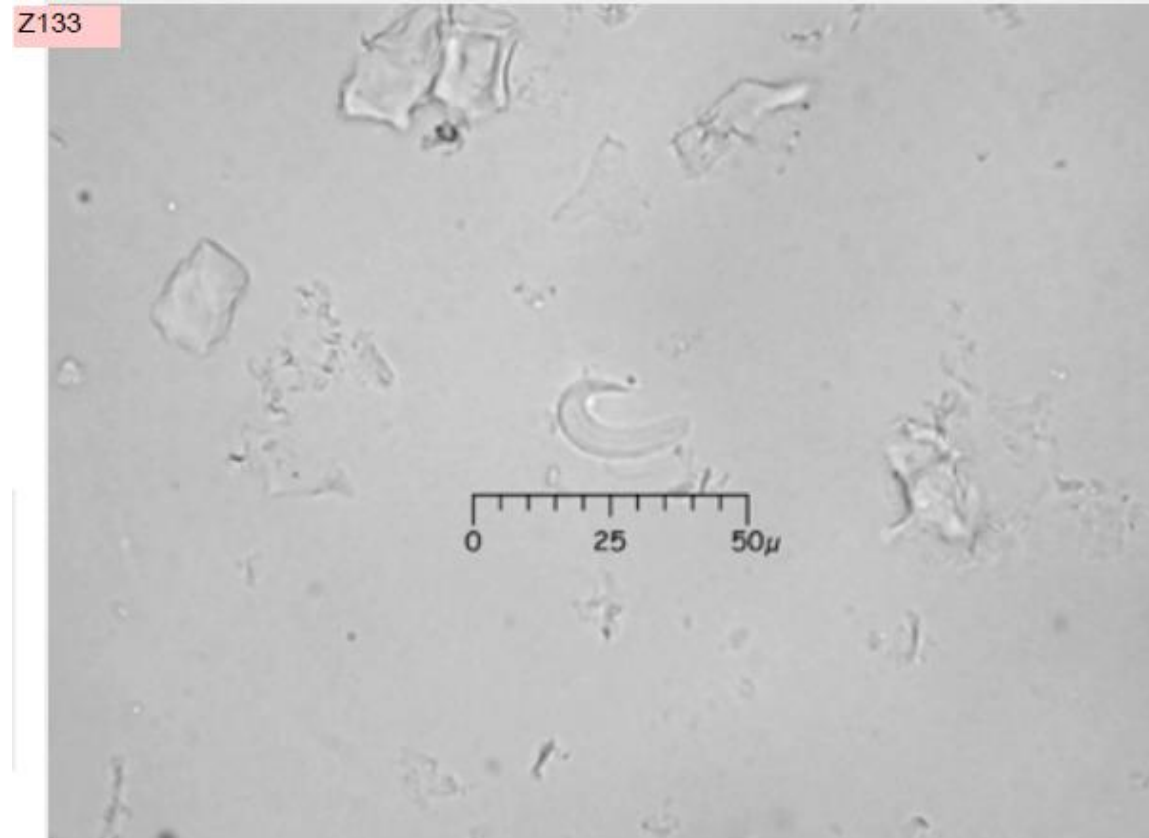
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Dalium guianense

## Phytolith

Slide 1766e leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus

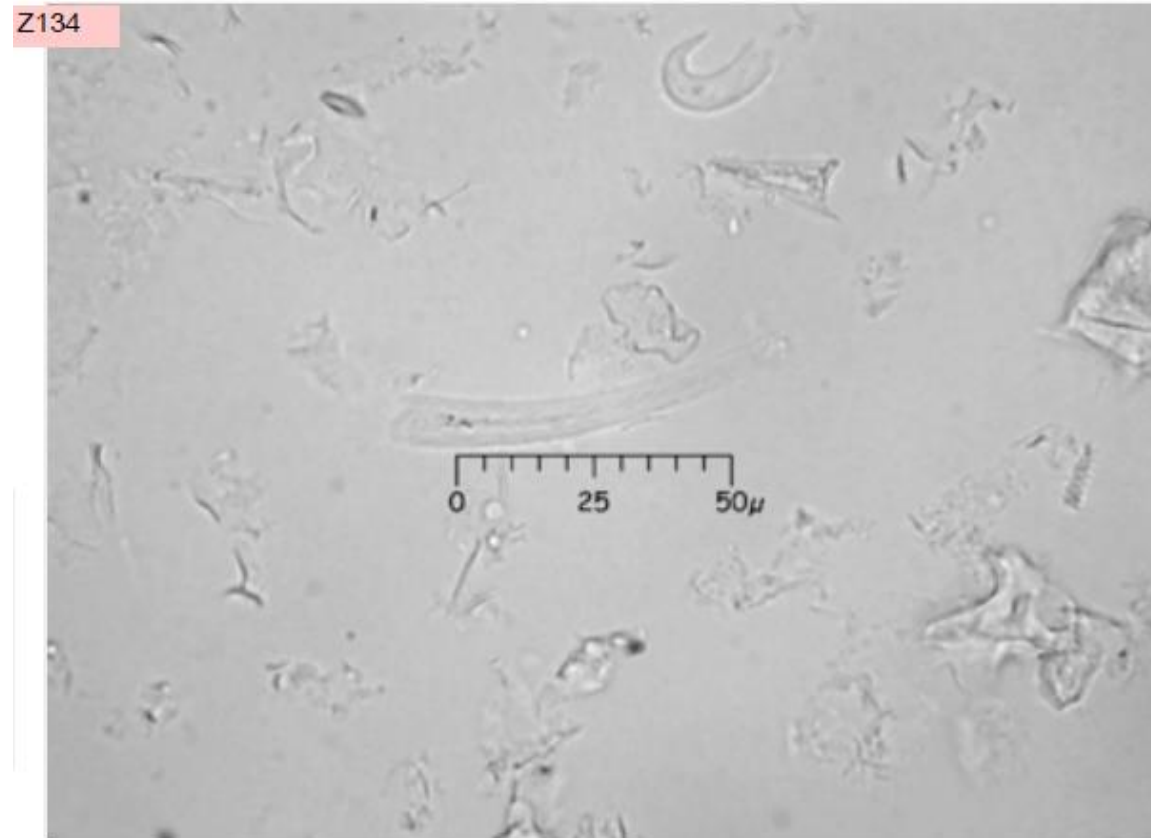


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Dalium guianense

## Phytolith

Slide 1766e leaf. Type defined by Shawn Collins 01/1999. Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Dalium guianense

## Phytolith

Ornamental Indigo.

From the top, this may be confused with *Brownea ucayalina*, rotate to see the thickness of the hair base. Slide 1766e leaf. Typed defined by Shawn Collins 01/1999.

Diagnostic level: genus Description



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Enterolobium cyclocarpum

## Starch

### APPENDIX:

Enterolobium cyclocarpum. Simple grains, very irregular in shape, with a rough surface. When turned to the side a long fissure can be seen.

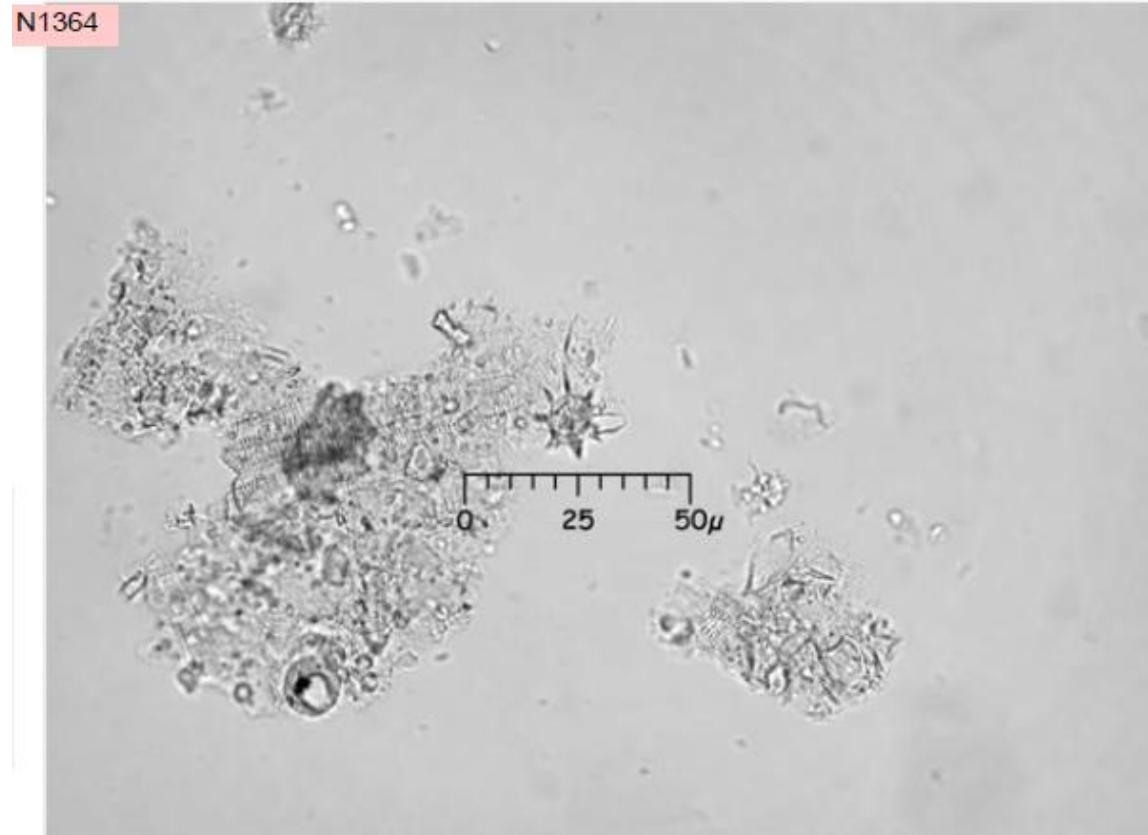
Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Erythrina amazonica

## Phytolith

Slide 1811. Leaf.

Diagnostic level: mixed Guazuma,  
Erythrina, Lithospermum



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Geoffroea decorticans

Leguminosae *Geoffroea decorticans* "chañar"

## Phytolith assemblage characterization

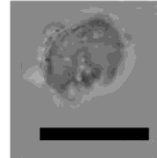
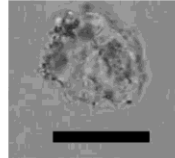
### *Endocarp and seed).*

Non diagnostic phytoliths ( $\pm$ ):

a) Semi-spherical faceted silica phytolith. Rare.

b) Sub-round silica phytolith. Rare.

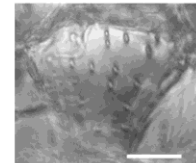
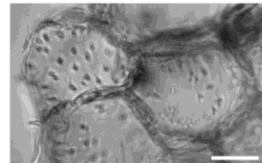
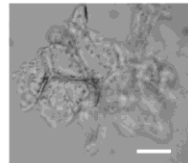
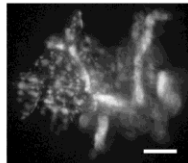
fruit



## Starch assemblage characterization

### *Endocarp.*

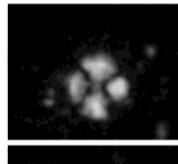
a) Compound grains, with a polyhedral package five- to six- sided; variable in size, to 60 $\mu$ m long length, compounded by at least 24-26 granula different in size. Granula range in size from 3 $\mu$ m to 9 $\mu$ m; very distinct centric hilum as a circle; not visible lamella; distinct centric cross, with four arms visible.



fruit

### *Pulp.*

a) Single grains, spherical; to 8 $\mu$ m long length; not visible hilum and lamella; distinct centric cross, with four arms visible.



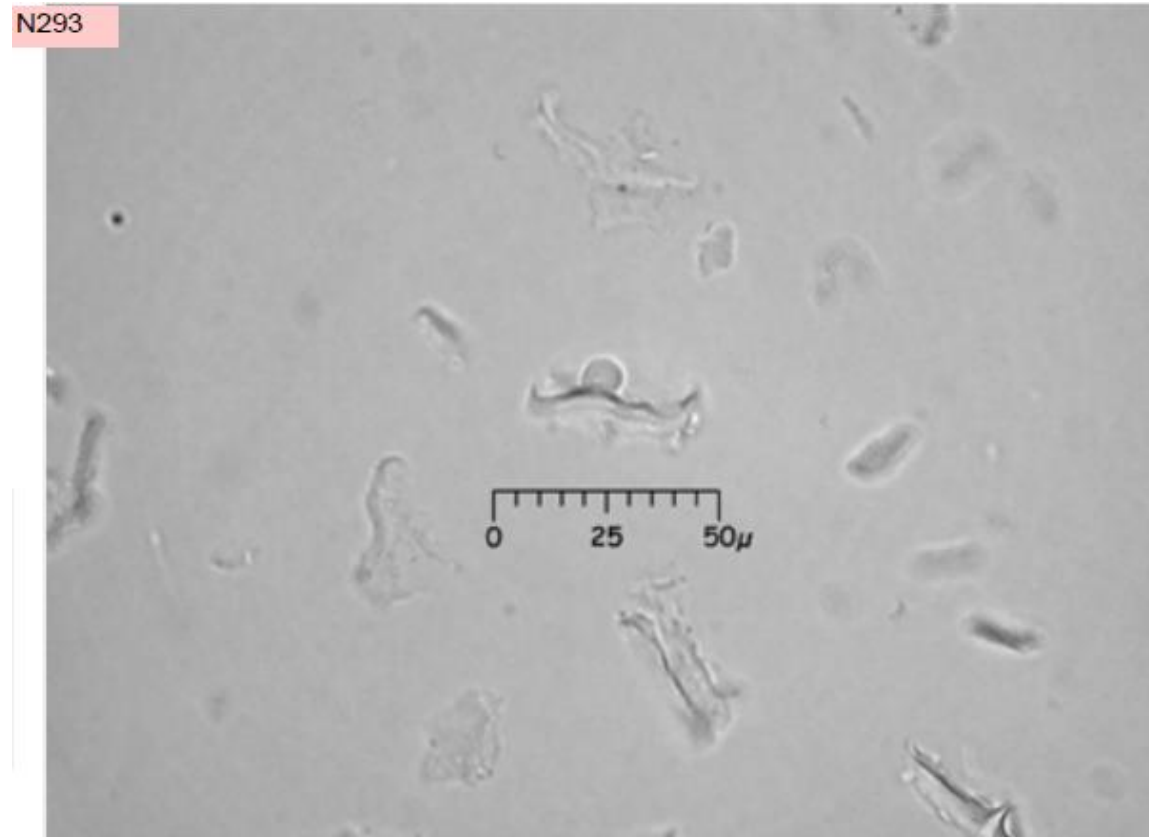
Scale bar = 20 $\mu$ m.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Inga densiflora

## Phytolith

Diagnostic level: genus

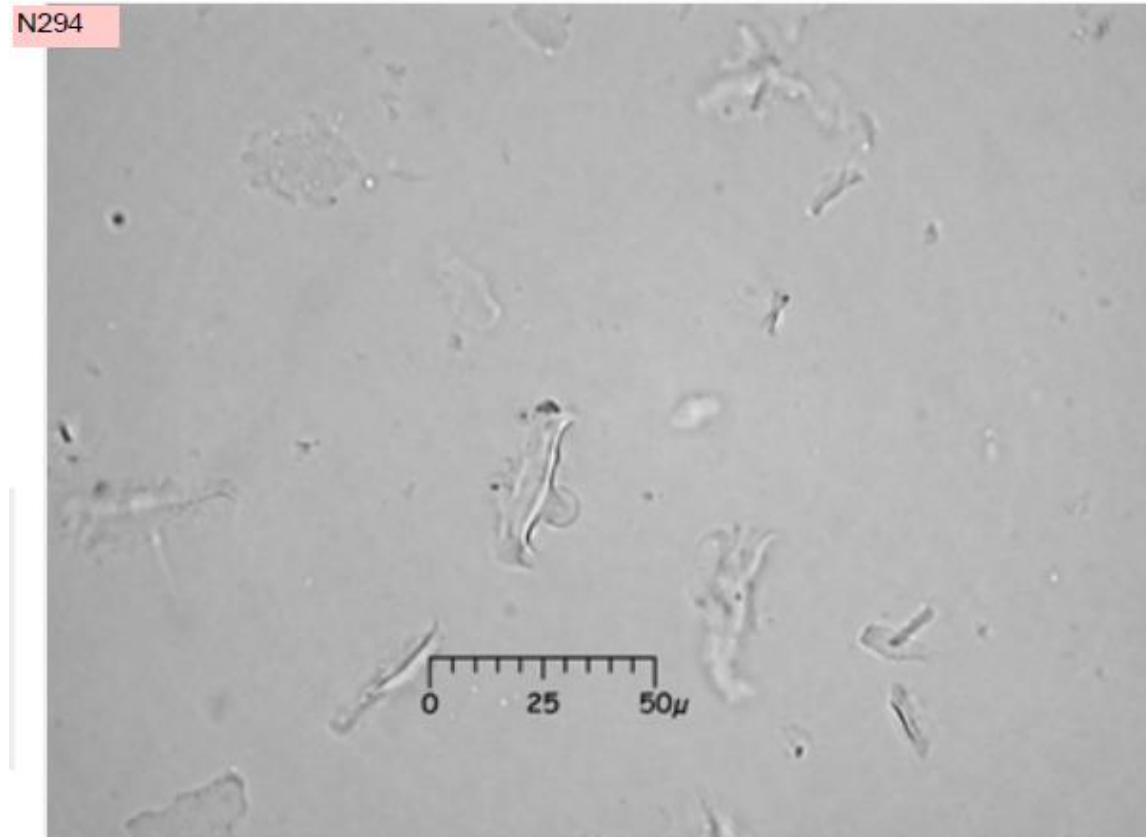


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Inga densiflora

## Phytolith

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Inga densiflora

## Phytolith

Diagnostic level: not diagnostic

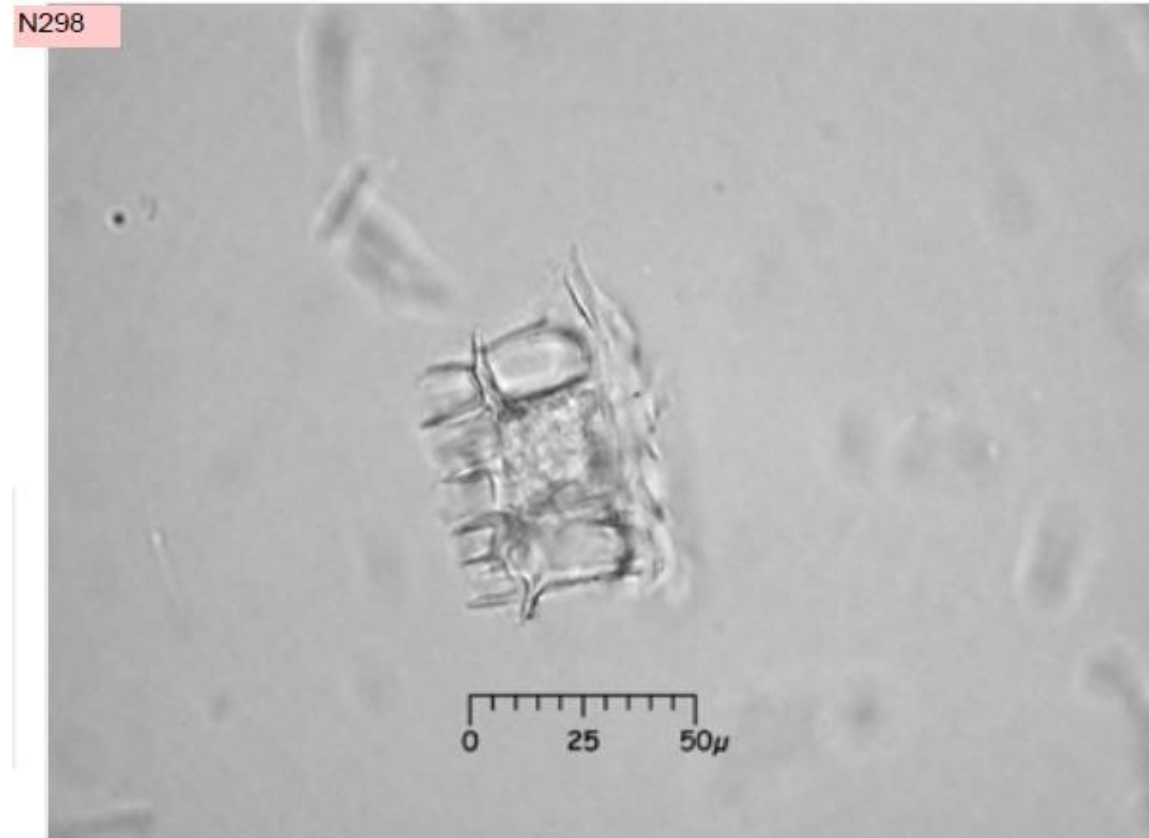


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Inga densiflora

## Phytolith

Side view. See Record #187 for top view.  
Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Inga densiflora

## Phytolith

Top - 3/4 view.

See side view (Record #186) to see two layers of surrounding cells. Diagnostic level: genus



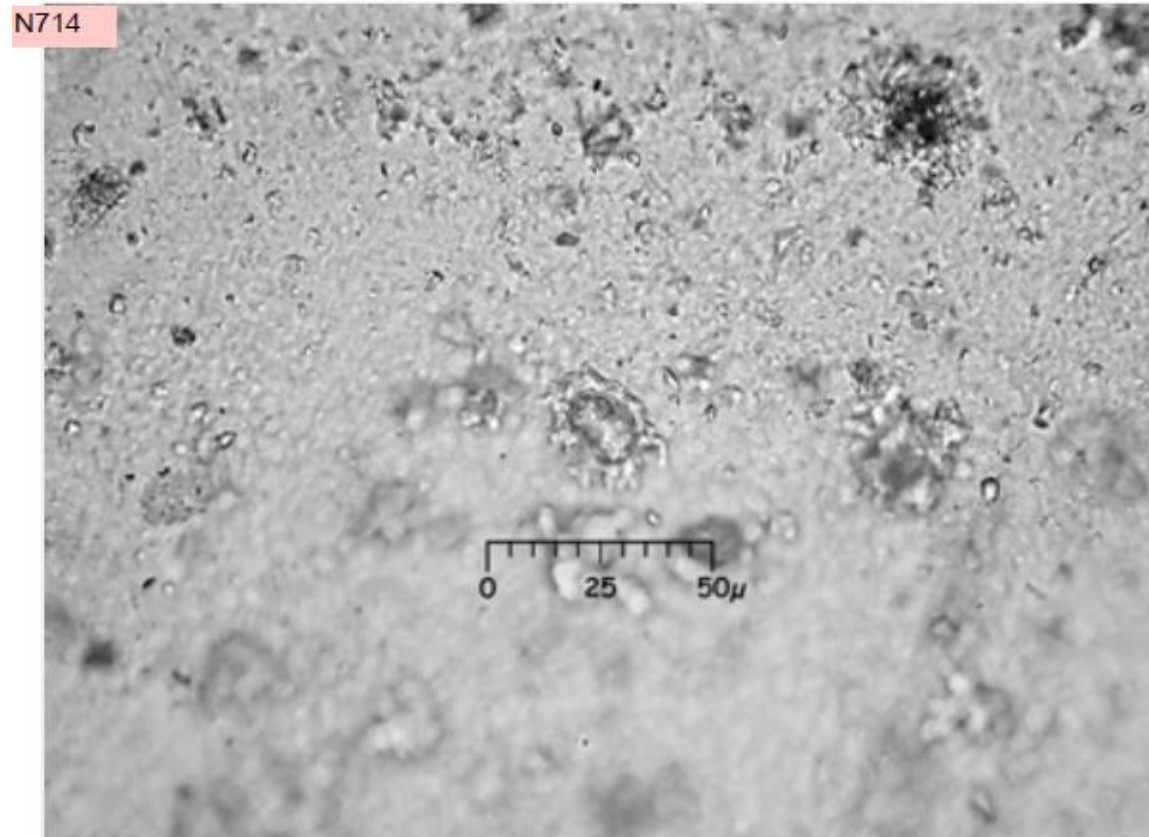
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Inga spectabilis

## Phytolith

Type established by Karol Chandler- Ezell,  
2004

Diagnostic level: not diagnostic



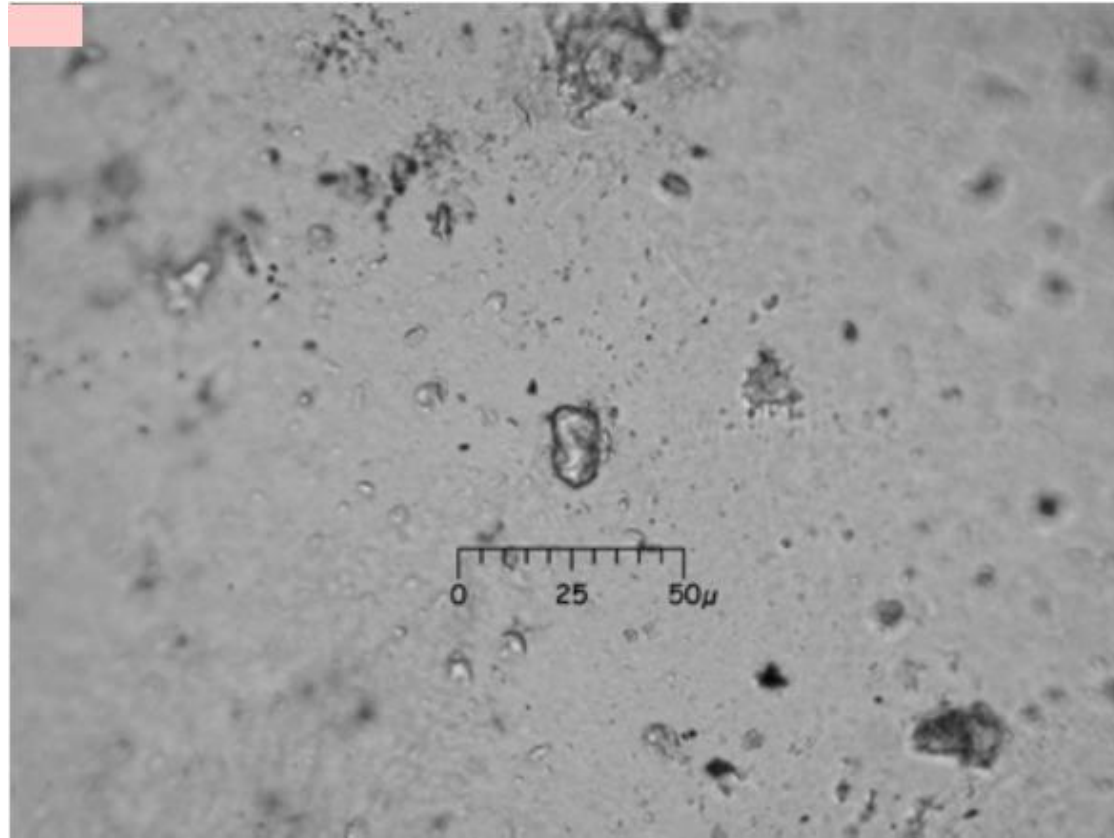
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Inga spectabilis

## Phytolith

Type established by Karol Chandler- Ezell,  
2004

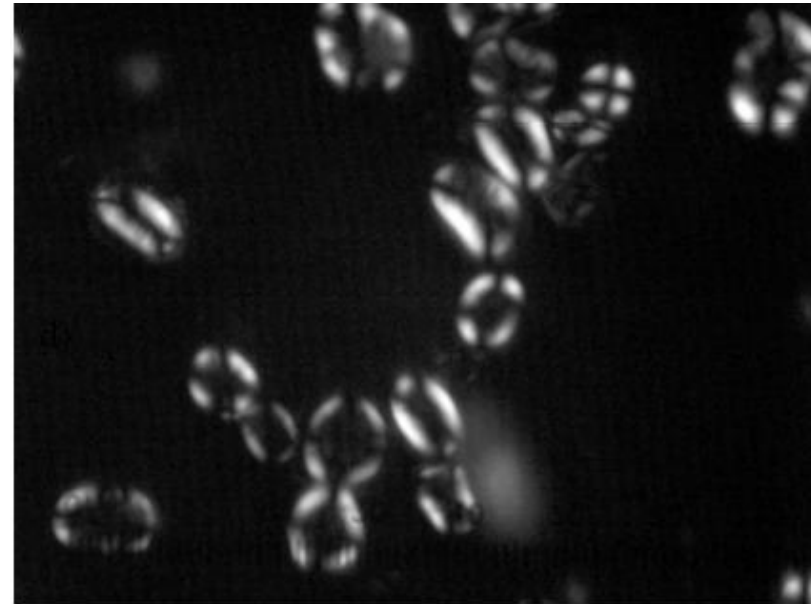
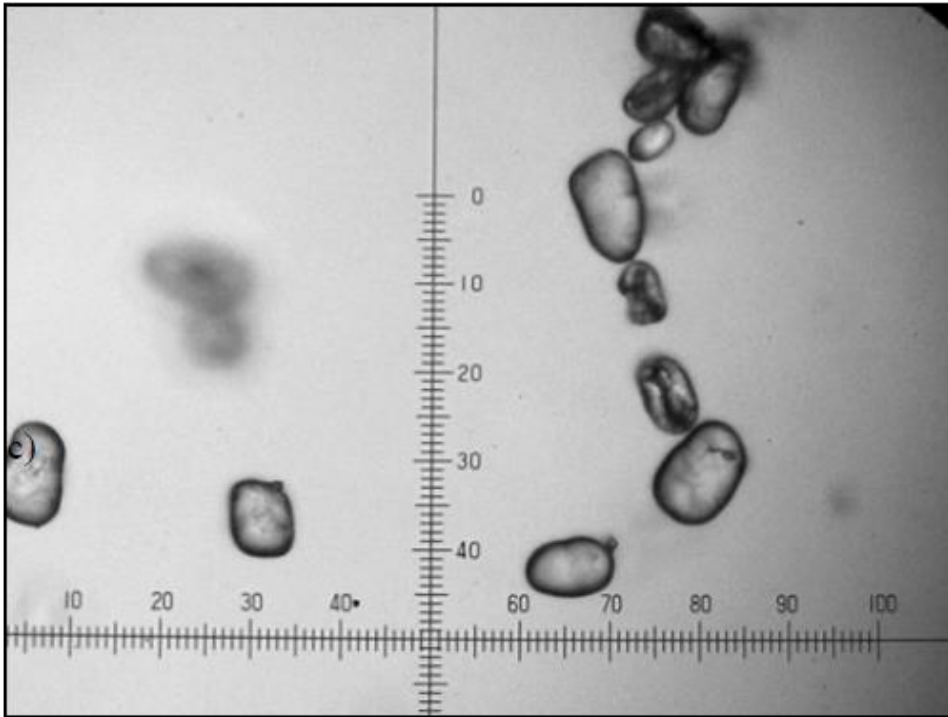
Diagnostic level: undetermined



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Lablab purpureus

## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Lens culinaris

## Starch

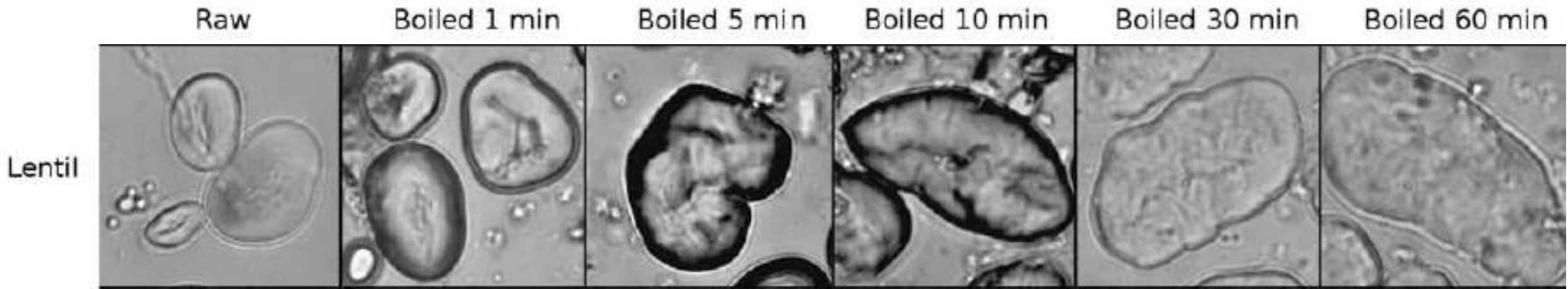


Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Lens culinaris

## Starch

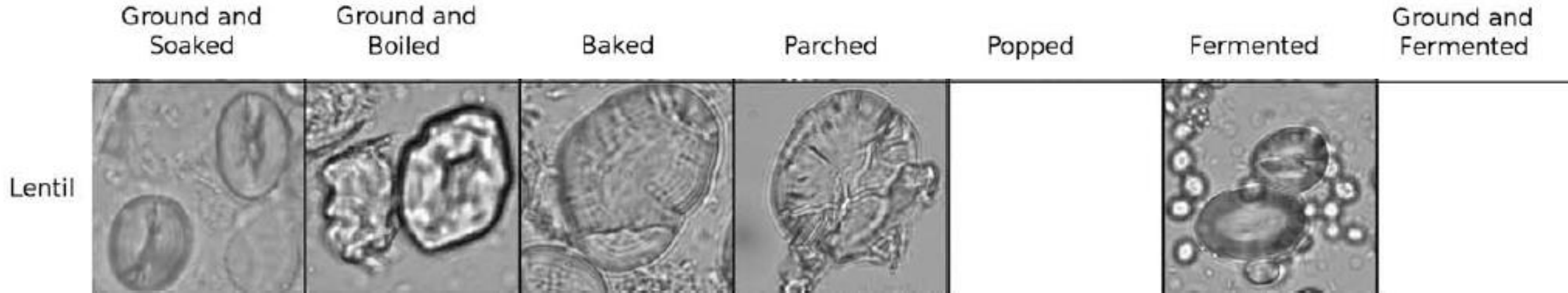


Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.



# Lupinus mutabilis

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

Leguminosae *Lupinus mutabilis* "tarwi"

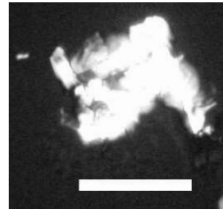
## Phytolith assemblage characterization

Non diagnostic phytoliths (\*):

a) Irregular silica phytolith.  
Rare.



b) Irregular calcium oxalate  
phytoliths. Common.



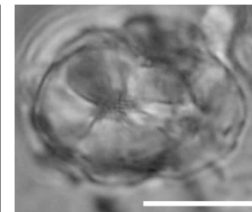
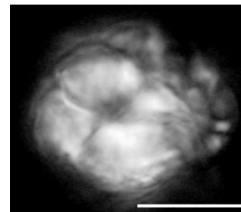
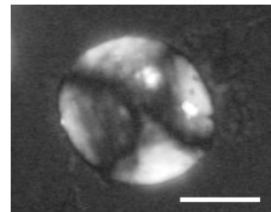
No phytoliths (\*).

seed

pod

## Starch assemblage characterization

a) Single grains, spherical to oval, well rounded; variable in size from 8µm to 40µm long length; indistinct centric hilum; not-visible lamella; sometimes irregular radiating or regular line fissures and a hollow at the center; distinct, centric or lightly eccentric cross, with four arms visible; distinct border.

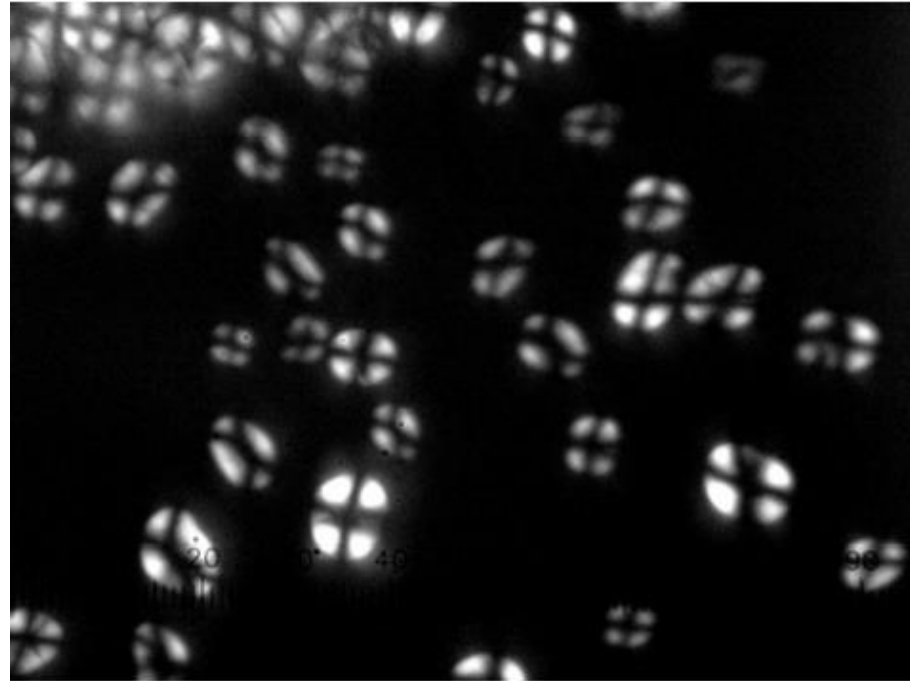


seed

Scale bar = 20µm.

# Macroptilium lathyroides

## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Pachyrhizus ahipa

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

Leguminosae *Pachyrizus ahipa* "ajipa"

## Phytolith assemblage characterization

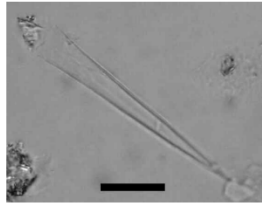
tuber

No phytoliths (\*).

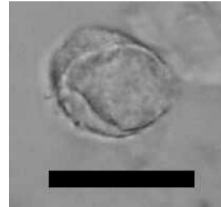
leaf

Non diagnostic phytoliths (\*):

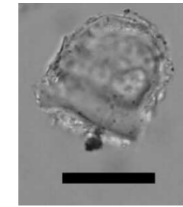
a) Acicular silica hair.  
Common.



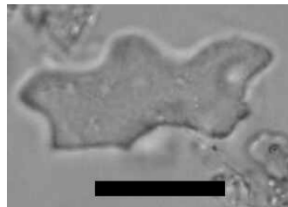
b) Roundel asymmetrical cavated silica phytolith. Common.



c) Semi-roundel gibbous silica phytolith. Rare.

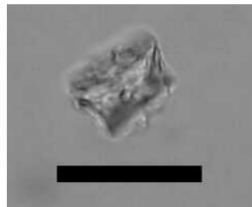


d) Irregular castelate silica phytolith.

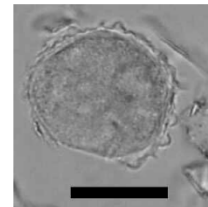


e) Roundel wrinkled silica phytolith. Not common.

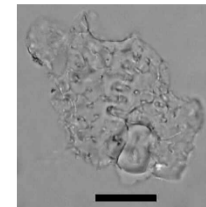
Lateral view.



Plane view.



f) Continuous crenate silica phytolith. Rare.



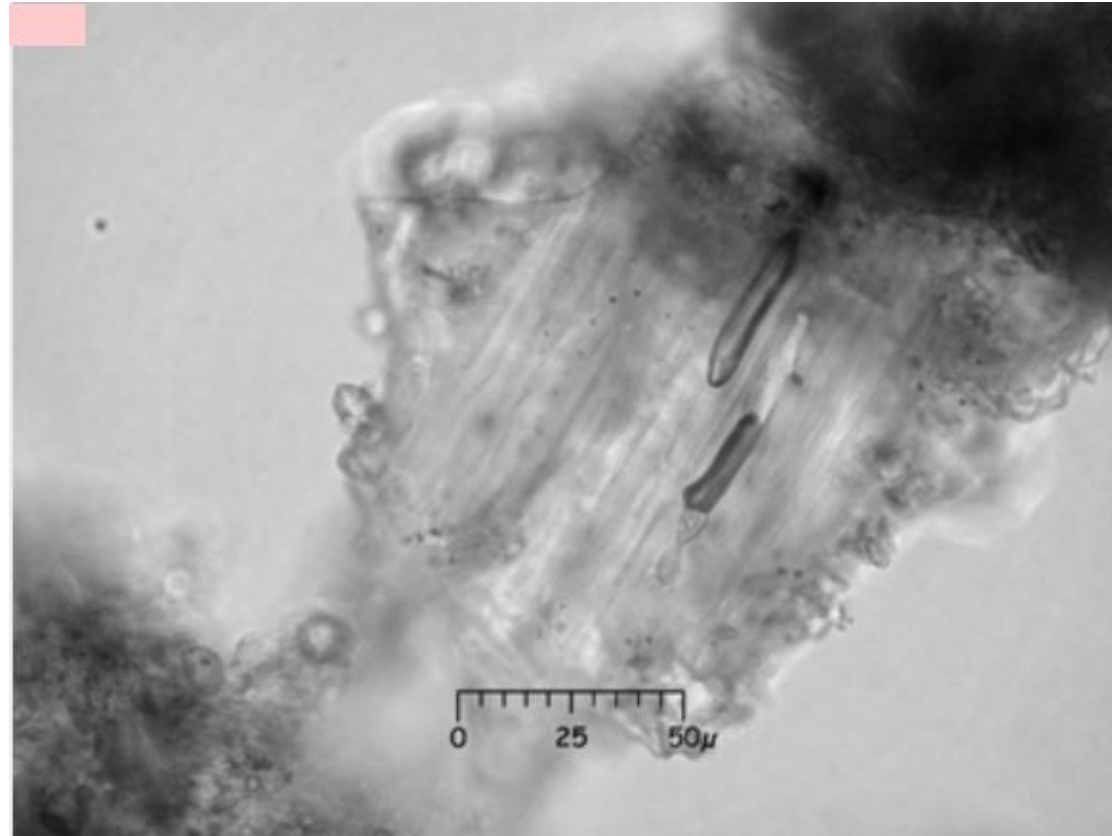
Scale bar = 20µm.

# Pachyrhizus erosus

## Phytolith

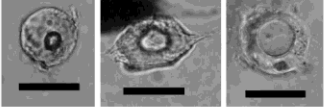
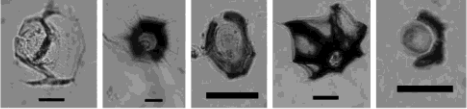
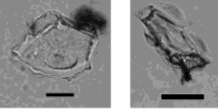
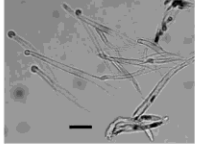
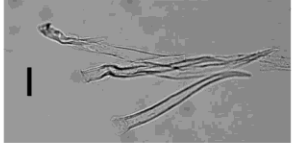

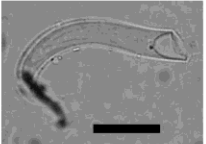
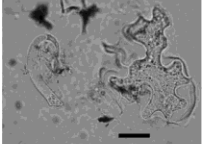
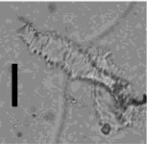
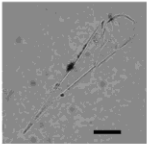
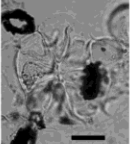
Type established by Karol Chandler- Ezell,  
2004

Diagnostic level: root/tuber



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Phaseolus lunatus

Leguminosae <i>Phaseolus lunatus</i> "poroto"	
<b>Phytolith assemblage characterization</b>	
pod	<p>Diagnostic phytoliths:</p> <p>a) Sub-spherical to irregular cavate and granulate silica phytolith. Common.</p>  <p>b) Polyhedral opaque silica hair base. Very common.</p>  <p>c) Polyhedral irregular silica phytolith. Rare.</p>  <p><b>References:</b> Reported in Bozarth 1986 (±) We have found no hooked silicified hairs in the pods but in the leaves.</p>
	<p>Non diagnostic phytoliths:</p> <p>a) Gemmate translucent silica hair cells. Very common.</p>  <p>b) Acicular translucent silica hair cells. Very Common.</p>  <p>c) Irregular translucent silica hair cells. Very common.</p> 
leaf	<p>Diagnostic phytoliths:</p> <p>a) Unciform translucent silica hair. Common.</p>  <p>b) idem and Sinuate silica epidermal cells. Very common.</p>  <p>c) Silica tracheid. Common.</p>  <p>d) Acicular silica hair cell. Not common.</p>  <p>e) Poly-lobate silica hair base. Rare.</p>  <p><b>References:</b> Reported in Bozarth 1986 for the pods.</p>
	<p>seed stem</p> <p>No phytoliths.</p>
<p>seed</p> <p>No phytoliths.</p>	
<b>Starch assemblage characterization</b>	
seed	<p><b>References:</b> Reported in Reichert 1913.</p>

Scale bar = 20µm.

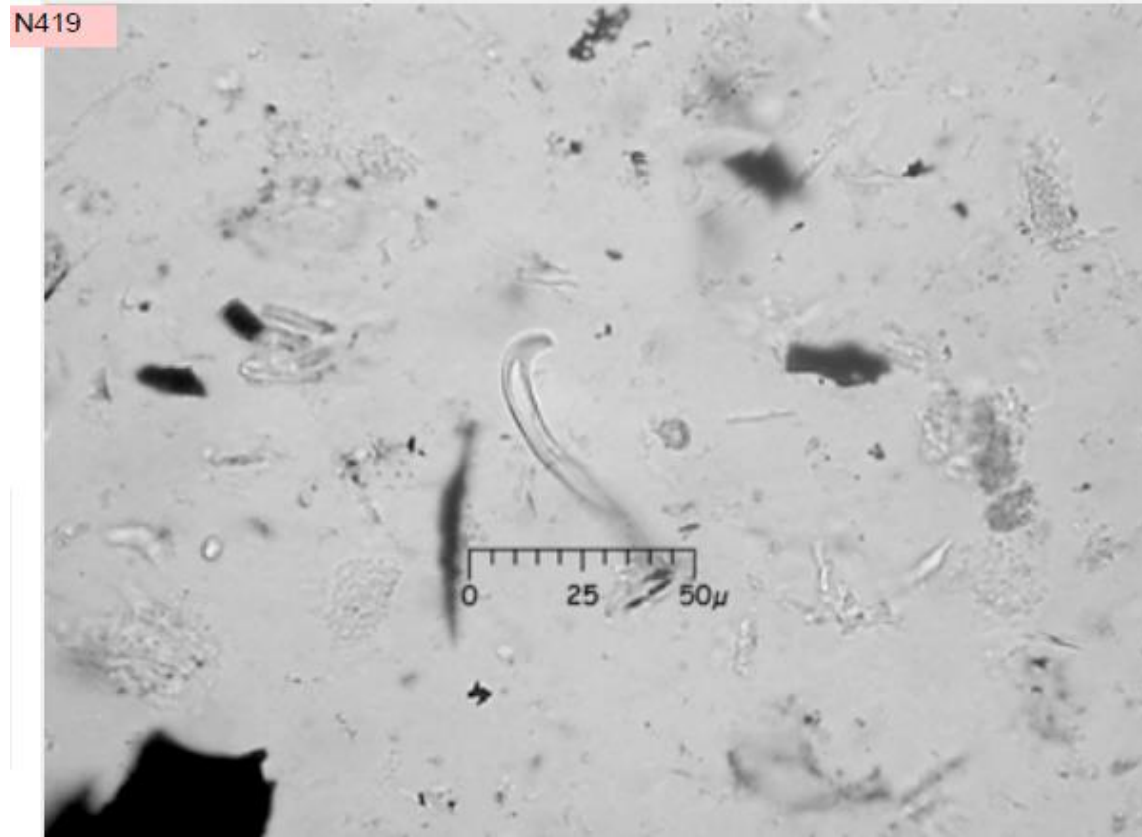
Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Phaseolus lunatus

## Phytolith

Phaseolus hair, small when compared to 40IIIAa301.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Phaseolus lunatus

## Phytolith

Phaseolus hair, small when compared to 40IIIAa301.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Phaseolus vulgaris

Leguminosae *Phaseolus vulgaris* - var. *vulgaris* "poroto"

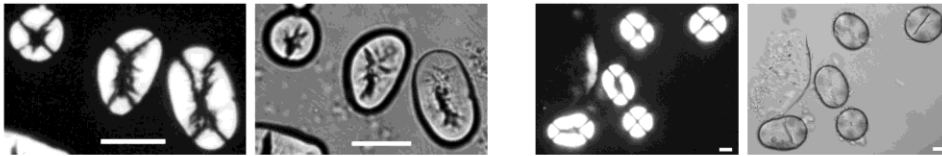
## Phytolith assemblage characterization

seed

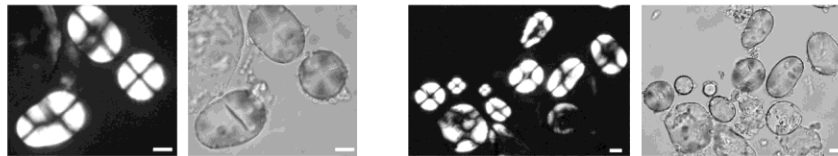
References: Reported in Bozarth 1990.

## Starch assemblage characterization

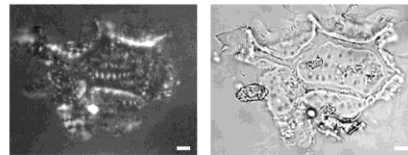
a) Single grains, oval, ovoid, spherical, kidney-shaped, irregularly lobated, polyhedral, ellipsoidal, irregular; variable in size from 2µm to more than 60µm long length; distinct centric hilum, elongated; distinct lamella; a ragged mesial fissure, and radiating lines from the hilum; distinct centric cross, with four irregular arms visible, intersecting at a central ragged line or dot, or meeting two by two.



b) Compound grains, compounded by two or more granula with a single external package. Granula variably in shape, size and orientation; same type of simple ones; distinct centric cross, with visible arms intersecting at different points.



c) Compound grains, with a fiber-like or polyhedral package; variable in size, to 60µm long length, compounded by granula different in size. Granula range in size from 3µm to 5µm; very distinct centric hilum circle-, v- or x-shaped; not visible lamella; distinct centric cross, with four arms visible.



References: Partially based on Piperno and Holst 1998, Reichert 1913, Yañez et al. 1997.

Scale bar = 20µm.

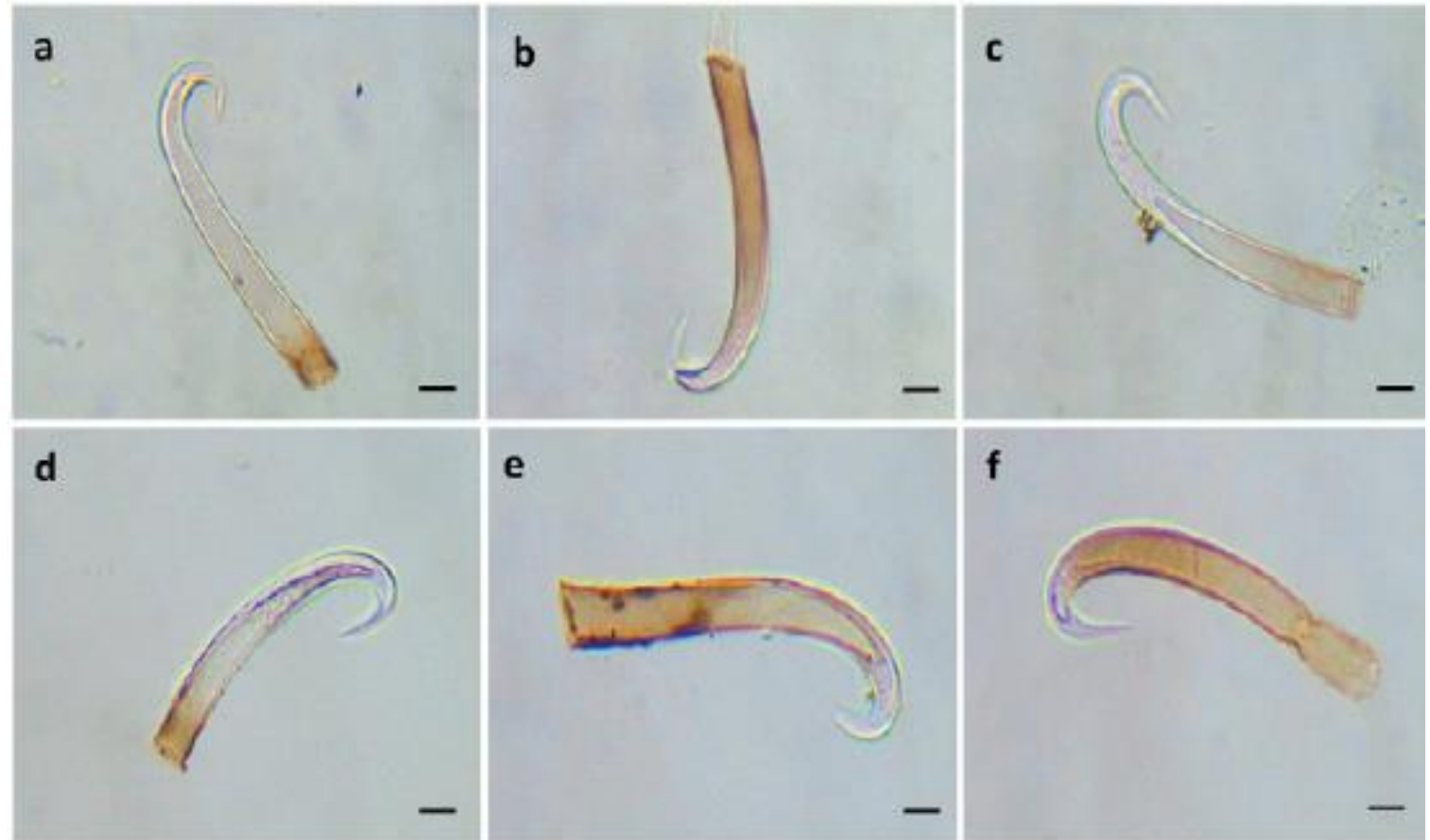
Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection



# Phaseolus vulgaris

## Phytolith

Figure 5. Phytoliths from leaves of common bean *Phaseolus vulgaris* L.; a) 92.4 $\mu$ m, 12.26 $\mu$ m; b) 78.2 $\mu$ m, 9 $\mu$ m; c) 88.64 $\mu$ m, 10.32 $\mu$ m; d) 102.96 $\mu$ m, 9.94 $\mu$ m; e) 57.37 $\mu$ m, 8.51 $\mu$ m; f) 93.5 $\mu$ m, 11.9 $\mu$ m. Scale: 10  $\mu$ m by 40X



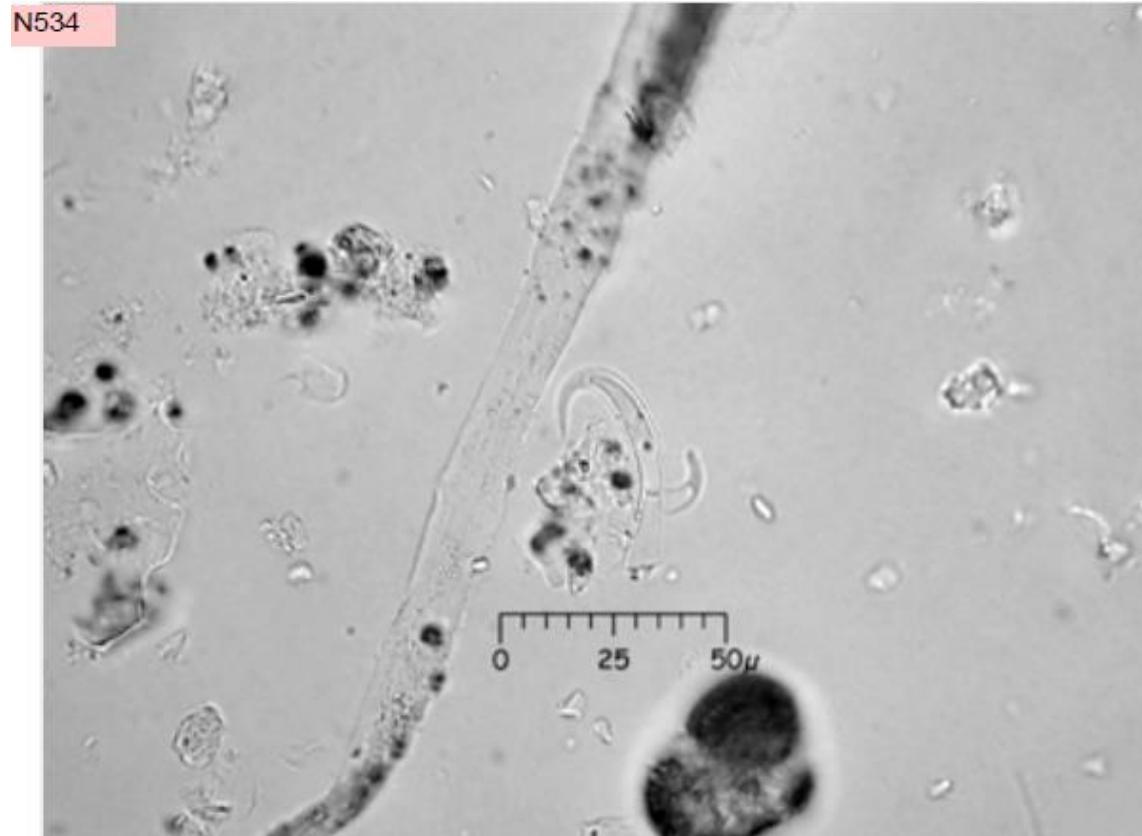
Poveda-Díaz, Nataly, Maria Eugenia Morales-Puentes, and Gregory Vaughan. 2016. Phytoliths Produced by Common Bean (*Phaseolus Vulgaris* L.), Achira (*Canna Indica* L.), and Squash (*Cucurbita Ficifolia* Bouché), Crop Species from Boyacá, Colombia. *Revista de La Academia Colombiana de Ciencias Exactas, Físicas y Naturales* 40 (154):137–46.

# Phaseolus vulgaris

## Phytolith

Phaseolus hair, small when compared to 40IIIAa301.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Phaseolus vulgaris

## Phytolith

Phaseolus hair, small when compared to 40IIIAa301.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Phaseolus vulgaris

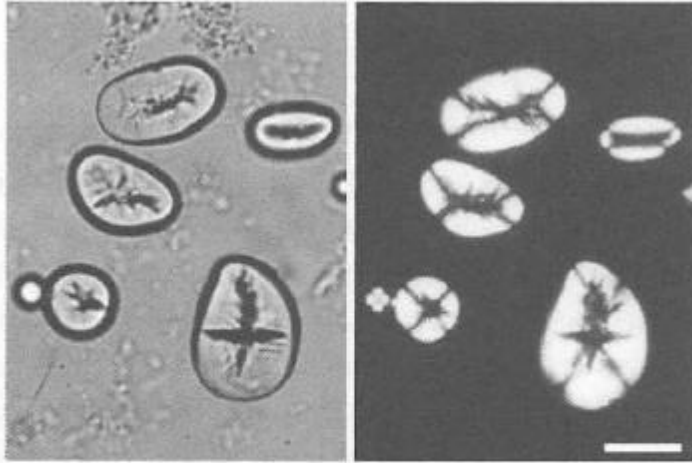


Figure 5. Common bean non-processed starch grains. Views with normal (left) and polarised light (right). Scale bar = 20 $\mu$ m.

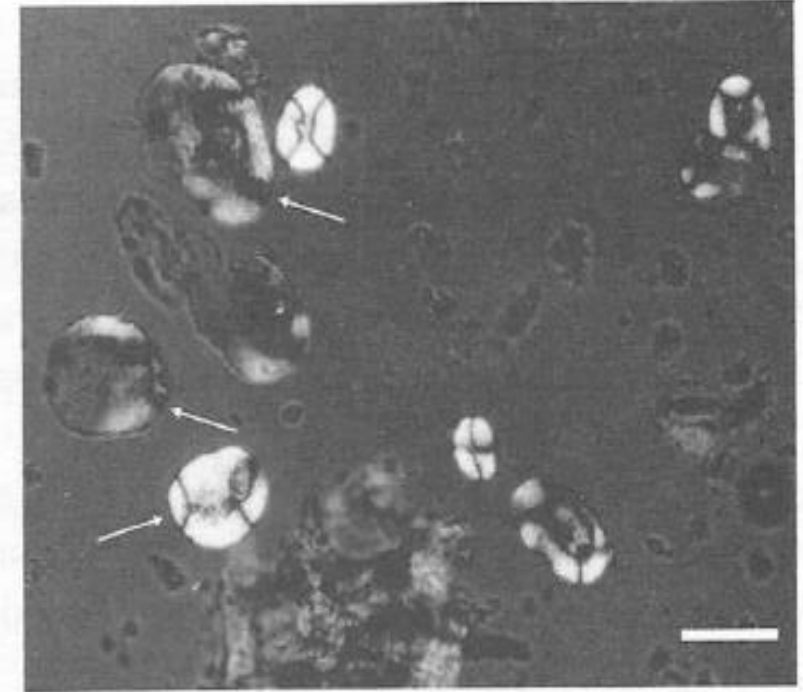
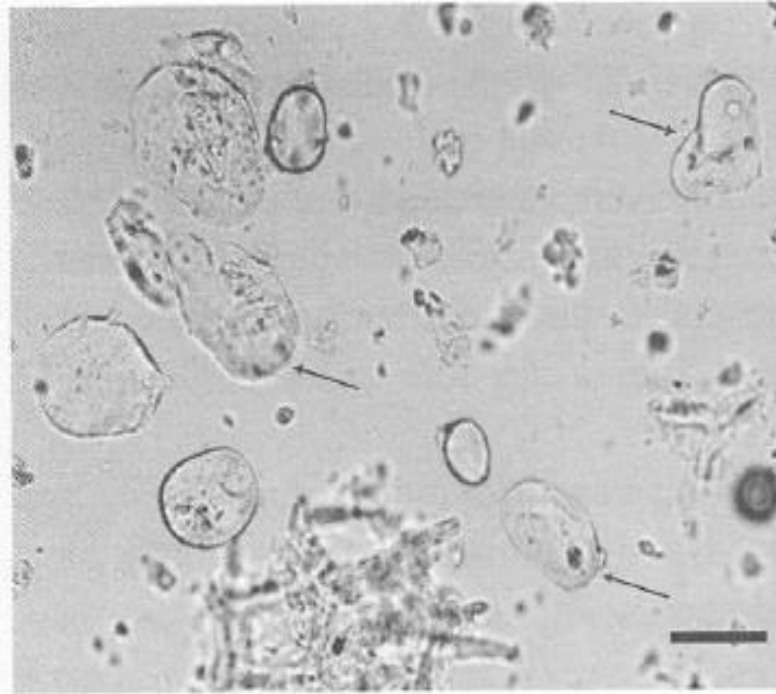
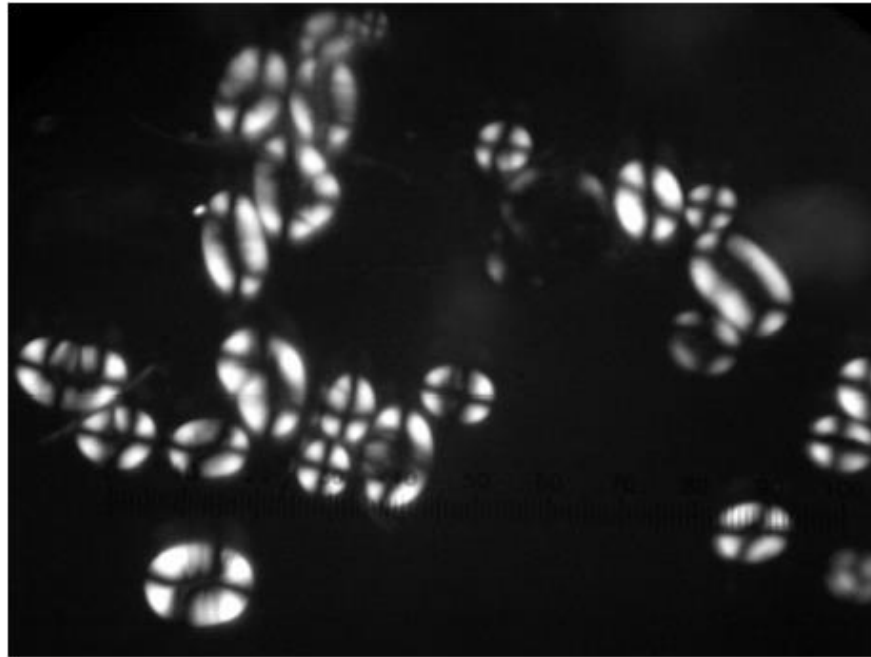
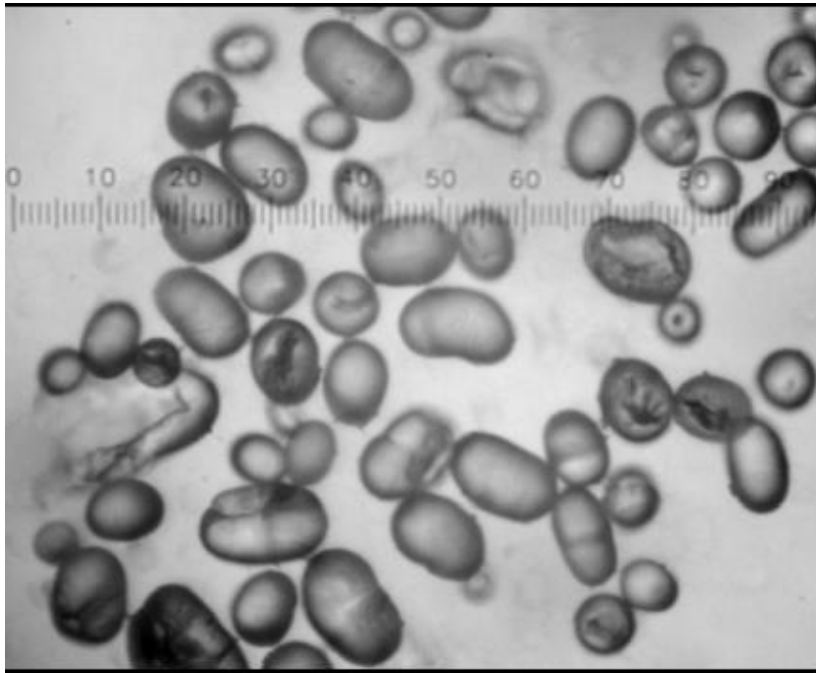


Figure 11. Starch of common bean flour showing milling effects. (a) Highly damaged granules which appear incomplete, fractured and collapsed with damaged surfaces and contours and a grain with a hole at the hilum are marked with arrows. View with normal light (left). (b) Partially obscure grains with low intensity of birefringence and defects in the shape and integrity of the extinction cross are marked with arrows. View with polarised light (right). Scale bar = 40 $\mu$ m.

Babot, María del Pilar. 2003. Starch Grain Damage as an Indicator of Food Processing. In *Phytolith and Starch Research in the Australian-Pacific-Asian Regions: The State of the Art*.

# Phaseolus vulgaris

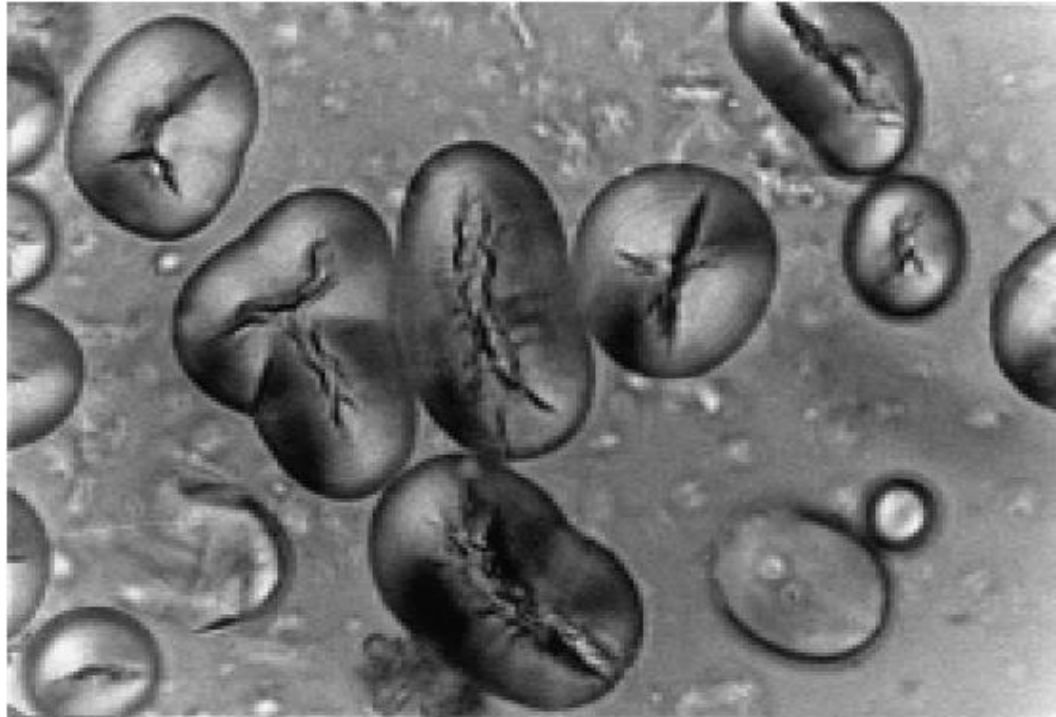
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Phaseolus vulgaris

## Starch



Starch grains from modern *Phaseolus vulgaris* beans. 160x

APPENDIX:  
*Phaseolus vulgaris* (common bean) (Figure 6). Simple grains, oval and laminated, with a large, ragged mesial fissure that extends the length of the grain. Size: 14– 6 microns long.

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Pisum sativum

## Starch

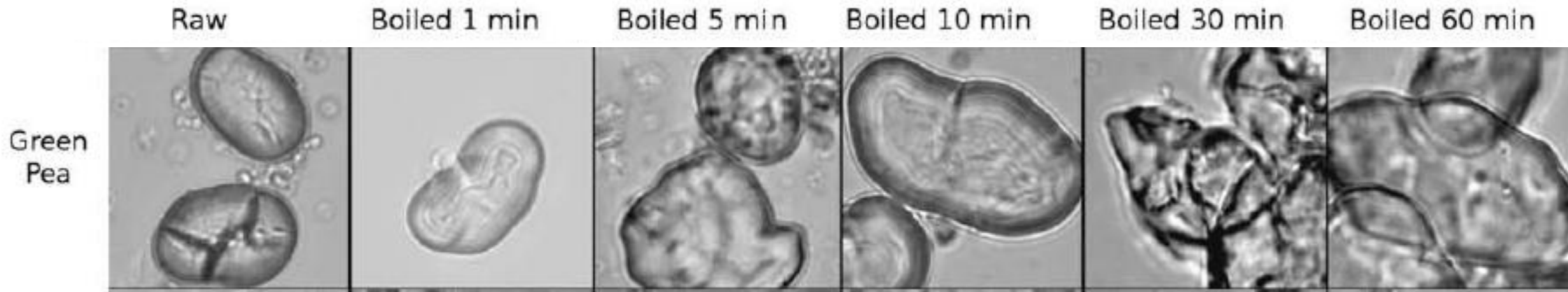


Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Pisum sativum

## Starch

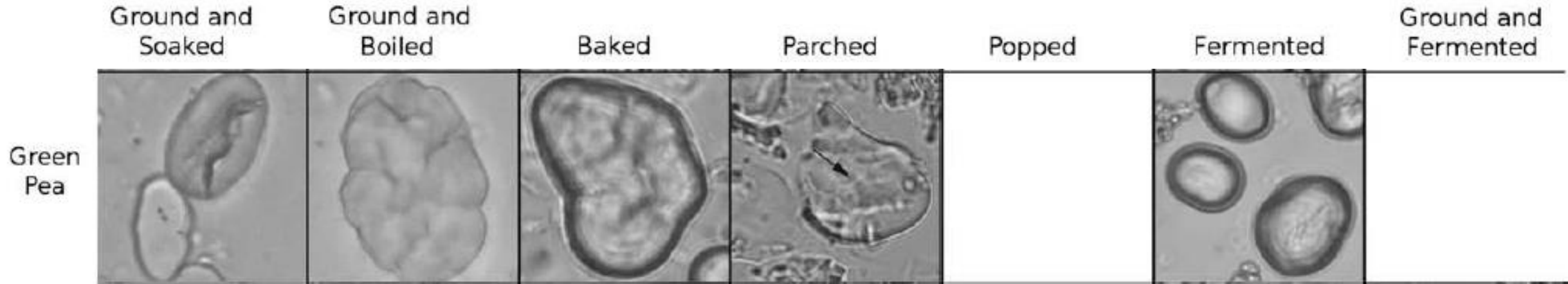


Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

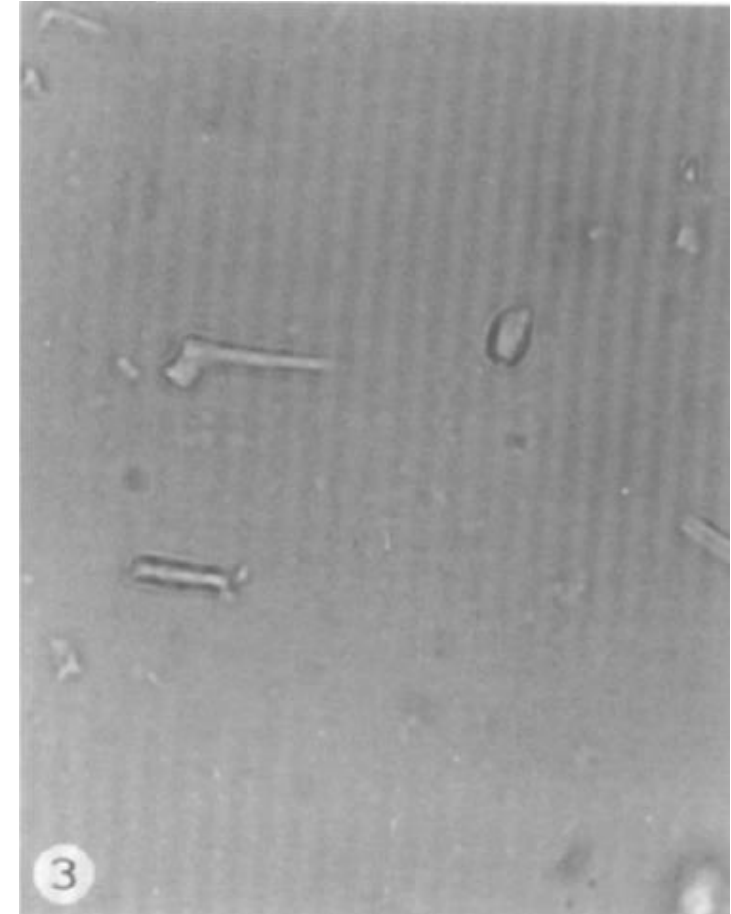
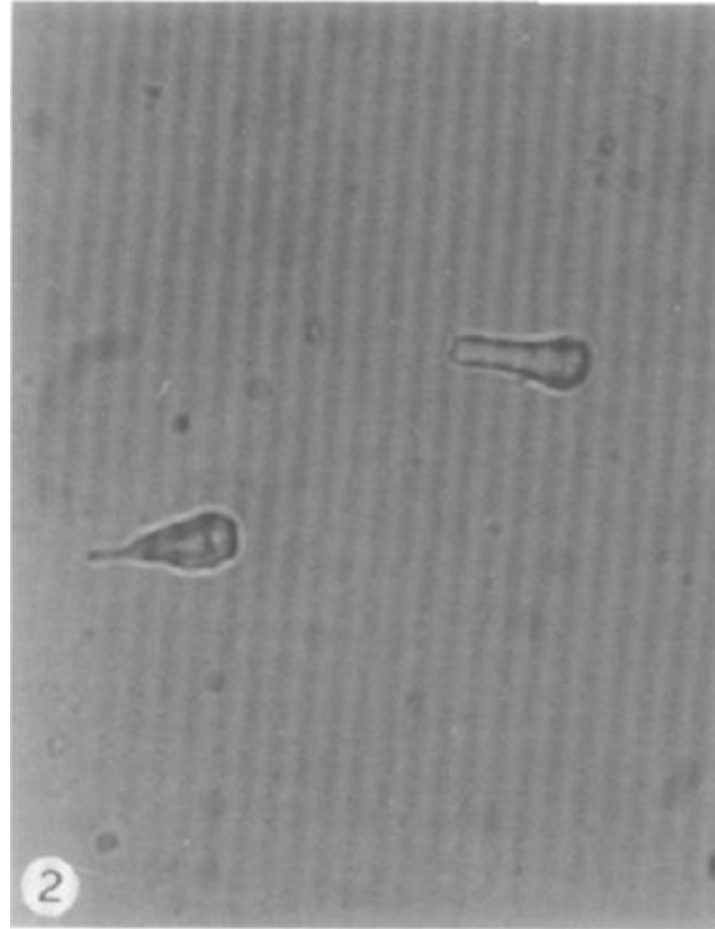
Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.



# Pithecolobium latifolium

## Phytolith

- 2. Silicified sclereids from *Pithecolobium latifolium* (250x).
- 3. Silicified sclereids from *Pithecolobium latifolium* (250x).



# Prosopis nigra et alba

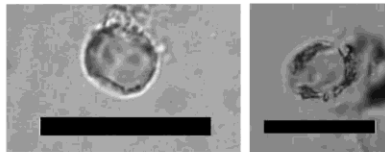
Leguminosae *Prosopis nigra et alba* "algarrobo"

## Phytolith assemblage characterization

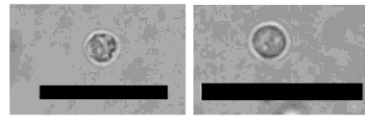
### Pod and seed.

Non diagnostic phytoliths:

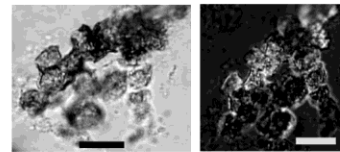
a) Round dorsal irregular faceted silica phytolith. Rare.



b) Round psilate silica phytolith. Rare.



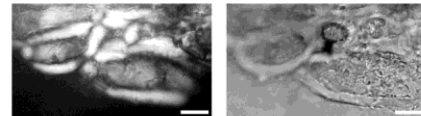
c) Polyhedral calcium oxalate phytolith.



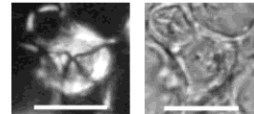
**References:** Reported as not present in Piperno 1988 for *Prosopis juliflora*.  
Reported as typical legume crystals in Cummings 1992.

## Starch assemblage characterization

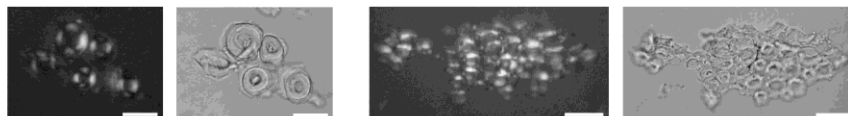
a) Single grains, variable in shape, oval and spherical, elongated; variable in size, to 80µm long length; sometimes distinct hilum as a line or circle; not visible lamella; a circular, oval or elliptical hollow at the center with a similar shape to the contour of the grain; distinct centric cross, with four arms visible, meeting at dark oval or circular hollow.



b) Also common spherical grains; distinct centric cross, with four arms visible.



a) Single grains, variable in shape, oval, spherical; variable in size, from 5µm to 30µm long length; sometimes distinct centric hilum as a line or circle; not visible lamella; a circular, oval or elliptical hollow at the center with a similar shape to the contour of the grain; distinct centric cross, with four arms visible, meeting at a dark oval or circular hollow. May occur in bunch aggregates.



b) Also common spherical grains; distinct cross, with four arms visible, intersecting at a vertical line or circle.

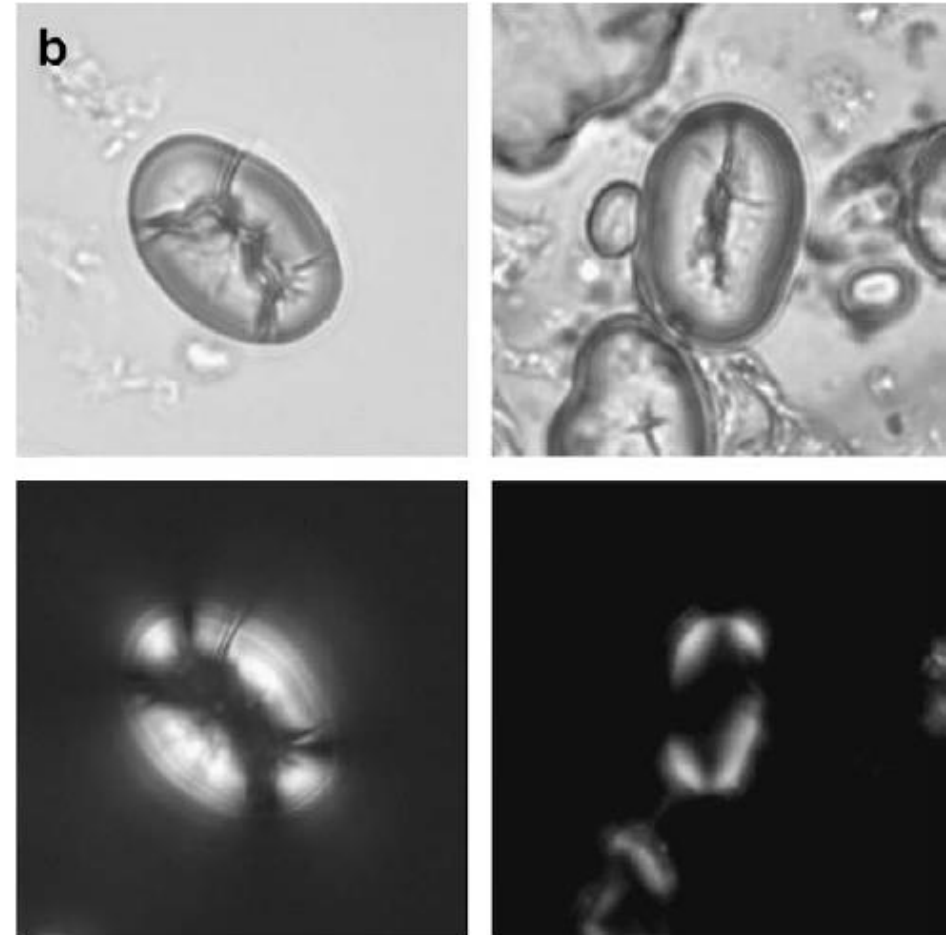
Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Vigna radiata

## Starch

Fig. 1. Comparisons of raw and boiled starch grains showing damage to extinction crosses. (b) Mung bean starch grains. Left side, raw mung bean starch grains; right side, mung bean starch grains boiled for 10 min. Once again the cross is faded around the outside and less distinct, though there is very little change visible under regular light. Each image is 50 mm wide.



Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Vigna radiata

## Starch

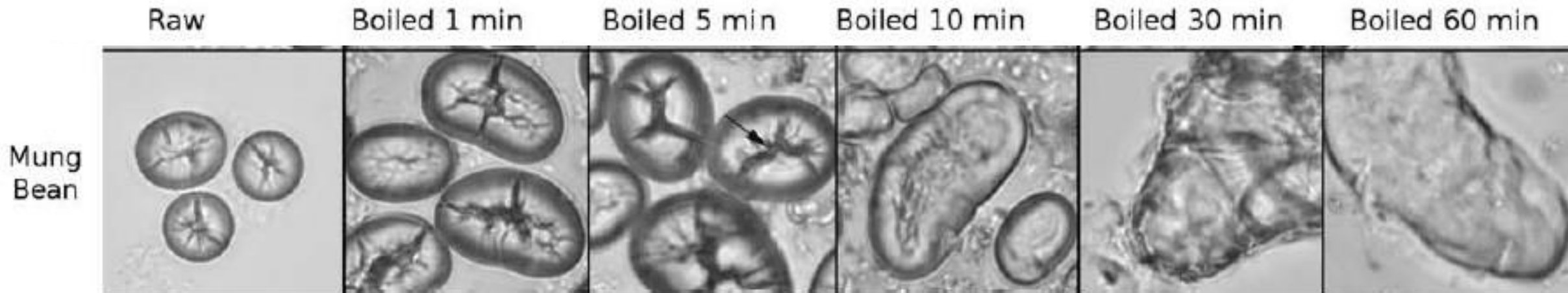


Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Vigna radiata

## Starch

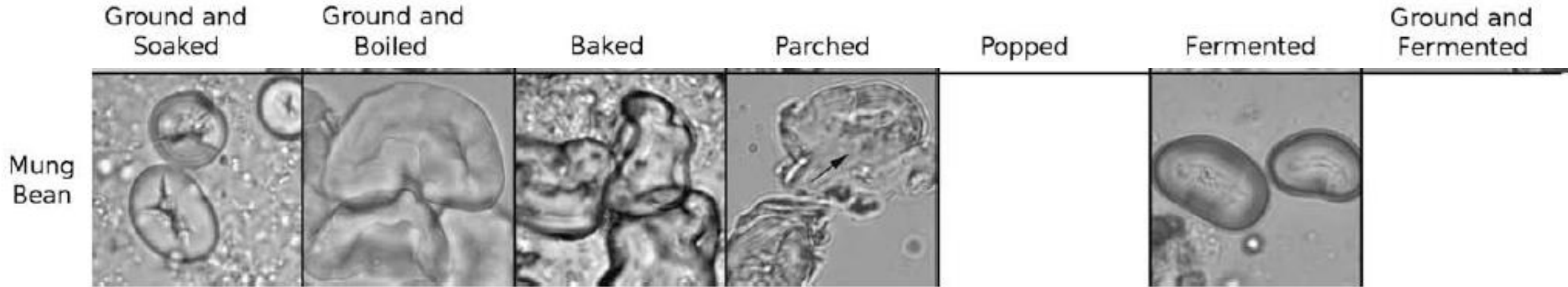


Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

FAGACEAE

# Lithocarpus acuminatissima

## Phytolith

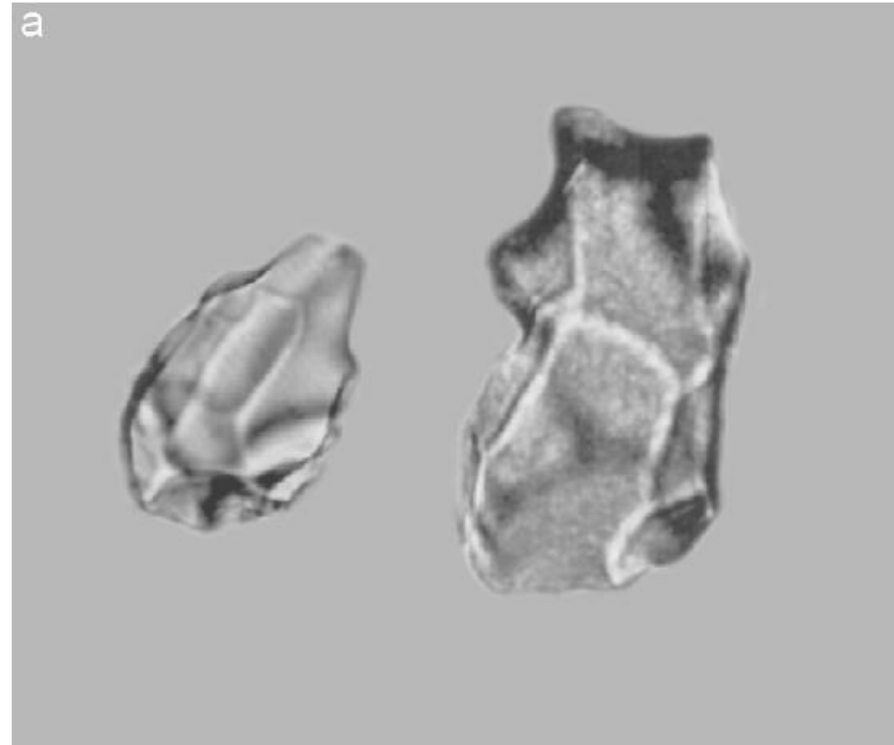


Fig. 3. (a) Facetate phytoliths from Asian Fagaceae (*Lithocarpus acuminatissima*), left, and Annonaceae (*Goniothalamus marcani*), right. Reprinted from Kealhofer and Piperno, 1998. Reprinted from Piperno (2006a), Copyright AltaMira Press.

Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

FLACOURTIACEAE



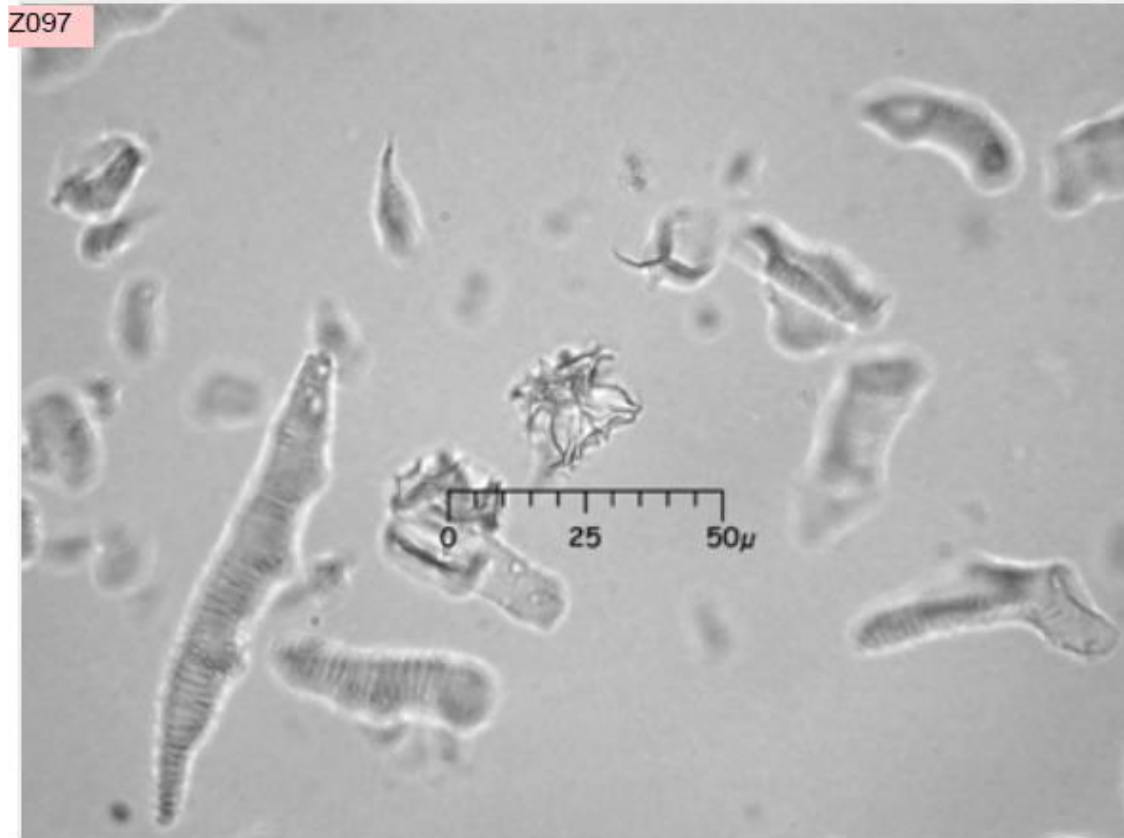
# Caesaria sylvestris

## Phytolith

See Record #140 for a variation of the same body. Occurs in the leaf. Small, tall hair cell base.

Note the decorated schlerids in background-- these are common in the sample.

Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Caesaria sylvestris

## Phytolith

Side view (see also Record #139); tall hair base, small. Occurs in the leaf. Note the decorated schlerids in background--these are common in the sample.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Caesaria sylvestris

## Phytolith

Stomate with two subsidiary cells.  
Diagnostic level: not diagnostic

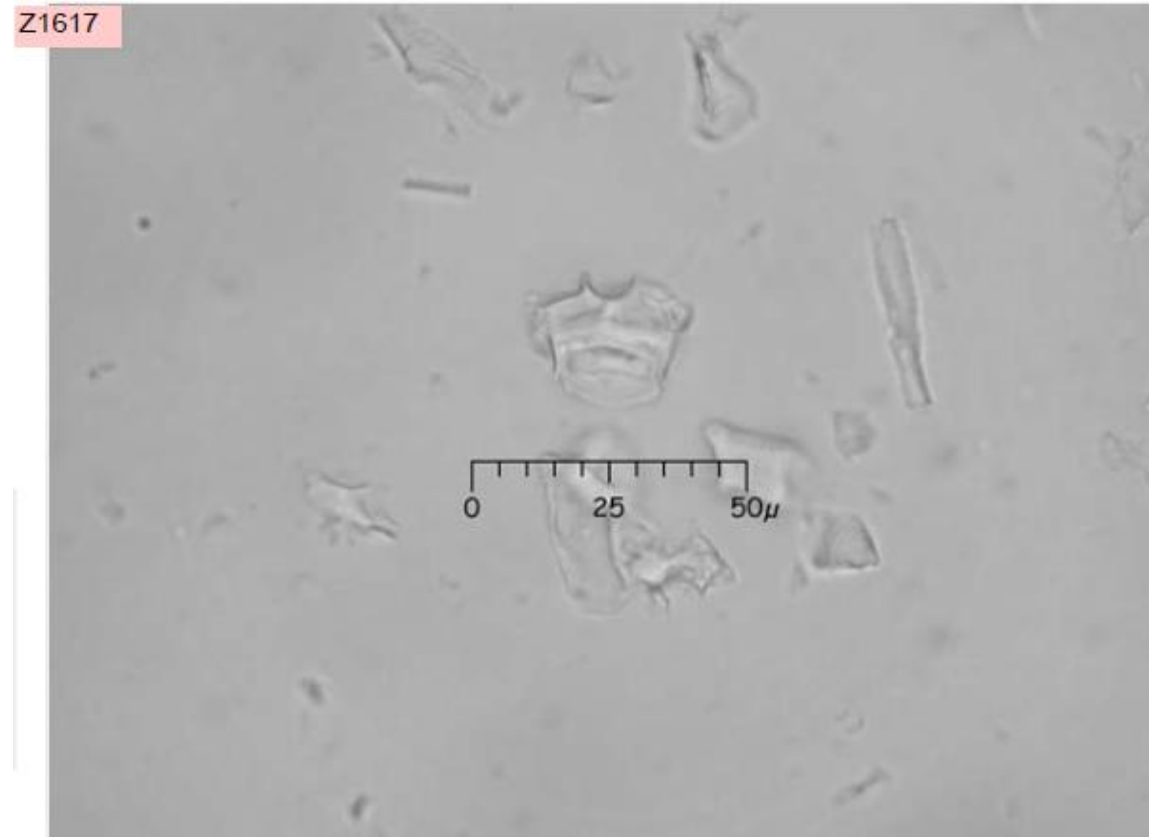


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Caesaria sylvestris

## Phytolith

Top view. See Records #140,139 for a variation of the same body. Occurs in the leaf. Small, tall hair cell base. Note the decorated schlerids in background--these are common in the sample.  
Diagnostic level: family

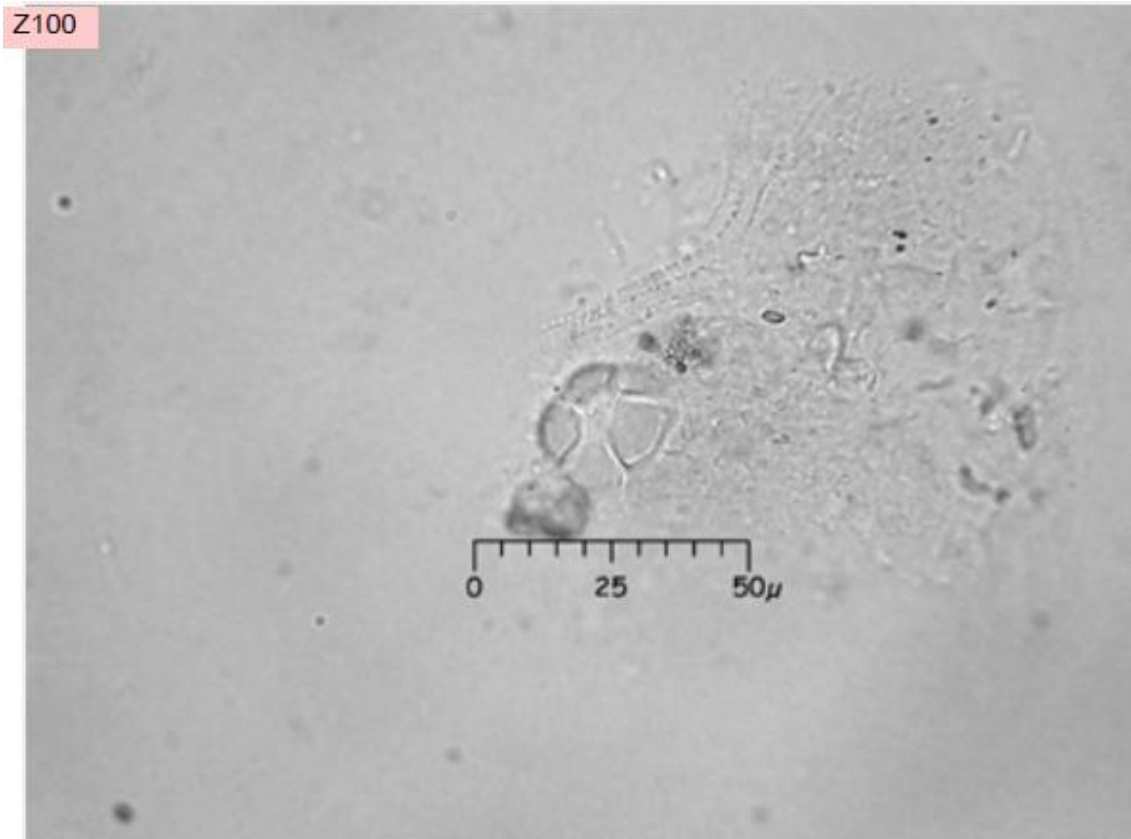


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pleuranthodendron lindenii

## Phytolith

Occurs in the leaf. Diagnostic level:  
family



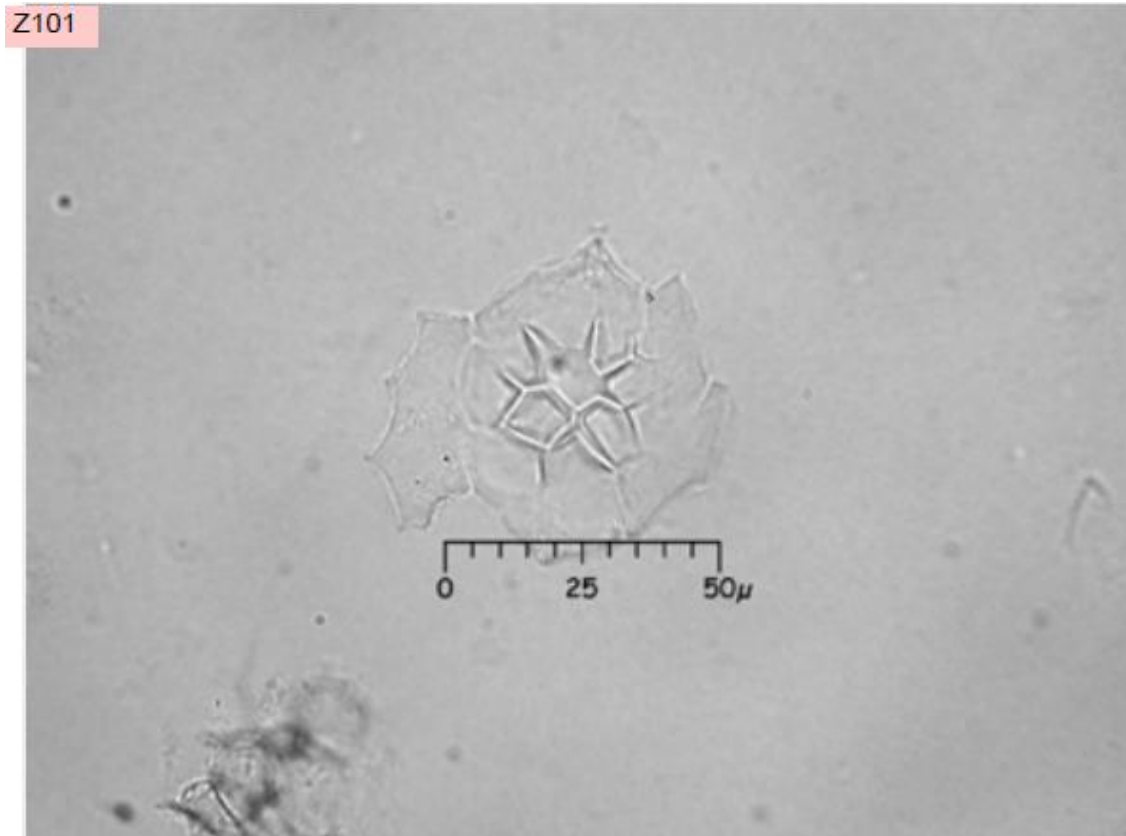
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pleuranthodendron lindenii

## Phytolith

Occurs in the leaf. In this example, the surrounding disk is not completely developed.

Diagnostic level: family



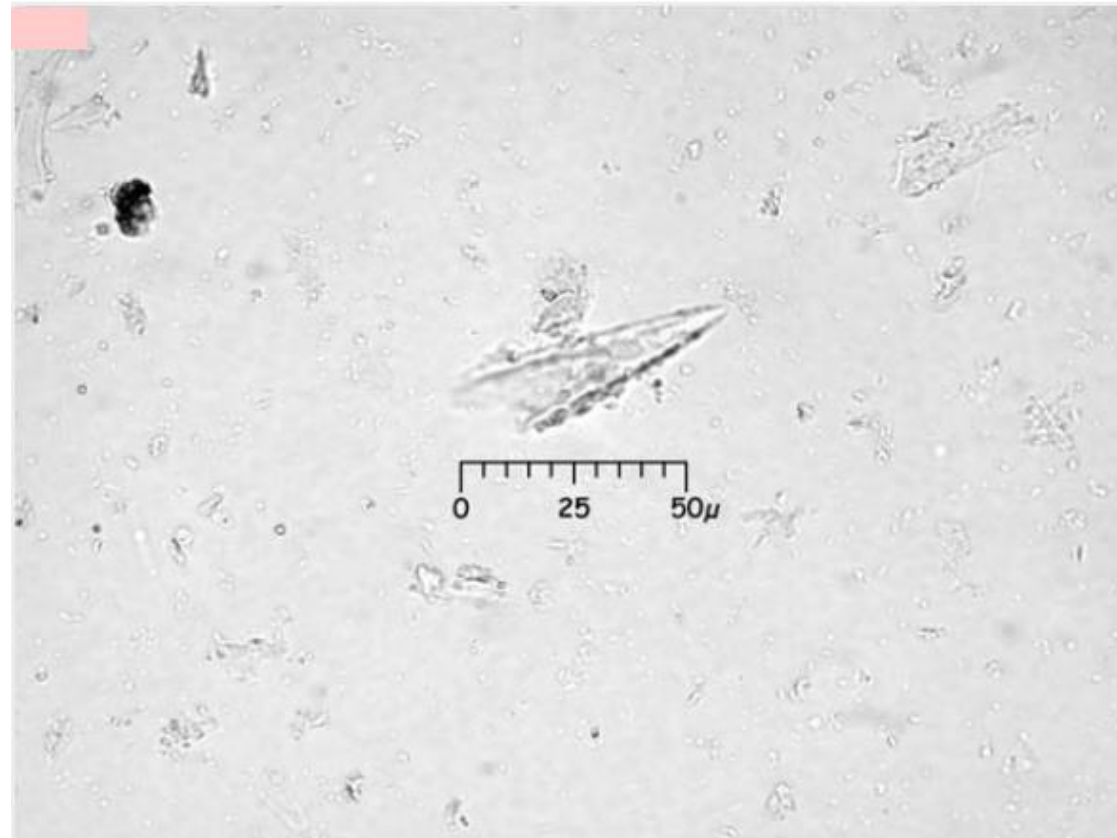
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pleuranthodendron lindenii

## Phytolith

Slide 1377 leaf.

Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pueraria phaseoloides

## Phytolith

Moderate to common in abundance.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Tetrathylacium macrophyllum

## Phytolith

Occurs in the leaf. Diagnostic level:  
family



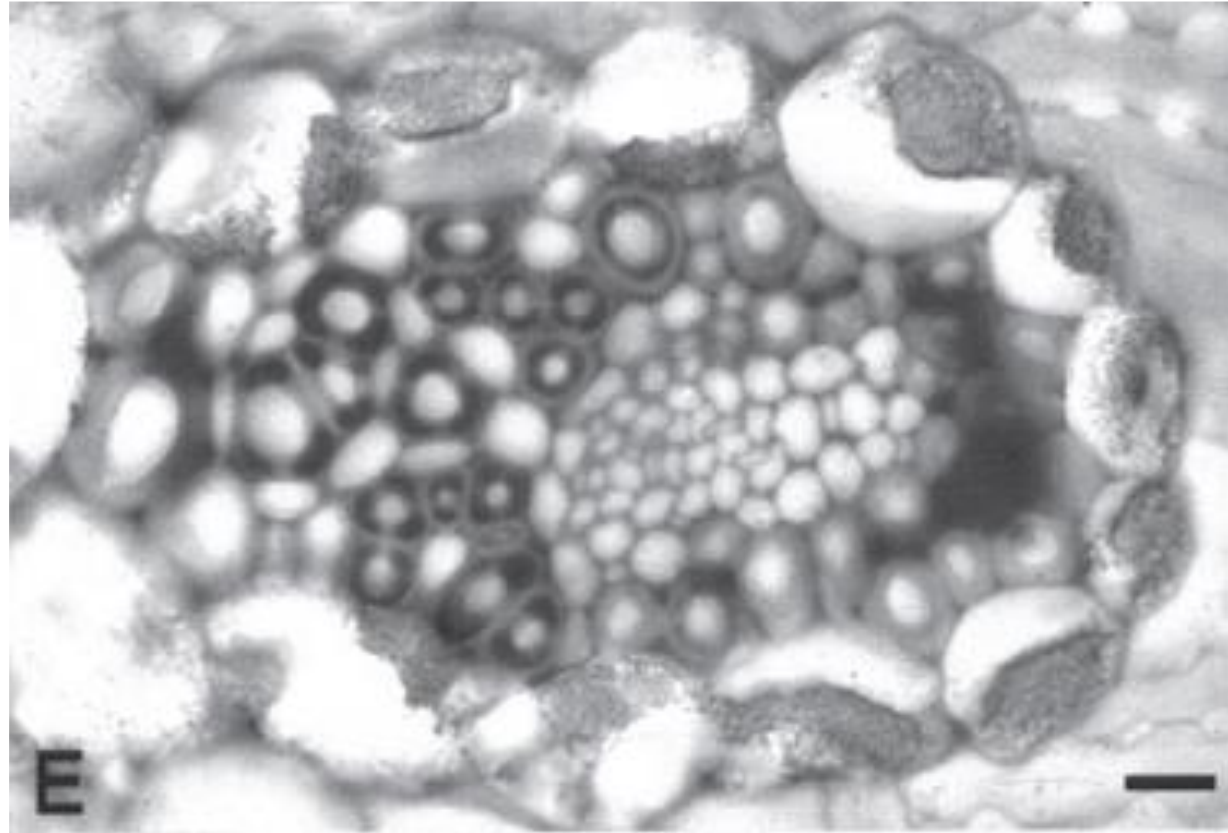
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

HAEMODORACEAE

# Conostylis bracteata

## Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. E. *Conostylis bracteata* (Haemodoraceae), large quantities of silica sand in vascular bundle-sheath cells (bar = 10  $\mu\text{m}$ ).

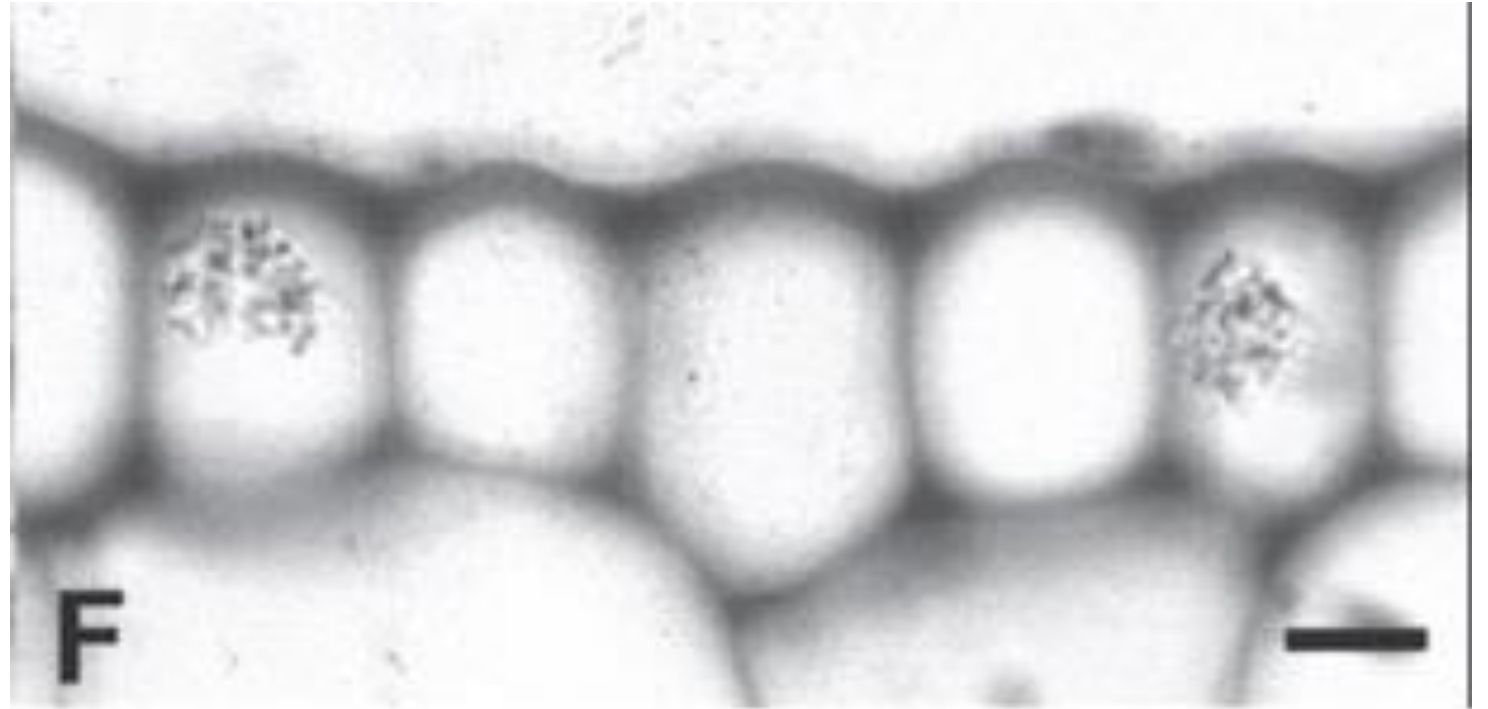


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Anigozanthos flavida

## Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. F. *Anigozanthos flavida* (Haemodoraceae) epidermal cells containing silica sand (bar = 10  $\mu\text{m}$ )

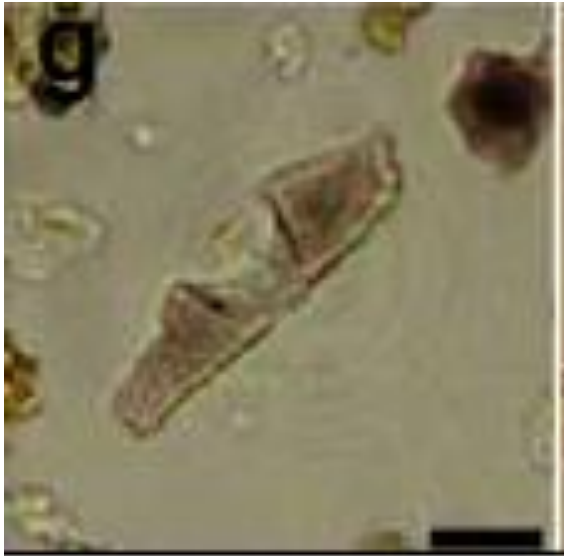


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

HELICONIACEAE

# Heliconiaceae

## Phytolith



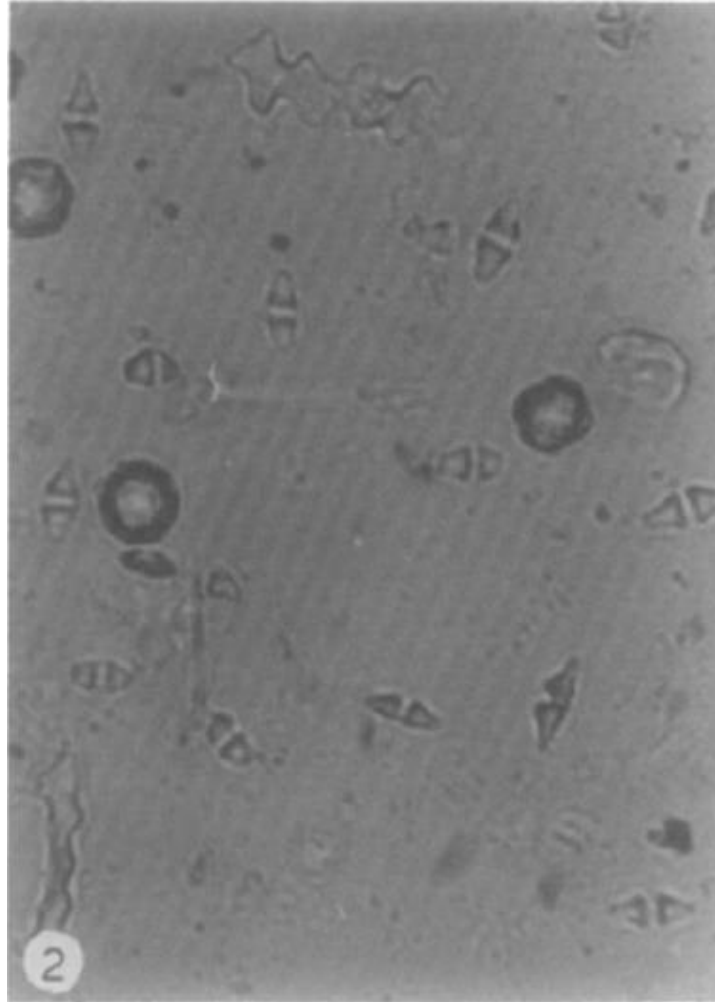
g. Morphotype with trough diagnostic of the wild plantain family (Heliconiaceae).

Abramiuk, Marc A., Peter S. Dunham, Linda Scott Cummings, Chad Yost, and Todd J. Pesek. 2011. Linking Past and Present: A Preliminary Paleoethnobotanical Study of Maya Nutritional and Medicinal Plant Use and Sustainable Cultivation in the Southern Maya Mountains, Belize. *Ethnobotany Research and Applications* 9:257–73.

# Heliconia sp.

## Phytolith

2. Silica bodies with troughs from *Heliconia* (250 x ). Also present are spherical rugulose phytoliths and two narrowly oblong sinuate phytoliths.



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Heliconia sp.

## Phytolith

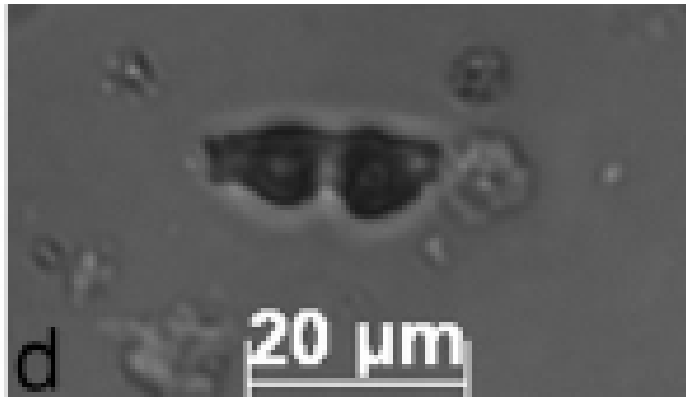


Fig. 3. Phytoliths from San Andre ´s. (d) A burned *Heliconia* phytolith from 1,115 cm

Pohl, Mary E. D., Dolores R. Piperno, Kevin O. Pope, and John Glendon Jones. 2007. Microfossil Evidence for Pre-Columbian Maize Dispersals in the Neotropics from San Andres, Tabasco, Mexico. *Proceedings of the National Academy of Sciences* 104 (16):6870–75. <http://www.pnas.org/cgi/doi/10.1073/pnas.0701425104>.



# Heliconia sp.

## Phytolith

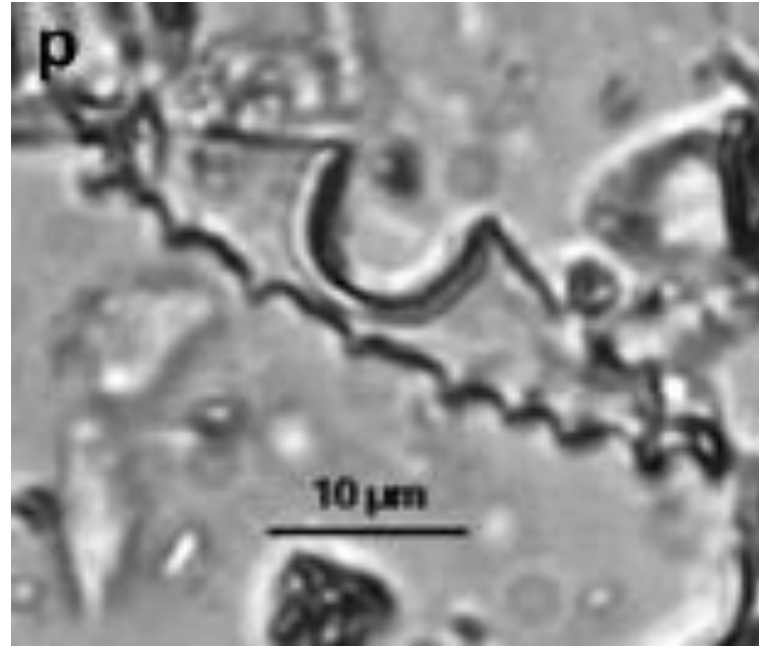


Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. p) Decorated Heliconia body with troughs (K-VIIIM3.1, 0e10 cm)

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Heliconia sp.

## Phytolith

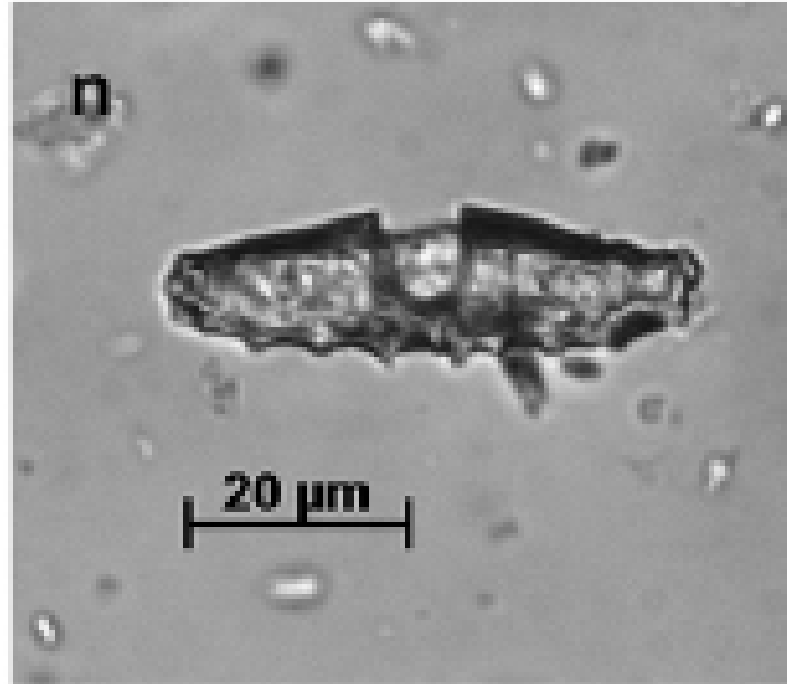


Fig. 5. Selected microbotanical remains. Phytoliths: n) Heliconia troughed phytolith (LM 02-2014)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Heliconia sp.

## Phytolith

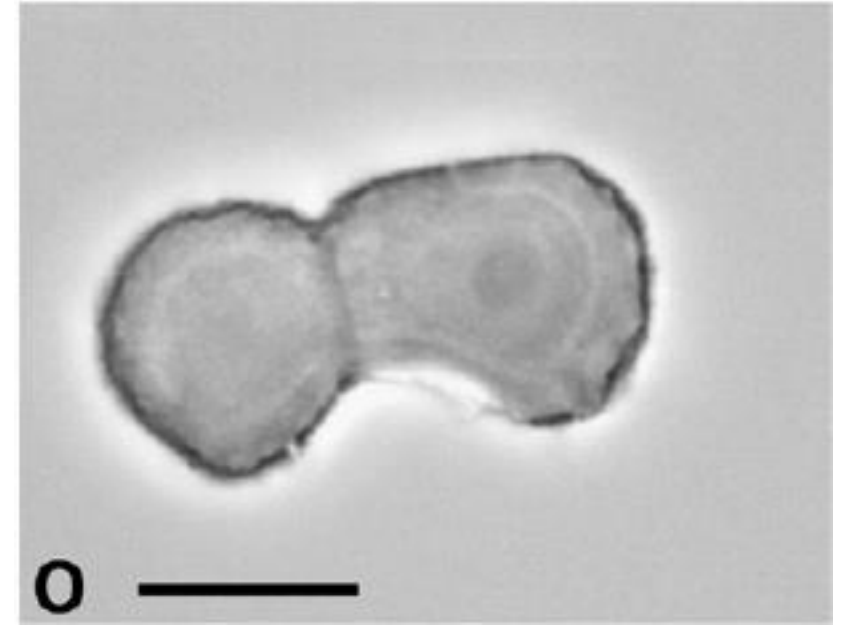
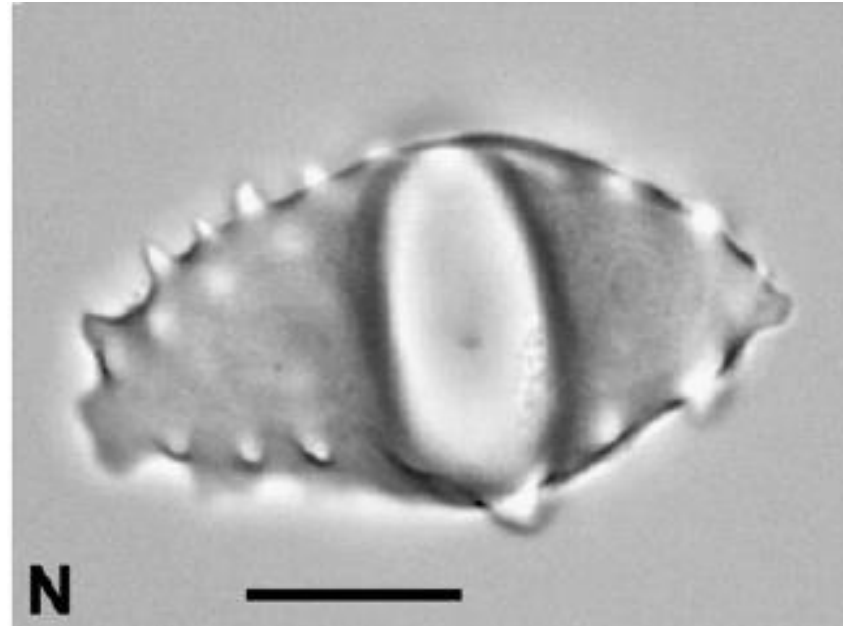
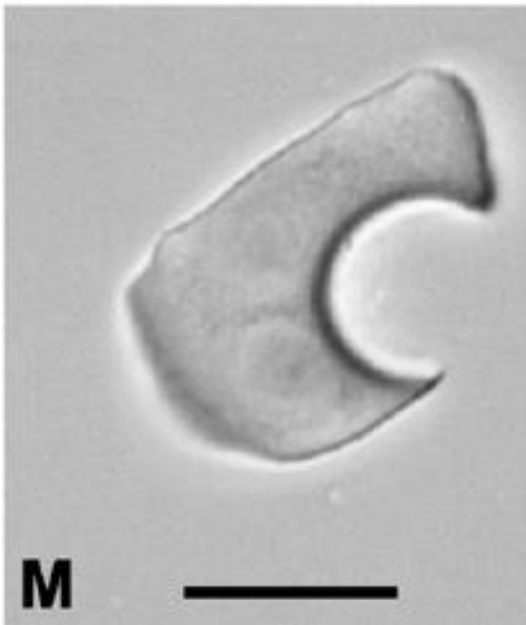


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). M, T1 psilate trough from *Heliconia* sp. rhizome. N, T1 papillate trough from *Heliconia* sp. rhizome. O, T3 trough (fused globulars) from *Heliconia* sp. rhizome. Scale bars: A–J, M–Z = 12  $\mu$ m; K, L = 5  $\mu$ m

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Heliconia bourgaeana

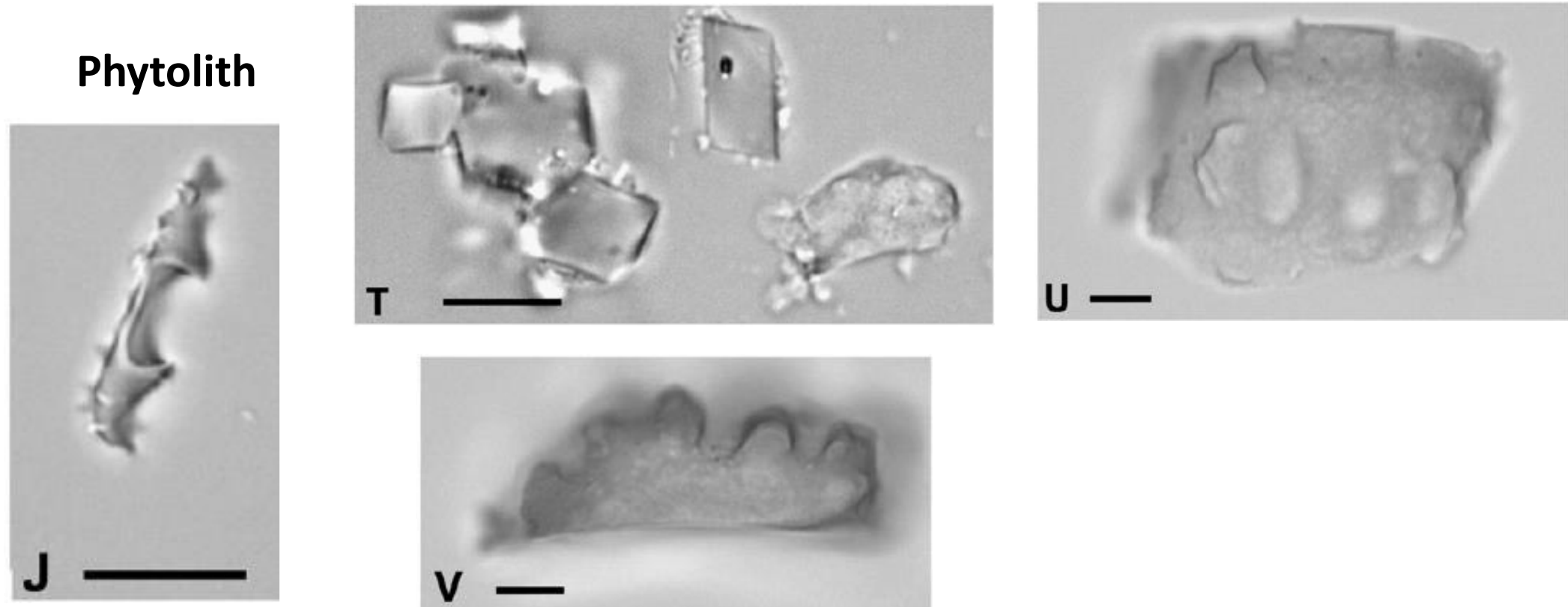


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). .J, T1 papillate trough from *Heliconia bourgaeana* leaf. T, small polygonal-psilates, occasionally with concavities, from *Heliconia bourgaeana* fruit. U, top-view of tabular-castelate from *Heliconia bourgaeana* fruit. V, side-view of tabular-castelate from *Heliconia bourgaeana* fruit. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

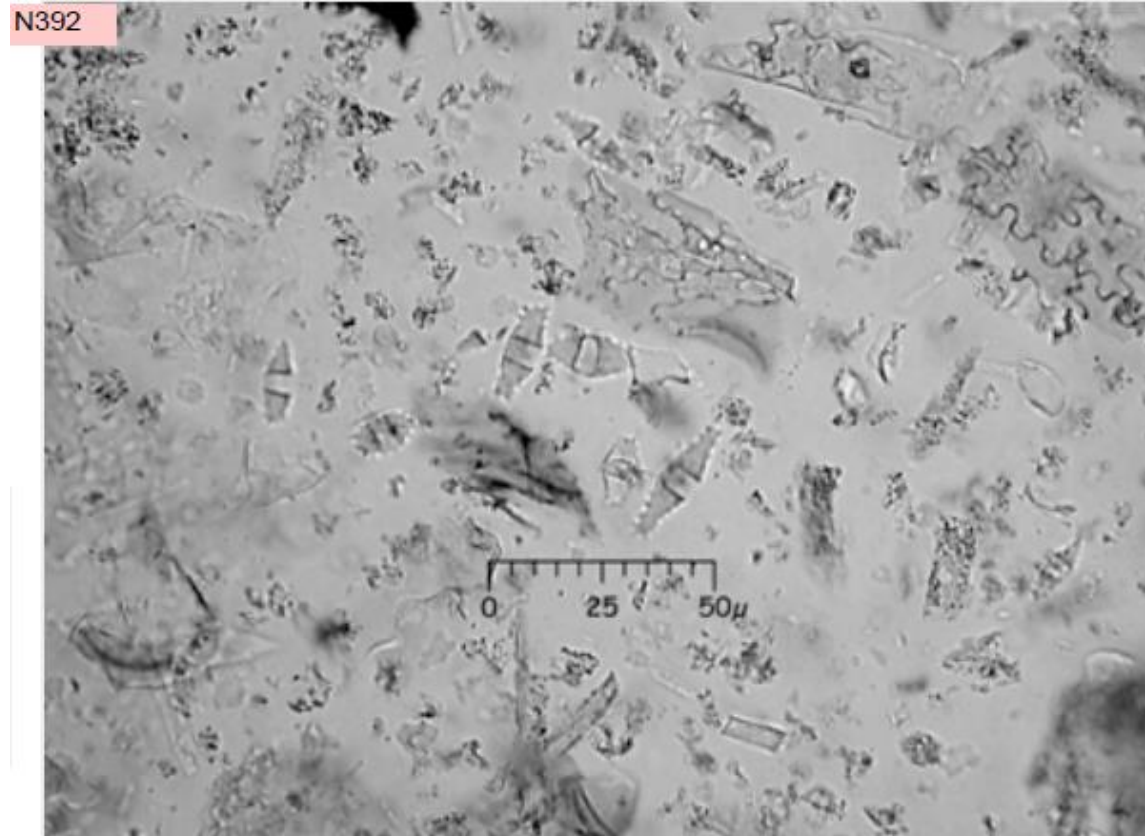
Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Heliconia curtispatha

## Phytolith

Be careful to rotate these phytoliths to see their shape (ellipse or blocky) and the depth of the trough. Check for surface decoration.

Diagnostic level: genus



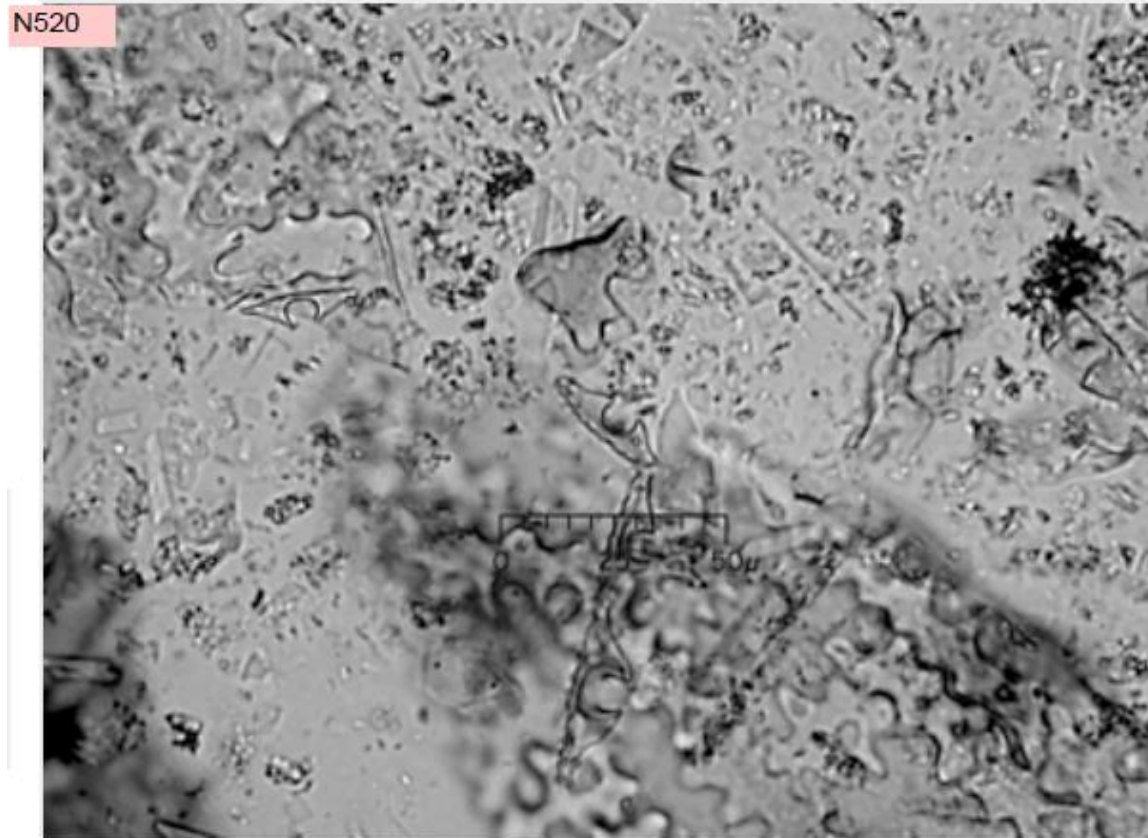
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Heliconia curtispatha

## Phytolith

Be careful to rotate these phytoliths to see their shape (ellipse or blocky) and the depth of the trough. Check for surface decoration.

Diagnostic level: genus



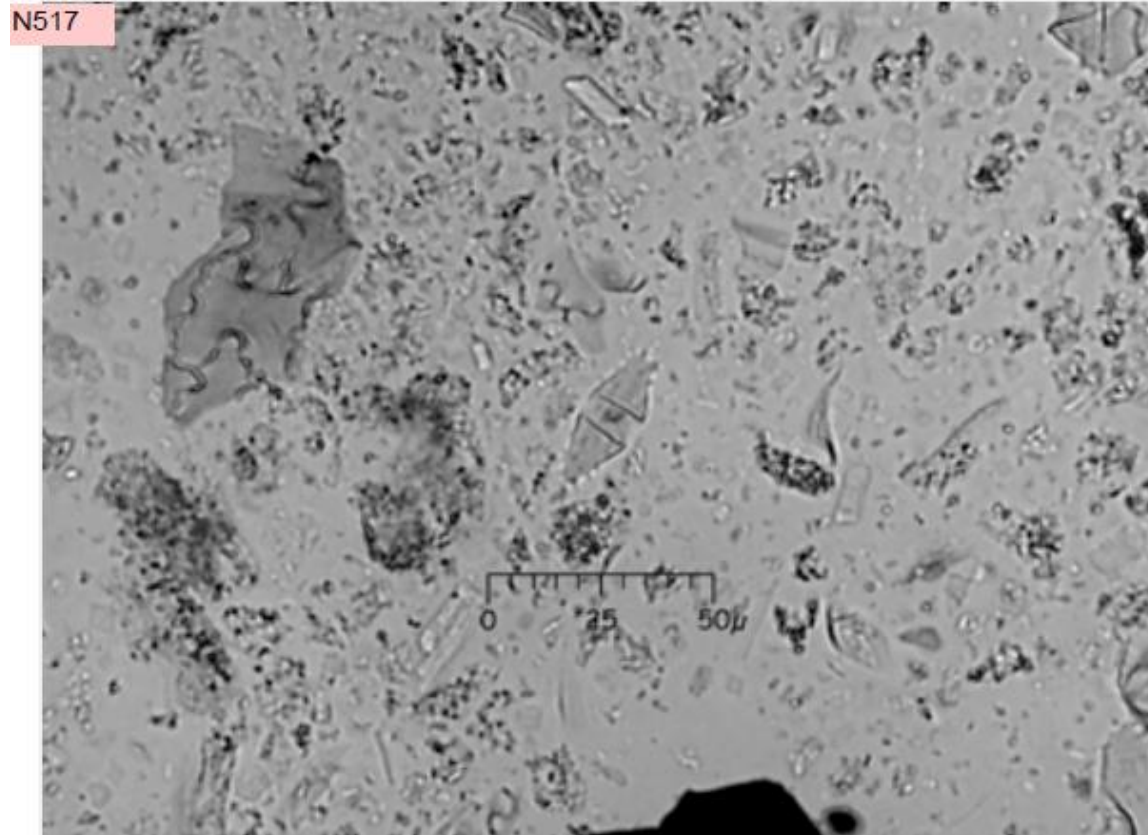
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Heliconia curtispatha

## Phytolith

Be careful to rotate these phytoliths to see their shape (ellipse or blocky) and the depth of the trough. Check for surface decoration.

Diagnostic level: genus



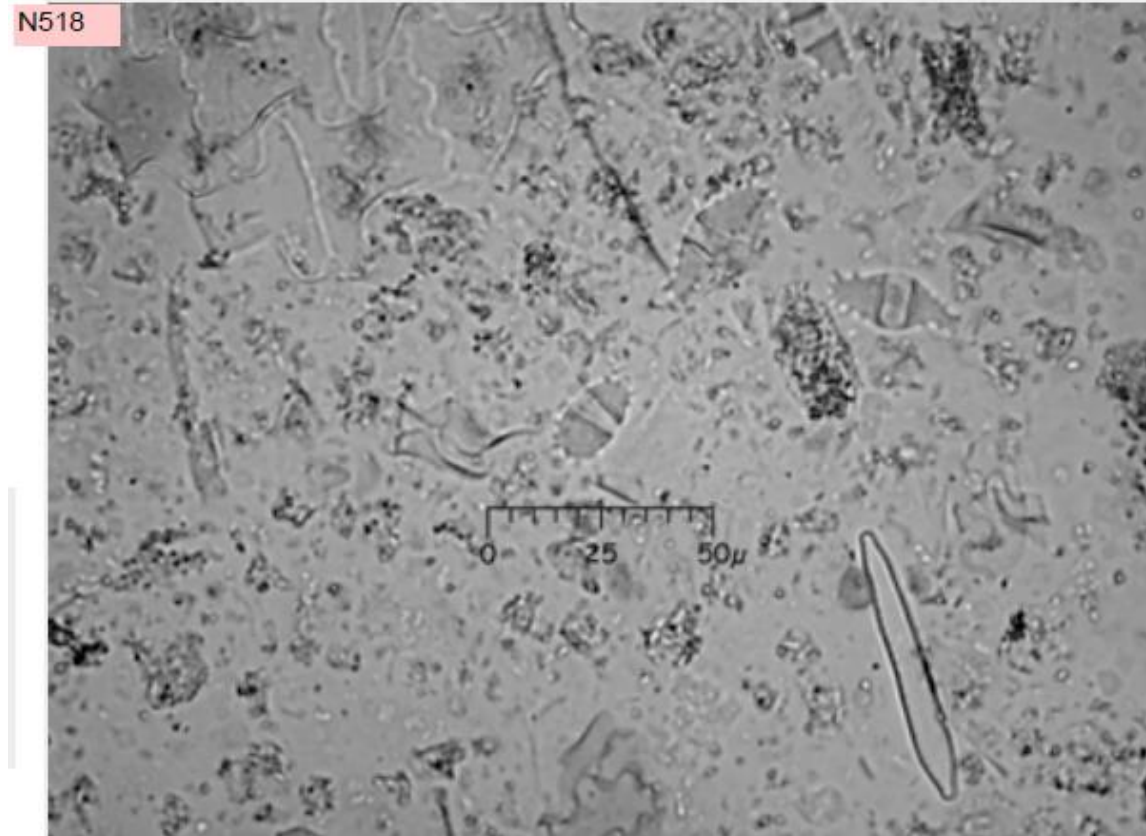
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Heliconia curtispatha

## Phytolith

Be careful to rotate these phytoliths to see their shape (ellipse or blocky) and the depth of the trough. Check for surface decoration.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Heliconia lathispatha

## Phytolith

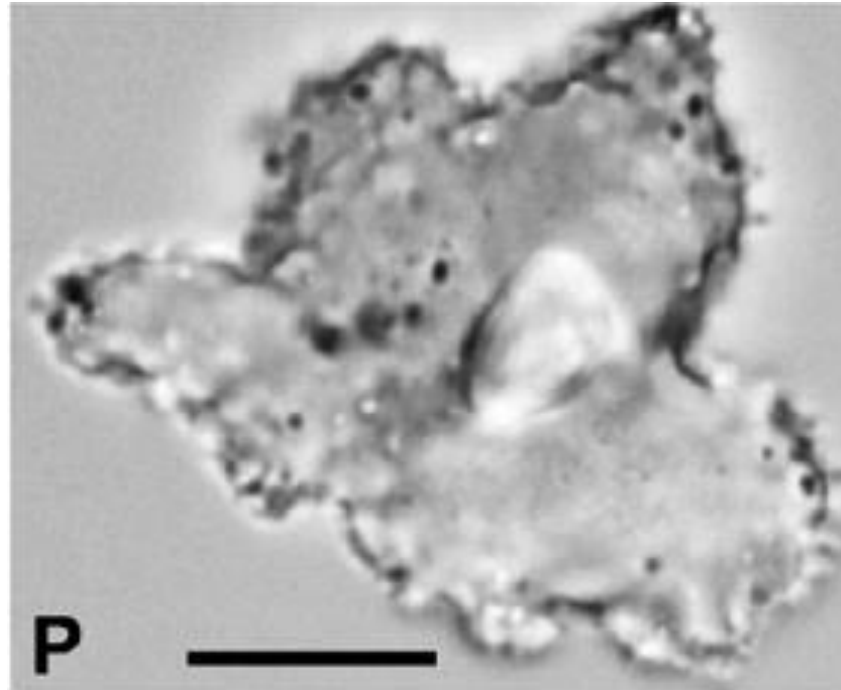


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). .P,Kn1 from *Heliconia lathispatha* seed. Scale bars: A–J,M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Heliconia librata

## Phytolith

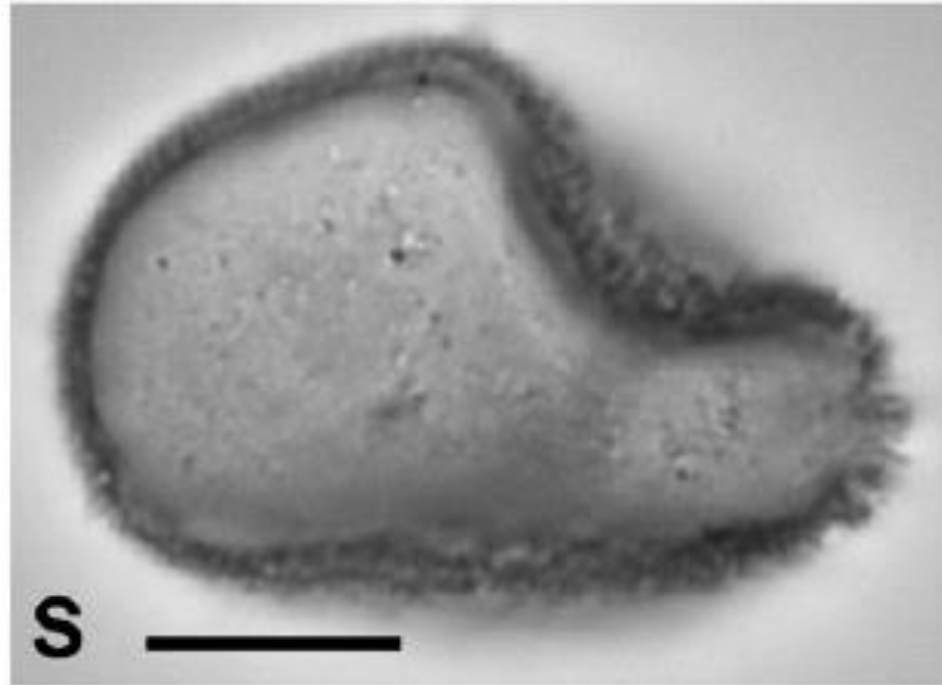


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). S, subglobular-granulate from *Heliconia librata* fruit. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Heliconia pendula

## Phytolith

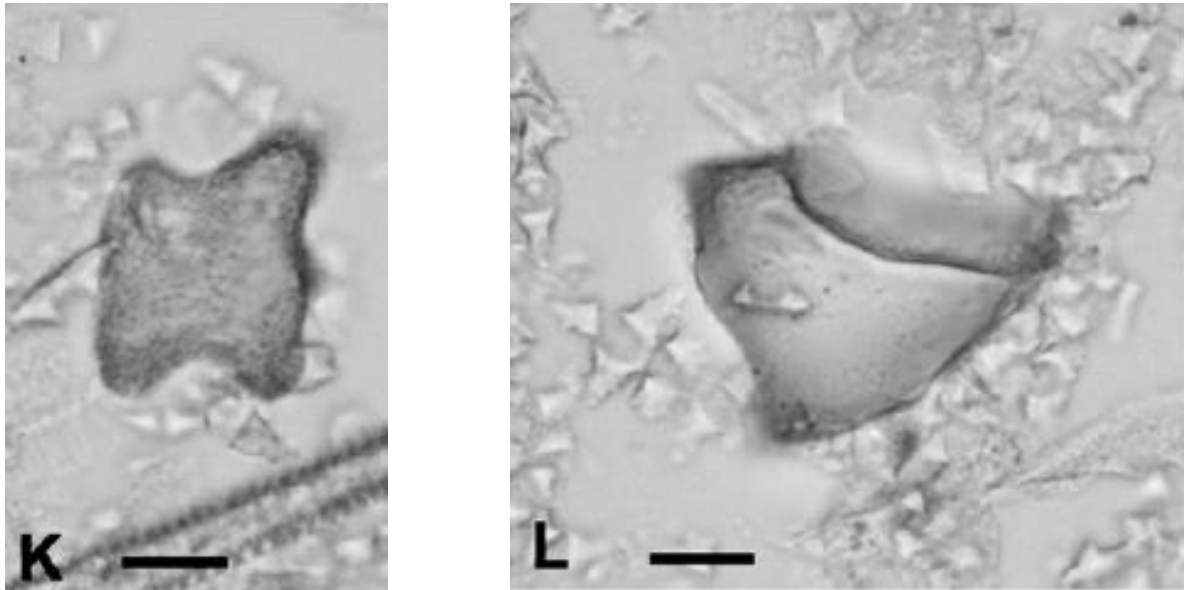


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). K, Ta3 (tabular-granulate) from *Heliconia pendula* leaf. L, thickened Ta3 from *Heliconia pendula* leaf. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Heliconia psittacorum

## Phytolith

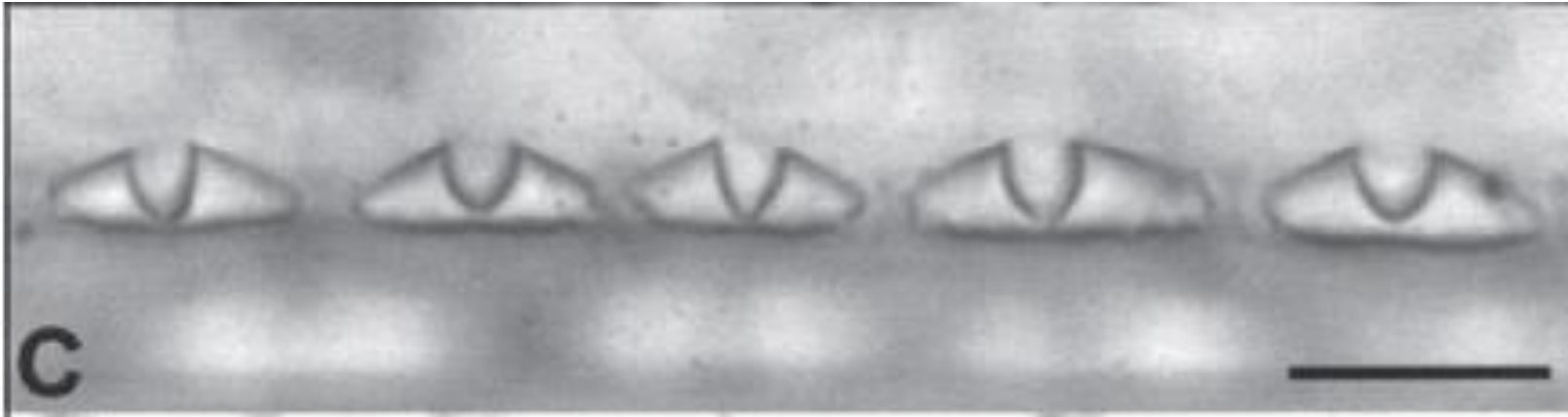


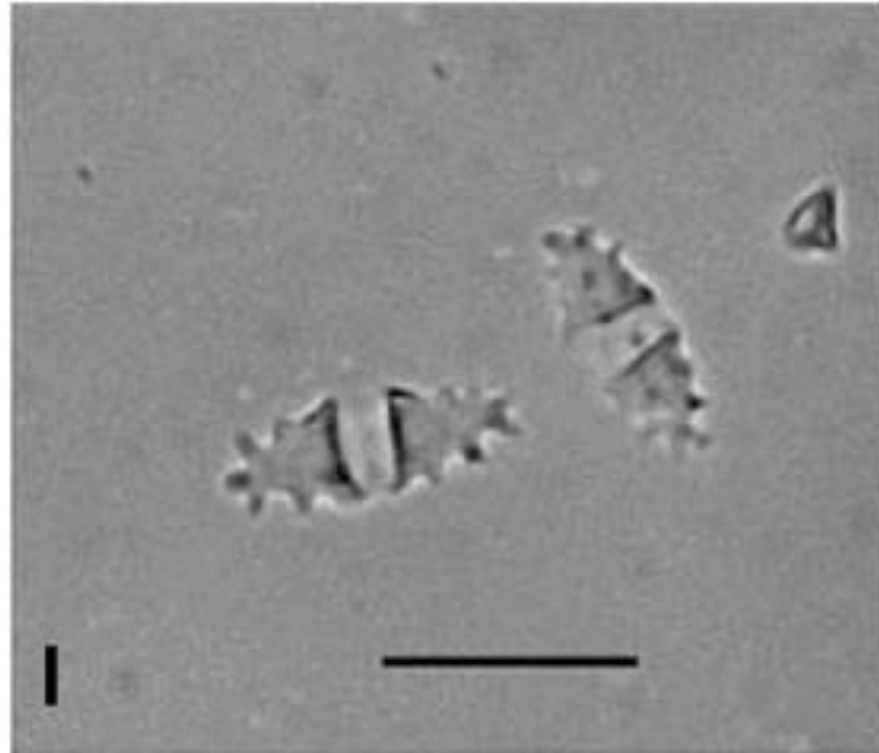
Fig. 3. Various silica body morphologies found in the order Zingiberales. C. *Heliconia psittacorum* (Heliconiaceae), trough-shaped silica bodies over vascular bundle-sheath fibers (bar = 20  $\mu\text{m}$ ).

Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Heliconia psittacorum

## Phytolith

Fig. 3. Phytoliths from non-grass monocots. I) Troughed bodies from *Heliconia psittacorum*



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Heliconia aff. tortuosa

## Phytolith



Fig. 3. Various silica body morphologies found in the order Zingiberales. D. *Heliconia* aff. *Tortuosa* (Heliconiaceae), trough-shaped silica bodies with silica fingers projecting from the base into the cell wall (bar = 10  $\mu$ m).

Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Heliconia velutina

## Phytolith

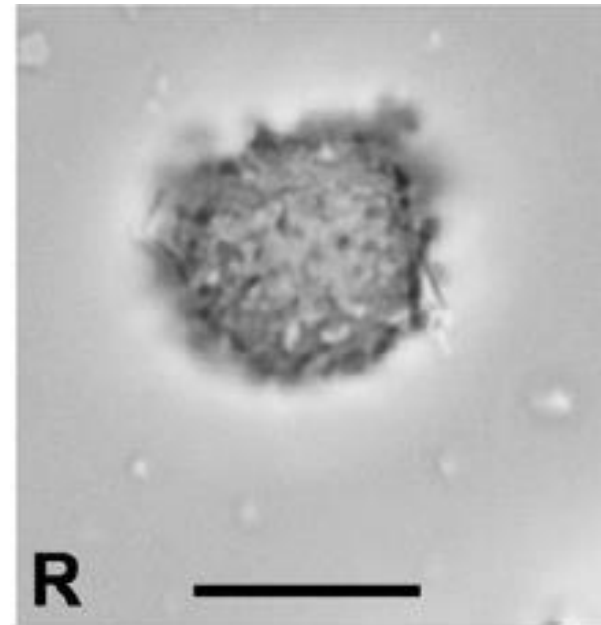
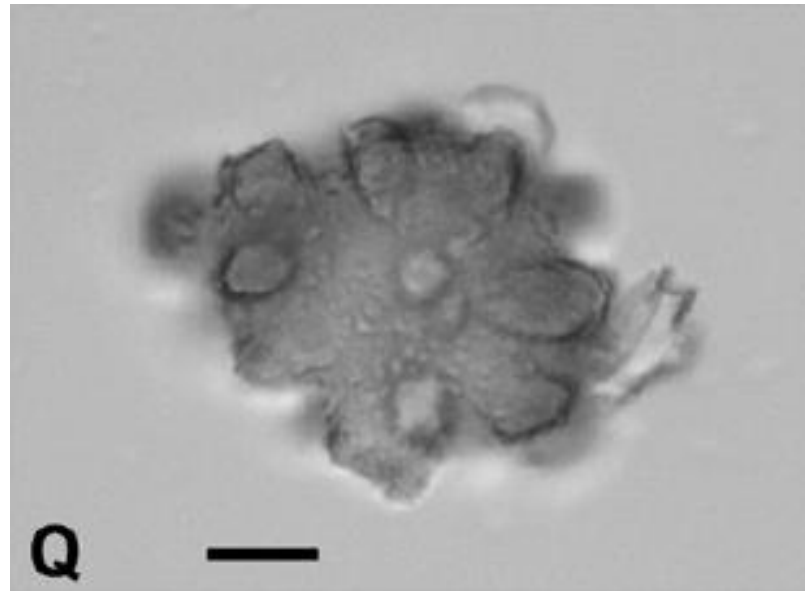


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). Q, Kn2 knobby from *H. velutina* fruit. R, globular-granulate from *Heliconia velutina* fruit. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

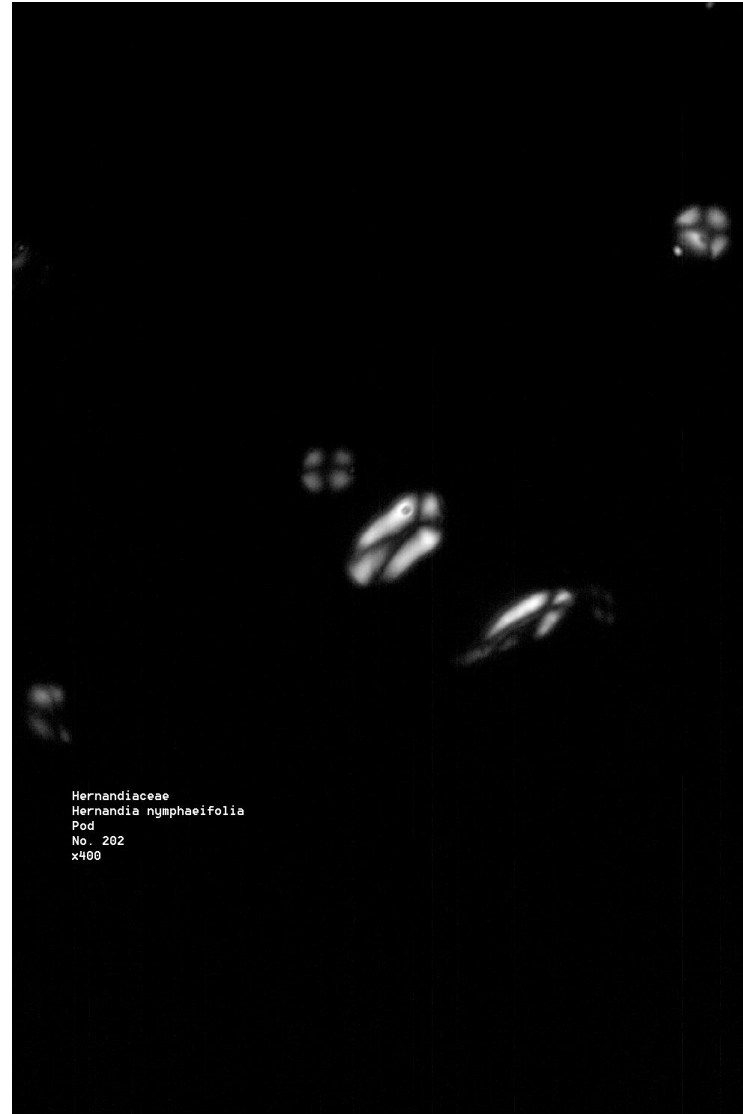
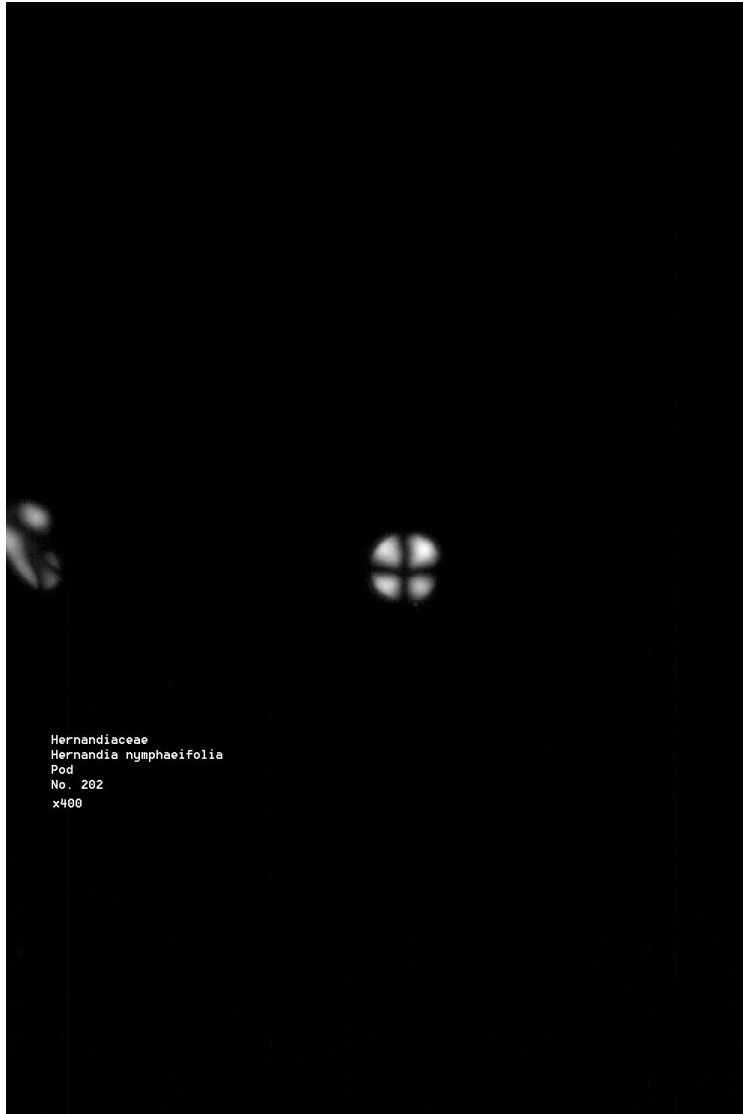
Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

HERNANDIACEAE



# Hernandia nymphaeifolia

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection

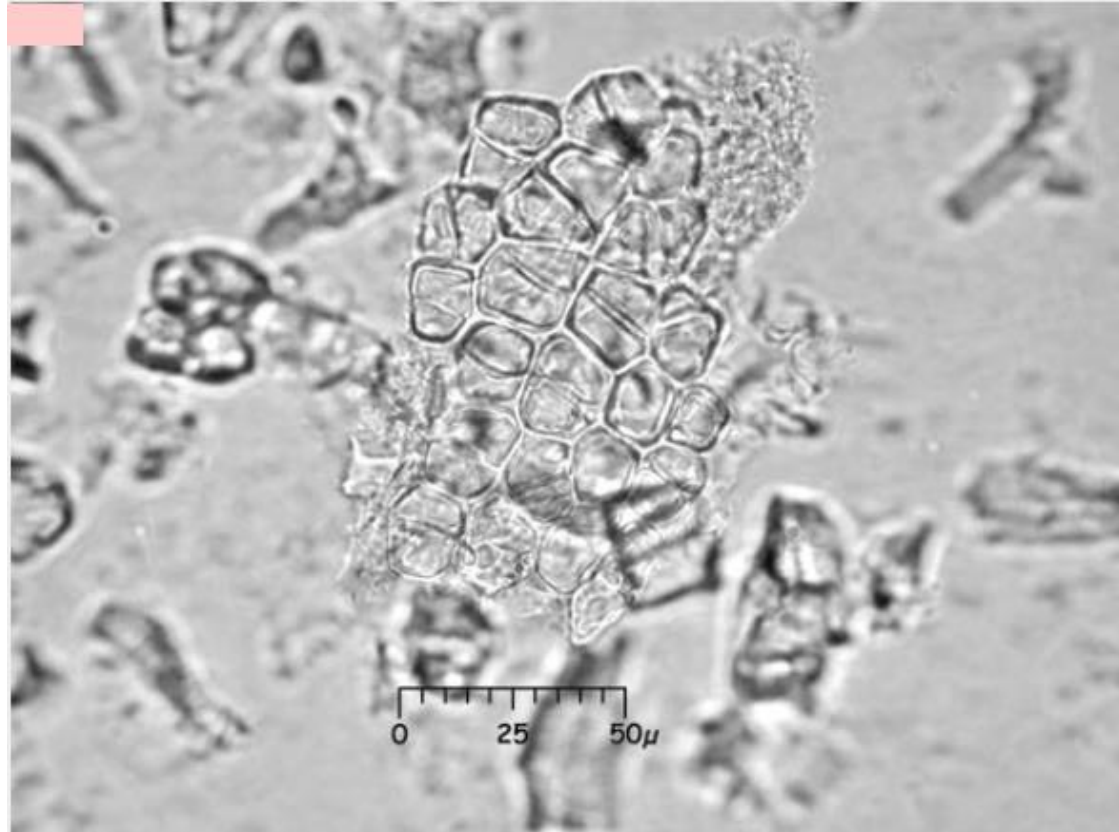


HUMIRIACEAE

# Humiriastrum procerum

## Phytolith

Occurs in leaf. Type defined by Cesar Vientimilla 05/1991. Diagnostic level: family

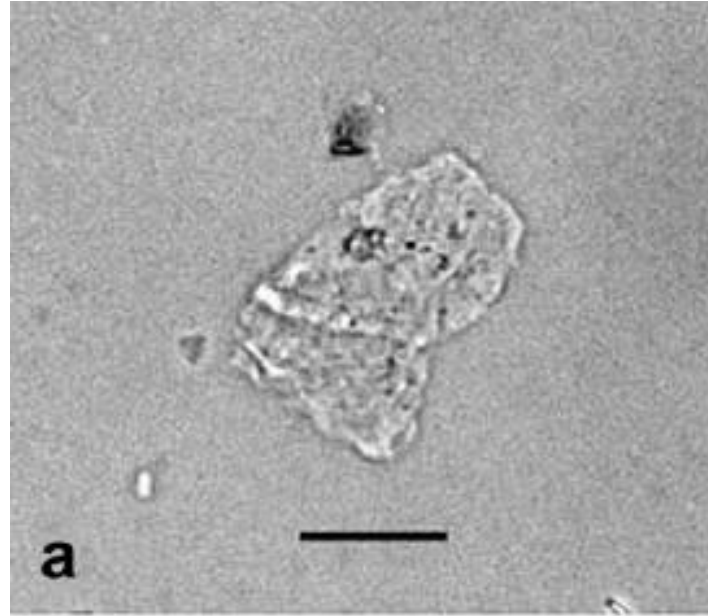


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Humiriastrum subcrenatum

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. a) Polyhedral epidermis from *Humiriastrum subcrenatum*



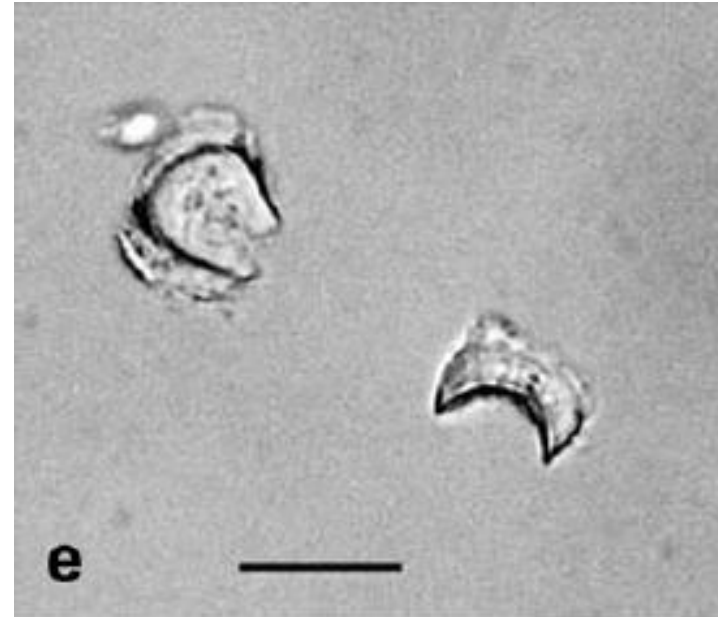
Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

HYMENOPHYLLACEAE

# Trichomanes hostmannium

## Phytolith

Fig. 6. Phytoliths from Pteridophytes. e) Bowl-shaped phytoliths from *Trichomanes hostmannium*



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

JUGLANDACEAE

# Juglans australis

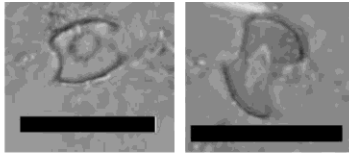
Juglandaceae *Juglans australis* "nuez criolla"

## Phytolith assemblage characterization

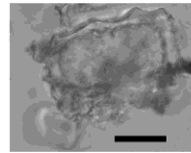
### Endocarp and seed embryo.

Non diagnostic phytoliths (\*):

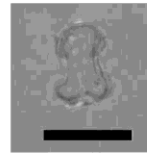
a) Bilobate (saddle) central depressed silica phytolith. Rare.



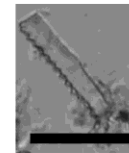
b) Rectangular irregular central depressed silica phytolith. Rare.



c) Tri-lobate irregular silica phytolith. Rare.



d) Rectangular dorsal echinate silica long cell. Rare.



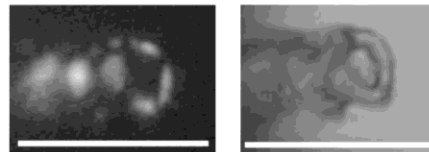
nut

**References:** Reported as not common epidermis, hair bases, mesophyl in Piperno 1988:35 for *Juglans nigra* leaf (quoting Geis 1973).

## Starch assemblage characterization

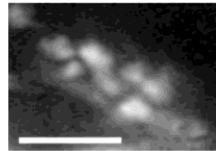
### Endocarp and seed embryo.

a) Single grains, variable in shape, oval, spherical, pear-shaped and irregular; variable in size, commonly from 9µm to 17µm, some to 45µm long length; not visible hilum and lamella; a centric hollow with similar shape to the contour of the grain; distinct centric cross, with four arms visible, meeting at a dark circular hollow.



nut

b) Some compound grains, compounded by two subspherical granula. Granula shorter than single ones.



Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

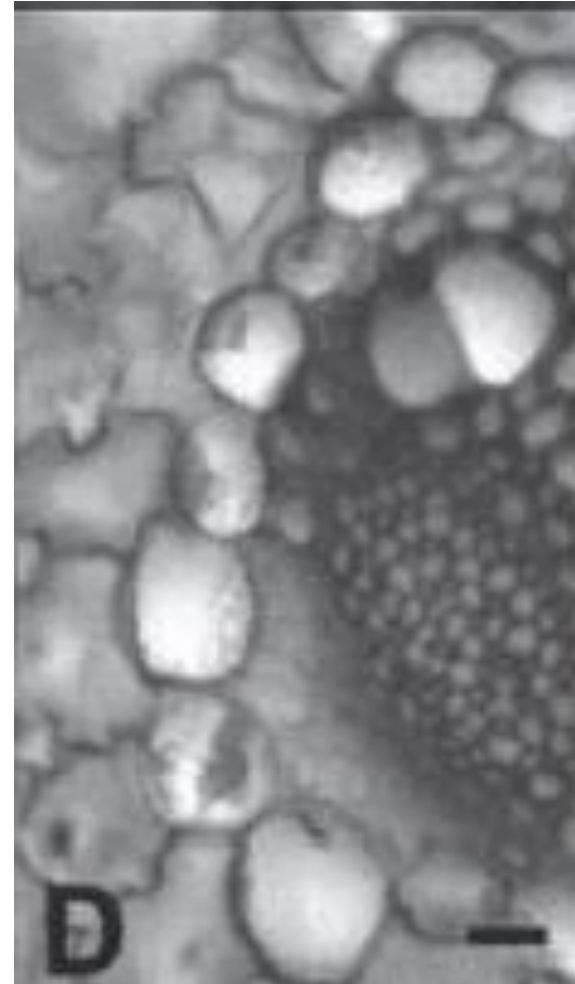


JUNCAEAE

# Juncus arabicus

## Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasypogonaceae. D. *Juncus arabicus* (Juncaceae), silica sand in vascular bundle-sheath cells (bar = 10 $\mu$ m).

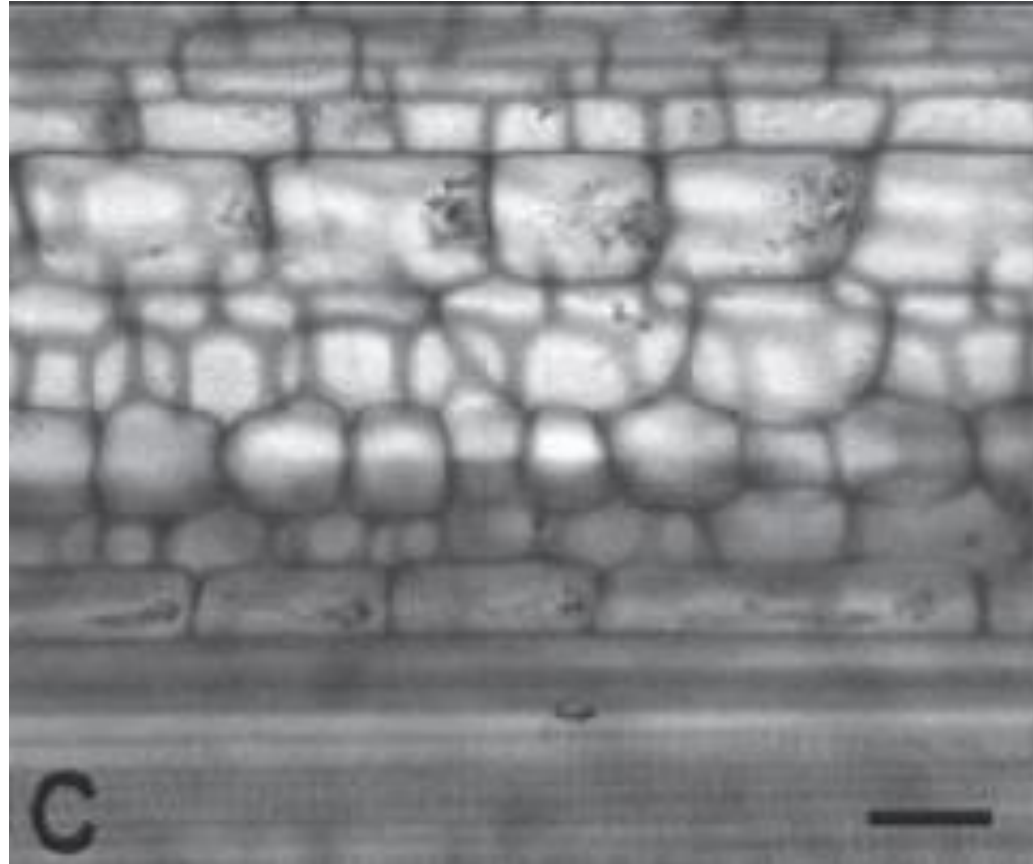


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Juncus inflexus

## Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasygongonaceae. C. *Juncus inflexus* (Juncaceae), silica sand in bundle-sheath cells (bar = 20  $\mu\text{m}$ ).



Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

LAURACEAE

# Aniba hostmanniana

## Phytolith

2 large examples of schlerids, note variation in facets, shape.

This taxa produces very sculpted, multi-surfaced bodies.

Diagnostic level: generalized arboreal



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

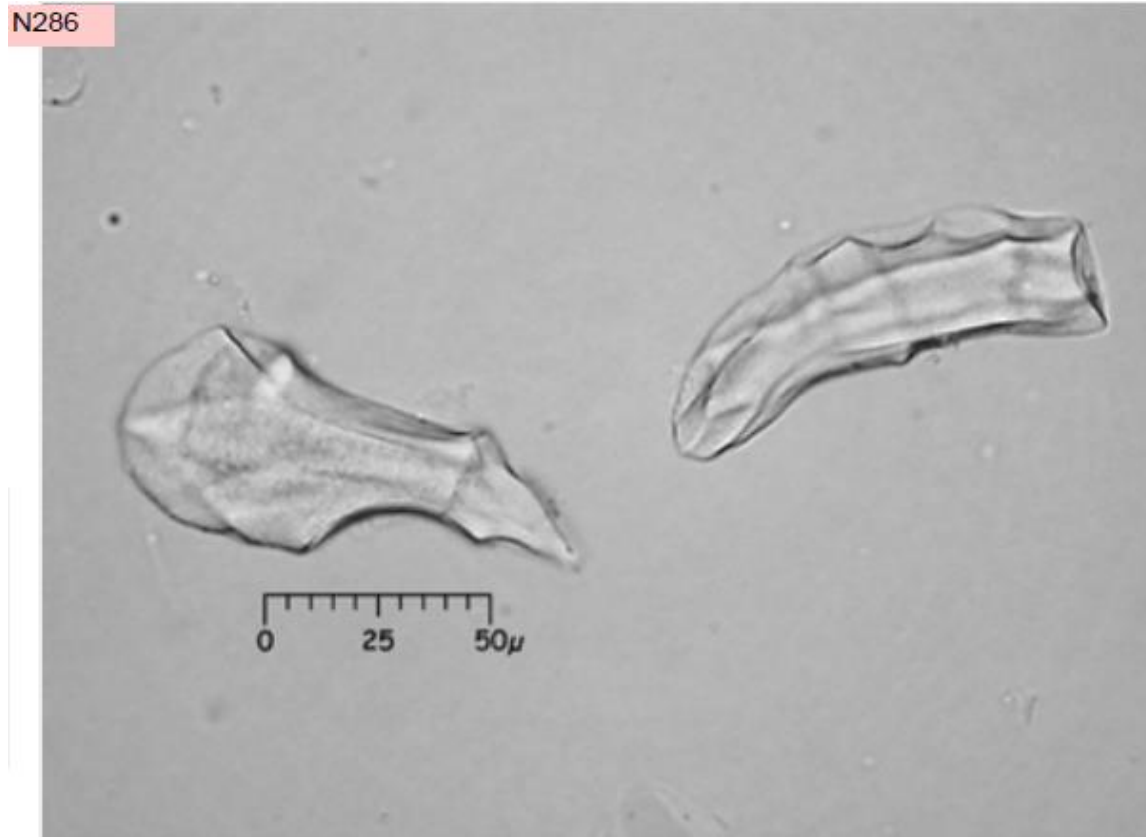
# Aniba hostmanniana

## Phytolith

2 large examples of schlerids, note variation in facets, shape.

This taxa produces very sculpted, multi-surfaced bodies.

Diagnostic level: generalized arboreal



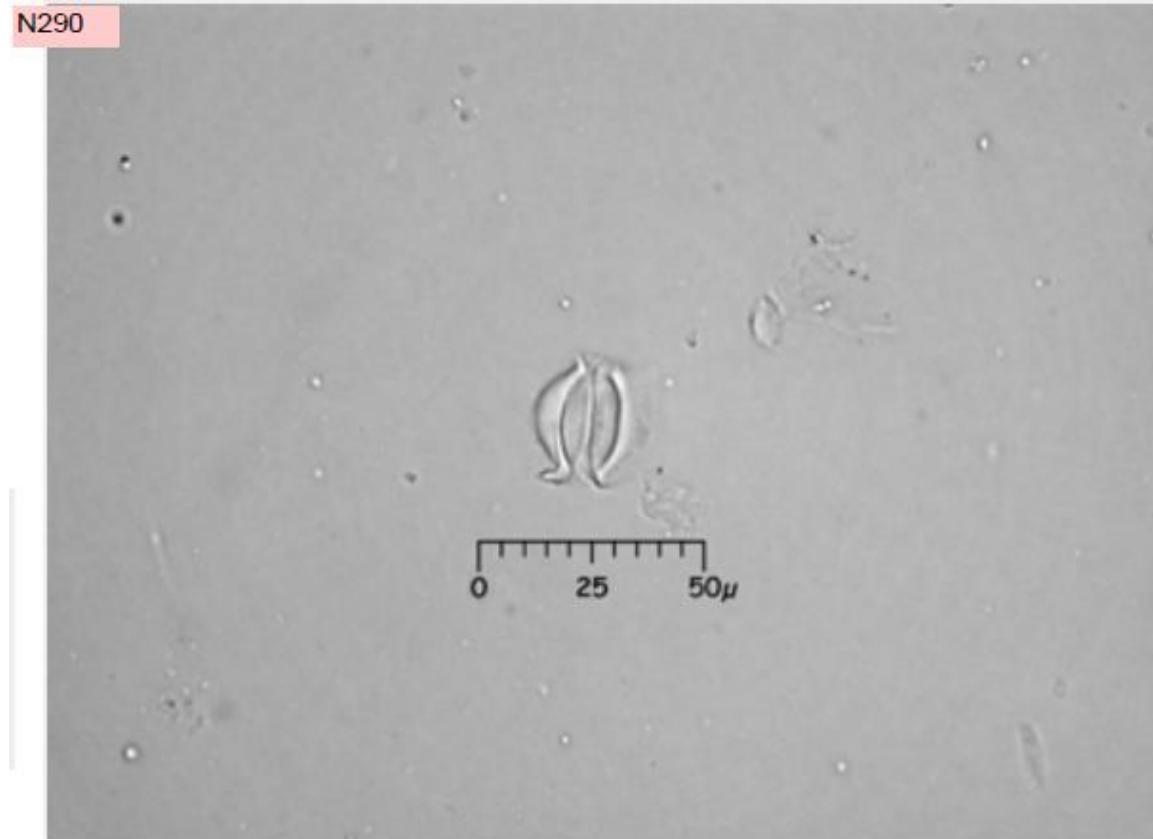
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Aniba hostmanniana

## Phytolith

Stomate, note guard cells and turgid state of cells.

Diagnostic level: not diagnostic



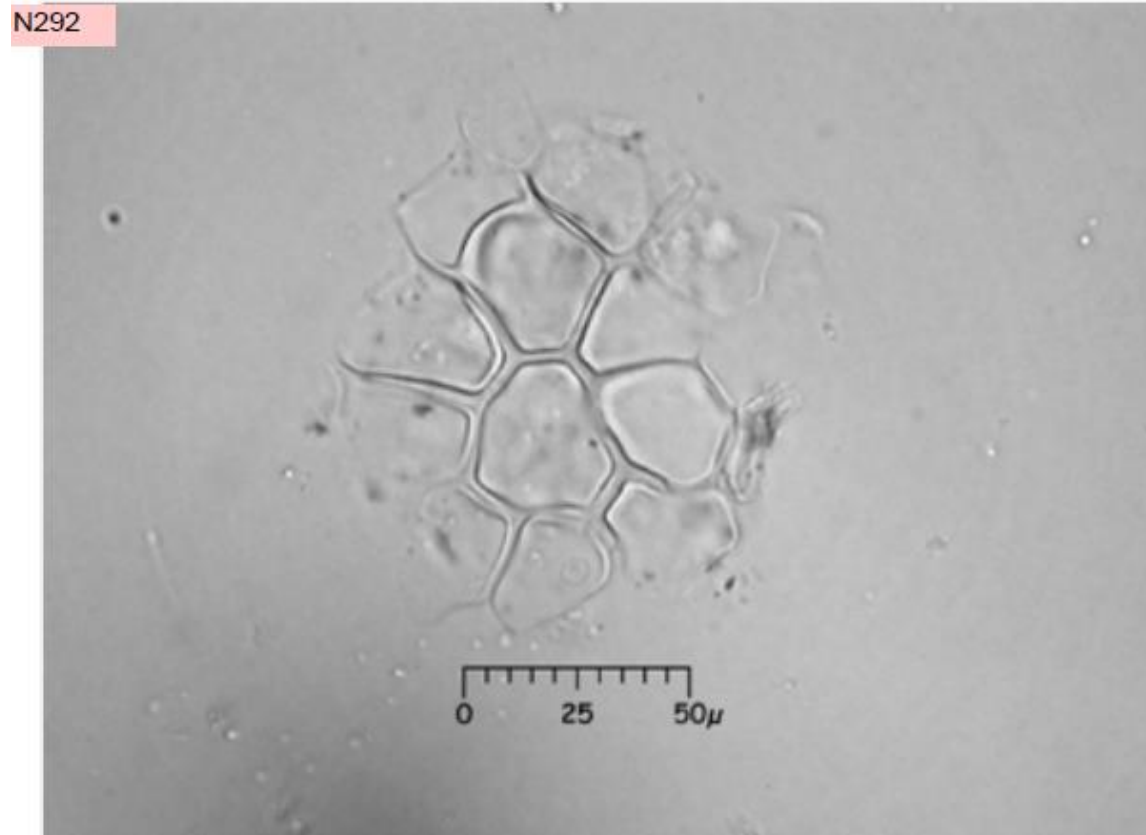
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Aniba hostmanniana

## Phytolith

Hair base.

Diagnostic level: family



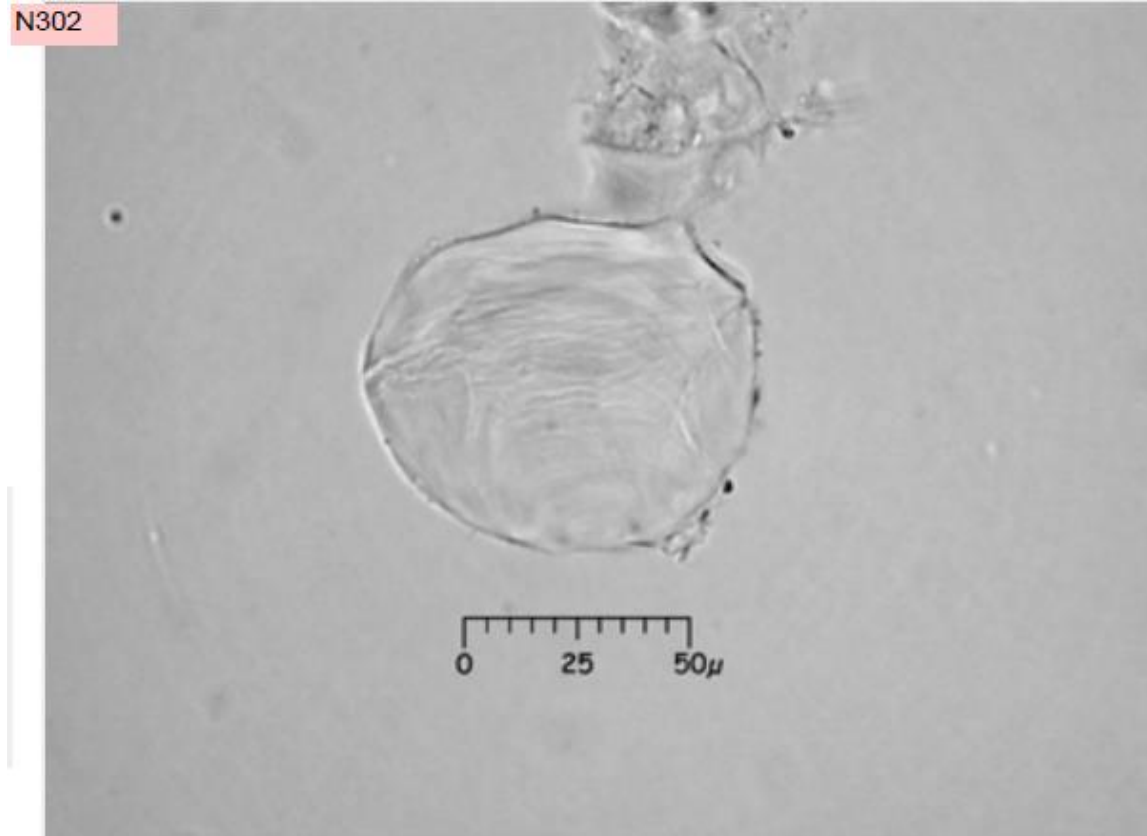
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Beilschmiedia alloiophylla

## Phytolith

Diagnostic level: family



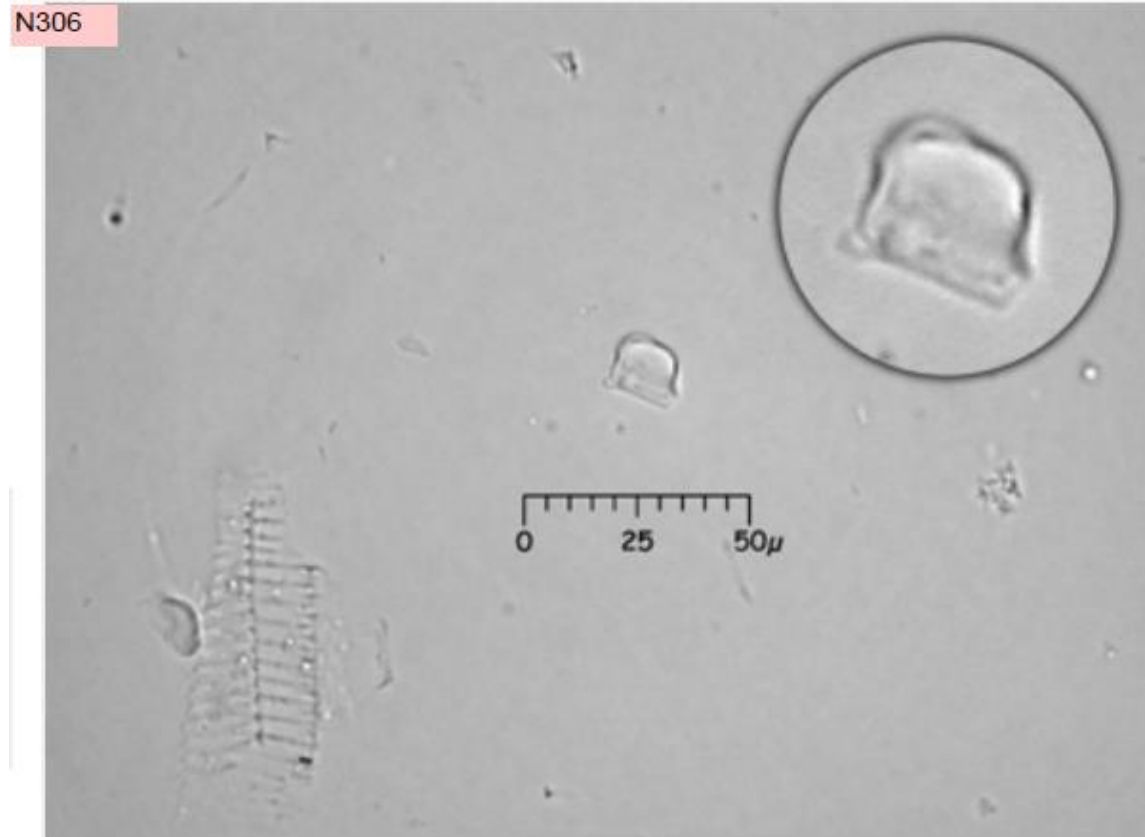
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Caryodaphnopsis fosteri

## Phytolith

Side view (see Record #193 for top view).

Diagnostic level: family



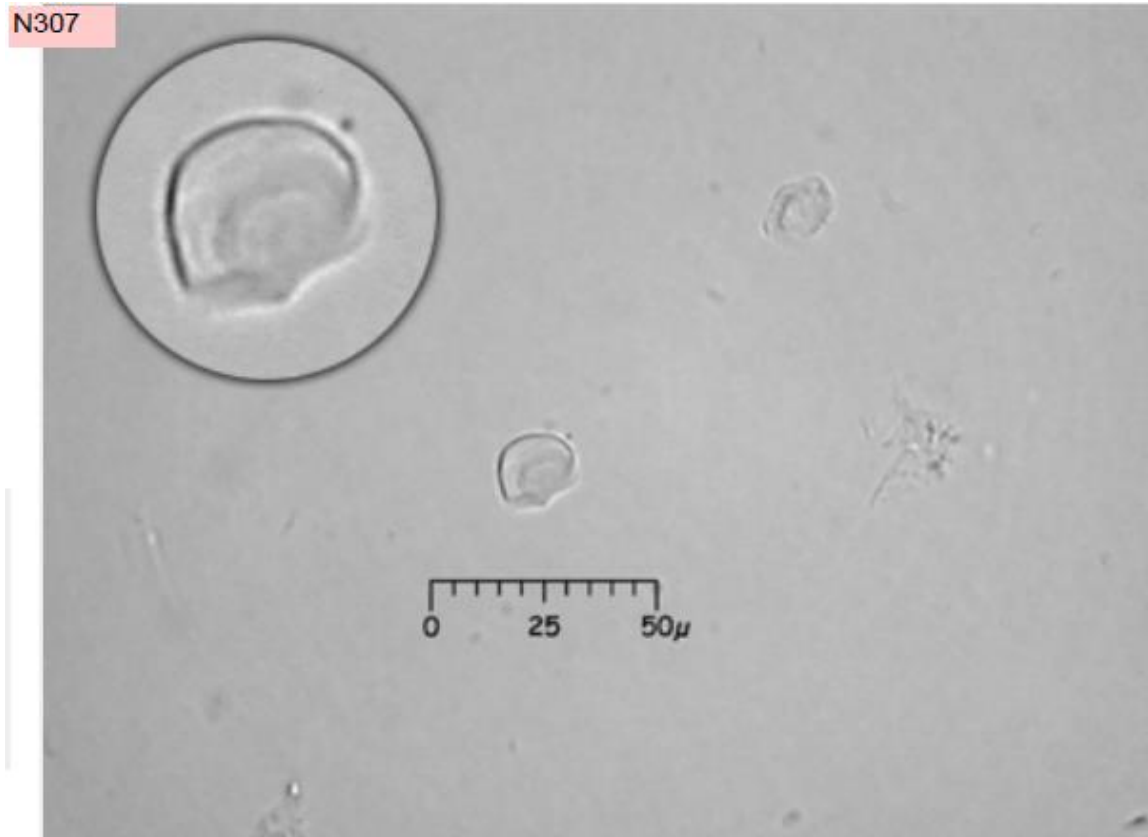
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Caryodaphnopsis fosteri

## Phytolith

Top view (see Record #192 for side view).

Diagnostic level: family

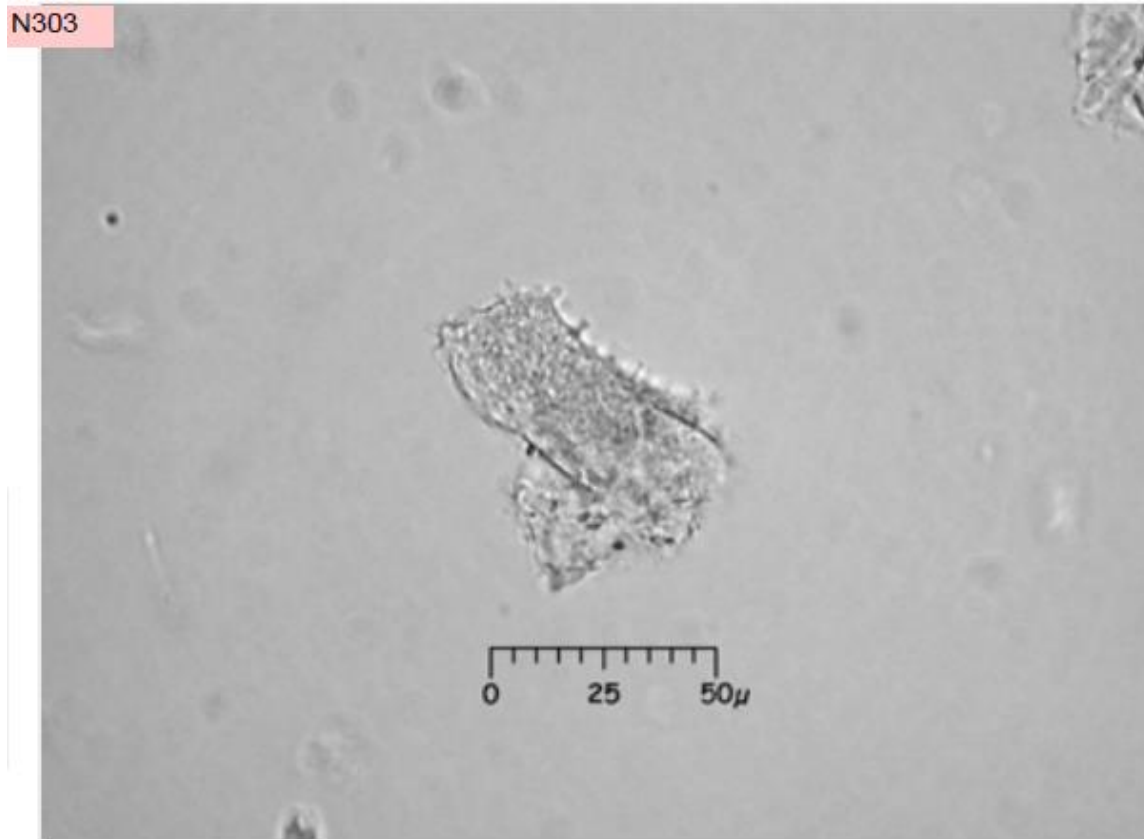


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Chlorocardium venenosum

## Phytolith

Diagnostic level: family

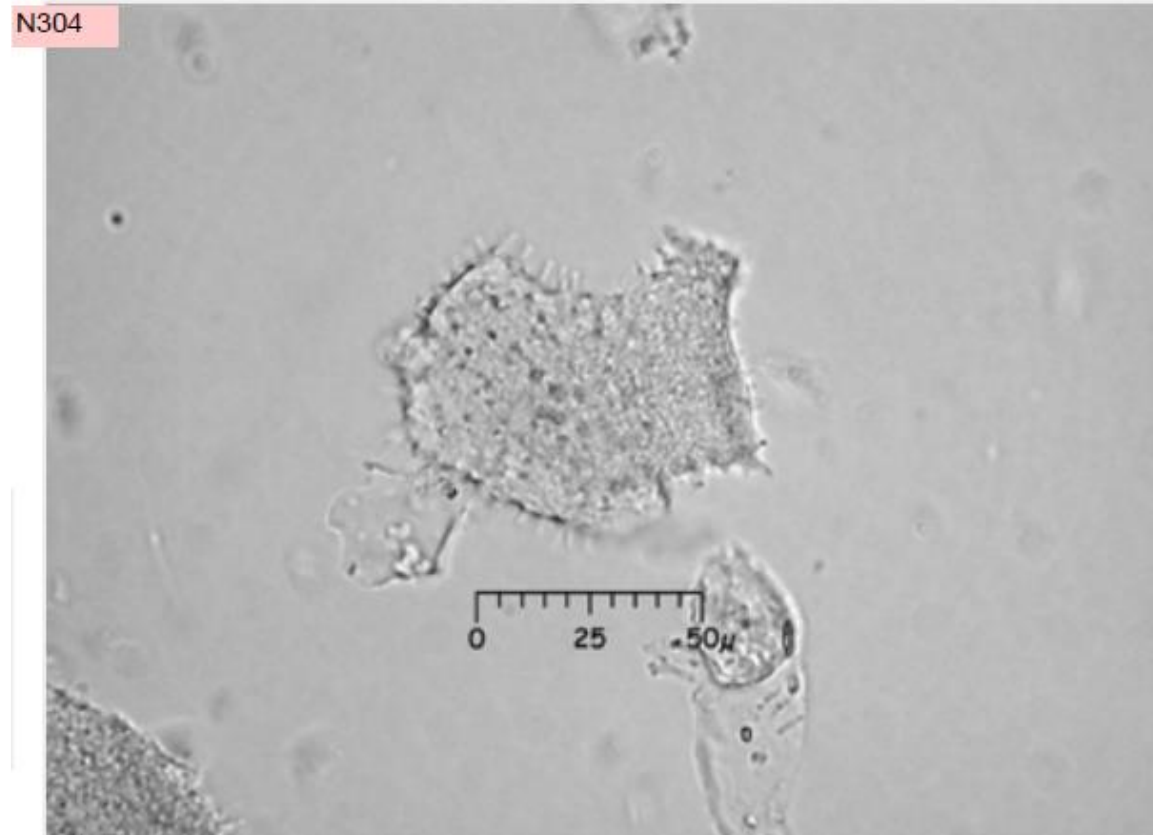


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Chlorocardium venenosum

## Phytolith

Diagnostic level: family

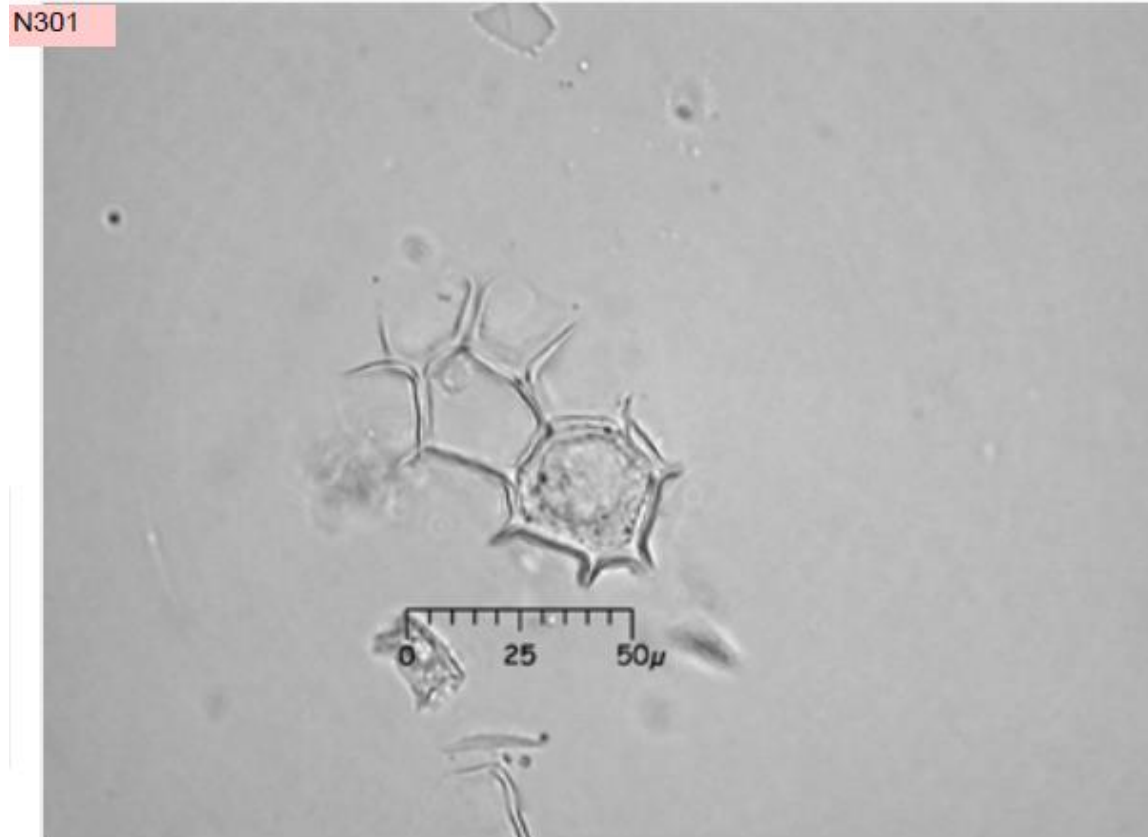


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Nectandra globosa

## Phytolith

Diagnostic level: not diagnostic



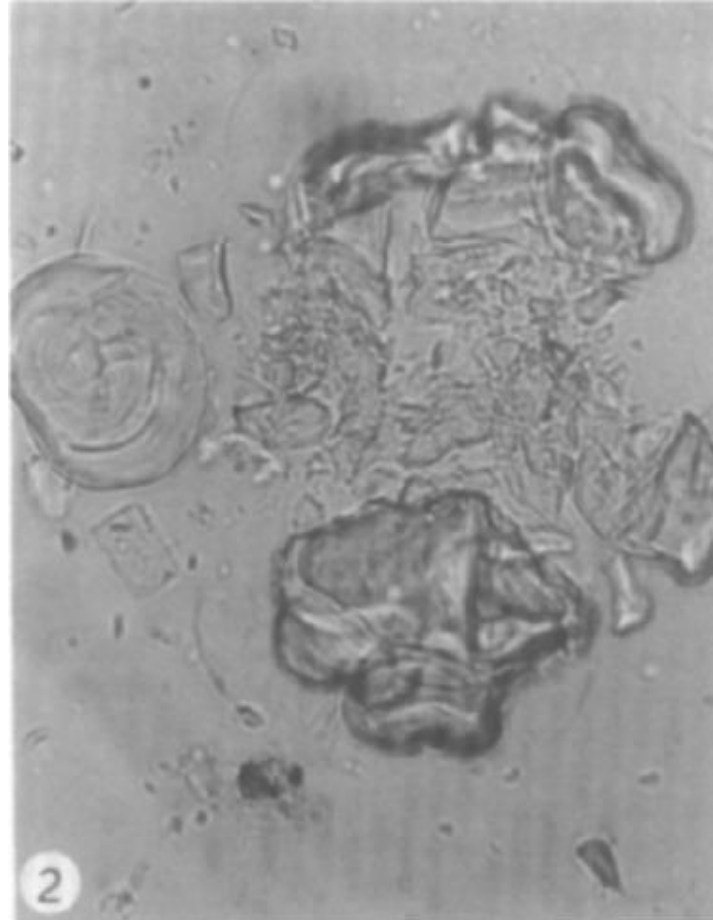
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

LORANTHACEAE

# Phrygilanthus corymbosus

## Phytolith

2. Irregular, unpointed chunks of silica from *Phrygilanthus corymbosus* (200 × )



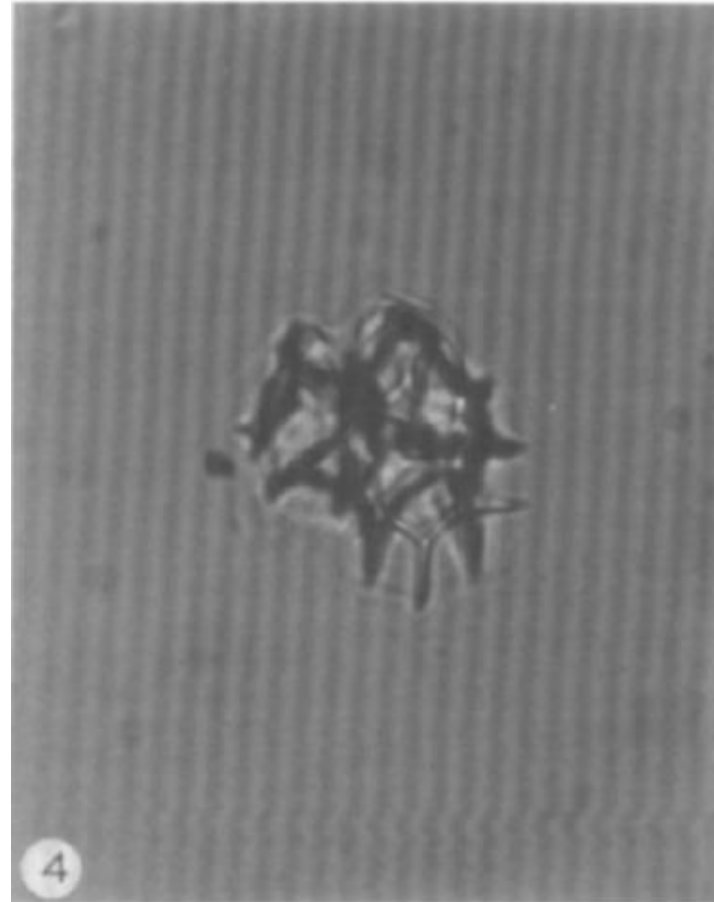
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.



# Phthirusa pyrifolia

## Phytolith

4. An irregular, pointed phytolith from *Phthirusa pyrifolia* (250 x )



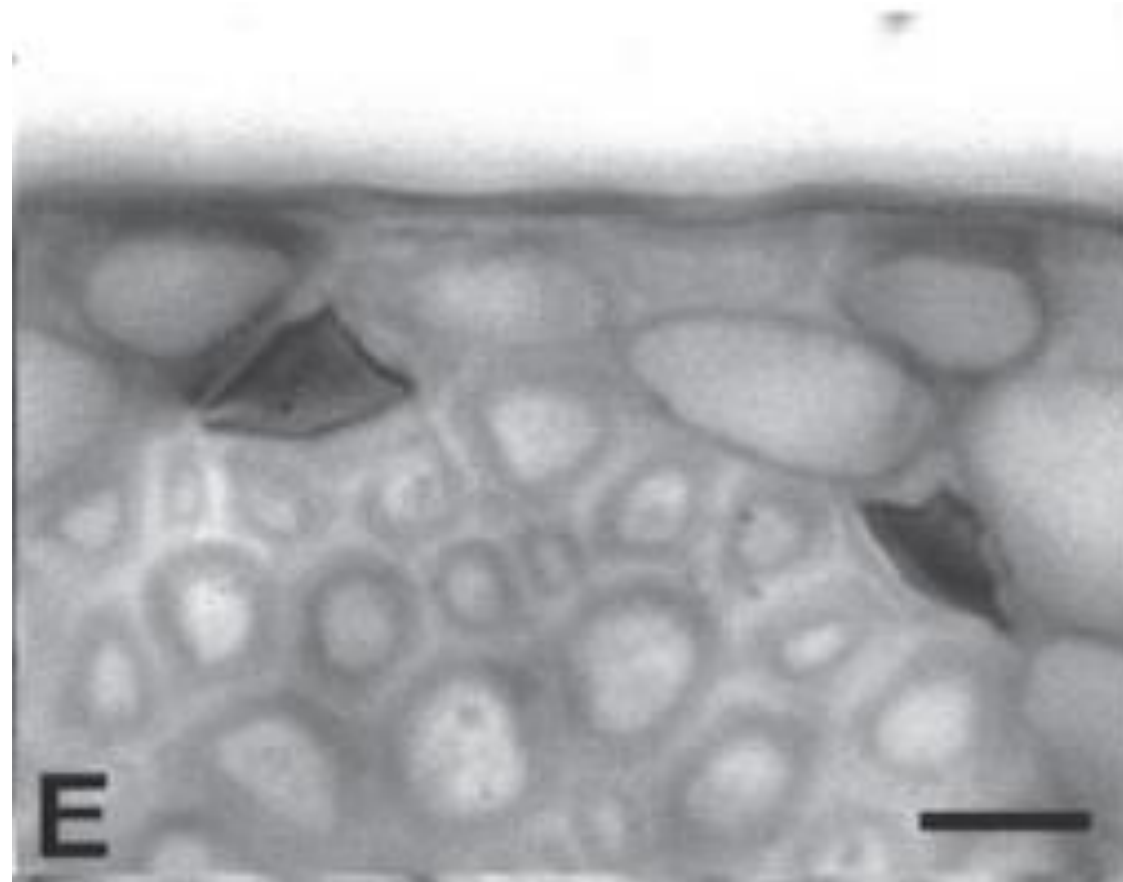
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

LOWIACEAE

# Orchidantha sp.

## Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. E. *Orchidantha* sp. (Lowiaceae), truncated conical silica bodies overlying a vascular bundle (bar =10  $\mu\text{m}$ ).



Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Orchidantha chinensis

## Phytolith

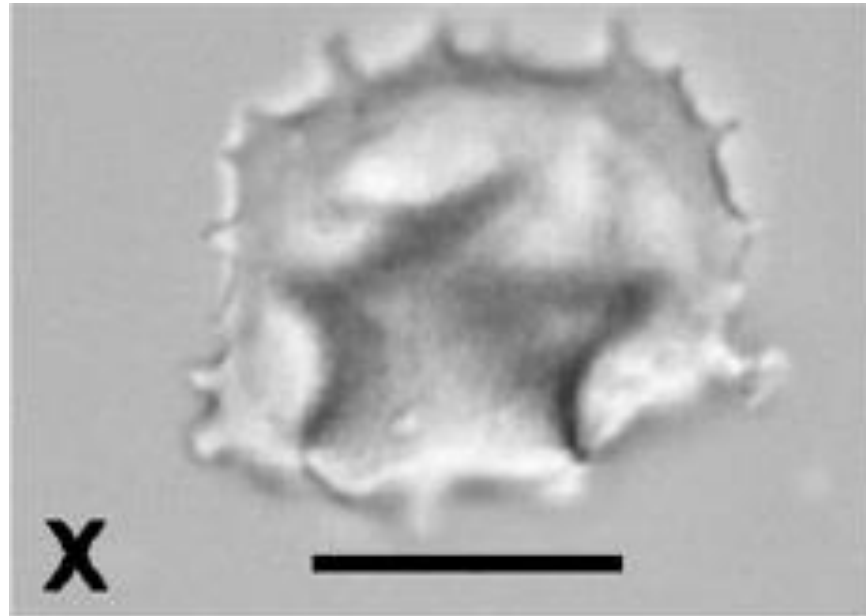


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). X, hat-shape with knobby edges from *Orchidantha chinensis* leaf. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Orchidantha longiflora

## Phytolith

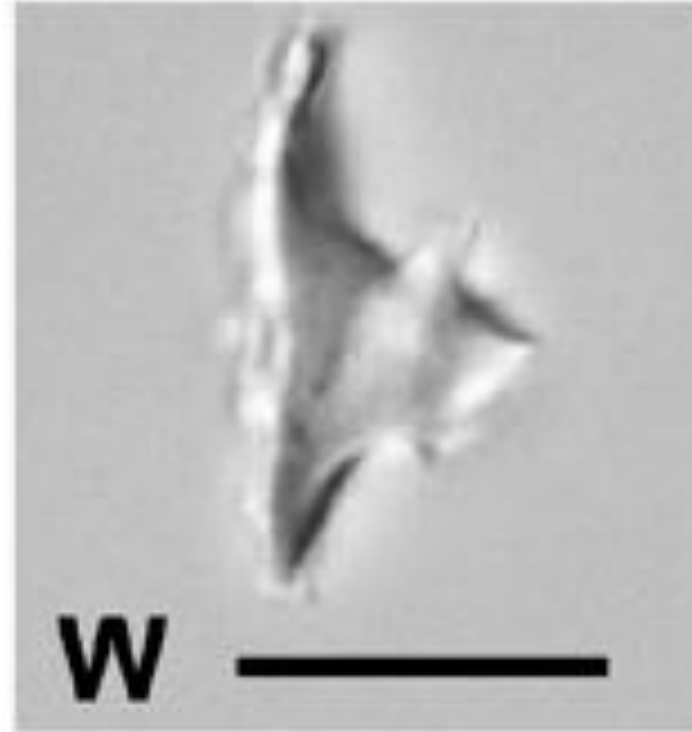


Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). W, side-view of hat-shape with knobby edges from *Orchidantha longiflora* leaf. Scale bars: A–J, M–Z=12  $\mu\text{m}$ ; K, L=5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Orchidantha siamensis

## Phytolith

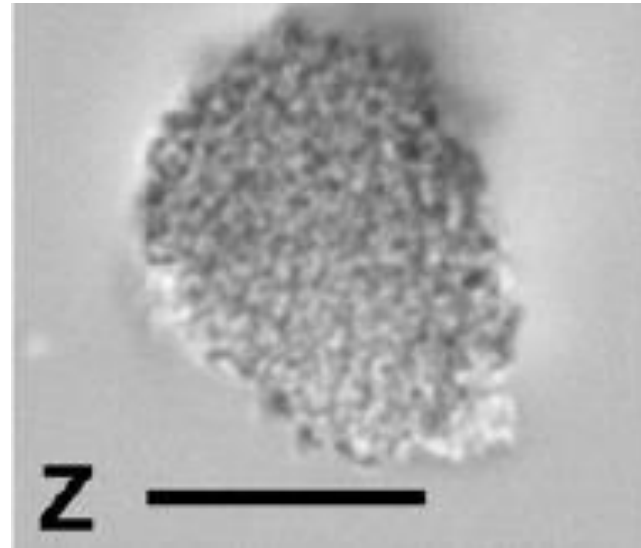
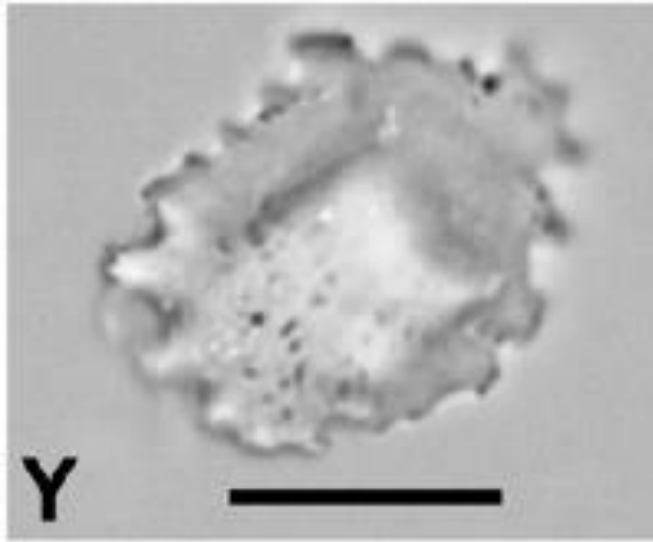


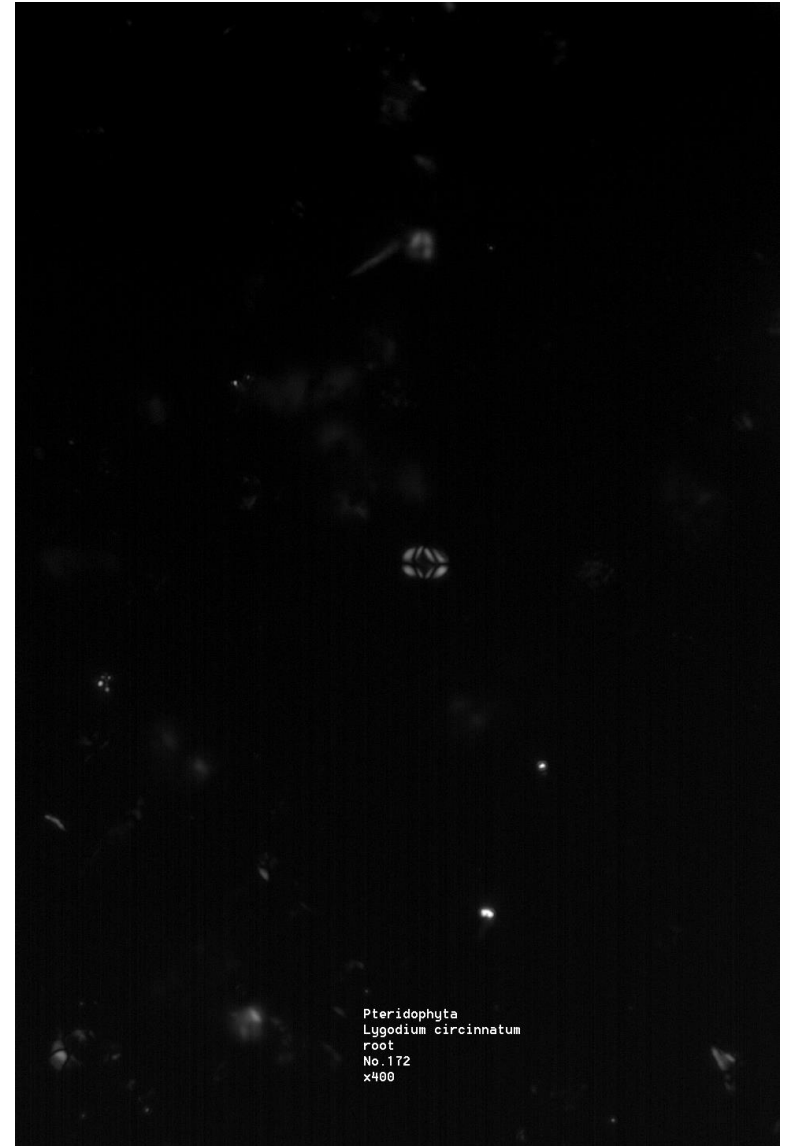
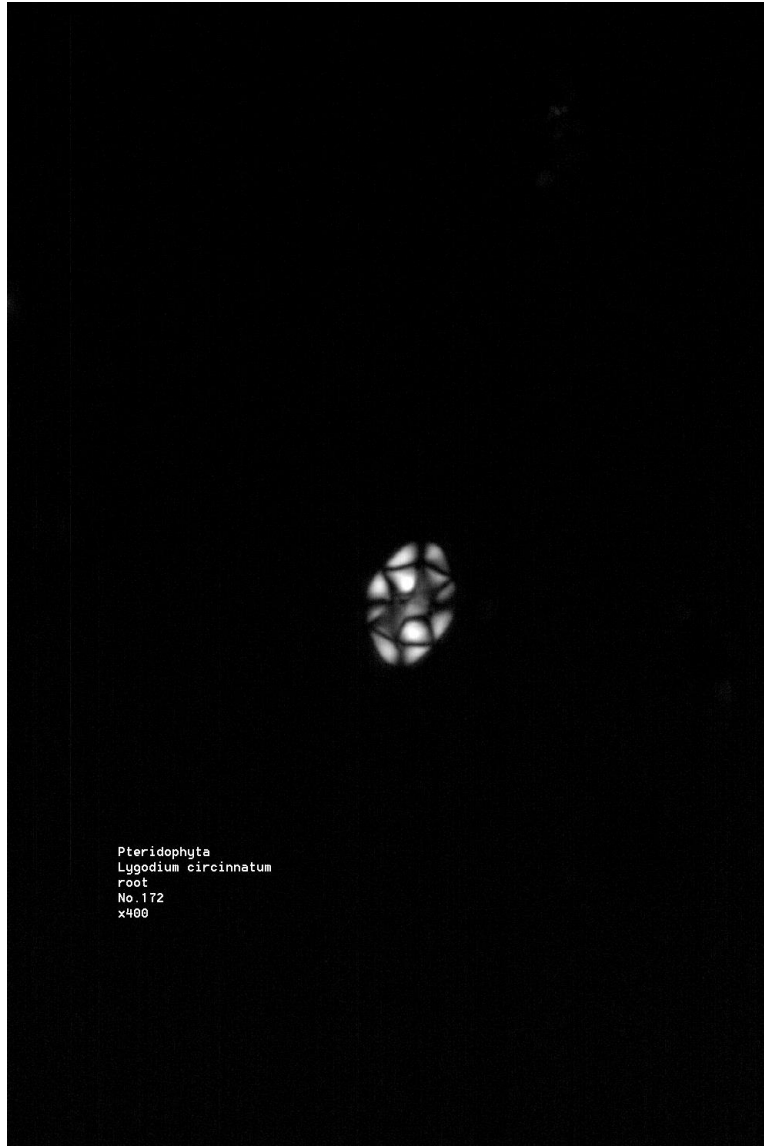
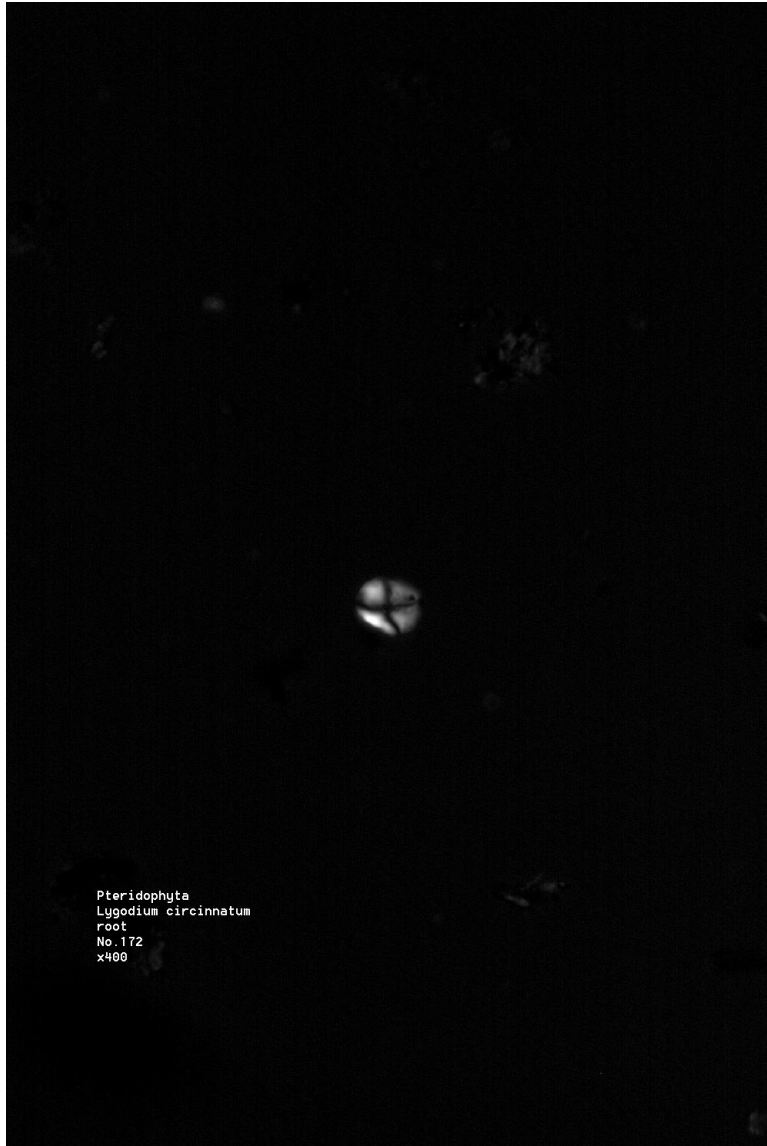
Fig. 2. Phytoliths from Cannaceae (A–D), Costaceae (E–I), Heliconiaceae (J–V), and Lowiaceae (W–Z). Y, hat-shape with crenate edges from *Orchidantha siamensis* leaf. Z, Ta3 (tabular-granulate) from *Orchidantha siamensis* leaf. Scale bars: A–J, M–Z = 12  $\mu\text{m}$ ; K, L = 5  $\mu\text{m}$

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

LYGODIACEAE

# Lygodium cirunntum

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection





# Lygodium cirunntum

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection

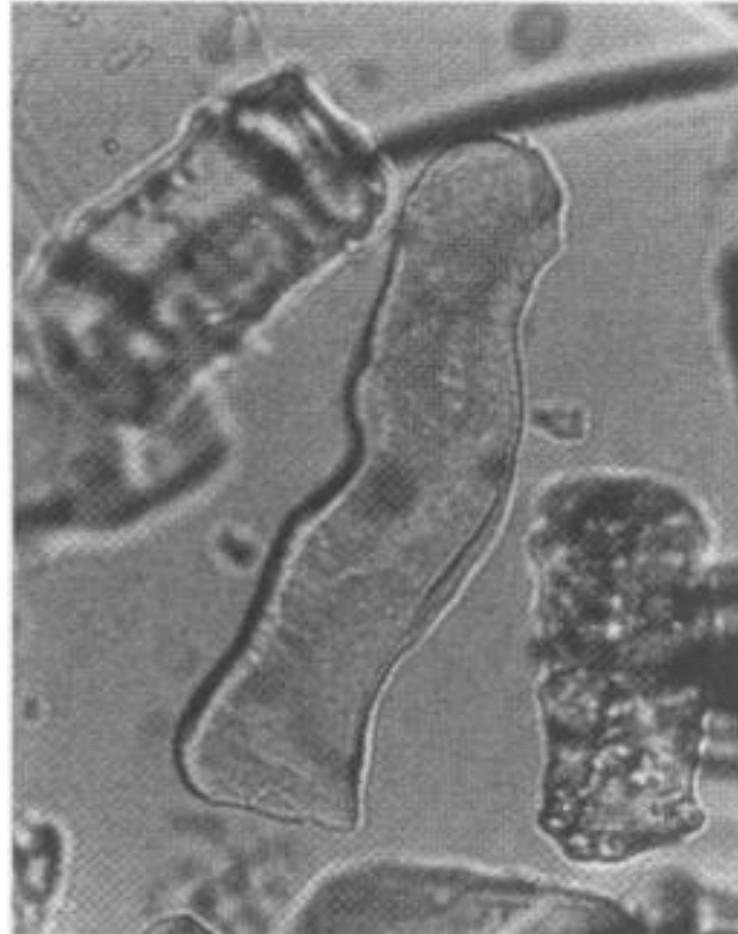


MAGNOLIACEAE

# Magnolia sp.

## Phytolith

Fig. 2. Center, a genus-specific phytolith from the leaves of *Magnolia* from (Magnoliaceae) Late Pleistocene-age lake sediment from Panama. Palynologists are unable to distinguish the pollen of the closely related taxa *Talauma* and *Magnolia*.



Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449.  
<http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Talauma sp.

## Phytolith

Fig. 1. Center, a genus-specific phytolith from the leaves of *Talauma* (Magnoliaceae) from modern soils underneath tropical montane forest in Panama.



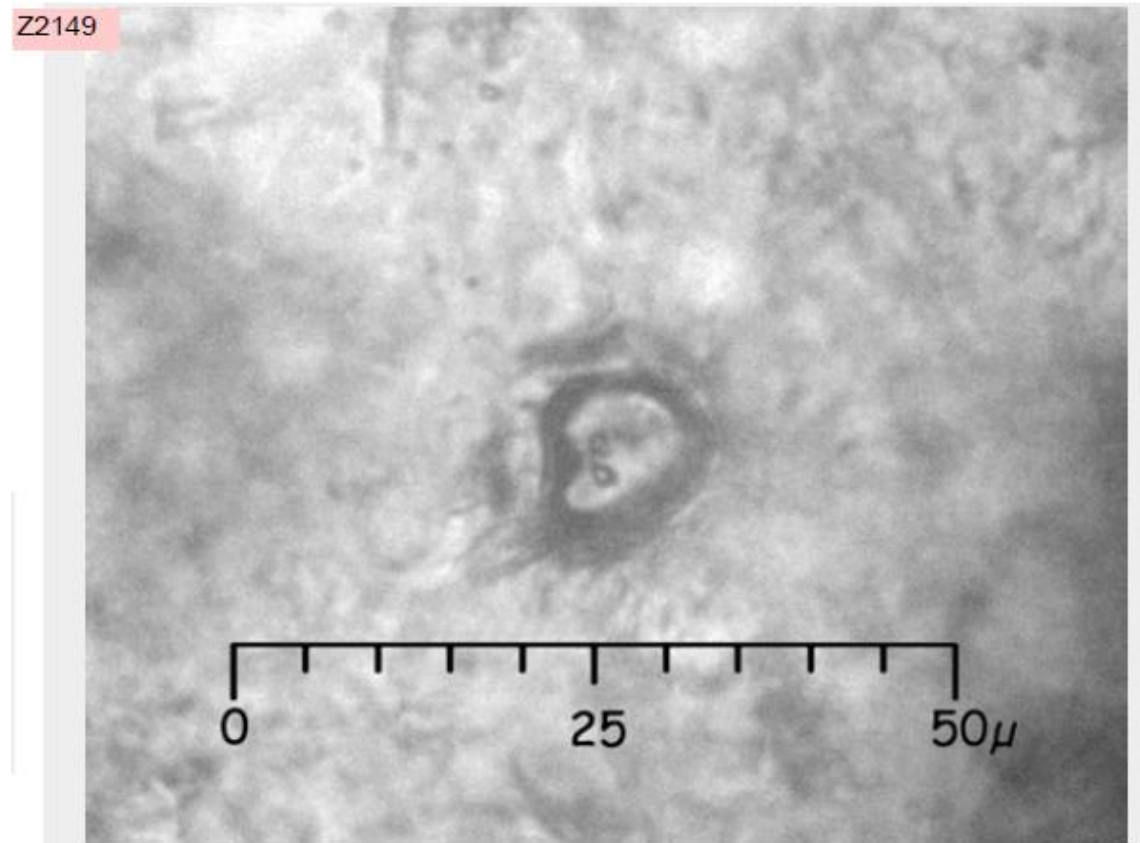
Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449.  
<http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

MALVACEAE

# Gossypium sp.

## Phytolith

Compare to 160I, small heart-shaped secretory body. 160II has a variably shaped center. Observed in *Gossypium* (PC 2665); diagnostic level under study.

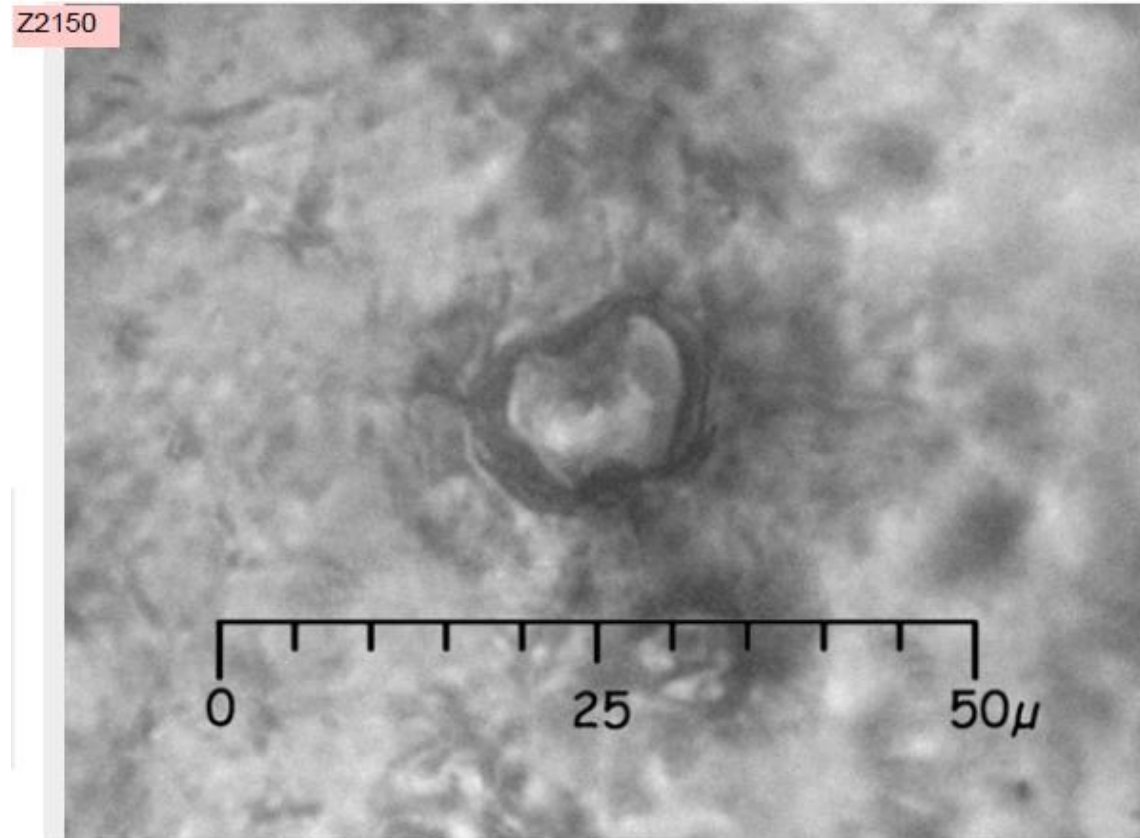


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Gossypium sp.

## Phytolith

Compare to 160I, small heart-shaped secretory body. 160II has a variably shaped center. Observed in *Gossypium* (PC 2665); diagnostic level under study.

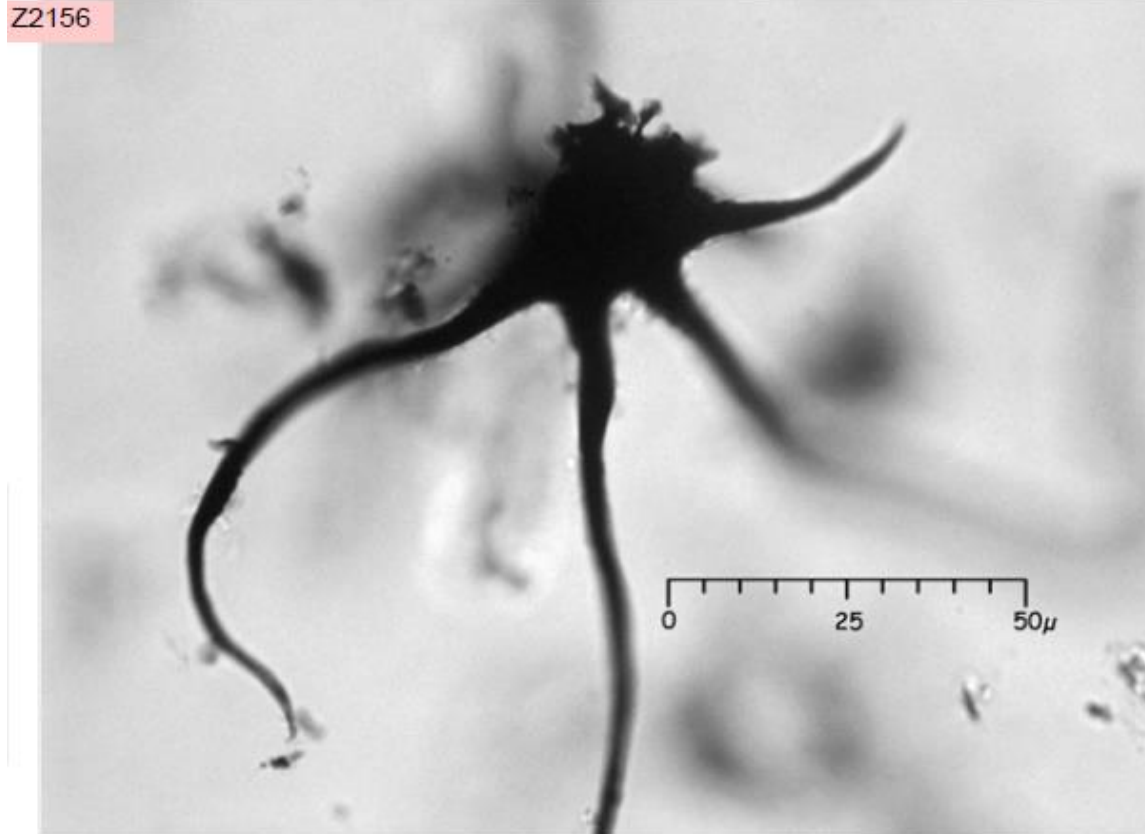


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Gossypium sp.

## Phytolith

In PC E1022, *Gossypium*. Also observed  
in PC E1004, *Malachra alceifolia*,  
Malvaceae  
Diagnostic level: Malvaceae



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

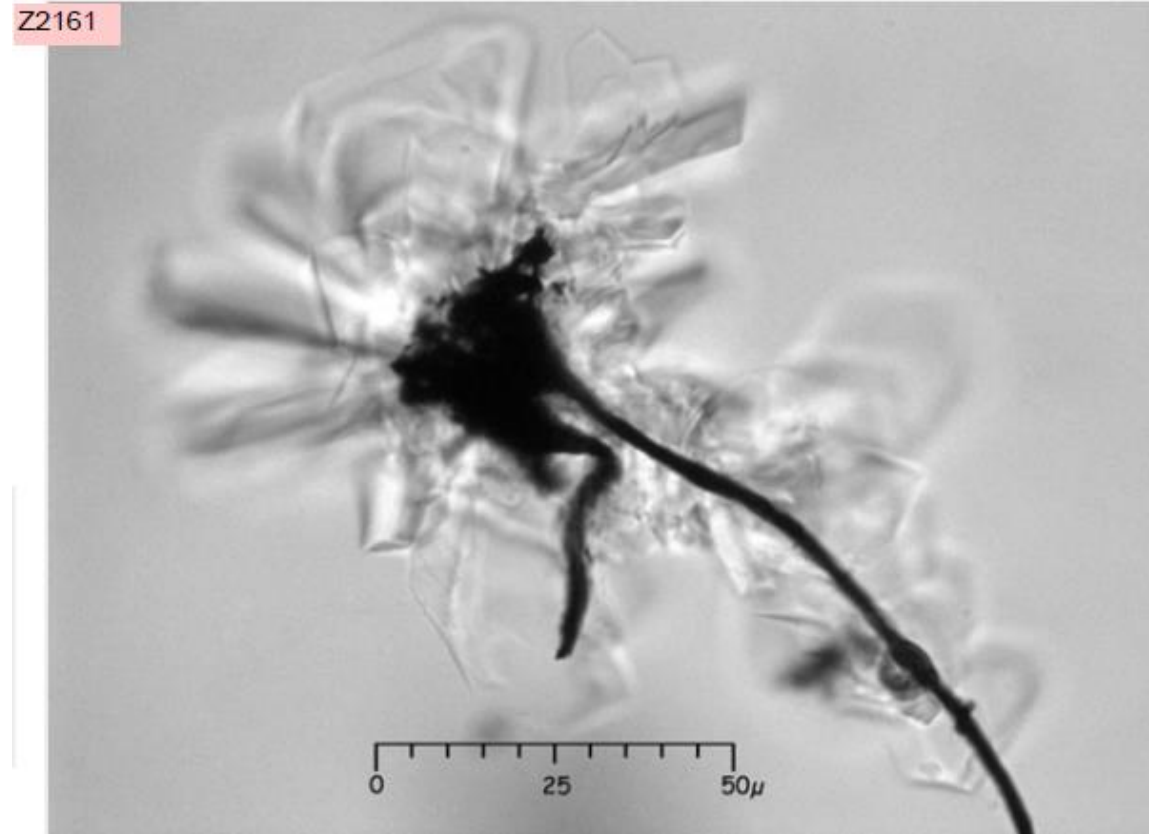


# Gossypium sp.

## Phytolith

PC E1022. This image shows hair base cells, a spherical cystolith of loose structure.

Diagnostic level: Malvaceae



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Gossypium sp.

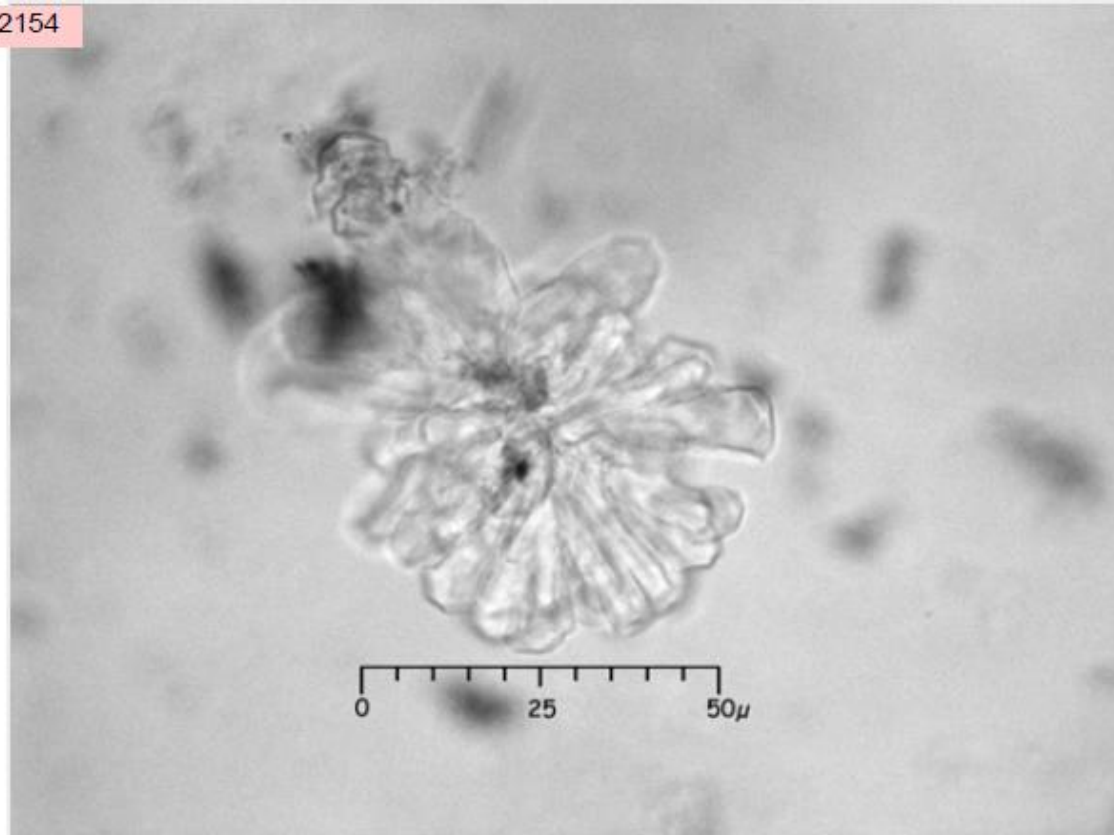
## Phytolith

See size variation in cystoliths.

Diagnostic level: generalized arboreal

Note that this type formed the base of hair 40IIIBb

Z2154

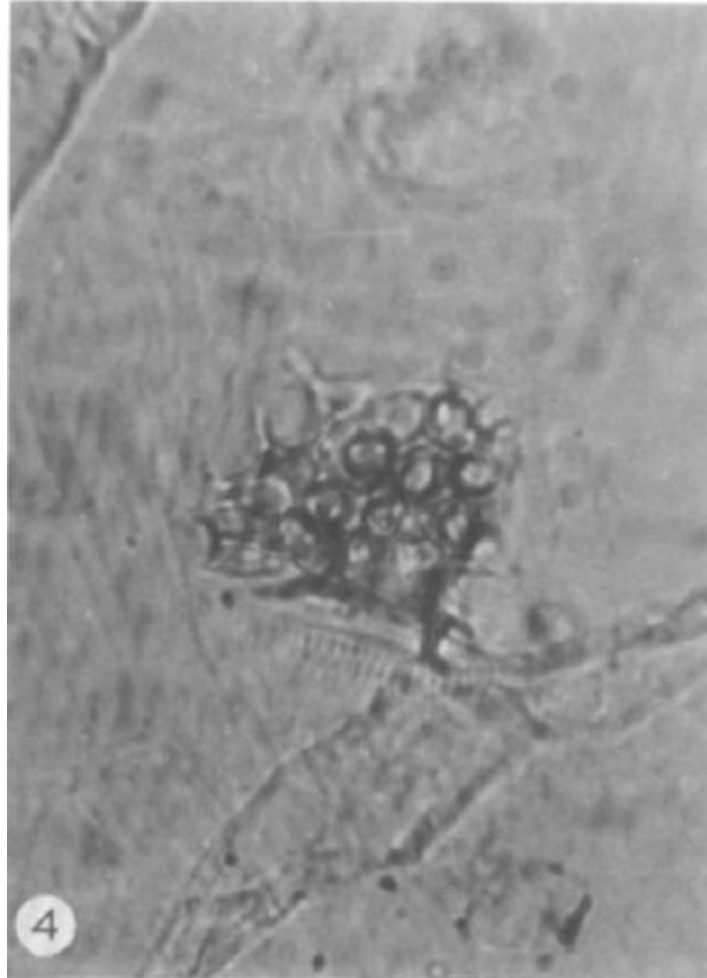


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Gossypium barbadense

## Phytolith

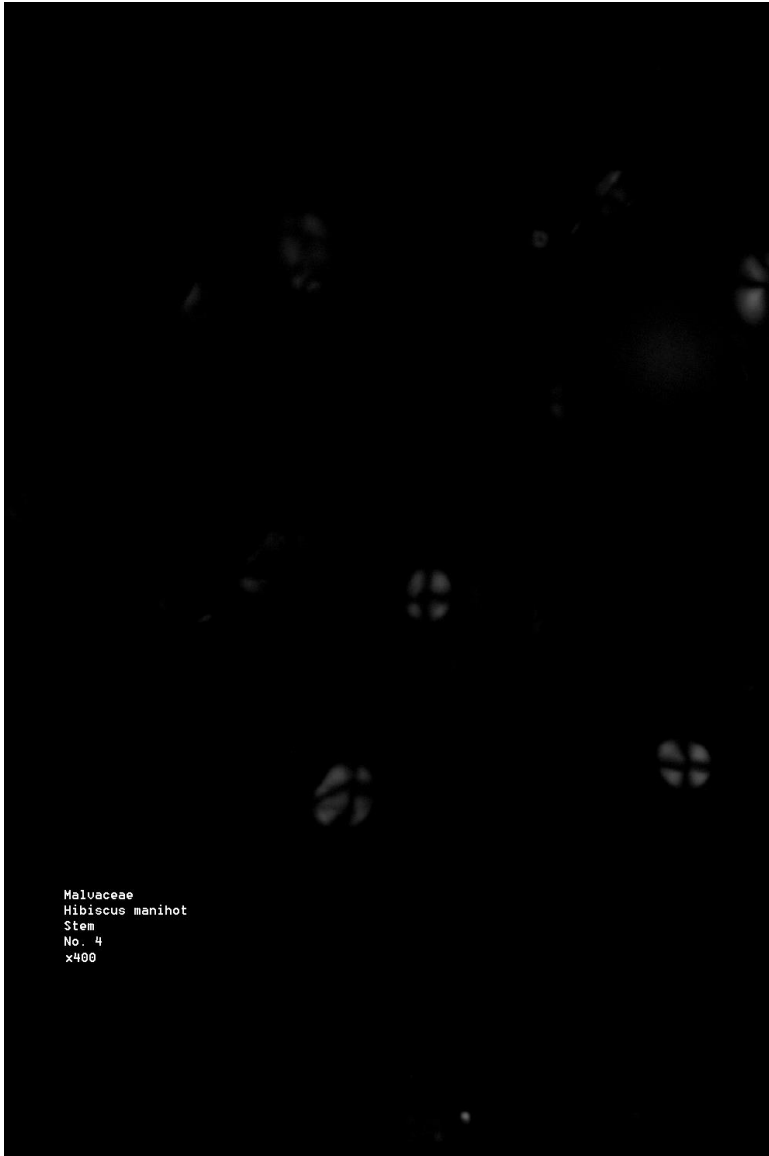
4. Silicified mesophyll cells from *Gossypium barbadense* (250 x ).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

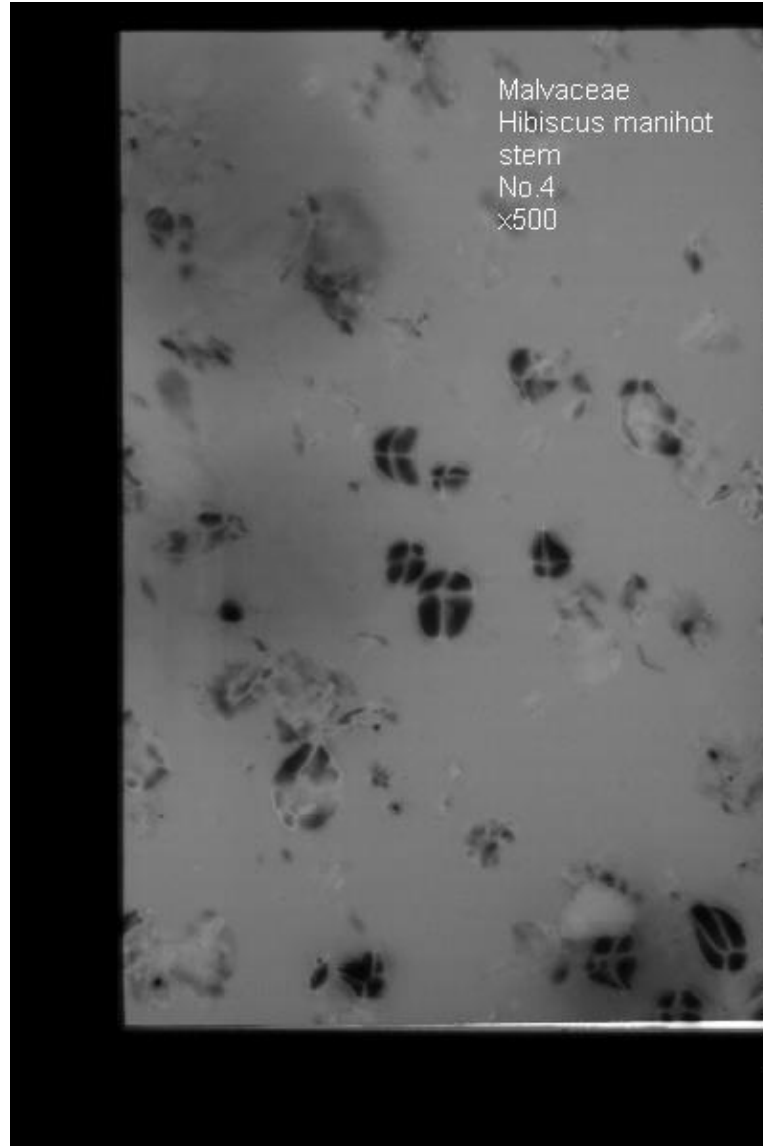
# Hibiscus manihot

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Hibiscus manihot

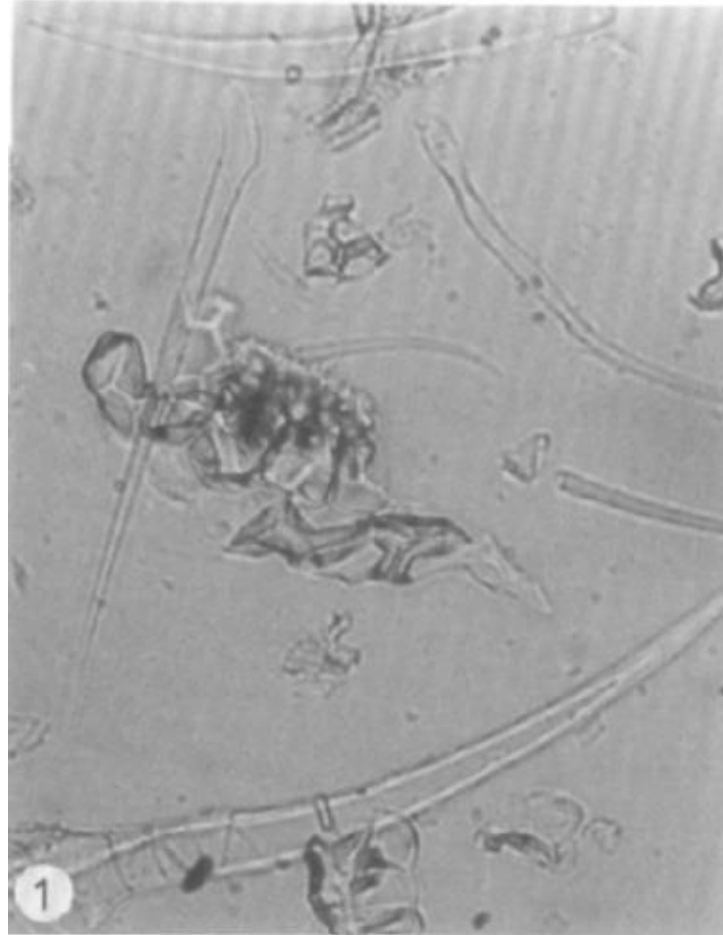
Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Malvaviscus arboreus

## Phytolith

1. Threadlike hairs from  
Malvaviscus arboreus (156 ×).

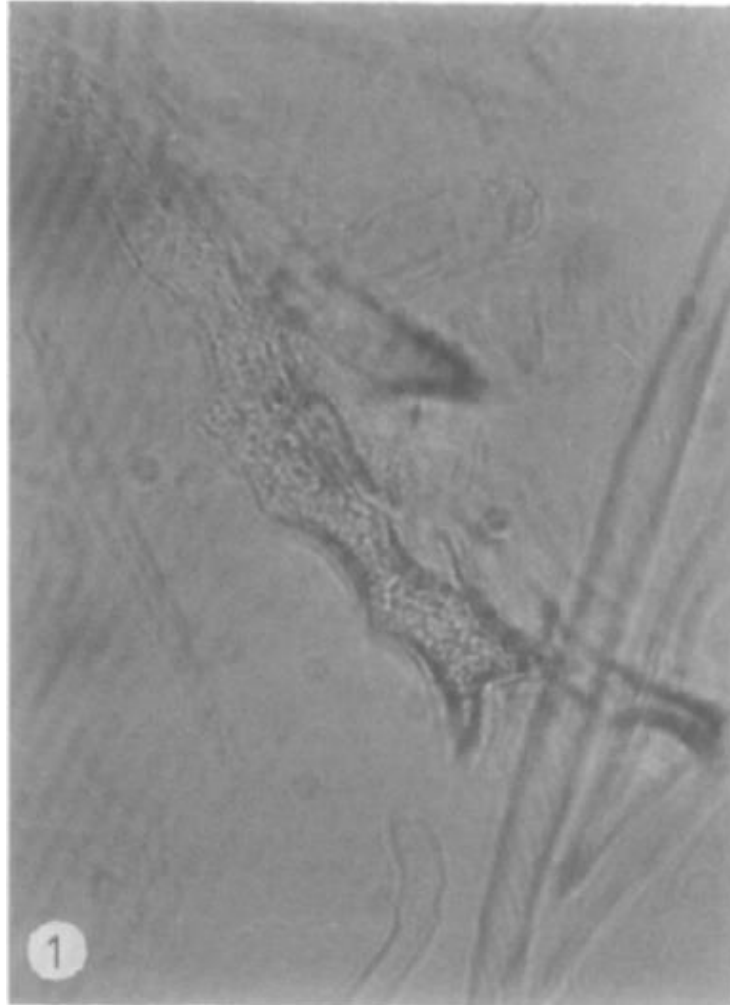


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Theobroma cacao

## Phytolith

1. A silicified tracheid from *Theobroma cacao* (250 ×).



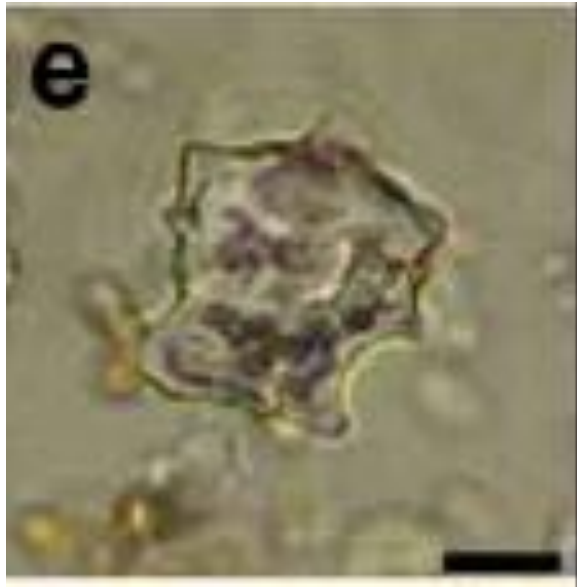
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

MARANTACEAE



# Marantaceae

## Phytolith



Morphotype diagnostic of the Marantaceae, and likely derived from the seed of arrowroot (*Maranta arundinacea* L.)

Abramiuk, Marc A., Peter S. Dunham, Linda Scott Cummings, Chad Yost, and Todd J. Pesek. 2011. Linking Past and Present: A Preliminary Paleoethnobotanical Study of Maya Nutritional and Medicinal Plant Use and Sustainable Cultivation in the Southern Maya Mountains, Belize. *Ethnobotany Research and Applications* 9:257–73.

# Marantaceae

## Phytolith

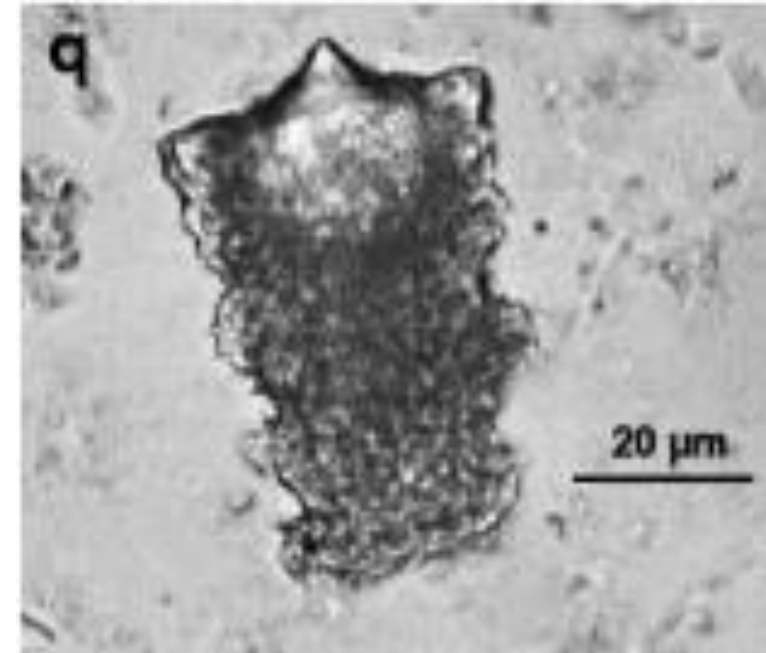
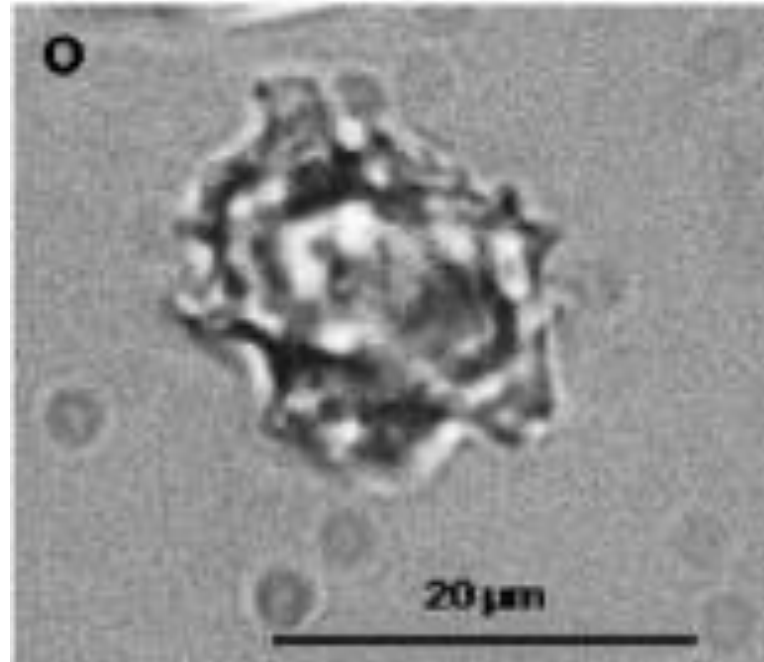


Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. o) Marantaceae sphere (BD M1, 20-30 cm). q) Marantaceae seed phytoliths (P Ridged Field 2, 10-20 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Marantaceae

## Phytolith

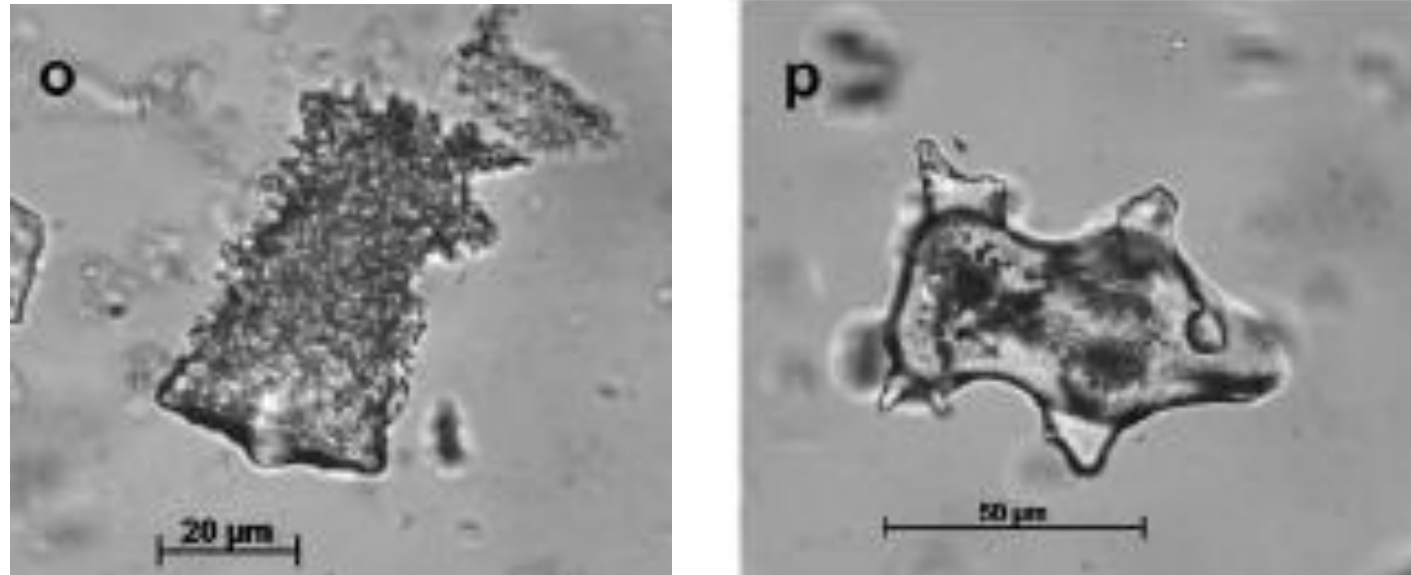


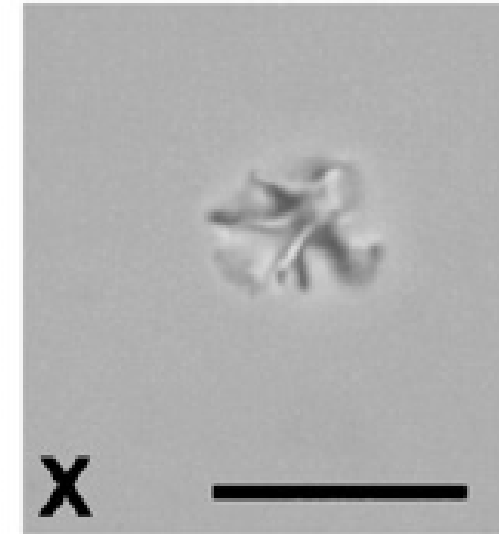
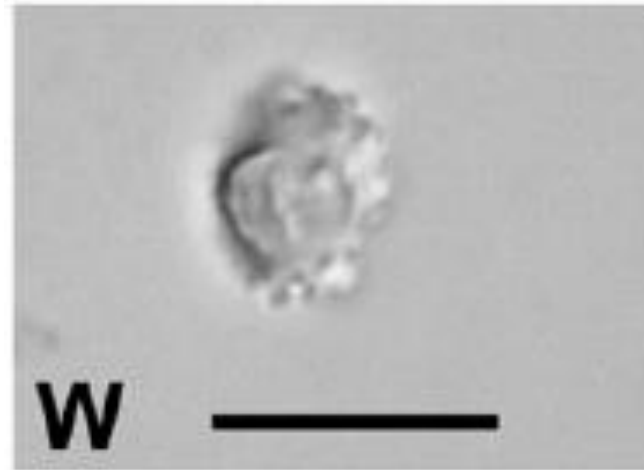
Fig. 5. Selected microbotanical remains. Phytoliths: o) Marantaceae 1 seed (Sed. Sample 4), p) Marantaceae 2 seed (Sed. Sample 3)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Ataenidia conferta

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). W, rugose hat-shape with sinulate margins from *Ataenidia conferta* leaf. X, D1 fringed druse from *Ataenidia conferta* leaf. Scale bars=12  $\mu\text{m}$ .

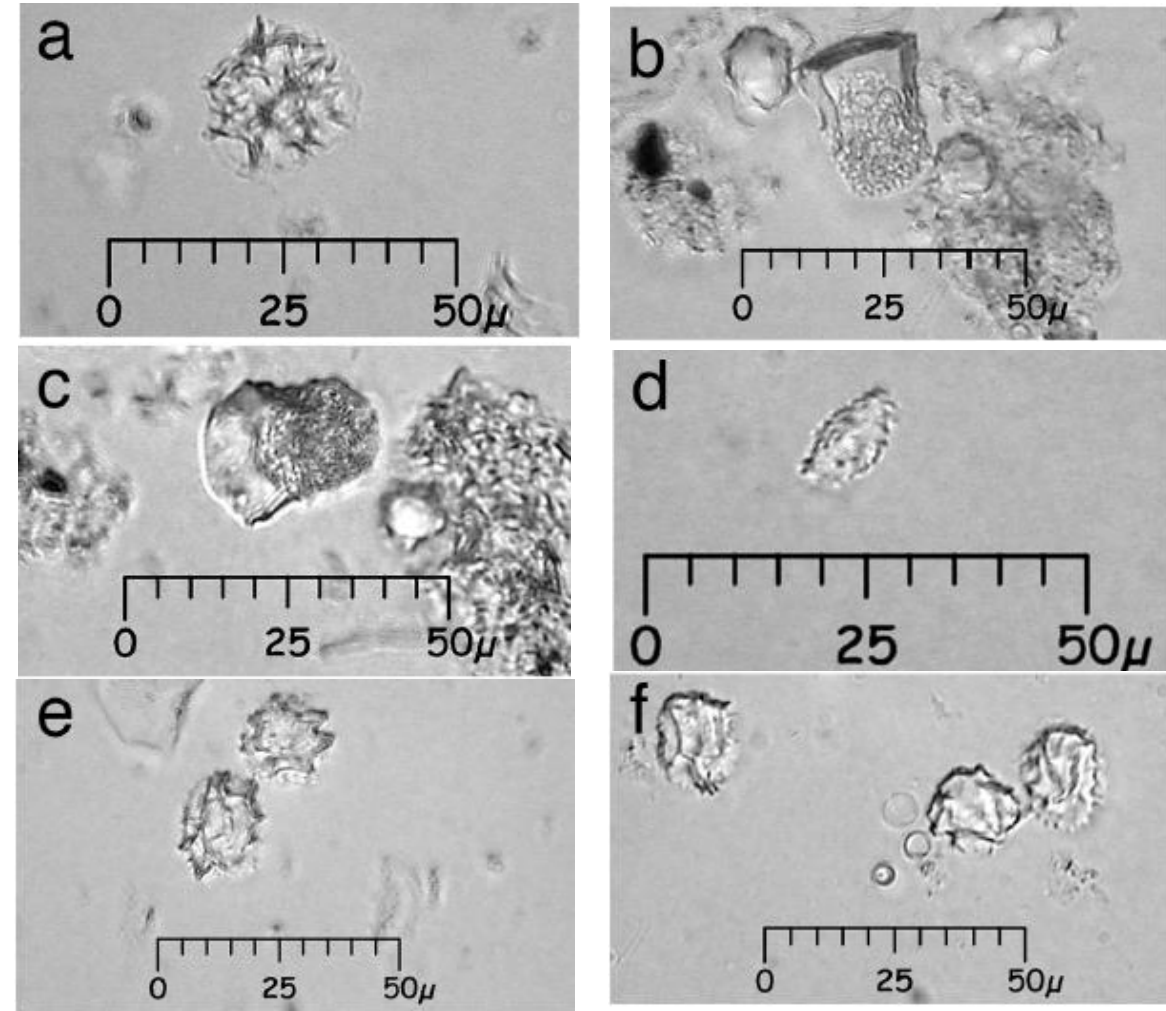


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Calathea/Maranta

## Phytolith

Fig. 1. Selected new diagnostic phytoliths. See MU Phytolith website (<http://www.missouri.edu/~phyto>) for photographs of all types. a. 26IAa Calathea (Marantaceae) irregular rhizome cylinder. b, c. 26IAb Calathea (Marantaceae) flat domed rhizome cylinder. d. 26IB Maranta/Calathea (Marantaceae) rhizome spindle. e, f. 26IIB Calathea (Marantaceae) flat rhizome type.



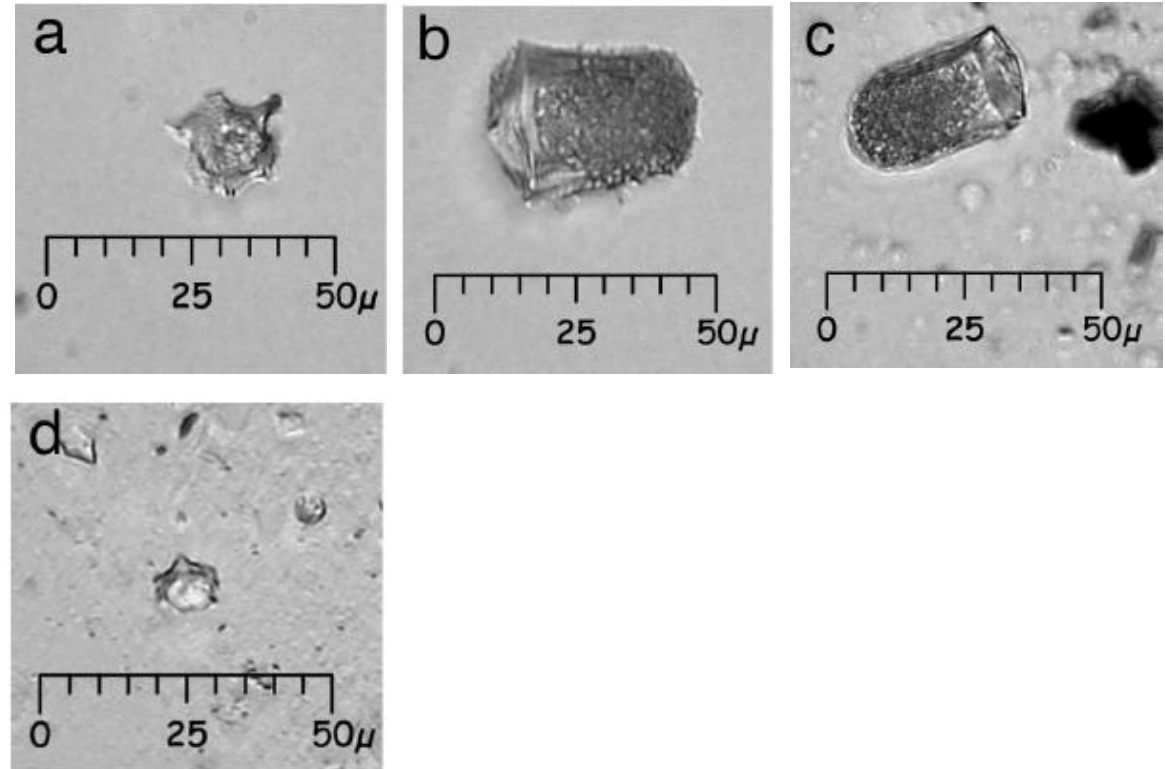
Chandler-Ezell, Karol, Deborah Marie Pearsall, and James A. Zeidler. 2006. Root and Tuber Phytoliths and Starch Grains Document Manioc (*Manihot Esculenta*), Arrowroot (*Maranta Arundinacea*), and Llerén (*Calathea Sp.*) at the Real Alto Site, Ecuador. *Economic Botany* 60 (2):103–20.

[http://www.bioone.org/doi/abs/10.1663/0013-0001\(2006\)60%5B103:RATPAS%5D2.0.CO%3B2](http://www.bioone.org/doi/abs/10.1663/0013-0001(2006)60%5B103:RATPAS%5D2.0.CO%3B2).

# Calathea sp.

## Phytolith

Fig. 5. Selected phytoliths and starch granules recovered from tools. See MU Phytolith website (<http://www.missouri.edu/~phyto>) for other photographs. a. 26IAa Calathea irregular rhizome cylinder, PS1749 FS 3290-A. b. 26IAb Calathea flat domed rhizome cylinder, PS1749 FS 3290-A. c. 26IAb Calathea flat domed rhizome cylinder, PS1765 FS 3293-B. d. 26IIB Calathea flat rhizome type, PS1804 FS3294-B.



Chandler-Ezell, Karol, Deborah Marie Pearsall, and James A. Zeidler. 2006. Root and Tuber Phytoliths and Starch Grains Document Manioc (*Manihot Esculenta*), Arrowroot (*Maranta Arundinacea*), and Llerén (*Calathea Sp.*) at the Real Alto Site, Ecuador. *Economic Botany* 60 (2):103–20.

[http://www.bioone.org/doi/abs/10.1663/0013-0001\(2006\)60%5B103:RATPAS%5D2.0.CO%3B2](http://www.bioone.org/doi/abs/10.1663/0013-0001(2006)60%5B103:RATPAS%5D2.0.CO%3B2).

# Calathea allouia

## Phytolith



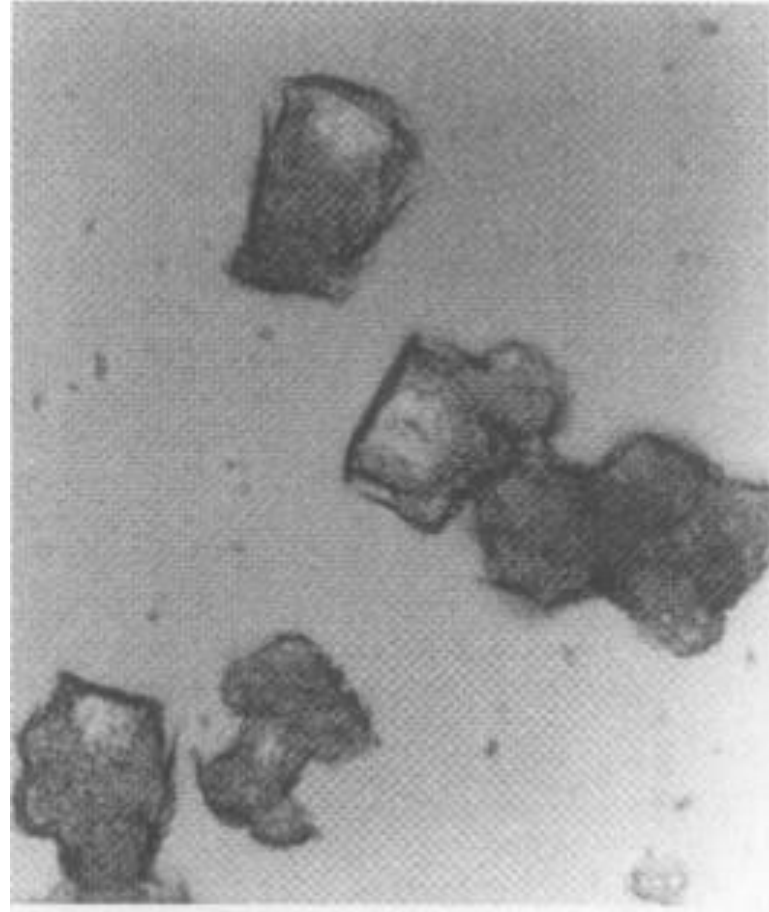
Fig. 8. Seed phytolith from Ileren. It is 40  $\mu$ m long. From Piperno, 2006.

Ball, Terry B., Karol Chandler-Ezell, Ruth Dickau, Neil Duncan, Thomas C. Hart, José Iriarte, Carol Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <http://dx.doi.org/10.1016/j.jas.2015.08.010>.

# Calathea allouia

## Phytolith

Fig. 18. Phytoliths from the seeds of *Calathea allouia* (Ieren). They are diagnostic because they have flat and undecorated upper bodies, in contrast to all other studied species in the Marantaceae.



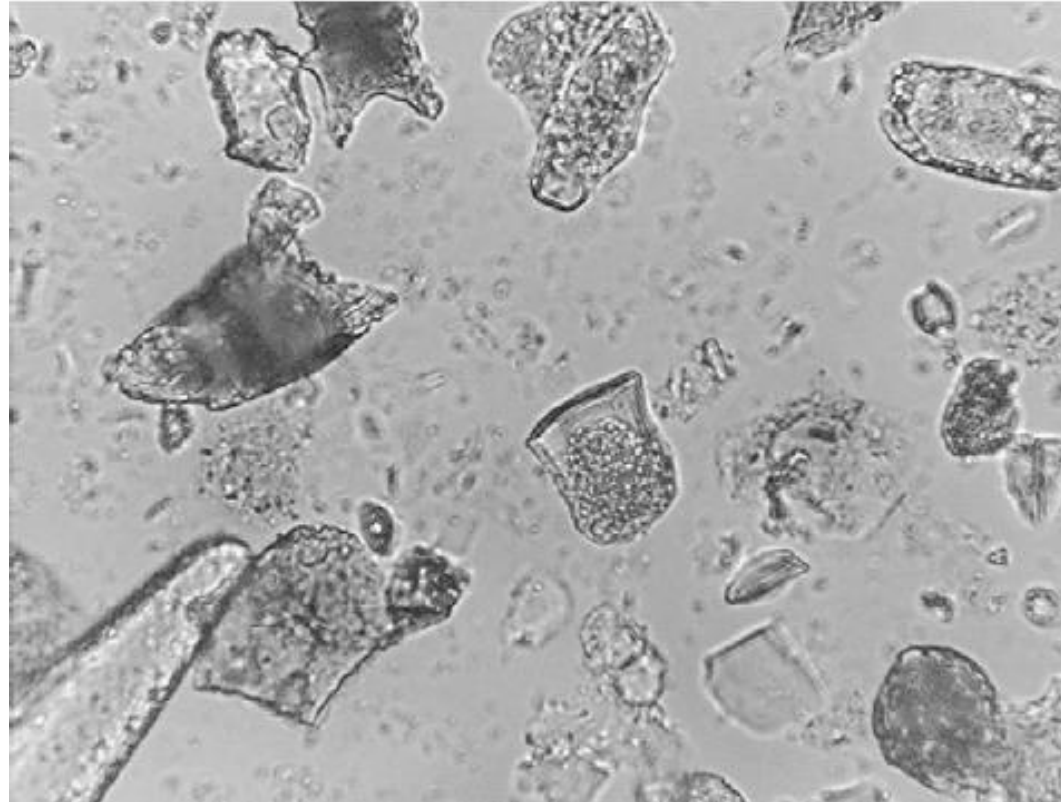
Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449. <http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.



# Calathea allouia

## Phytolith

Fig. 12. Center, a phytolith from the rhizome of *Calathea allouia* recovered from a preceramic level of Vegas Site 80. The phytolith assemblage of which it was a part was directly dated to 93207250 B.P. The phytolith is 30mm long.

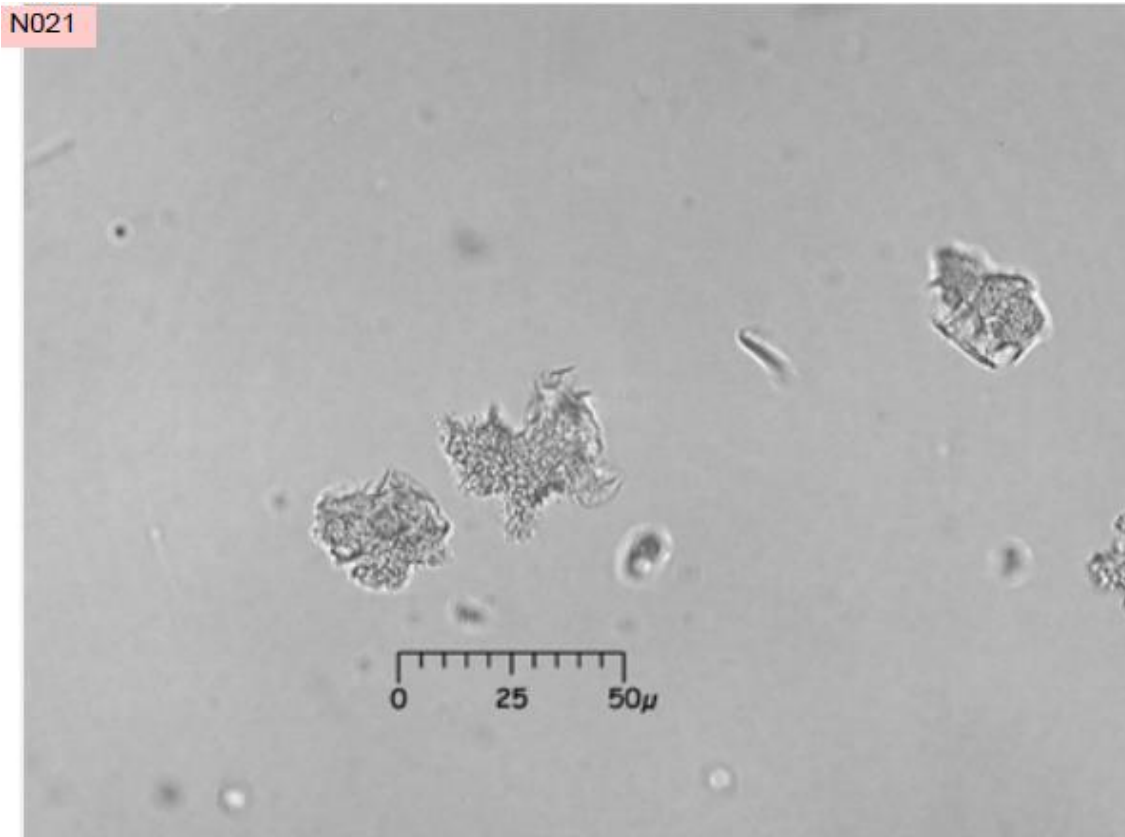


Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

# Calathea allouia

## Phytolith

Body on left is 22VIIbC2 (no spikes).  
Body on right is 22VIIbC3 (spikes).  
Diagnostic level: species (both types)

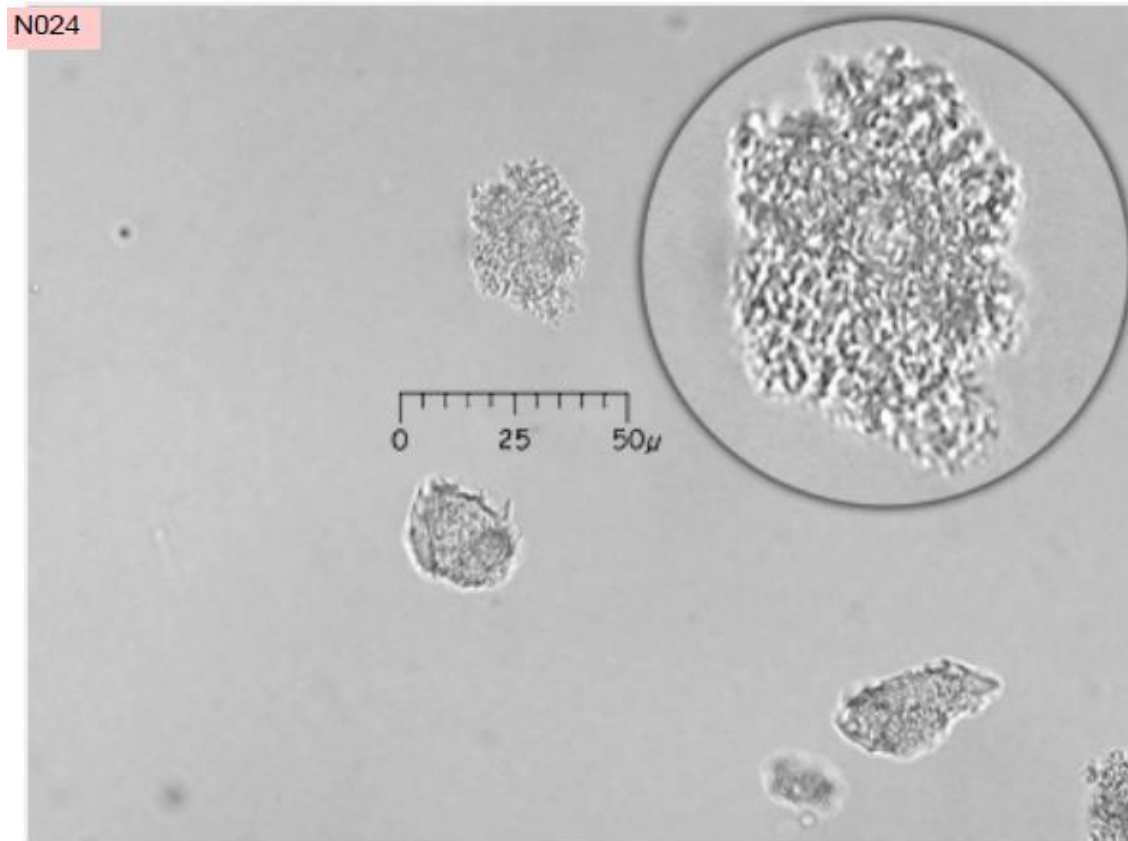


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

“Top” or dome-side view of “tip only” from *Calathea allouia*. You can only identify to species if you can match dome and spines. Otherwise identify only to Genus. Inset shows closeup of underside of *C. allouia* “tip only” where shaft of cylinder has broken away.

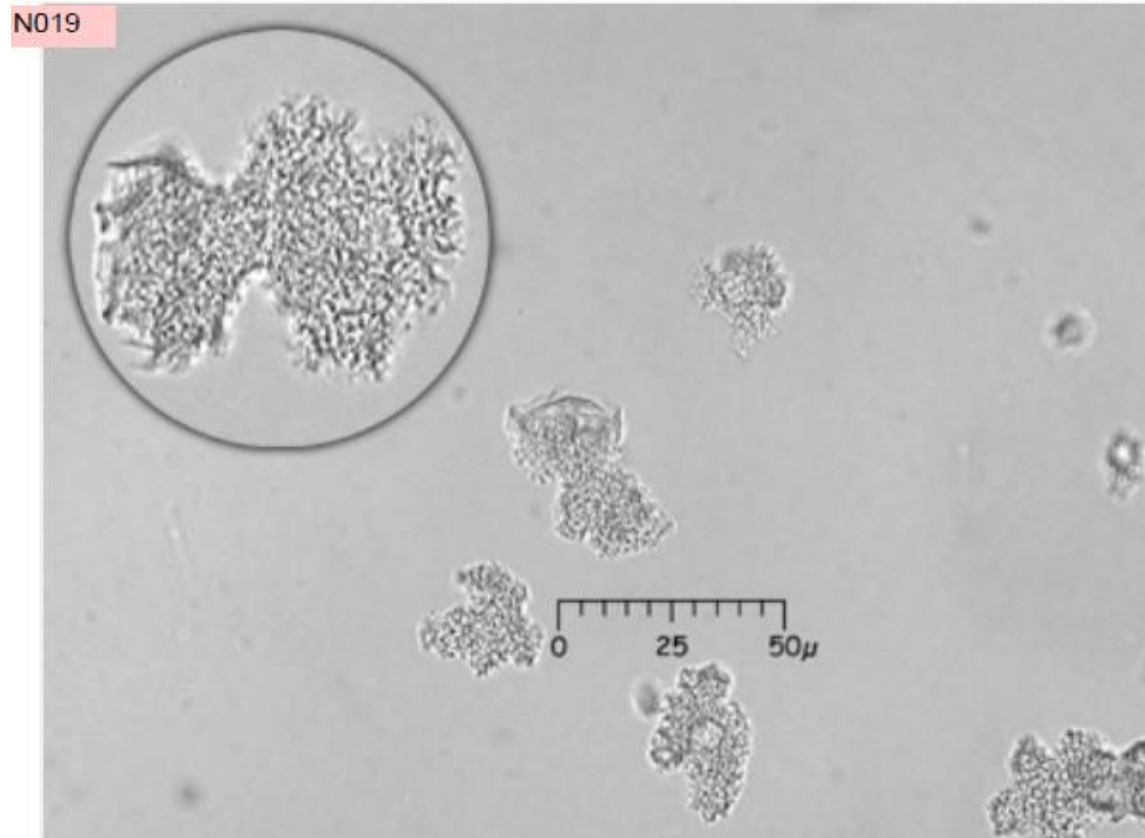


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

Diagnostic level: species Note that the “tip only” and pieces of cylinder only are also visible in this image (bottom view of “tip only” in bottom right side of field, piece of cylinder only in center left side of field). Inset shows closeup of C.allouia type... Notice the distinctive traits of the thin spines surrounding a flattened dome tip.



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

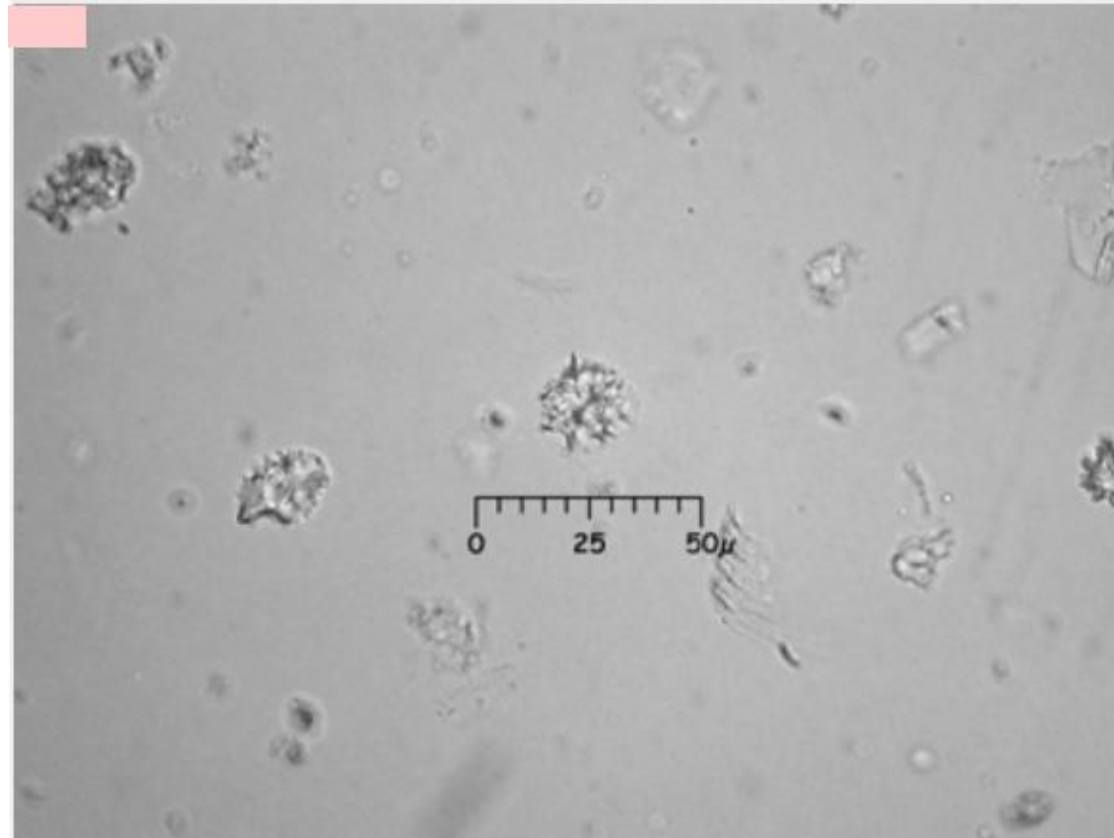
# Calathea allouia

## Phytolith

The phytolith to the left of the scale shows the tip clearly.

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: *Calathea* rhizomes



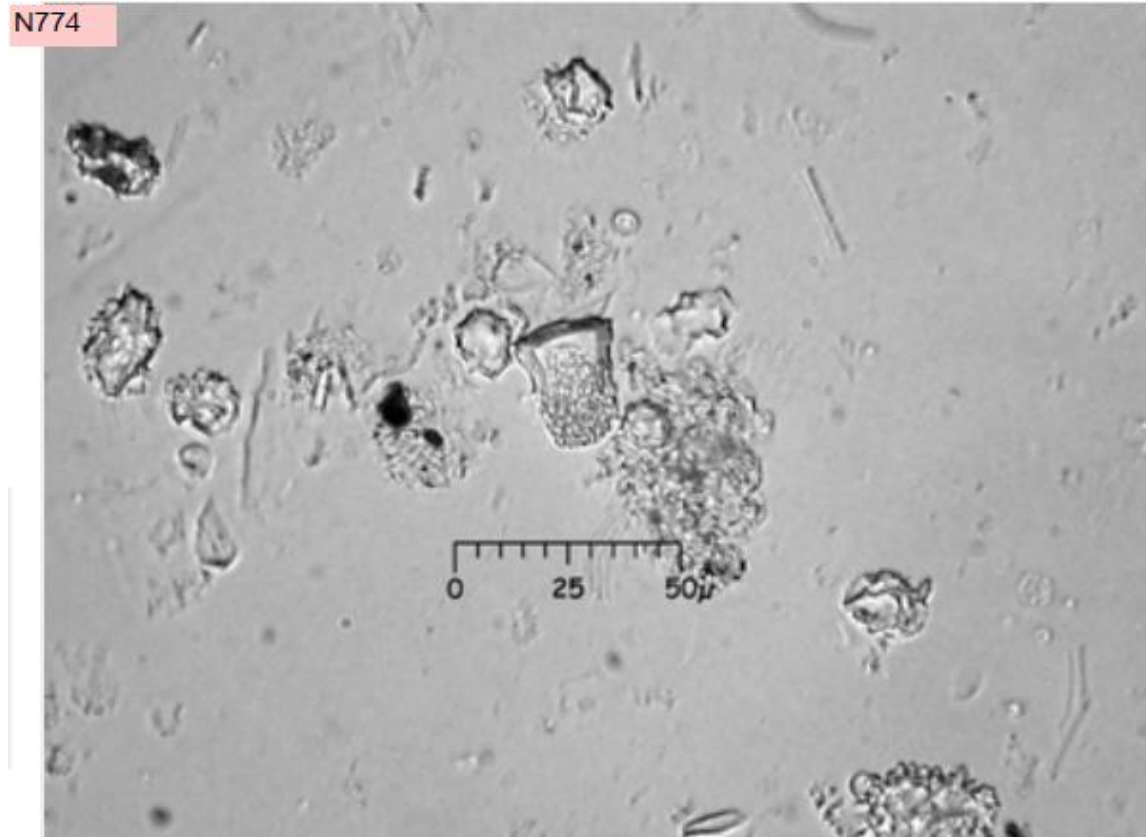
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: *Calathea* rhizomes



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

Phytoliths above the scale are this type.

Phytolith at lower right is 26IAa (see record 258)

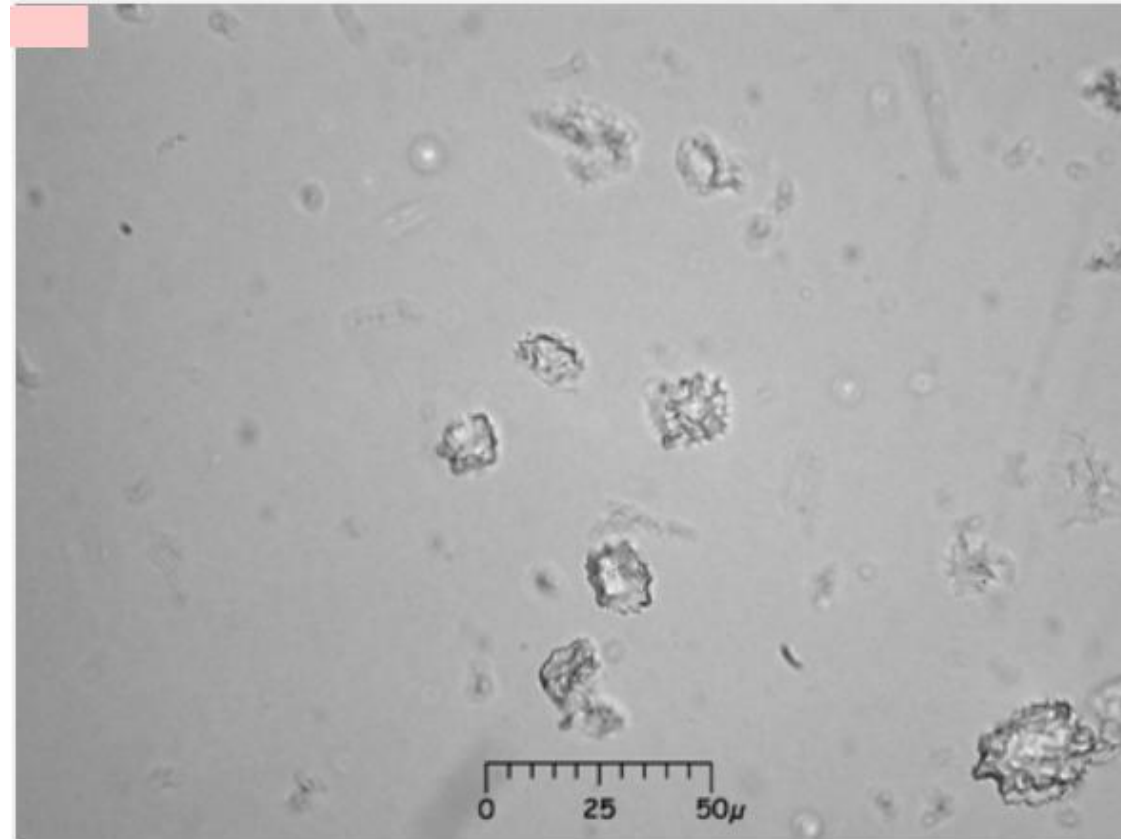
Type established by Karol Chandler-Ezell, 2004

Diagnostic level: Calathea genus, rhizome

See phytolith at lower right. The other forms are 26IIB

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: Calathea, rhizome



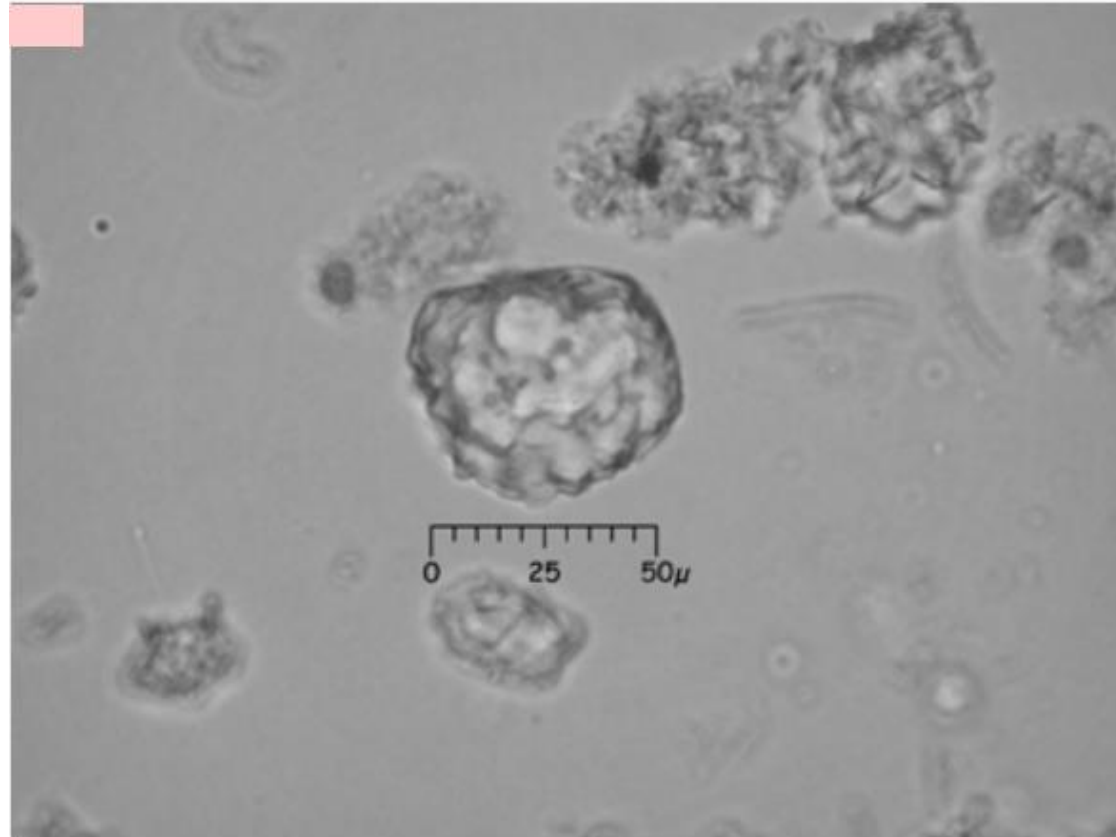
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

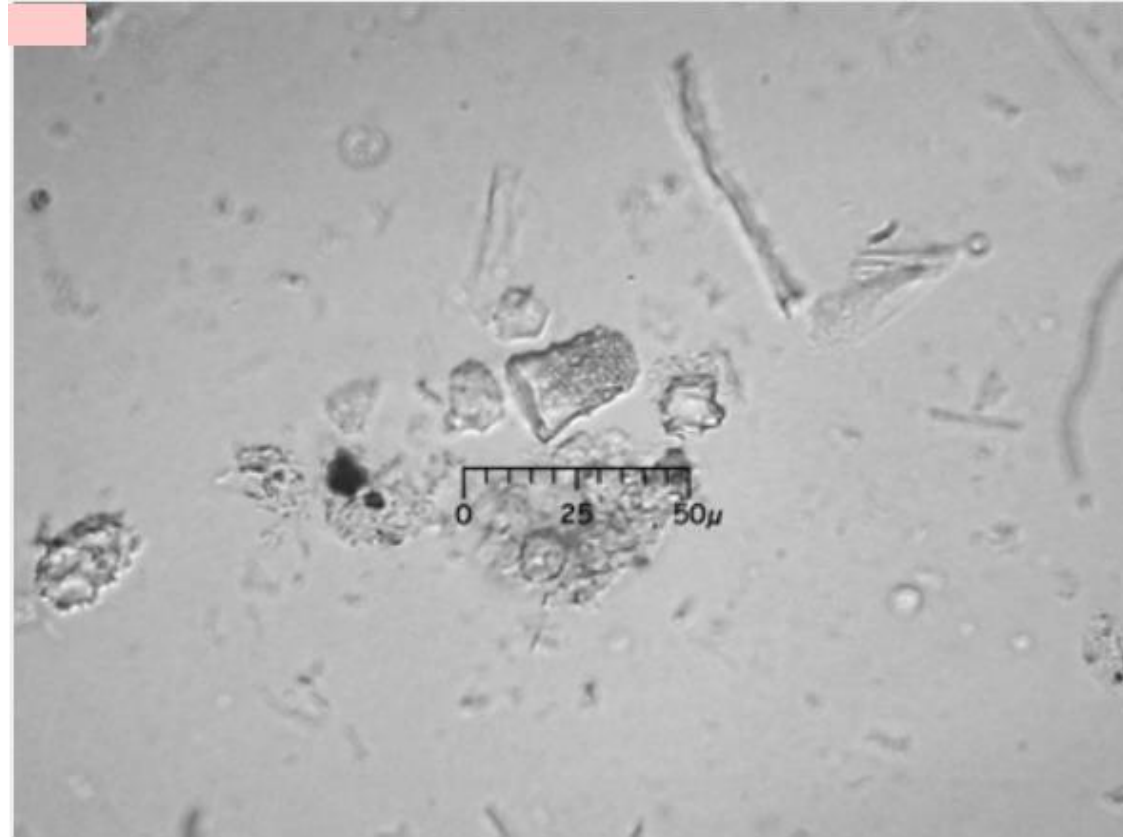


# Calathea allouia

## Phytolith

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: Calathea, rhizome



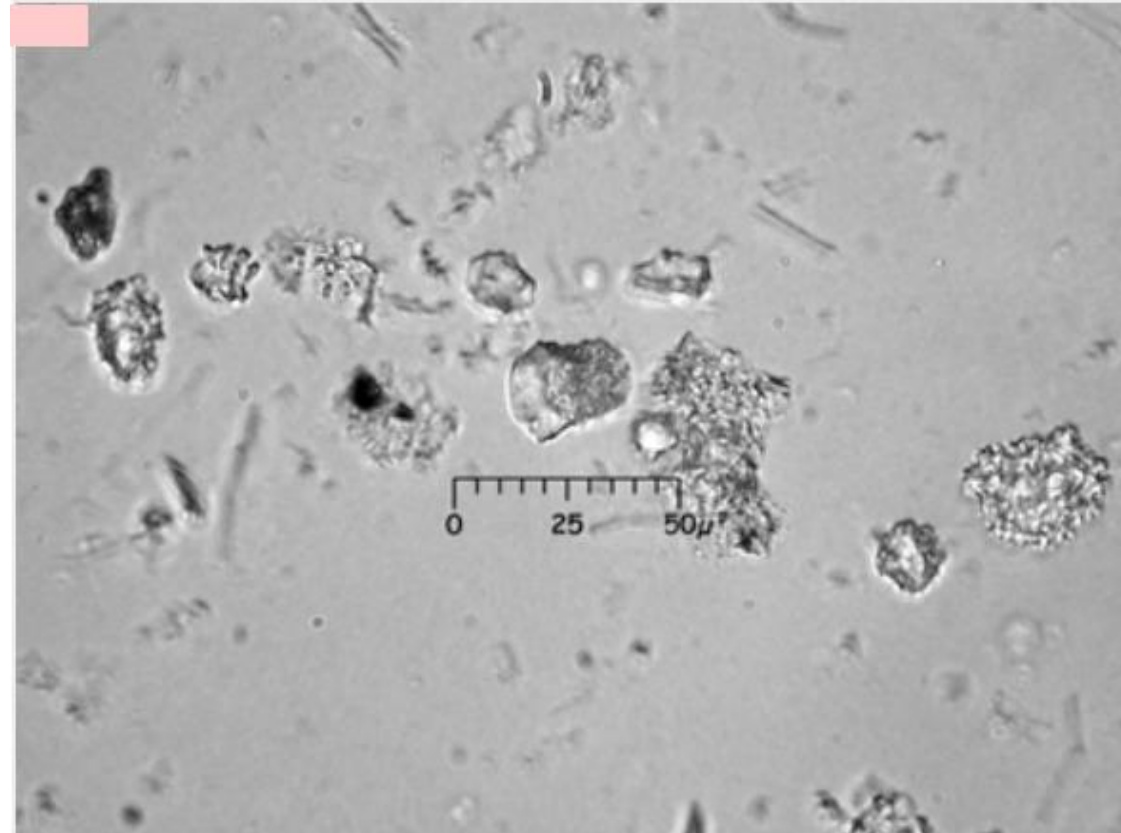
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: Calathea, rhizome



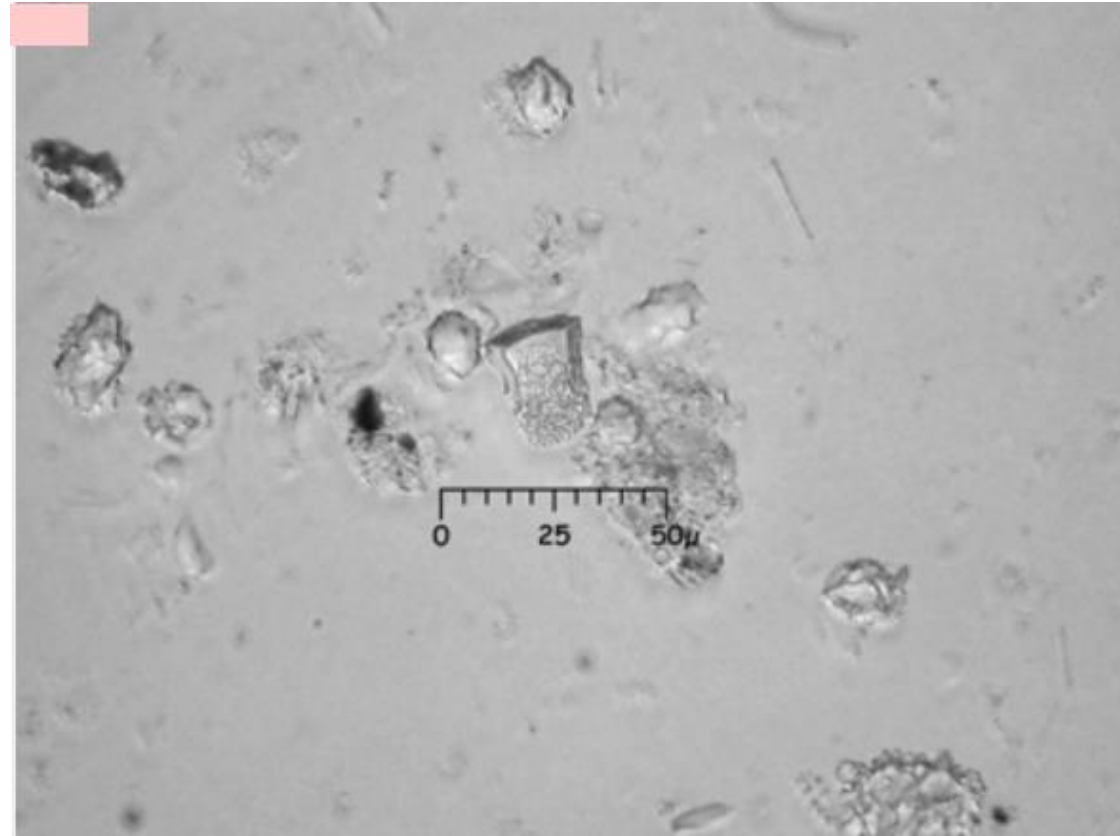
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: Calathea, rhizome

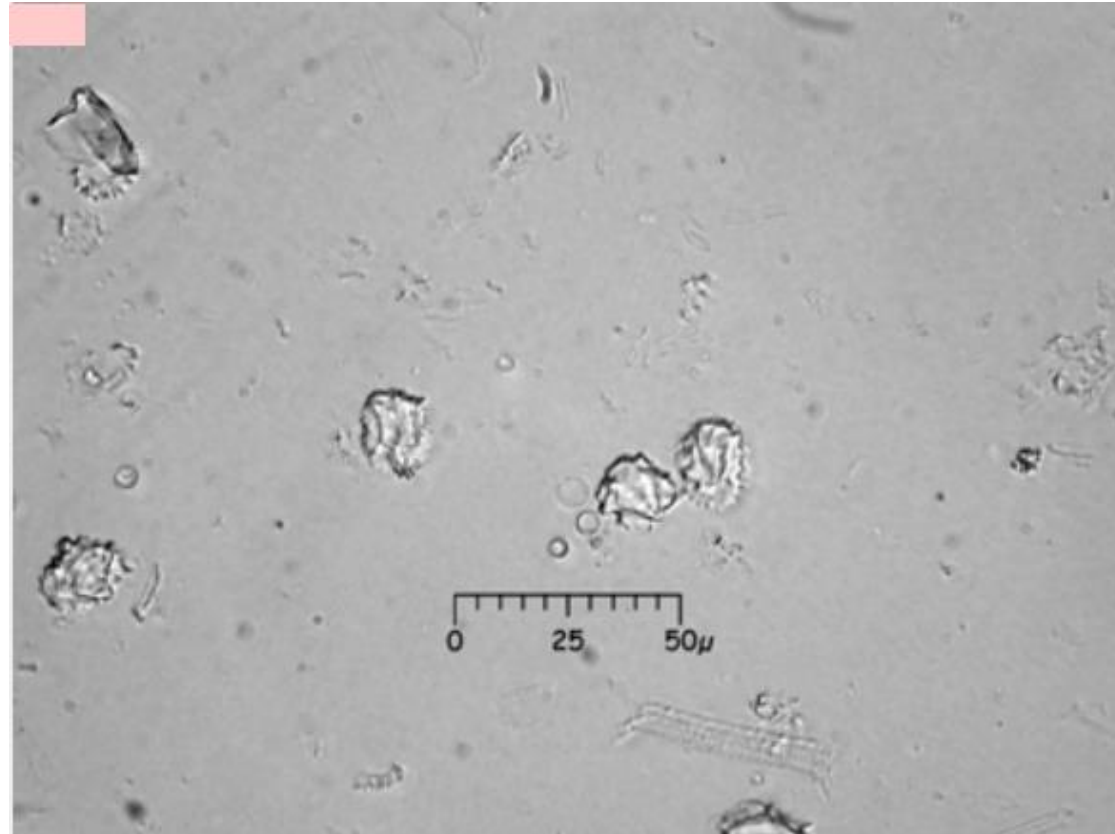


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

Type established by Karol Chandler-Ezell, 2004  
Diagnostic level: Calathea genus,  
rhizome

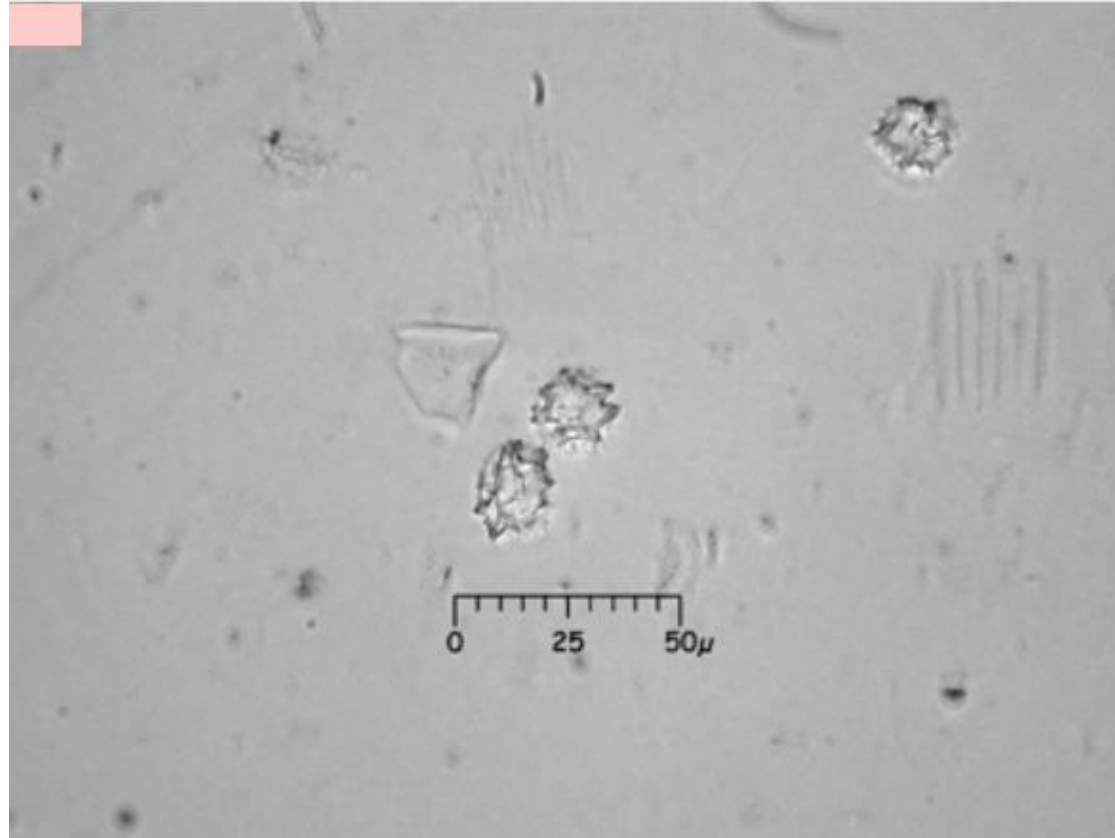


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

Type established by Karol Chandler-Ezell, 2004  
Diagnostic level: Calathea genus,  
rhizome



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

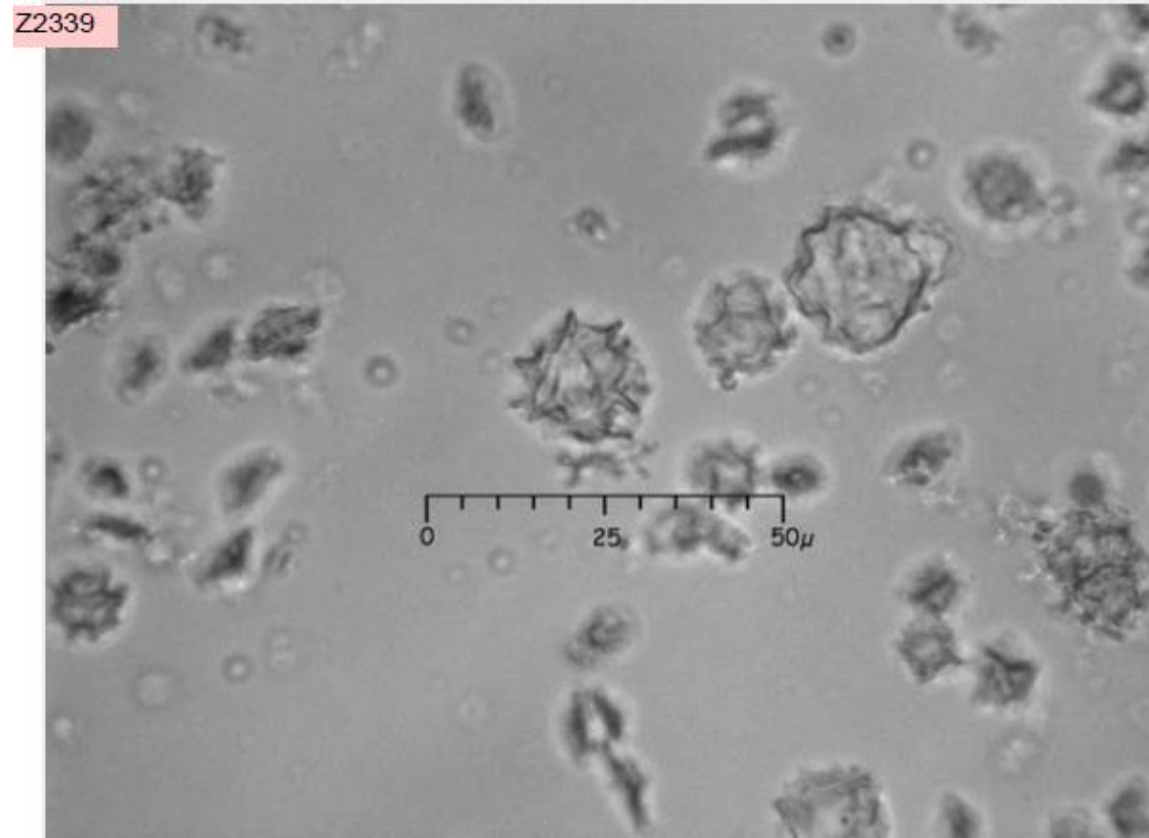
# Calathea allouia

## Phytolith

PC2458

Diagnostic level: Potential species-level diagnostic. Type overlaps with 80IKa, but is distinguished by size.

Occurs in leaf and less often in inflorescence



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

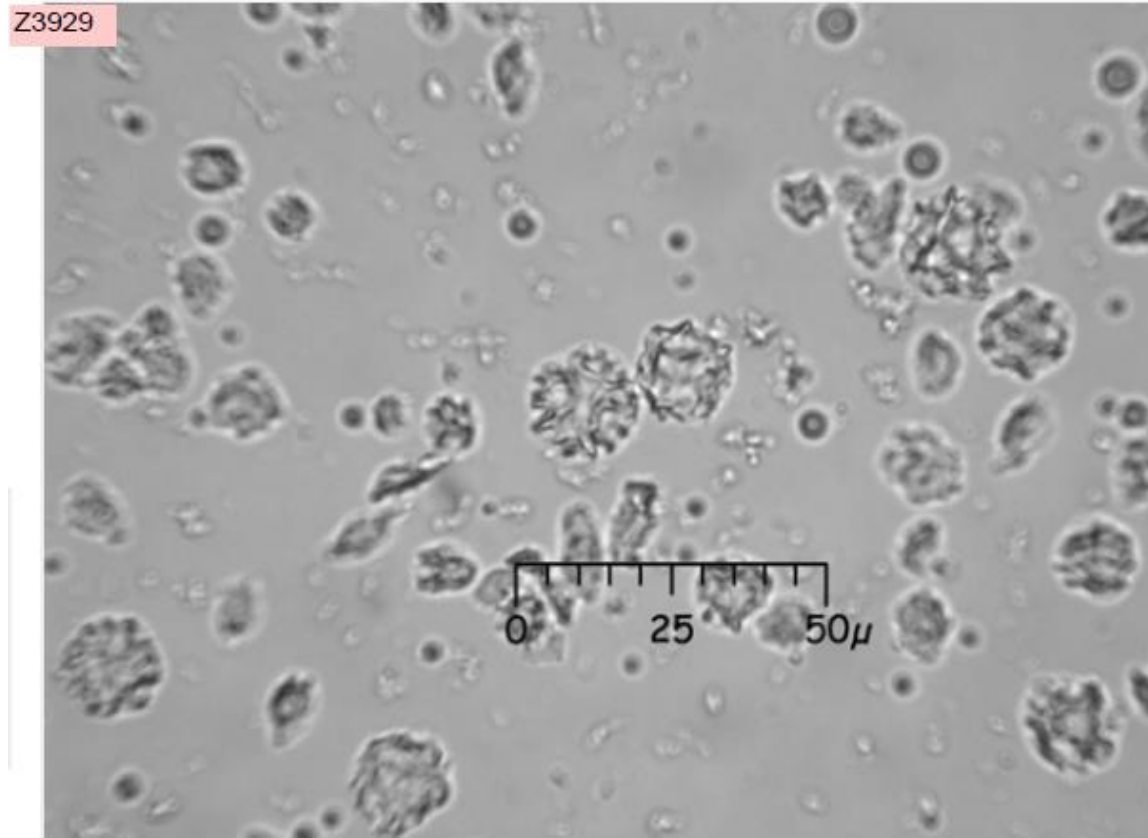
# Calathea allouia

## Phytolith

PC2458

Diagnostic level: Potential species-level diagnostic. Type overlaps with 80IKa, but is distinguished by size.

Occurs in leaf and less often in inflorescence



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

PC2596 *Calathea allouia* leaf These folded/angled spheres have distinctive nodules separate from the folds. Grade into rugulose (bumpy, rough surface) spheres.

Type first defined by Karol Chandler-Ezell

Diagnostic level under study



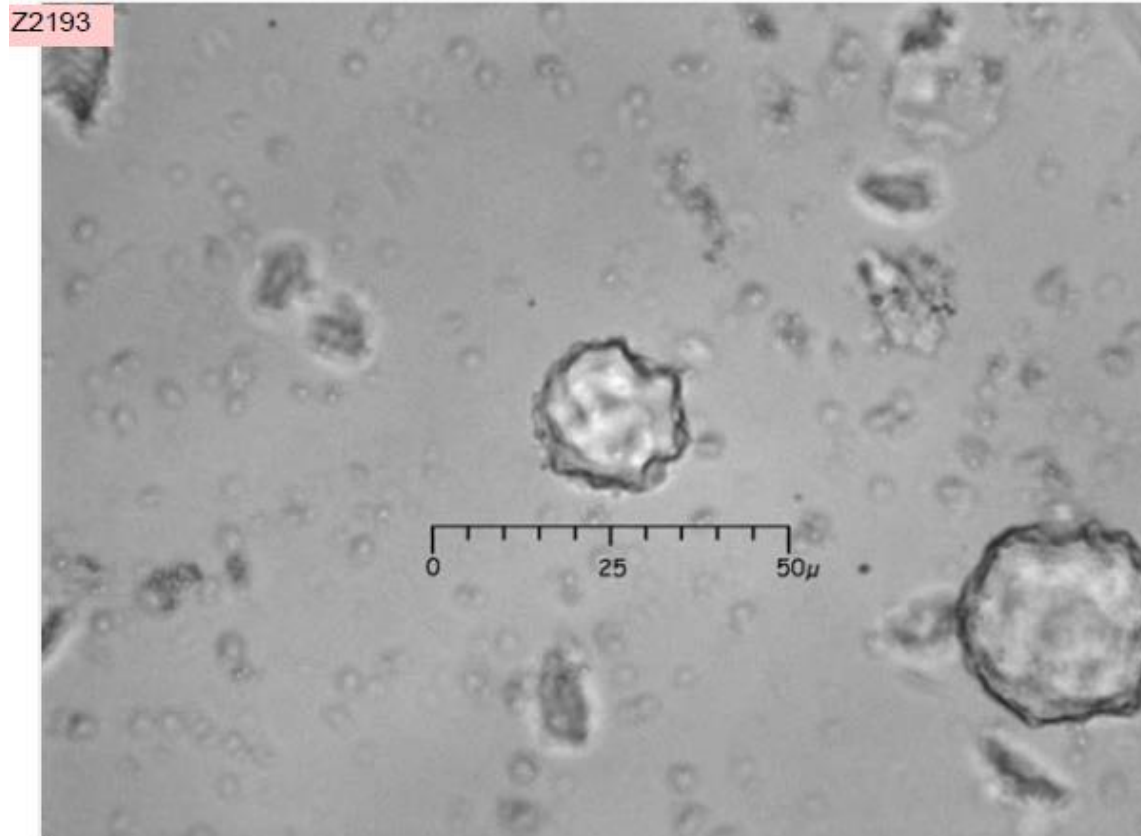
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Calathea allouia

## Phytolith

PC2596 Calathea allouia leaf These folded/angled spheres have distinctive nodules separate from the folds. Grade into rugulose (bumpy, rough surface) spheres. Diagnostic level under study

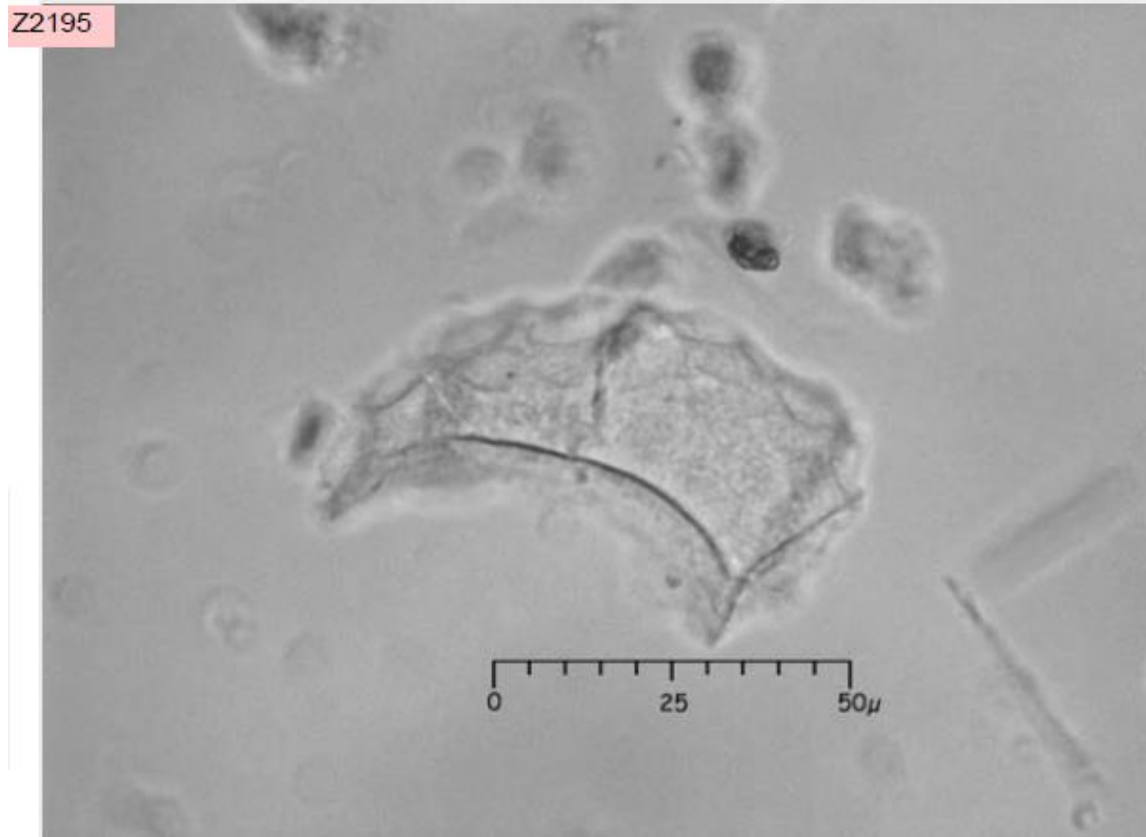


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

PC2597 *Calathea allouia* stem some examples are curved, but not hemispherical  
Diagnostic level: under study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

PC2597 *Calathea allouia* stem some examples are curved, but not hemispherical  
Diagnostic level: under study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

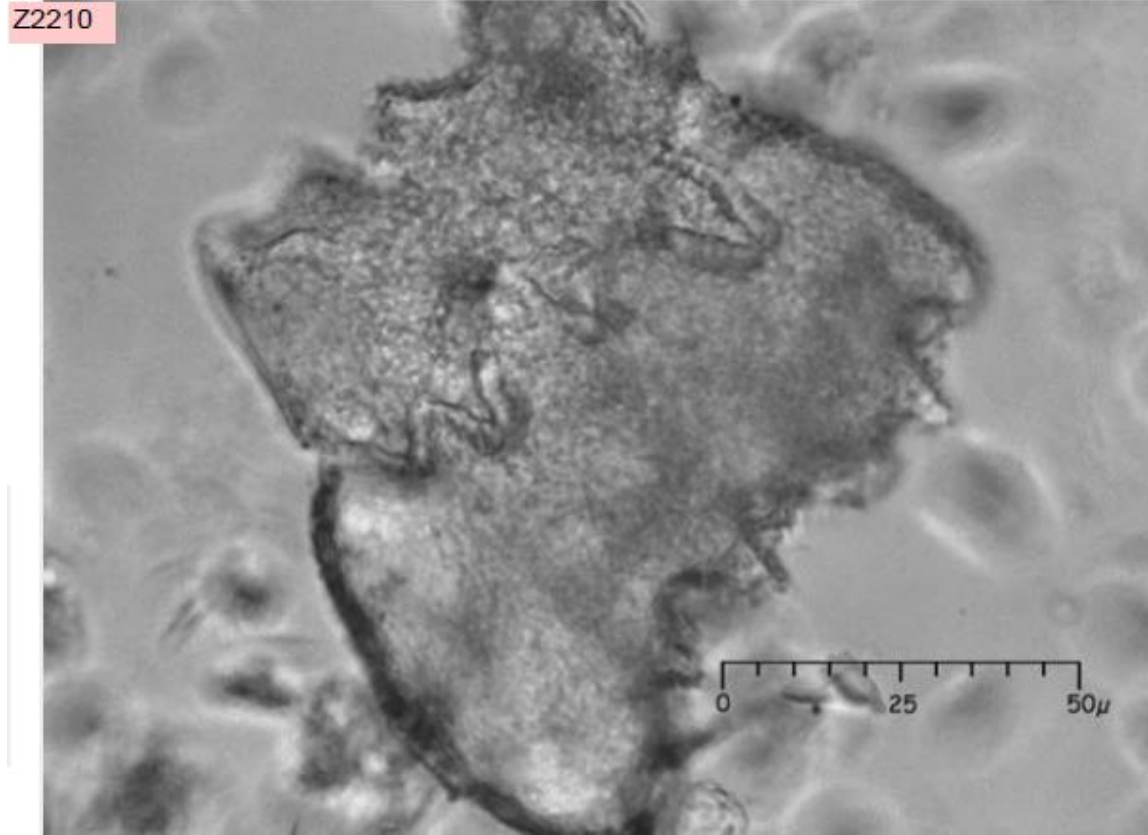
# Calathea allouia

## Phytolith

PC2598, inflorescence

Note that this type can be quite long;  
considerable variation is present

Diagnostic level: species



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

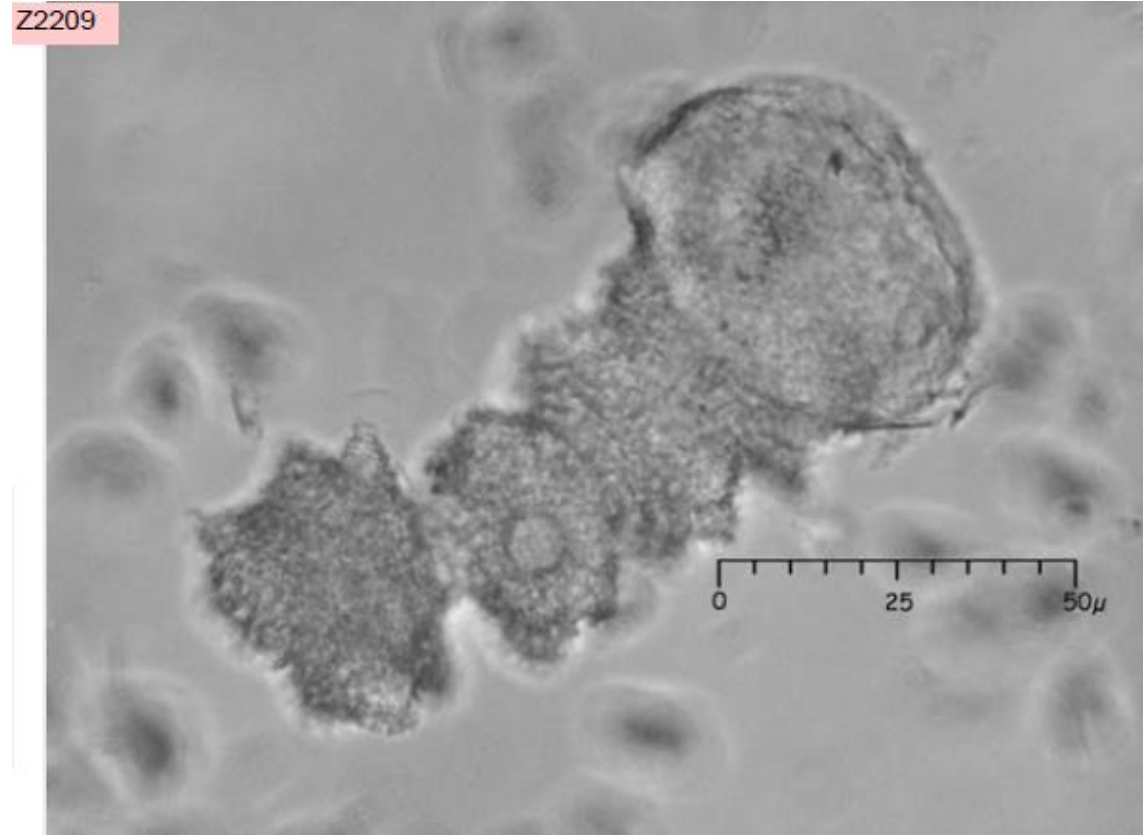
# Calathea allouia

## Phytolith

PC2598, inflorescence

Note that these inflorescence types can be quite large; size is variable

Diagnostic level: species



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

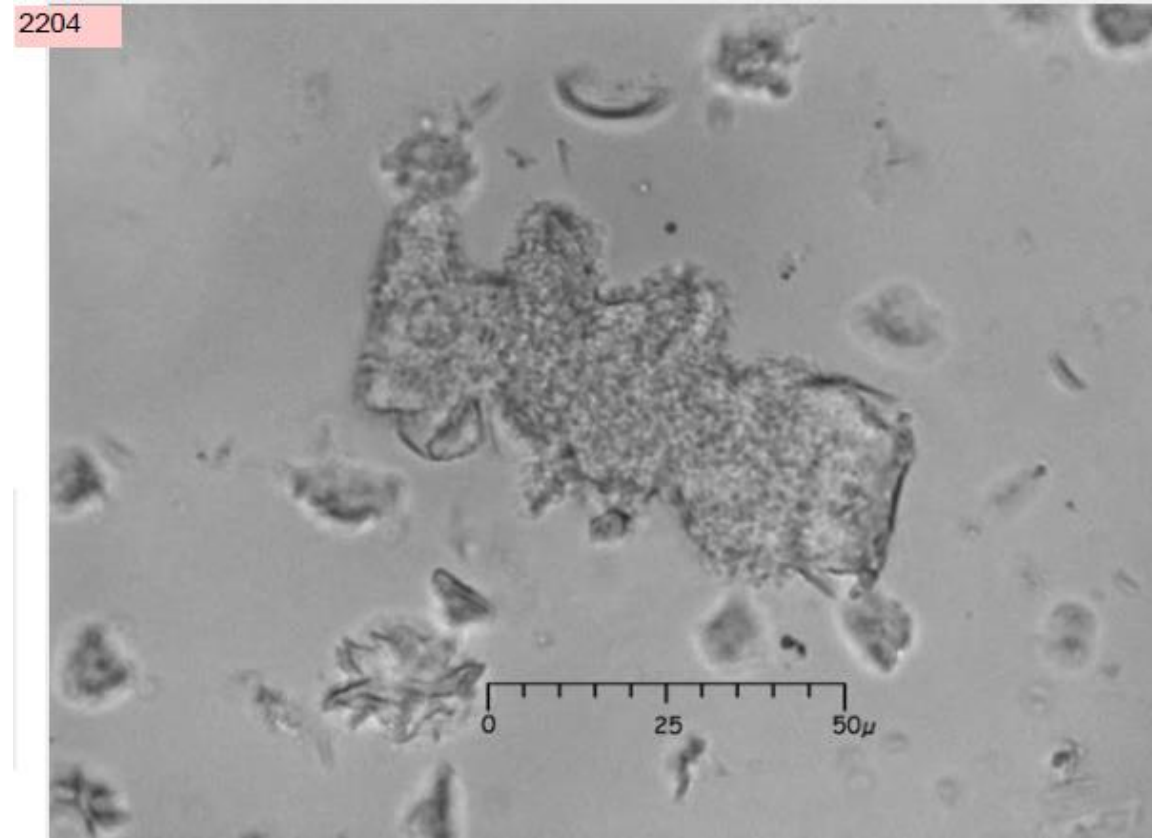
# Calathea allouia

## Phytolith

PC2598, inflorescence

Note that these inflorescence types can be quite large; size is variable

Diagnostic level: species



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

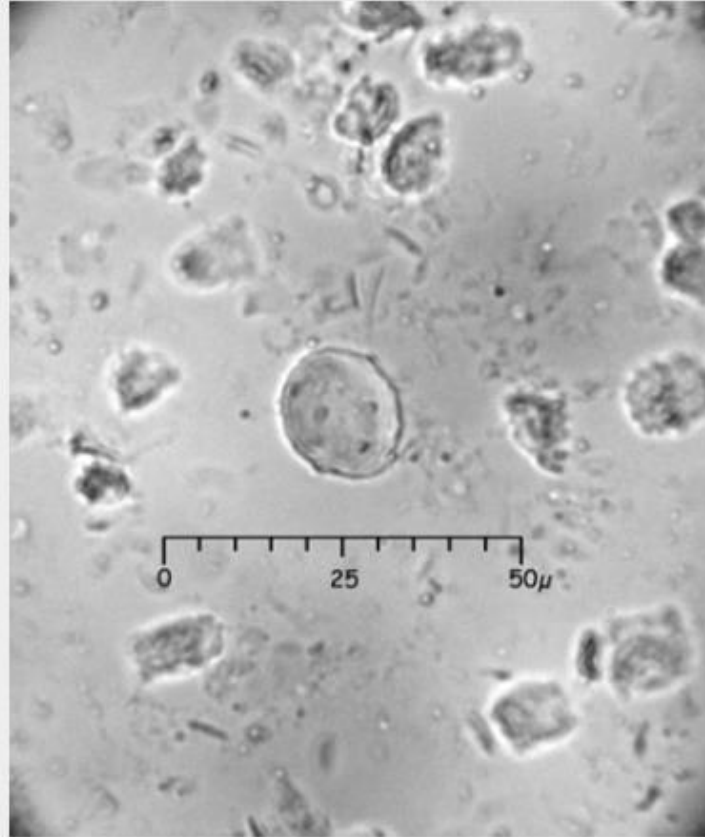
## Phytolith

Z4276

PC2598, inflorescence, type occurs rarely

Spheres produced by *Canna* range from smooth to rugulose to irregularly angled or folded. Type 80IAa201 is based on a modern specimen of *Canna edulis* leaf. Ephemeral spherical bodies are not included in this type.

Diagnostic level: *Canna* genus (rare in *Calathea*)

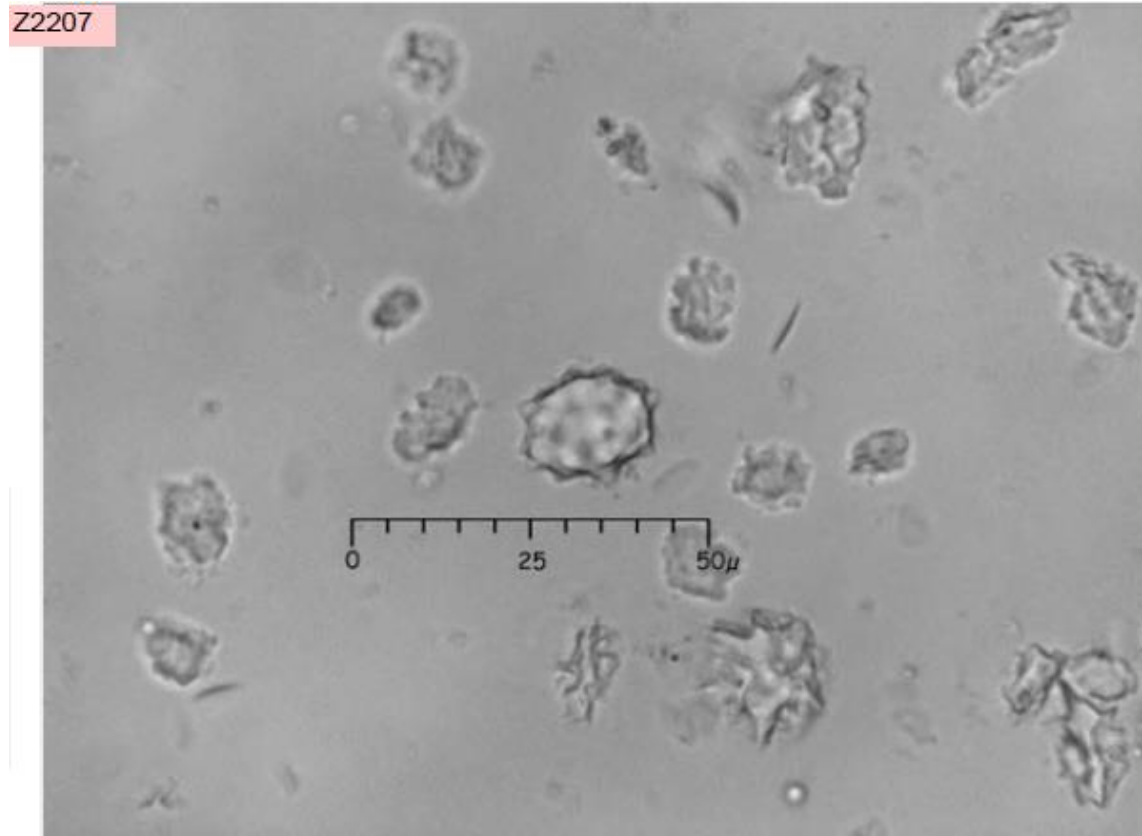


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

PC2598, inflorescence Nodular spheres moderate in occurrence, variable in size and height of projections. This is a large example (80ICa2); smaller also present (80ICa1)



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Calathea allouia

## Phytolith

type established by Karol Chandler-Ezell  
PC2348, *C. allouia* inflorescence  
Diagnostic level: *Calathea*/Maranta



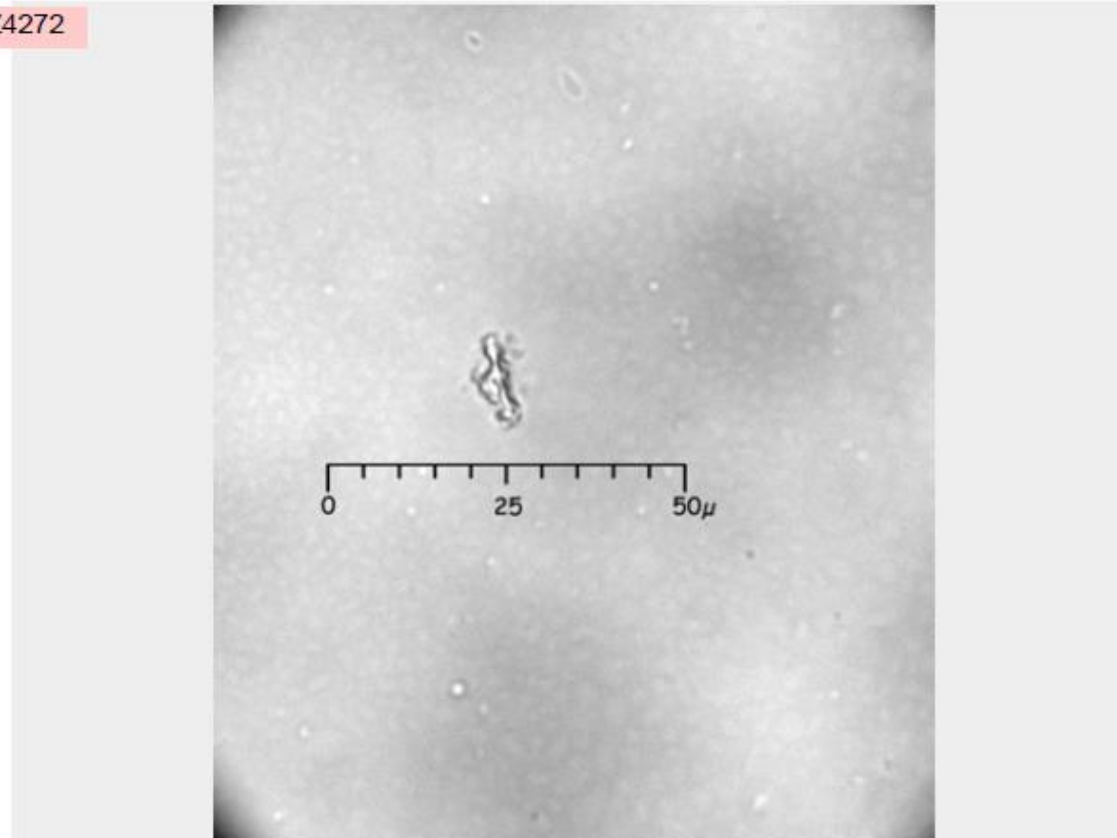
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Phytolith

type established by Karol Chandler-Ezell  
PC2348, *C. allouia* inflorescence  
Diagnostic level: *Calathea*/Maranta

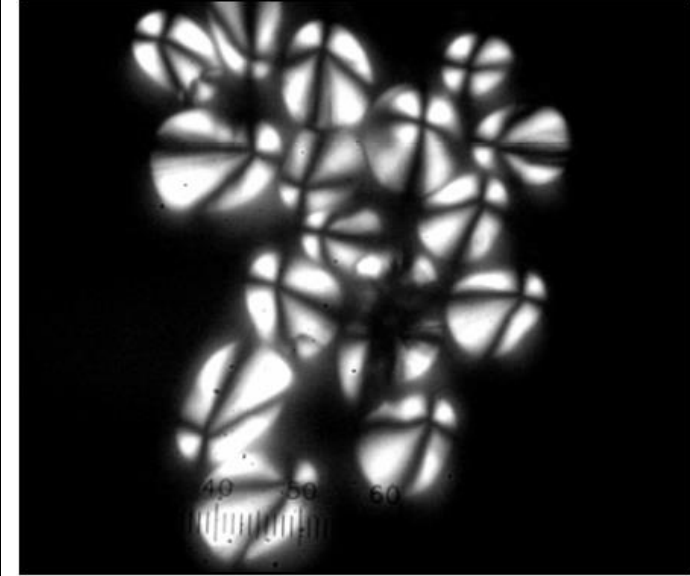
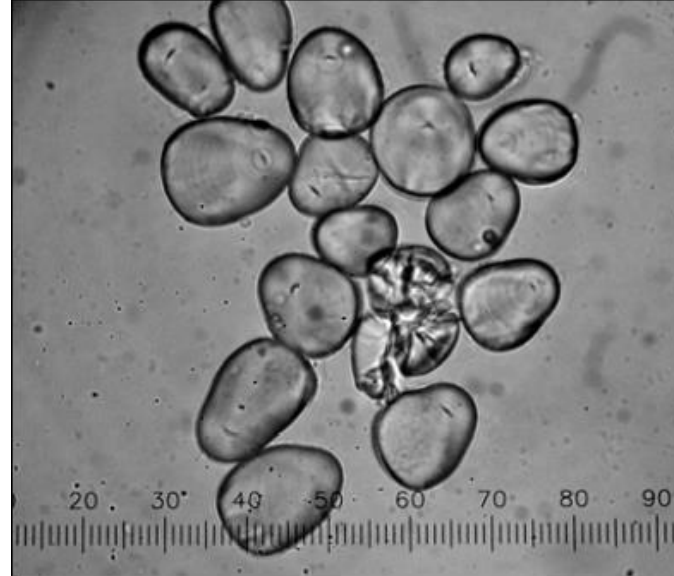
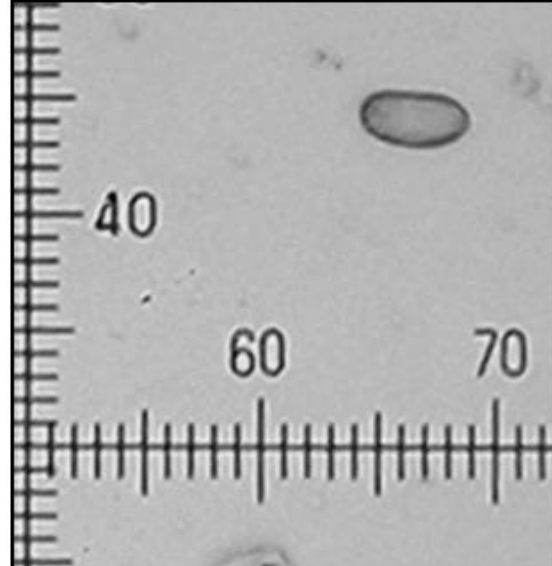
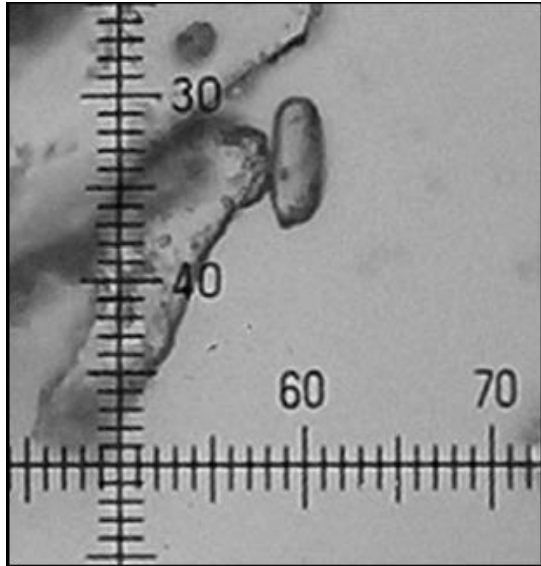
Z4272



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea allouia

## Starch

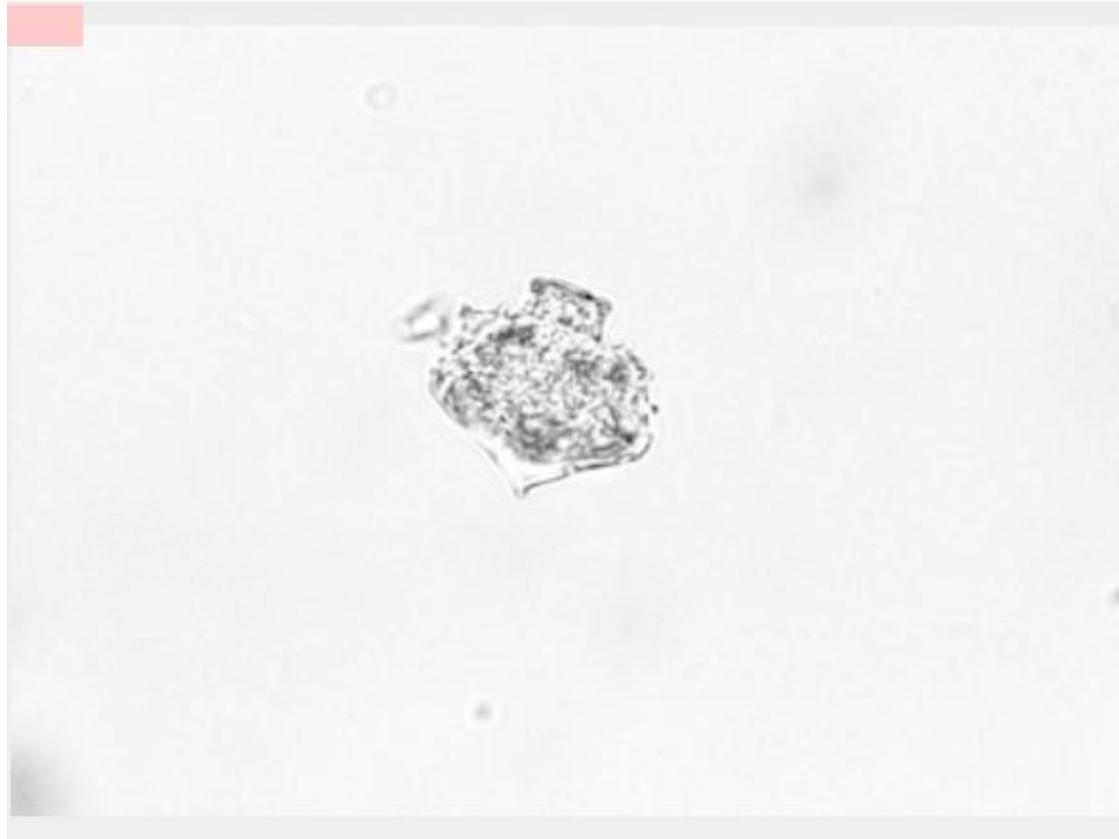


Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Calathea altissima

## Phytolith

Calathea spp.  
seed body, Still has distinct, curved stalk  
tip of Calathea spp., but cylinder is very  
short relative to width. Diagnostic level:  
genus

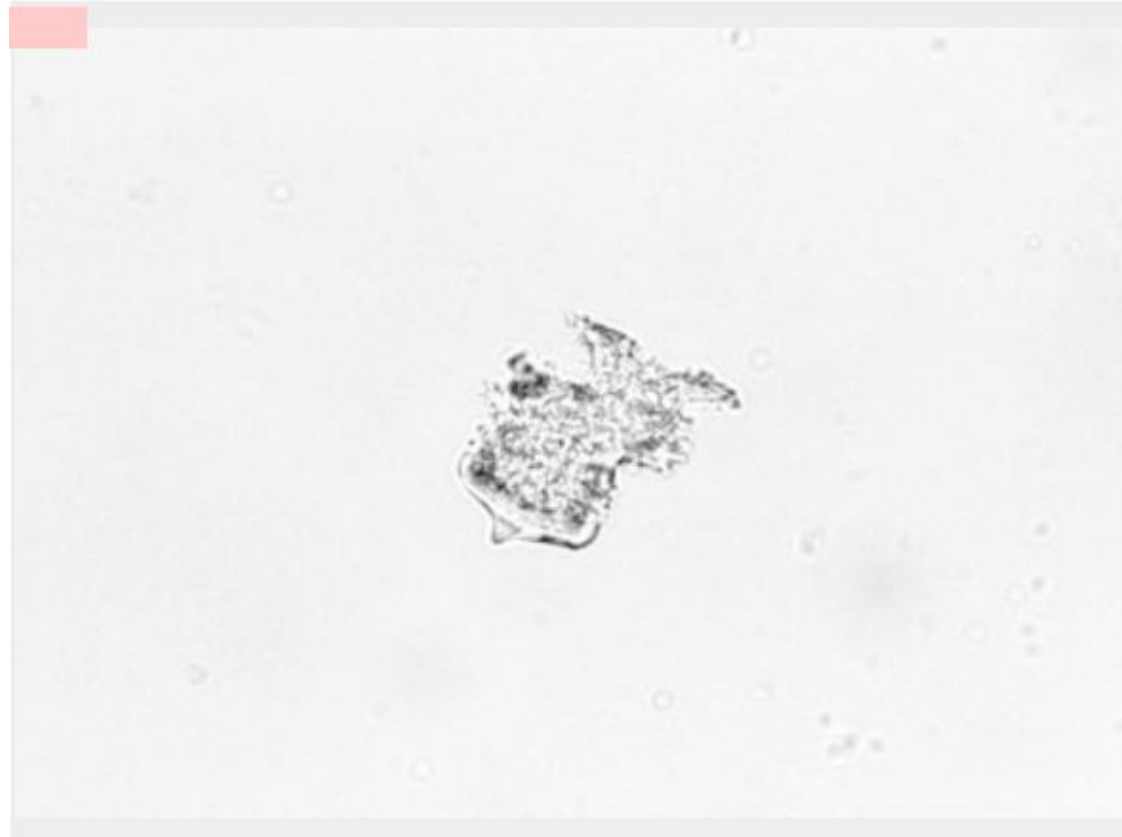


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea altissima

## Phytolith

seed body, Still has distinct, curved stalk tip of Calathea spp., but cylinder is very short relative to width. note "corkscrew" axis of main body shaft. This appears to be a point where the bodies "break" resulting in Tip pieces and base pieces. Diagnostic level: genus

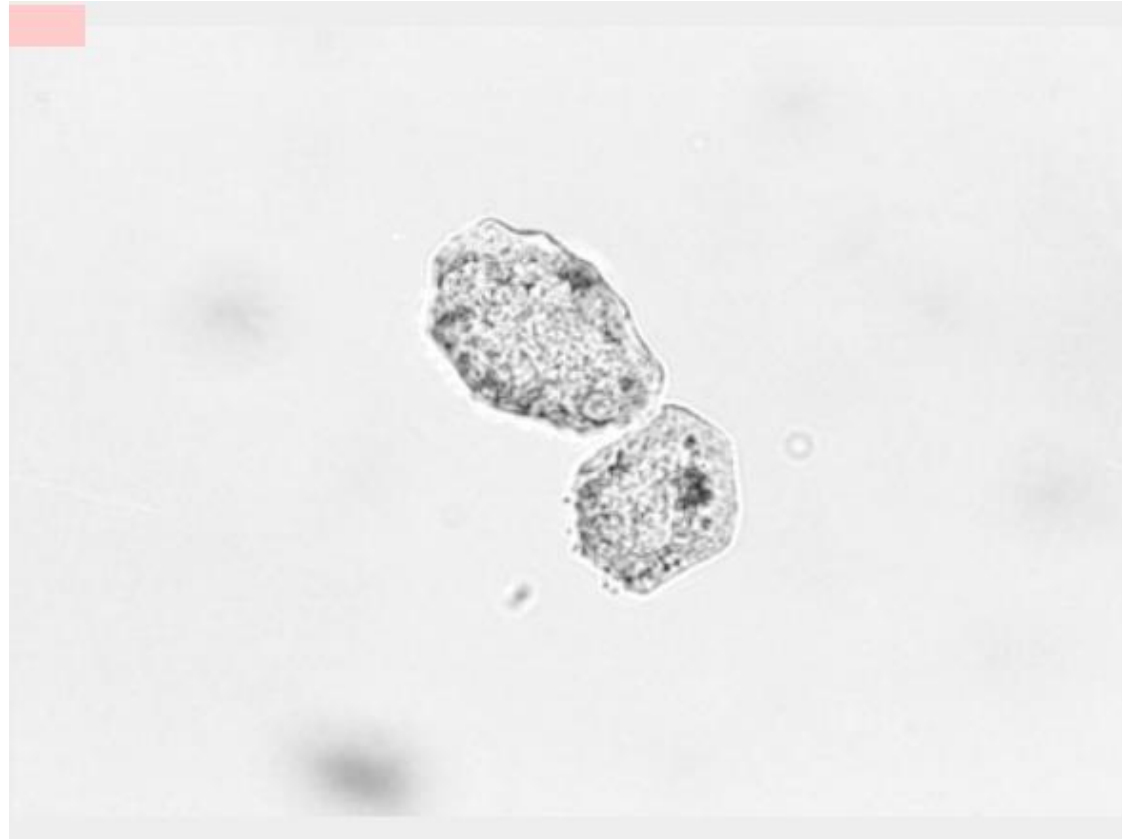


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea altissima

## Phytolith

“underside” of seed bodies, Note flattened, polygonal edges, finely rugulose/granular underside Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

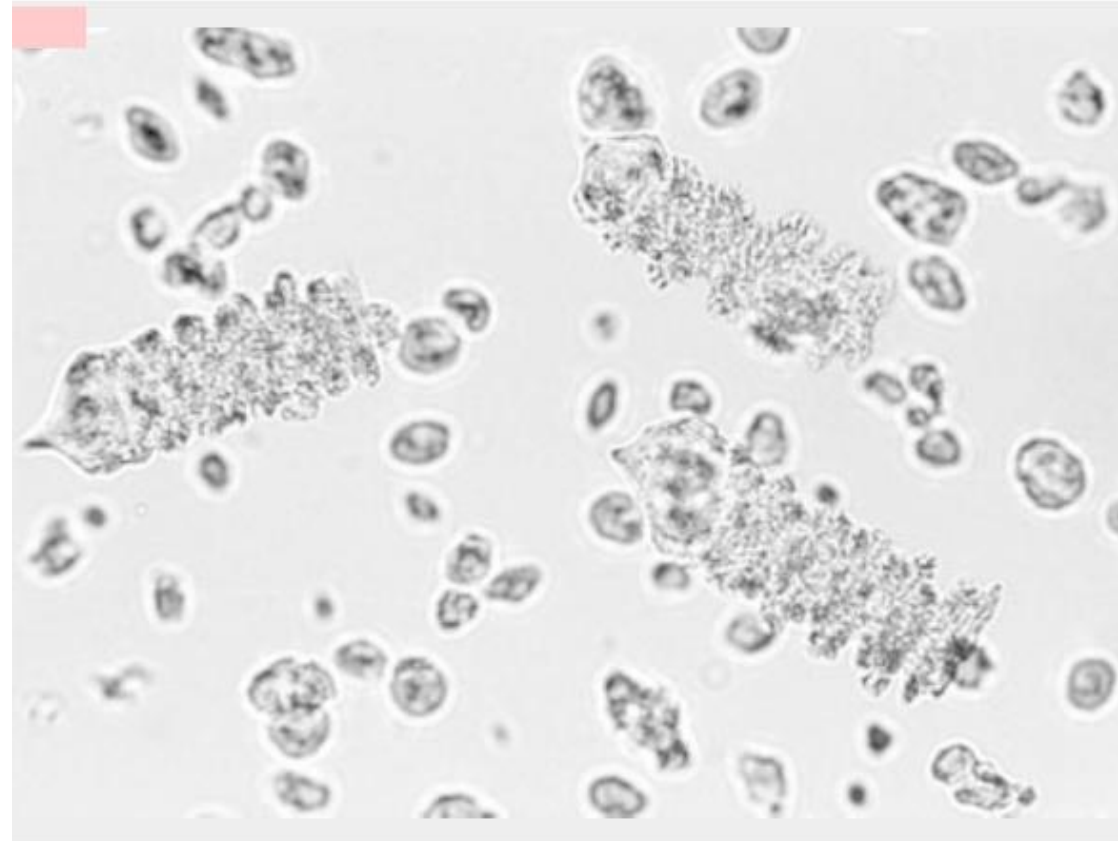
# Calathea crotalifera

## Phytolith

Note the 80III B rugulose conical bodies in background....

Especially note bulbous rims of seed body tips.

Diagnostic level: family, wild taxa



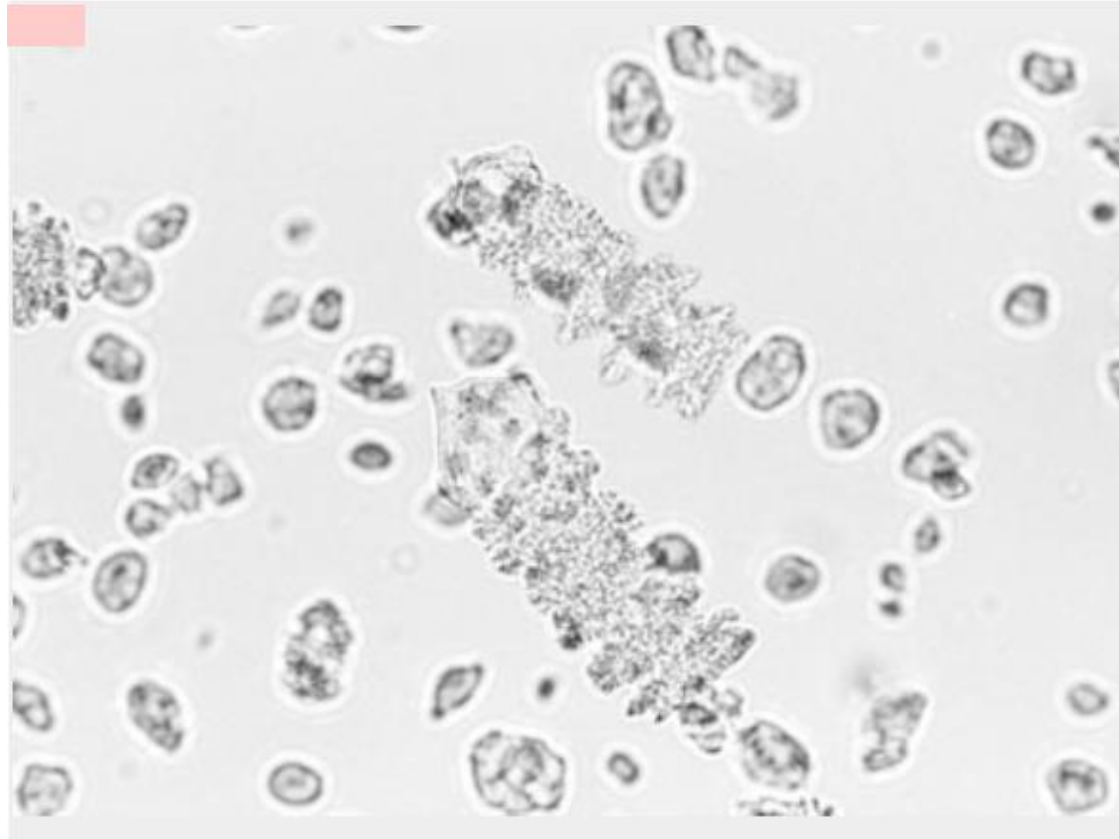
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea crotalifera

## Phytolith

seed bodies, background has rugulose  
conical bodies

Diagnostic level: family, wild taxa



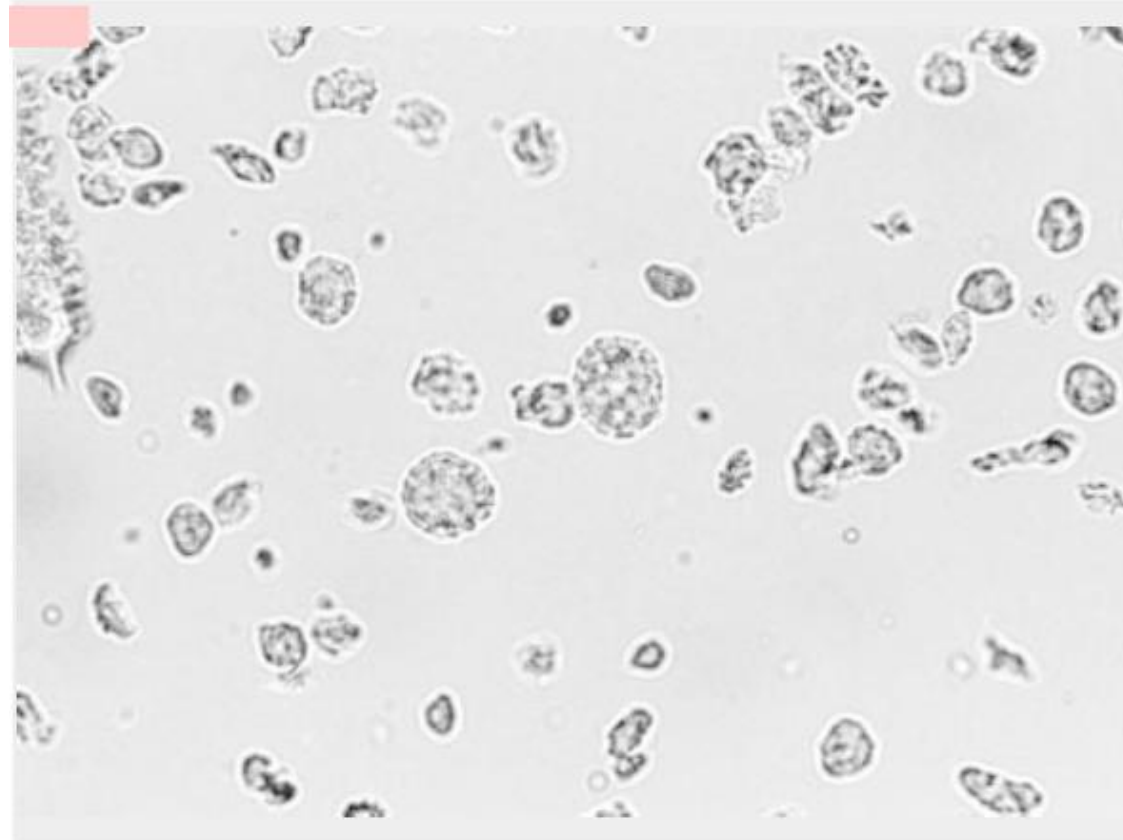
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Calathea crotalifera

## Phytolith

Marantaceae nodular spheres and  
rugulose conical bodies Diagnostic  
level:  
Marantaceae/Bombacaceae

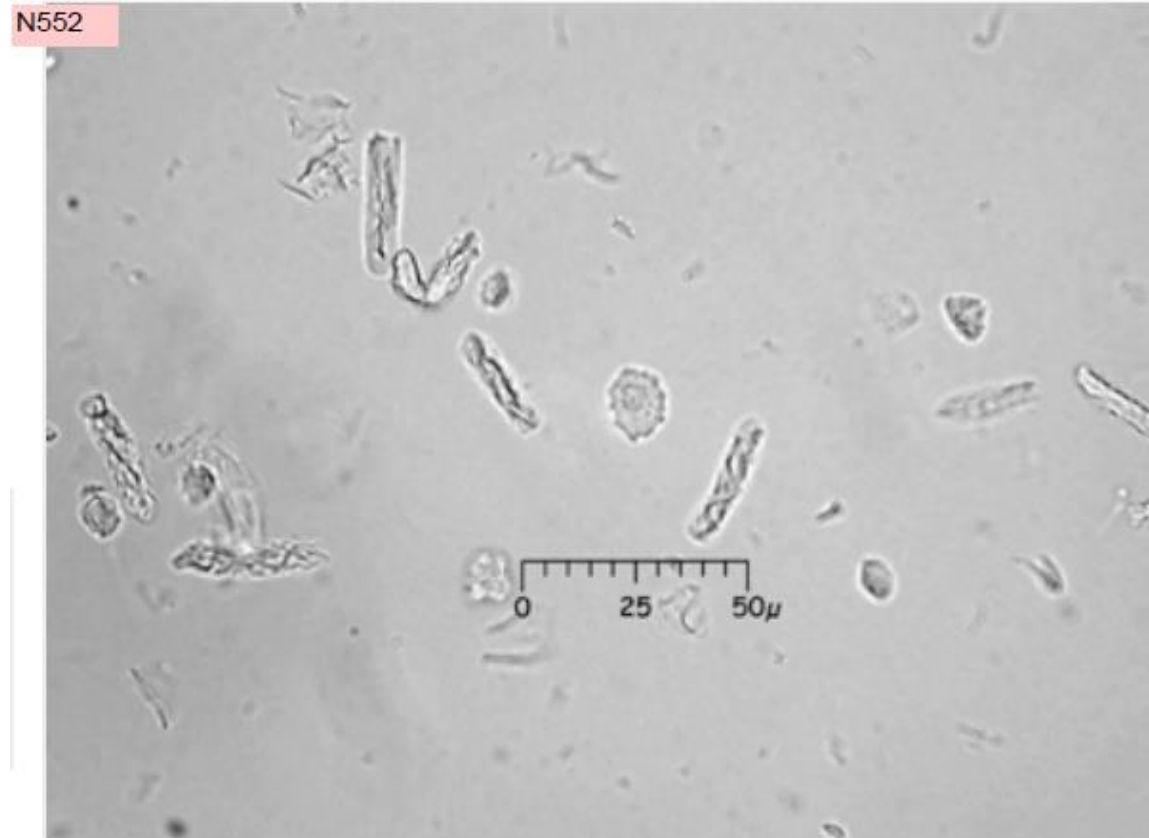


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea lutea

## Phytolith

Marantaceae conical body Top view.  
Type is centered above the 25.  
Diagnostic level: family

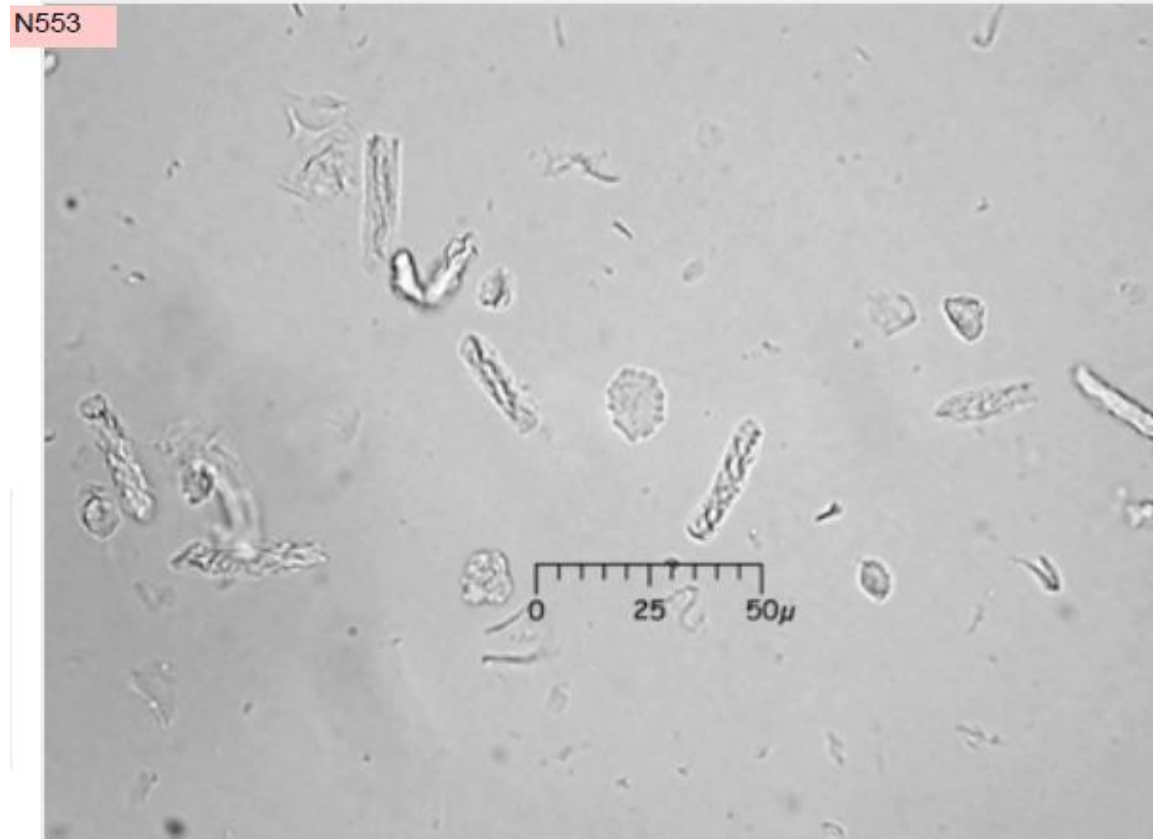


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea lutea

## Phytolith

Length is 27.5 microns leaf sample.  
Body occurs to the right of the 80IIIB  
example.  
Diagnostic level: family



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea lutea

## Phytolith

PC2594, floret

These are large examples of the type,  
VA

Diagnostic level: Calathea/Maranta



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

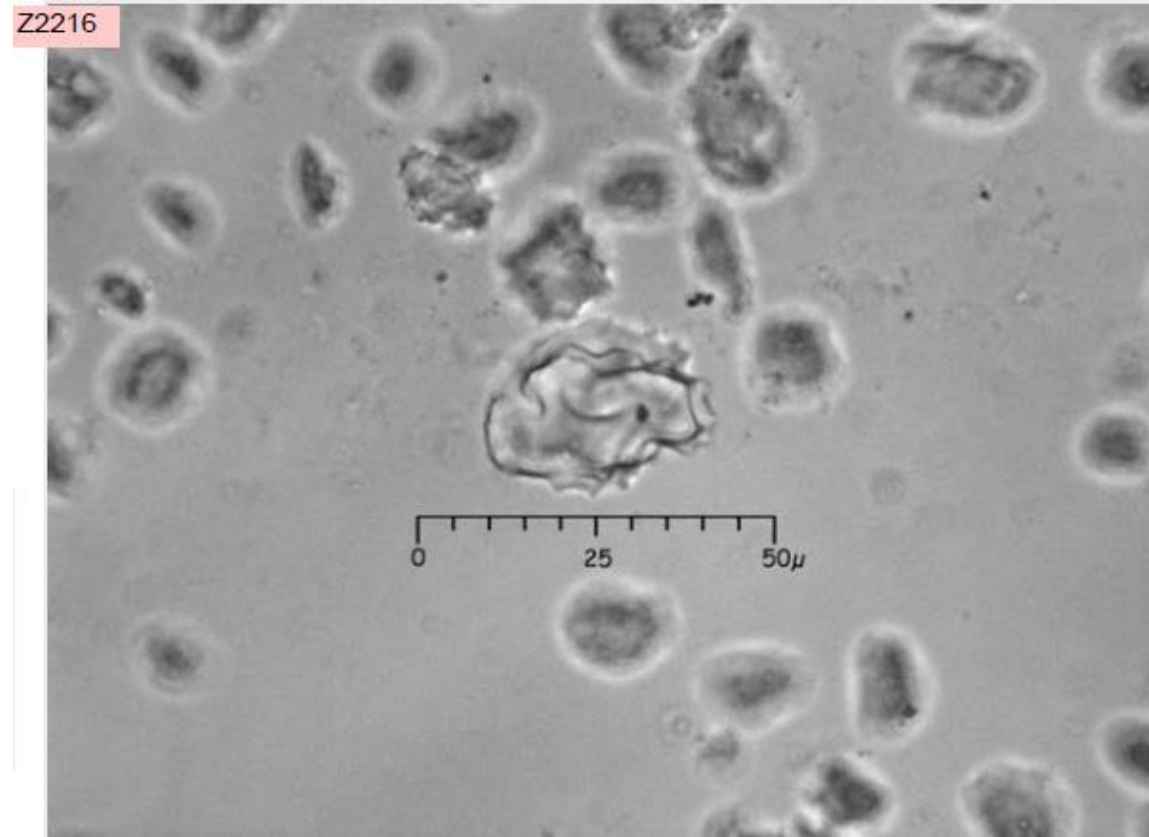
# Calathea lutea

## Phytolith

PC2594, floret

These are large examples of the type,  
VA

Diagnostic level: Calathea/Maranta



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

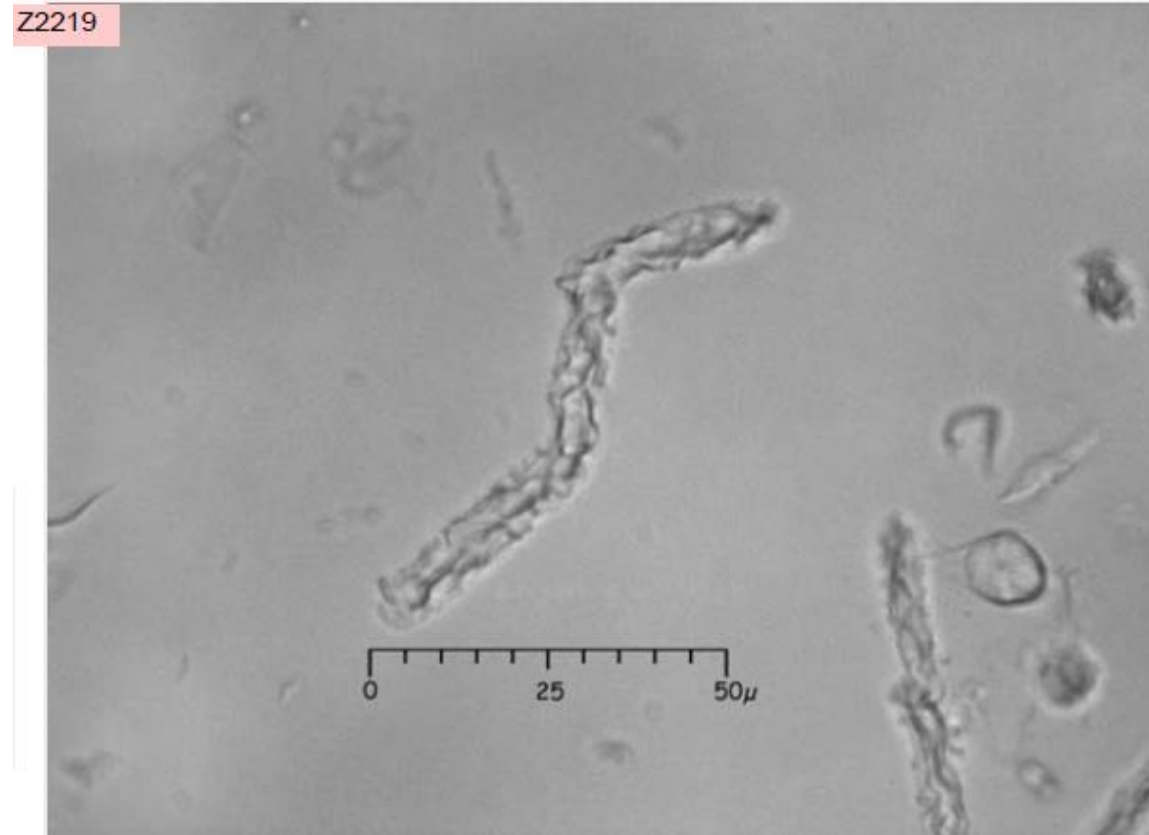
# Calathea lutea

## Phytolith

PC2595, leaf

This photo shows a string of the bodies

Diagnostic level: family

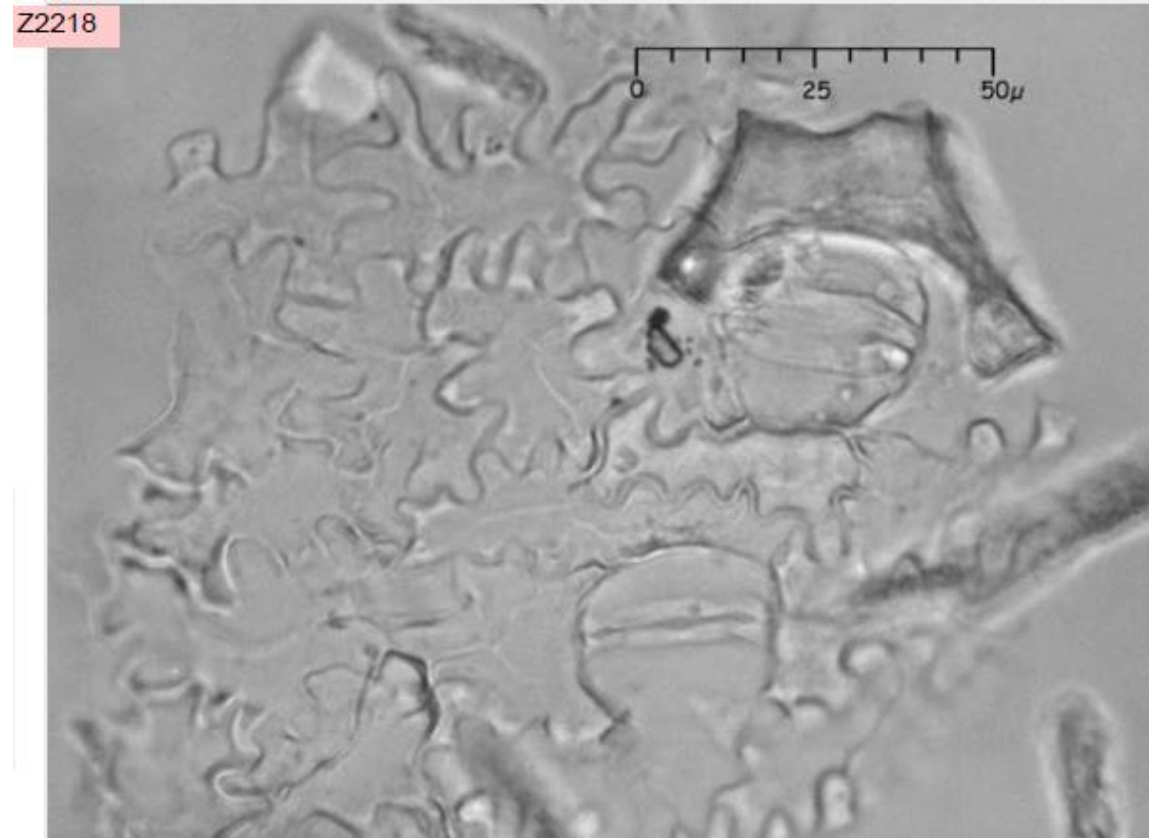


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea lutea

## Phytolith

PC2595, leaf, abundant  
Epidermis fragment showing anticlinal cells (20IA), stomata (120), and schlerids (110).  
Diagnostic level: not diagnostic

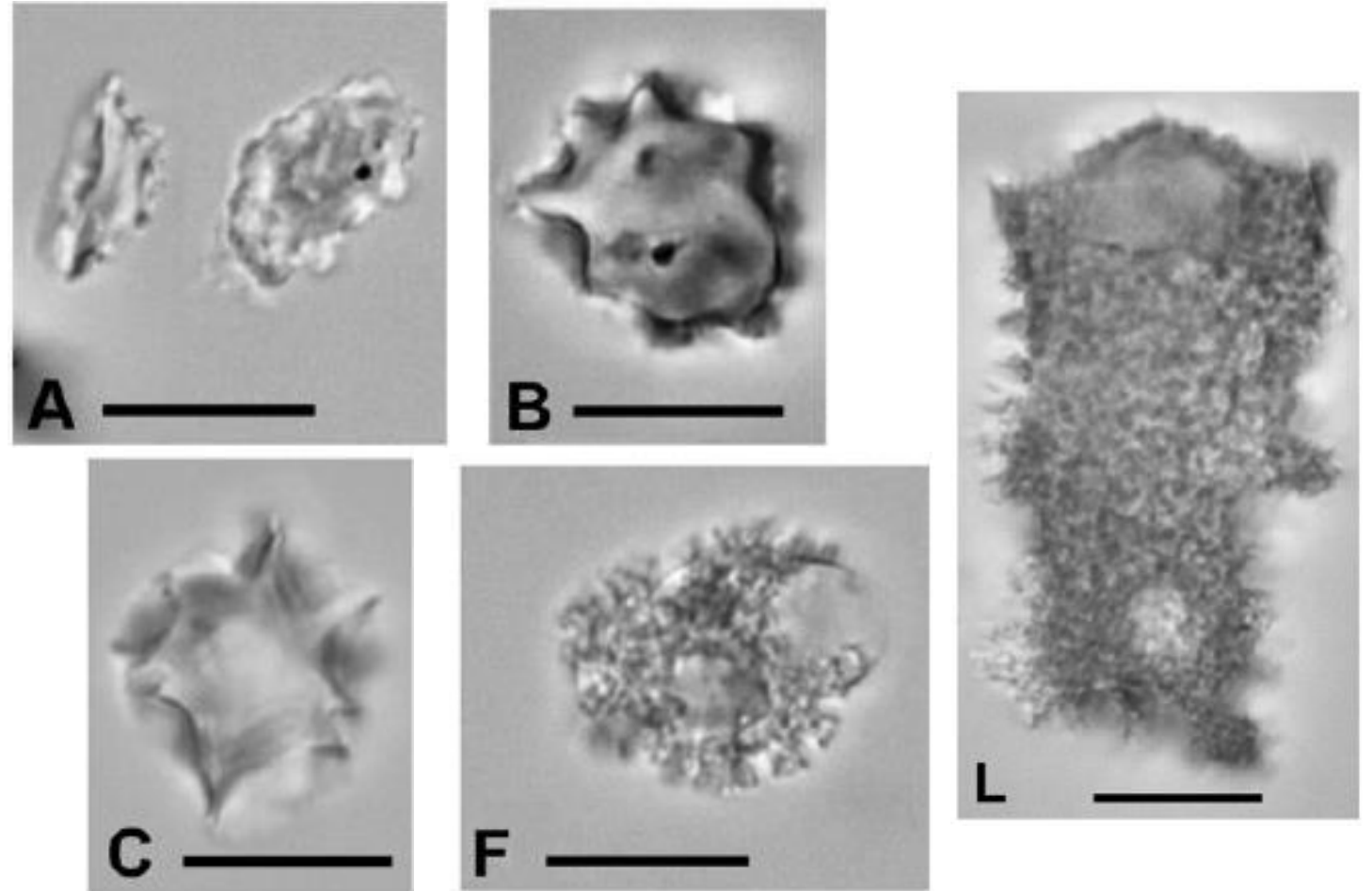


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea macrosepala

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). A, rugose hat-shapes from Calathea macrosepala leaf. B, subglobular-papillate from Calathea macrosepala leaf. C, D1 fringed druse from Calathea macrosepala stem. F, globular-densely granulate with non-centered concavity from Calathea macrosepala seed. L, cylindrical-densely granulate with non-centered concavity from Calathea macrosepala seed. Scale bars=12  $\mu$ m.



Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.



# Calathea macrosipalia

## Phytolith

Length is 27.5 microns leaf specimen  
Diagnostic level: family

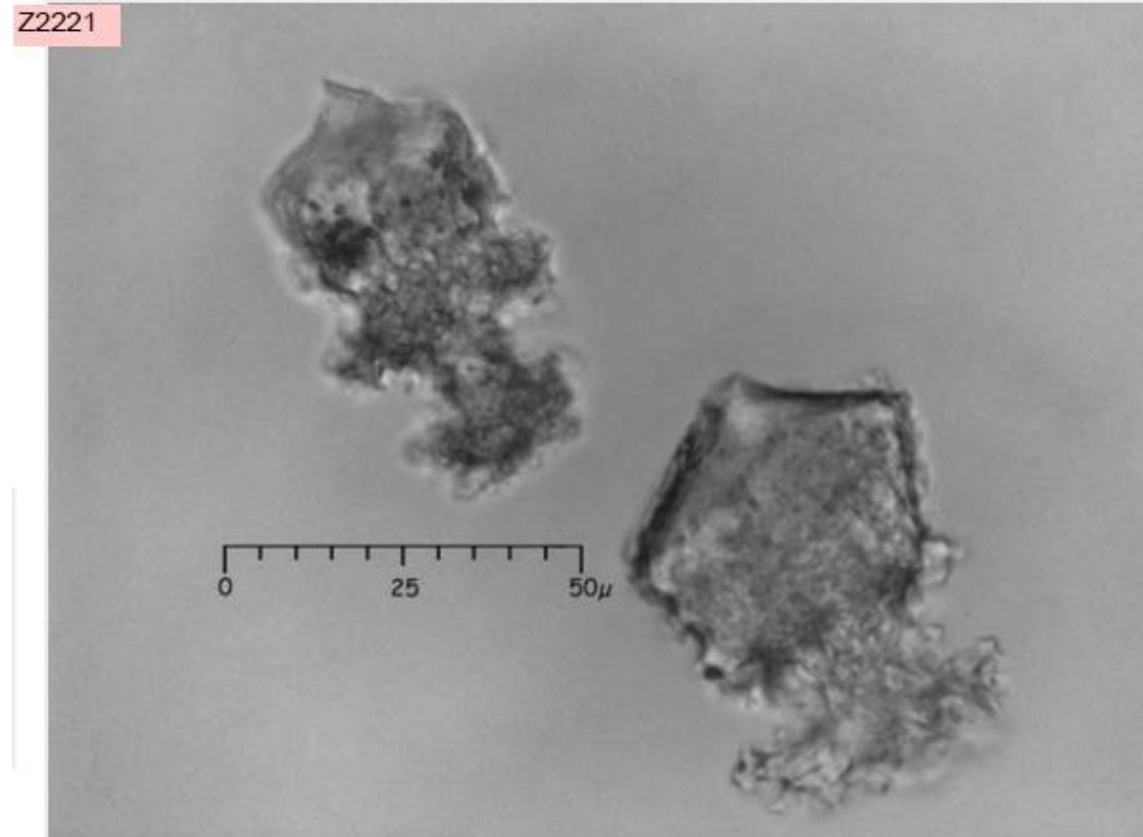


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea majestica

## Phytolith

PC1385a, fruit, very abundant seed body, still has distinct, curved stalk tip of *Calathea* spp., but cylinder is very short relative to width.  
note "corkscrew" axis of main body shaft. This appears to be a point where the bodies "break" resulting in Tip pieces and base pieces. Diagnostic level: genus

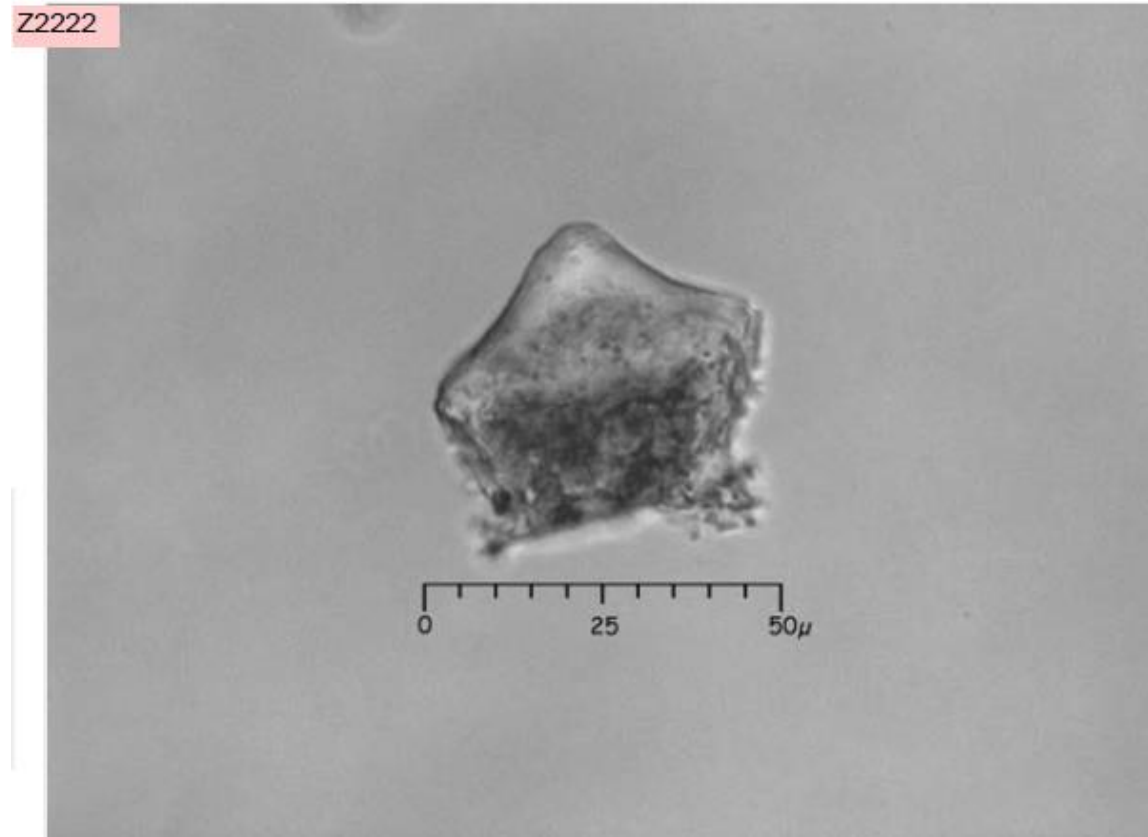


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea majestica

## Phytolith

PC1385a, fruit, very abundant seed body, still has distinct, curved stalk tip of *Calathea* spp., but cylinder is very short relative to width.  
note "corkscrew" axis of main body shaft. This appears to be a point where the bodies "break" resulting in Tip pieces and base pieces. Diagnostic level: genus

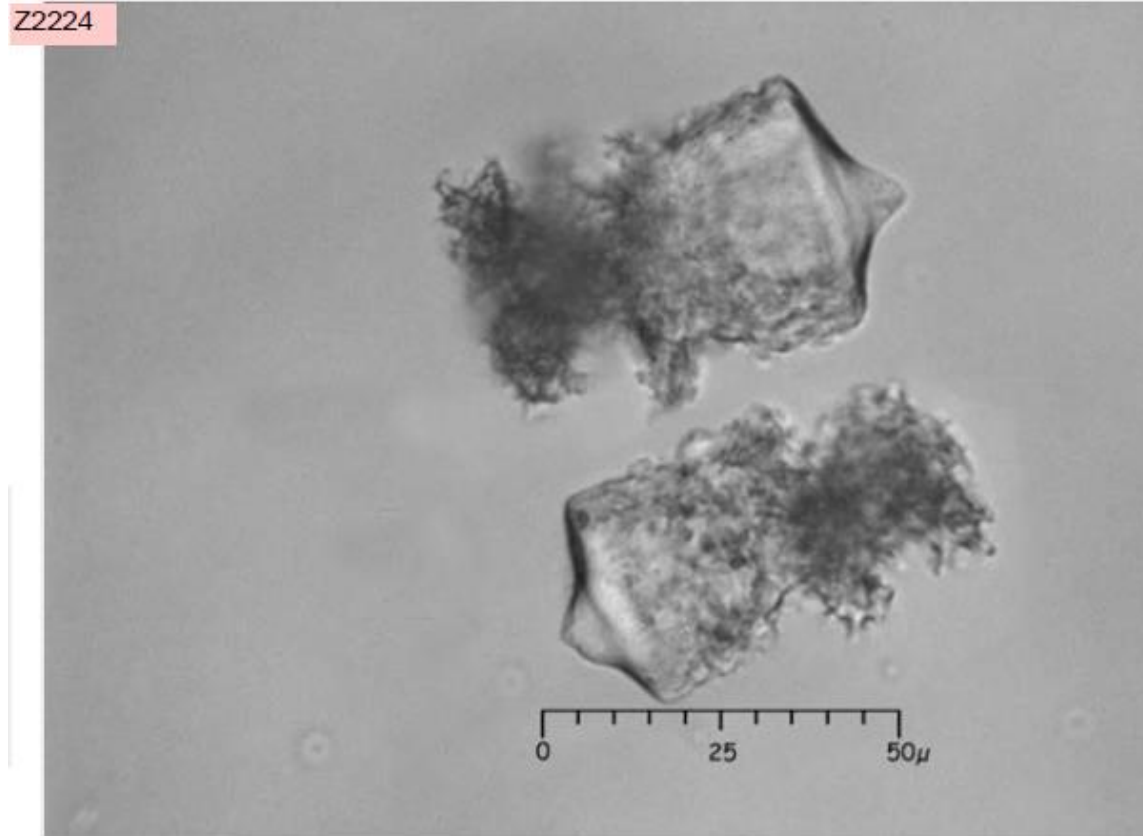


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea majestica

## Phytolith

PC1385a, fruit, very abundant seed body, still has distinct, curved stalk tip of *Calathea* spp., but cylinder is very short relative to width.  
note "corkscrew" axis of main body shaft. This appears to be a point where the bodies "break" resulting in Tip pieces and base pieces. Diagnostic level: genus



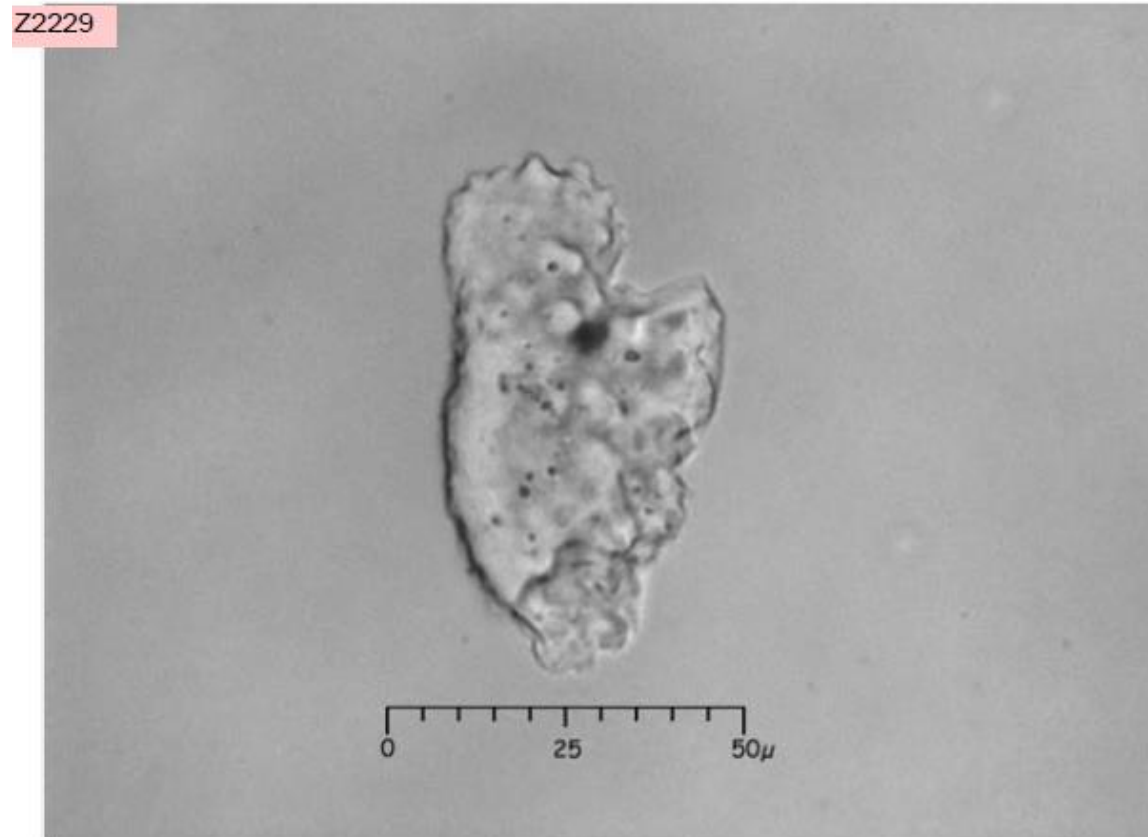
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea majestica

## Phytolith

PC1385a fruit

Diagnostic level: under study

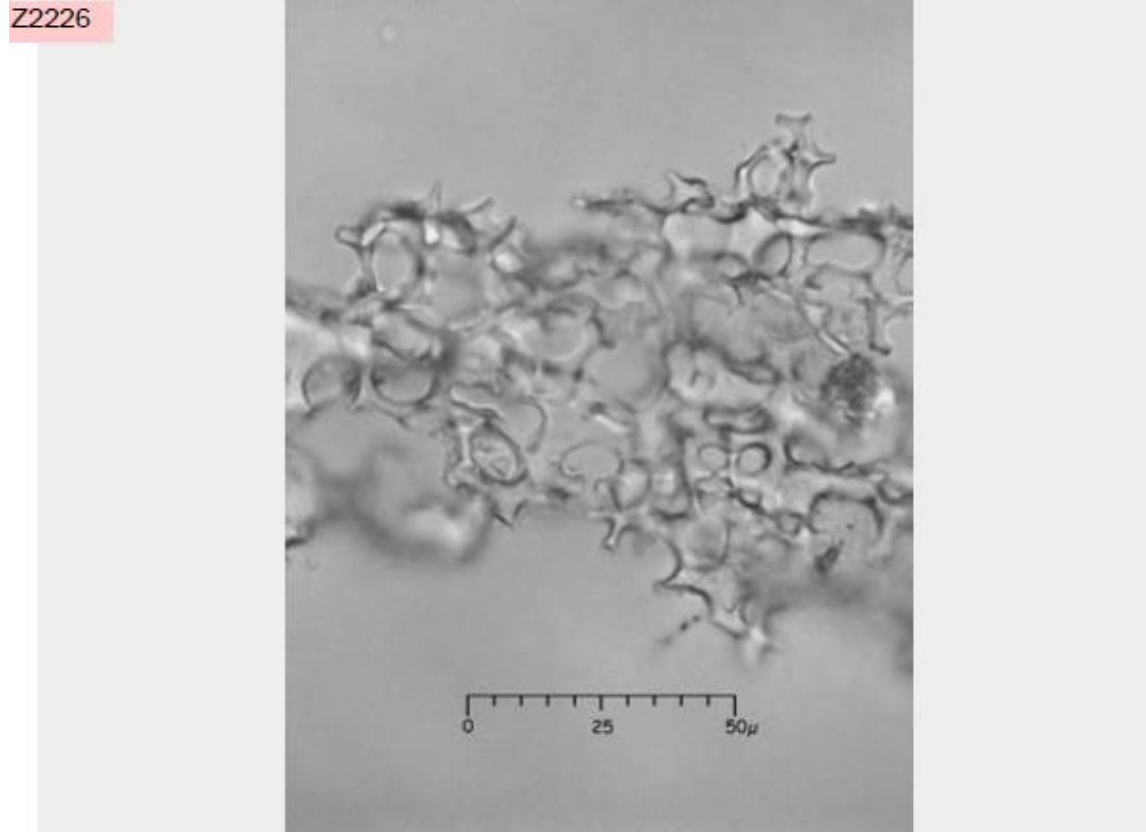


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea majestica

## Phytolith

PC1385 fruit, rare. Also observed in  
Donax, Maranta specimens  
Diagnostic level: under study

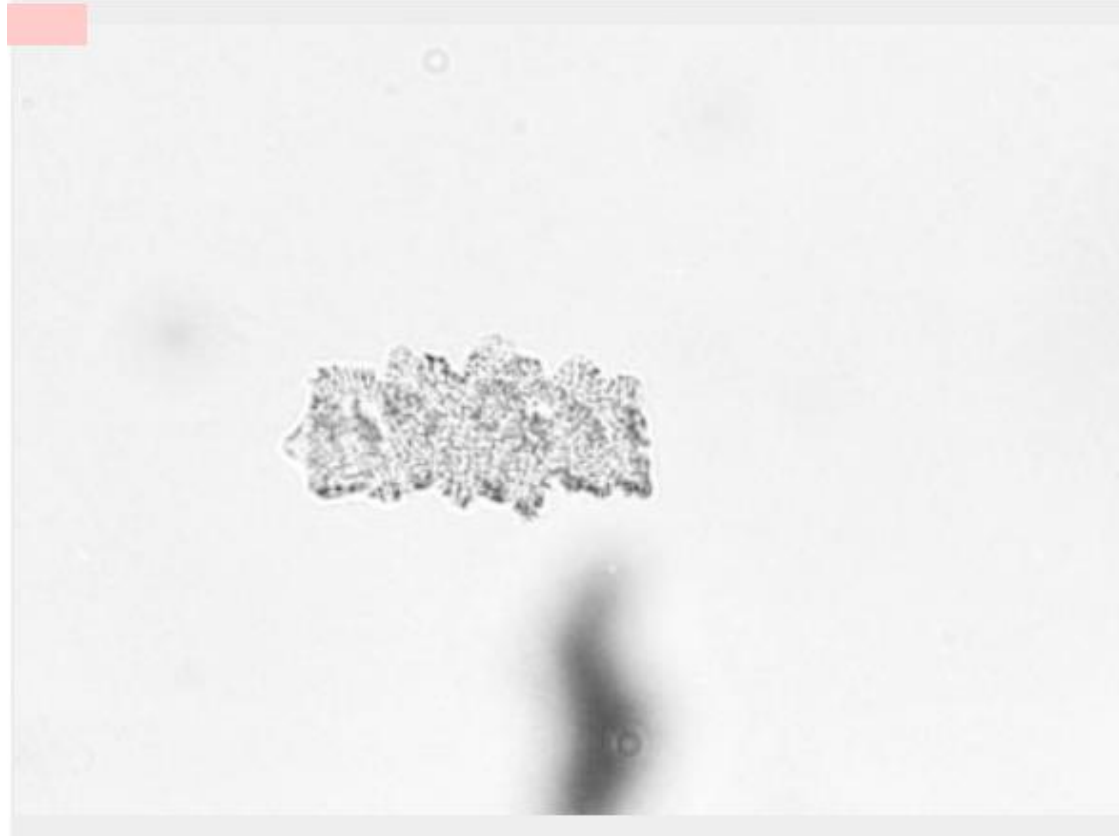


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea marantina

## Phytolith

Wild Marantaceae seed body.  
Diagnostic level: family, wild taxa



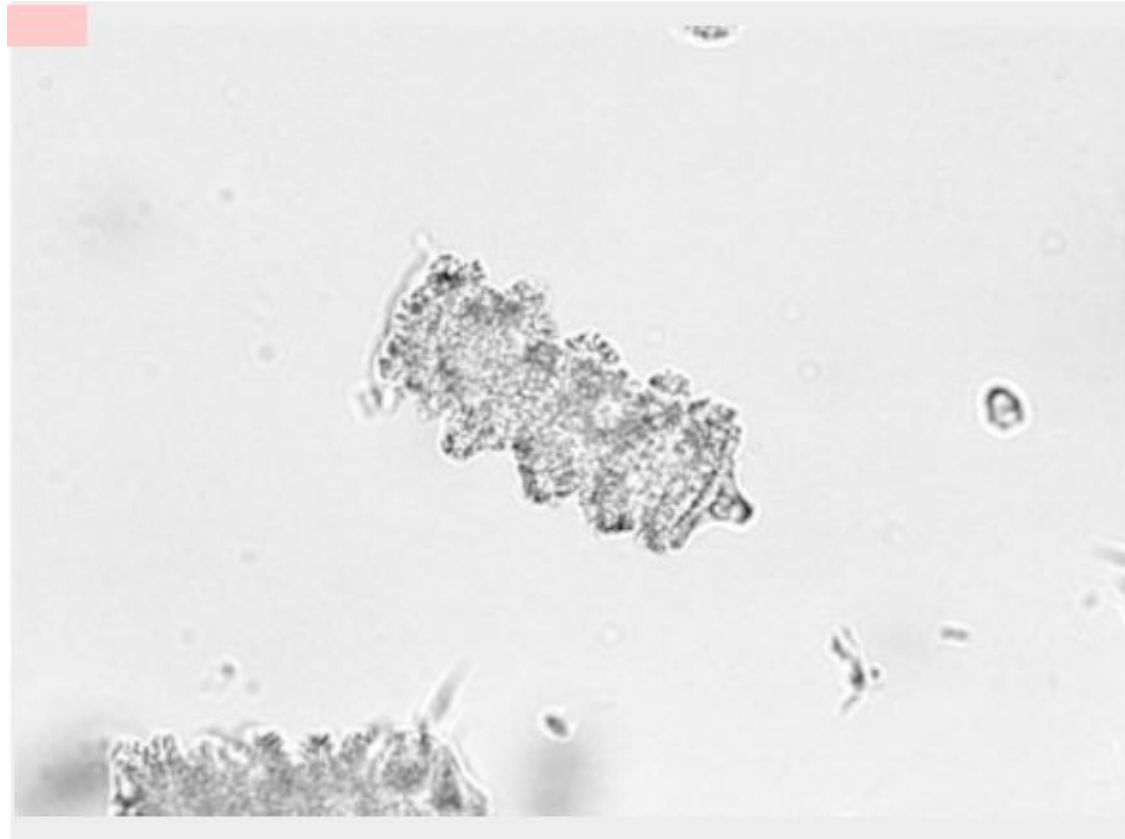
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea marantina

## Phytolith

seed body

Diagnostic level: family, wild taxa



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Calathea marantina

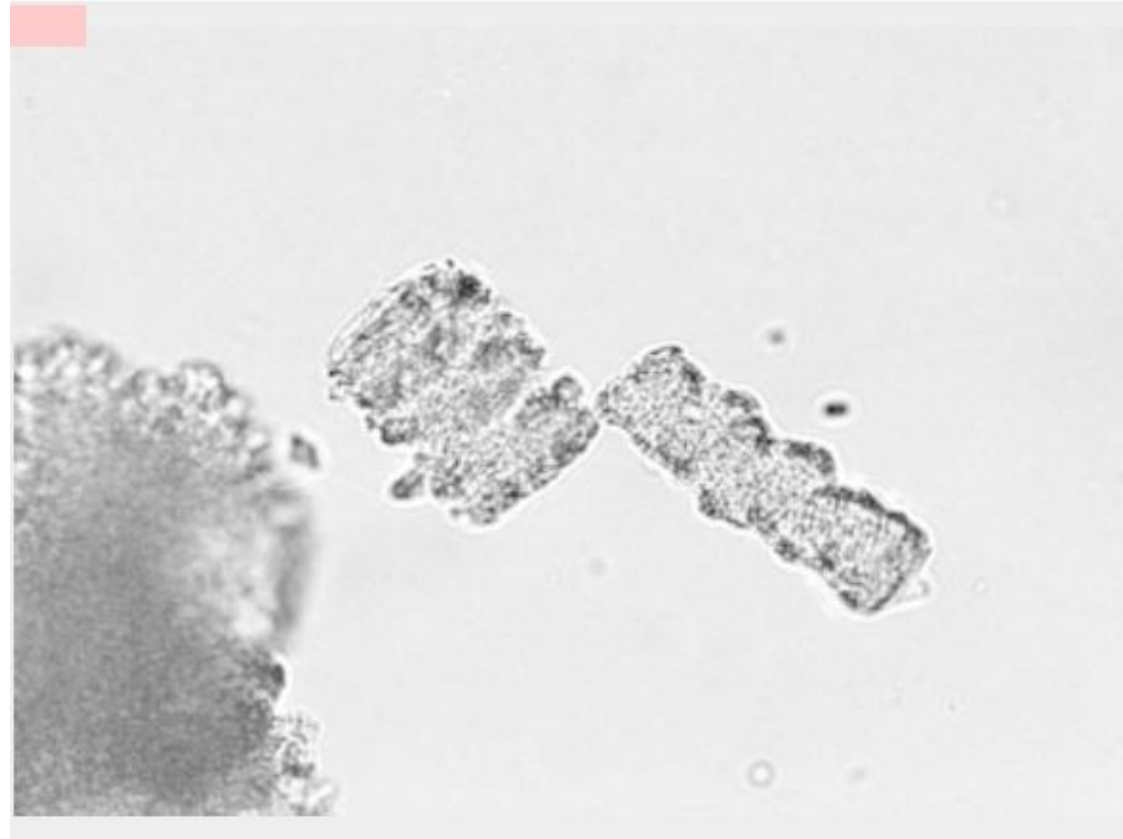
## Phytolith

seed body.

Note variation in width of cylinder, Stalk on tip of body on left is very small, reduced.

Stalk is missing on body on the left.

Diagnostic level: family, not Maranta

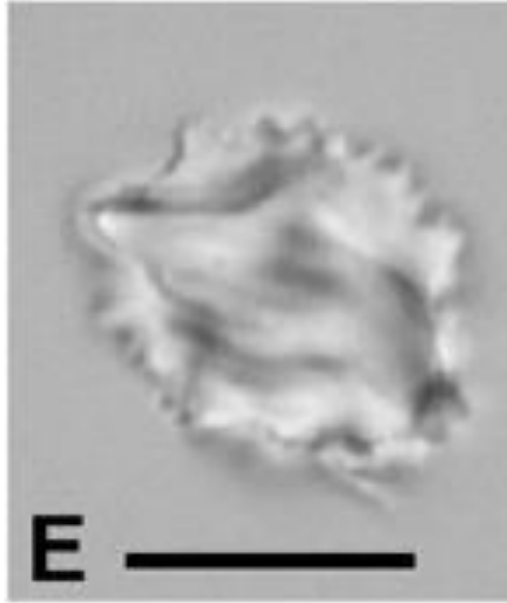


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Calathea micans

## Phytolith

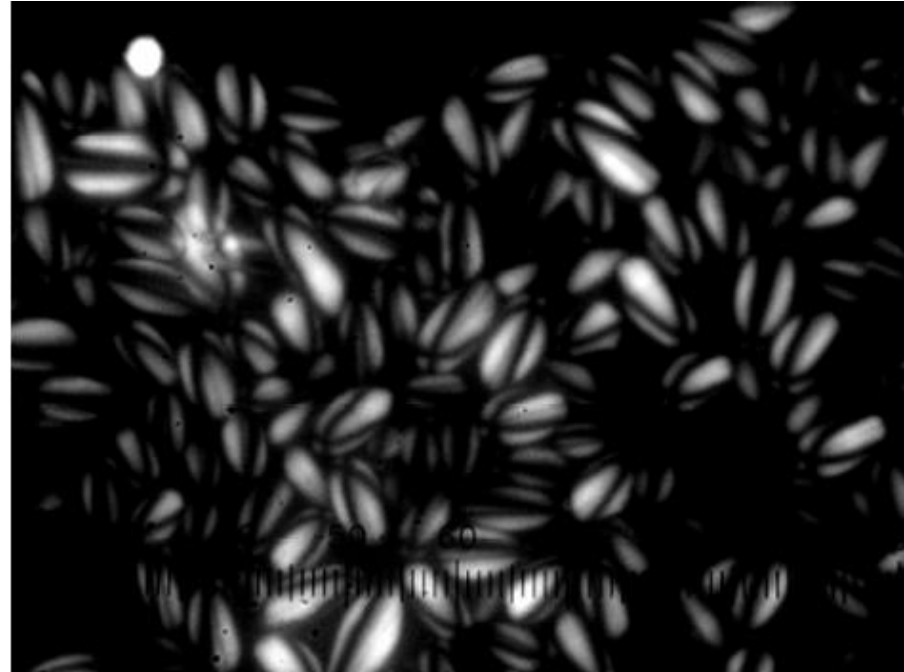
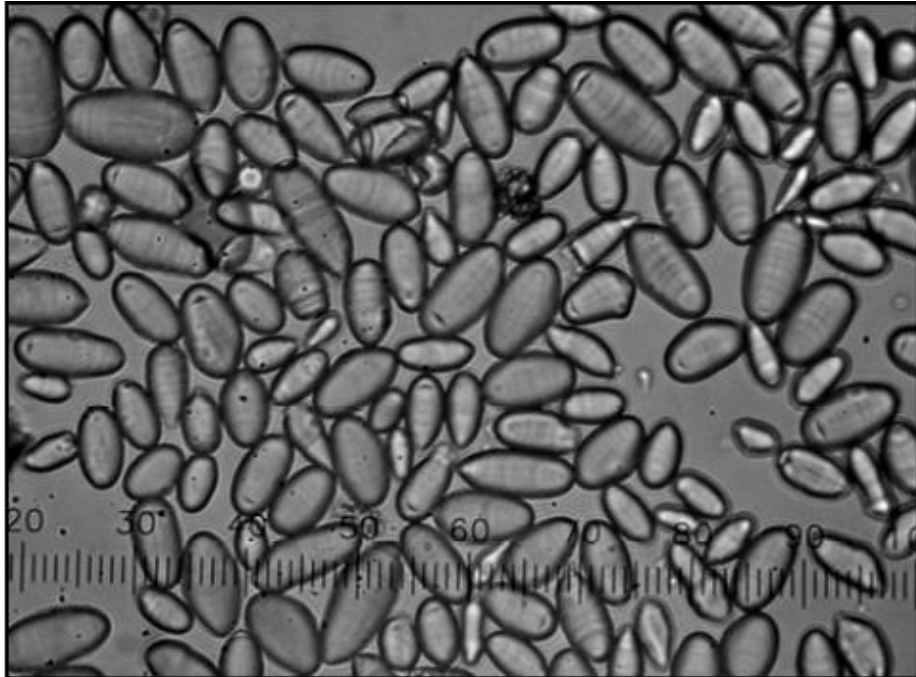
Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). E, globular-rugulate from *Calathea micans* rhizome+root. Scale bars=12  $\mu\text{m}$ .



Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Calathea veitchiana

## Starch

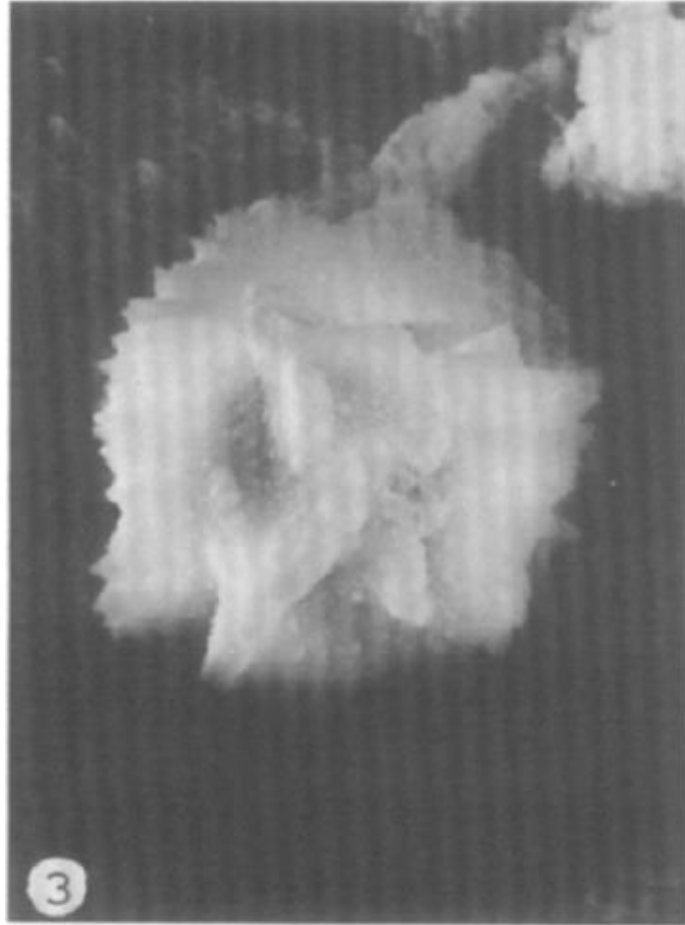


Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Calathea violacea

## Phytolith

SEM photograph of a phytolith with an irregularly angled or folded surface from *Calathea violacea* (4000x).

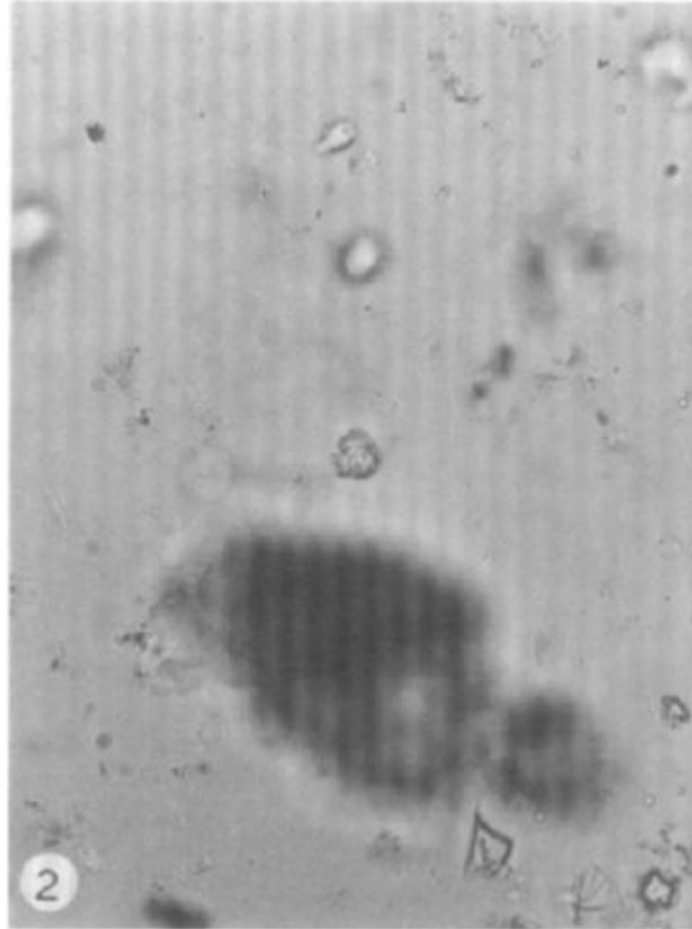


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Calathea violacea

## Phytolith

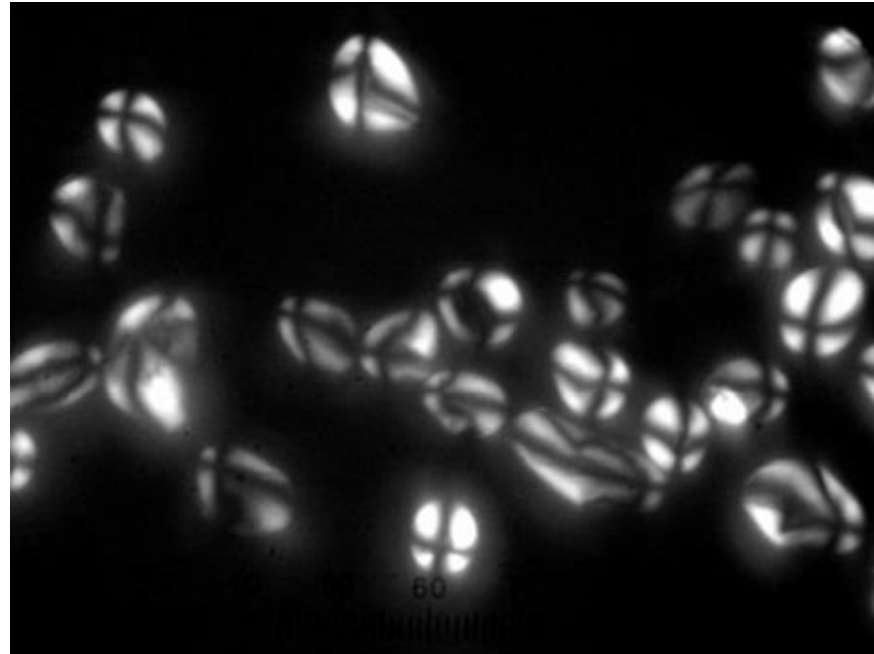
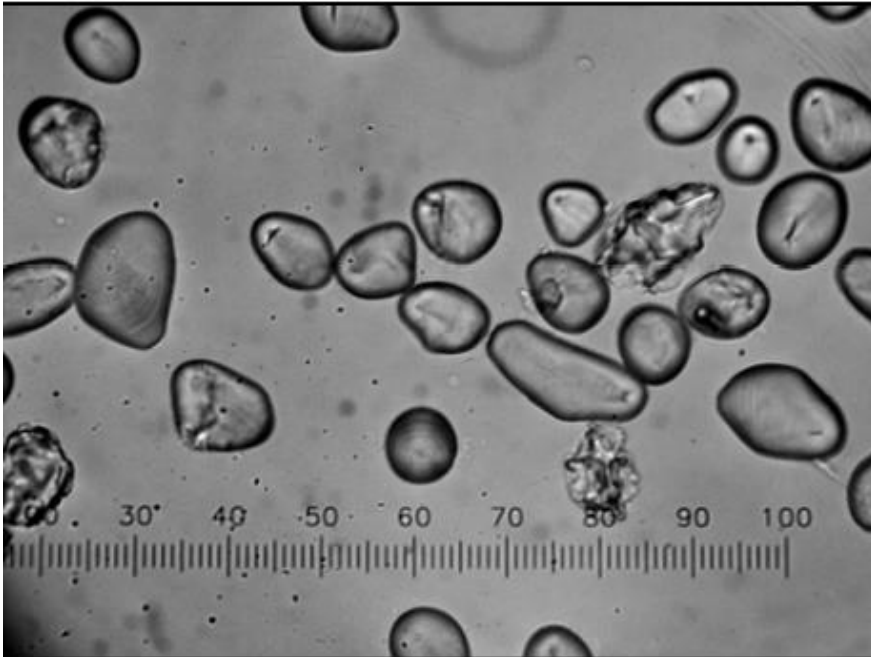
2. Center, a hat-shaped nodular silica body from *Calathea violacea* (400 x ).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Calathea zebrina

## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Calathea zebrina

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). D, elongate D1 fringed druse from *Calathea zebrina* rhizome. Scale bars=12  $\mu\text{m}$ .



Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Calathea sp.

## Starch



A cf. *Calathea* starch grain from La Mula. 160x. The grain measures 50 microns by 16 microns.

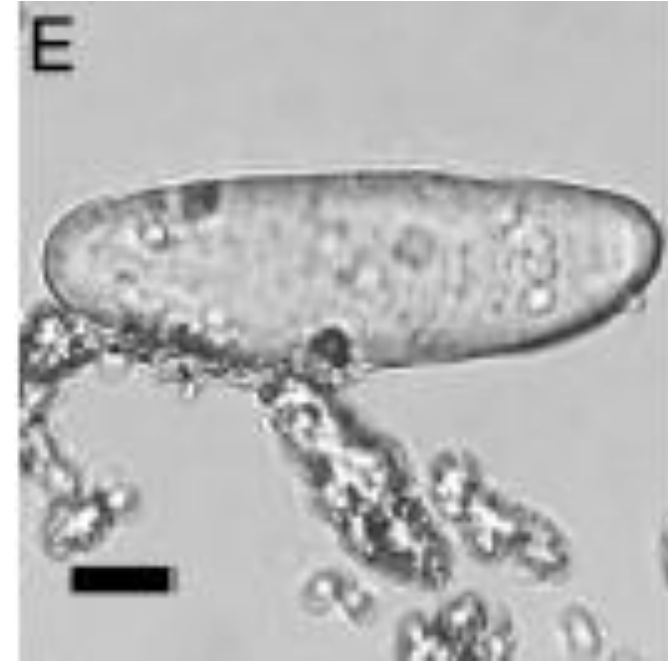
Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.



# Calathea sp.

## Starch

Fig. 2. Selected archaeological starch grains. (E) *Calathea* sp. starch from Casita de Piedra, edge-battered cobble 69/2, ?3600 cal BP. (Scale bar: 10  $\mu$ m.) Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8.

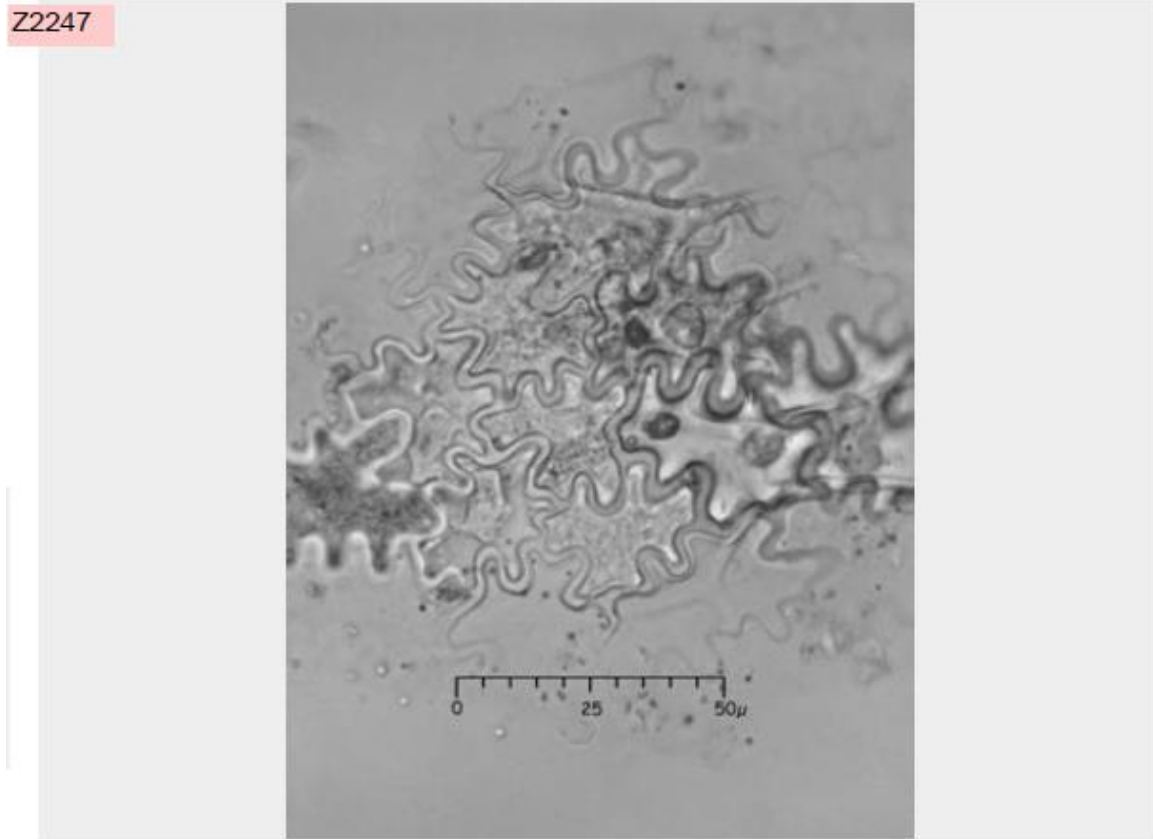


Dickau, Ruth, Anthony J. Ranere, and Richard G. Cooke. 2007. Starch Grain Evidence for the Preceramic Dispersals of Maize and Root Crops into Tropical Dry and Humid Forests of Panama. *Proceedings of the National Academy of Sciences of the United States of America* 104 (9):3651–56.

# Donax sp.

## Phytolith

PC1387, leaf, common  
Epidermis fragment showing anticlinal  
cells  
Diagnostic level: not diagnostic

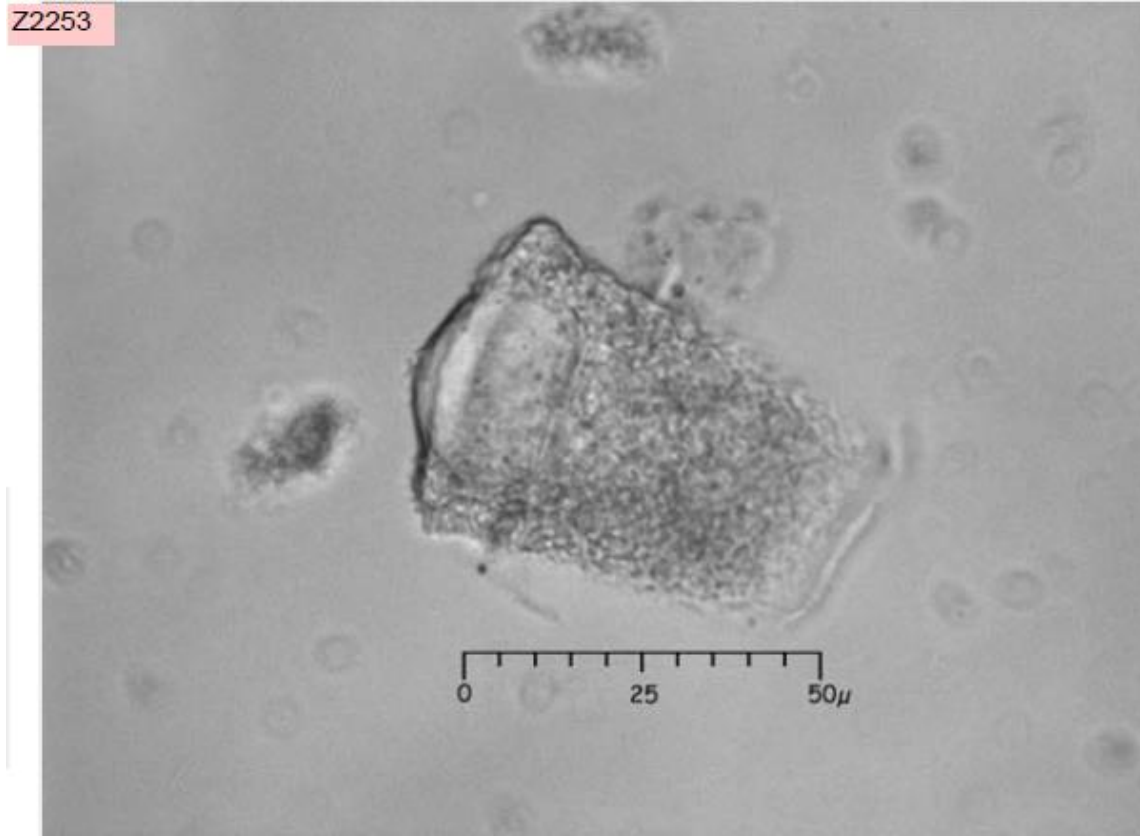


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax sp.

## Phytolith

PC1388 fruit, very abundant Diagnostic  
level: Donax

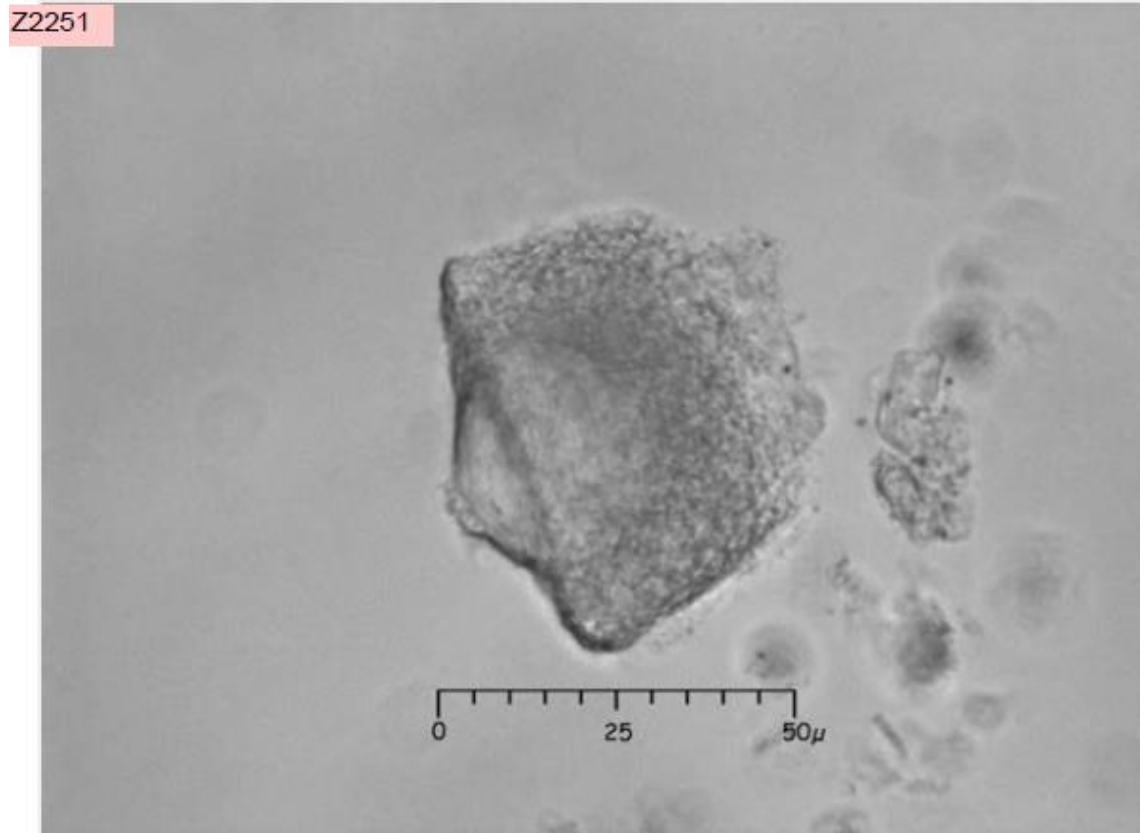


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax sp.

## Phytolith

PC1388 fruit, very abundant Diagnostic  
level: Donax

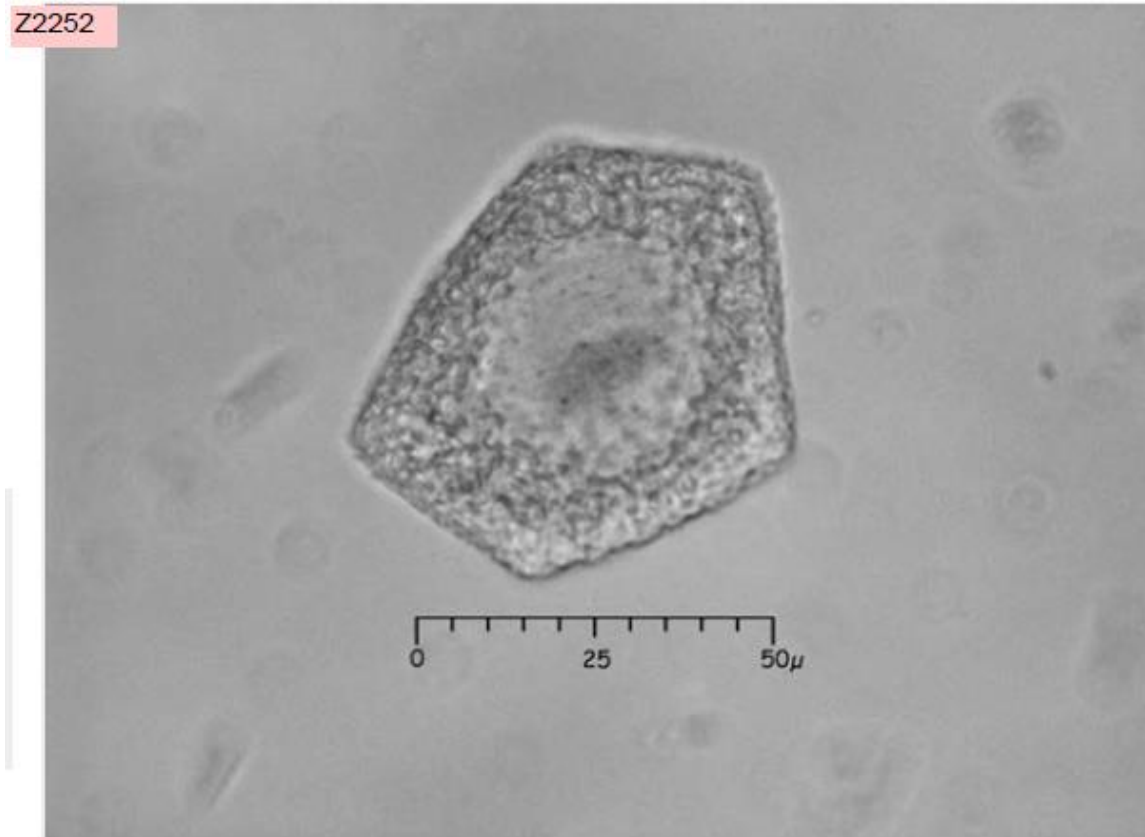


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax sp.

## Phytolith

PC1388 fruit, very abundant Diagnostic level: Donax  
This image shows the base of the head, within the cylinder (from beneath)

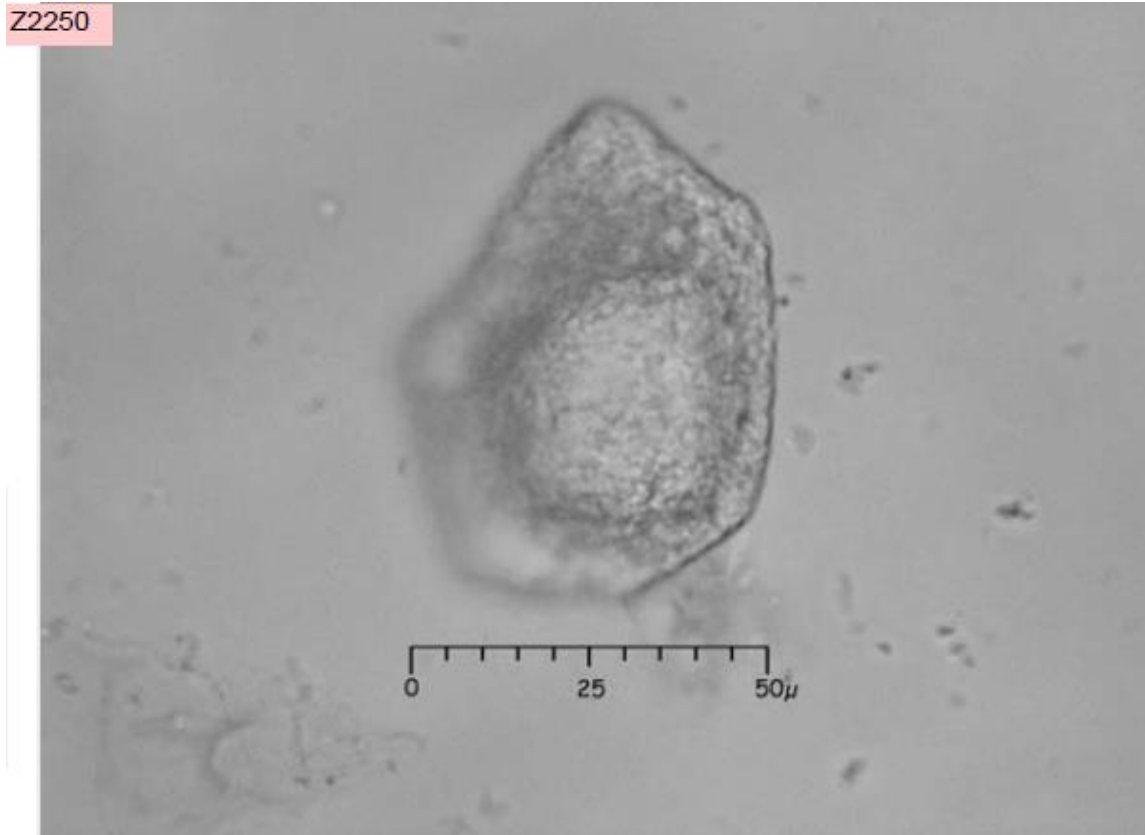


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax sp.

## Phytolith

PC1388 fruit, very abundant Diagnostic level: Donax  
This image shows the top of the head, extending out from the cylinder

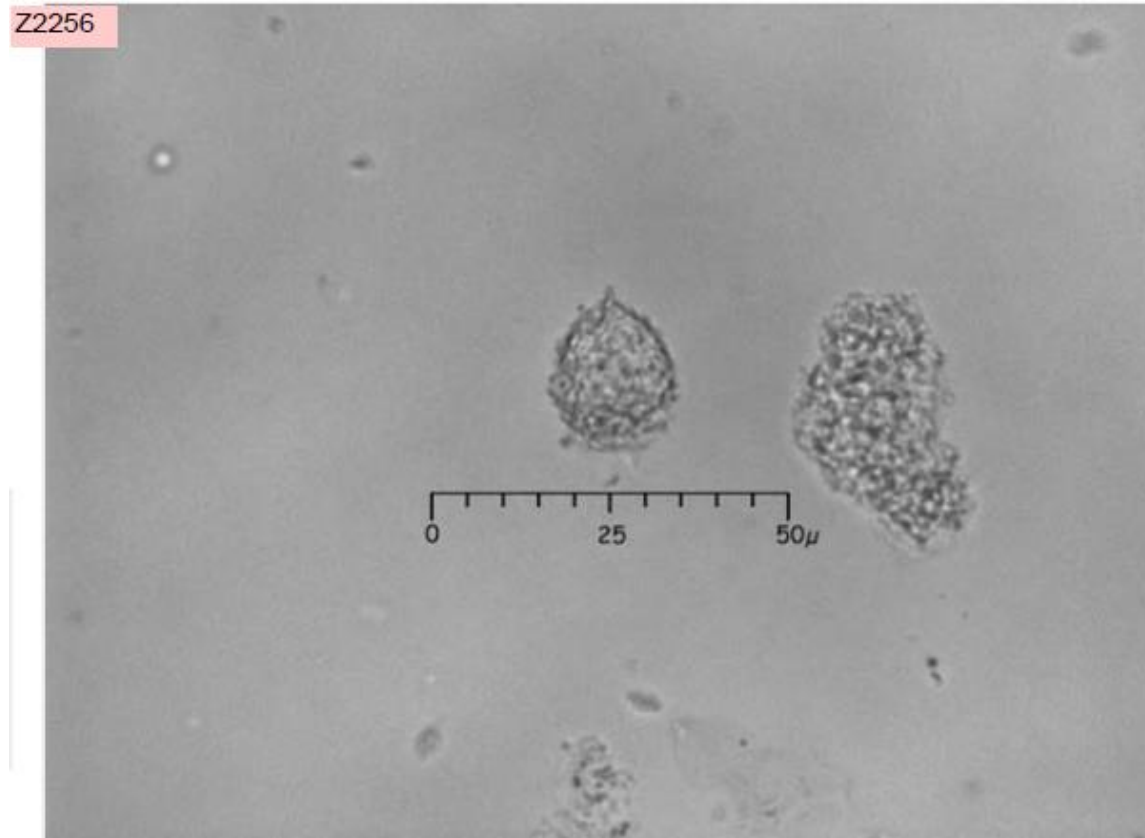


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax sp.

## Phytolith

PC1388 fruit Moderate  
Diagnostic level under study

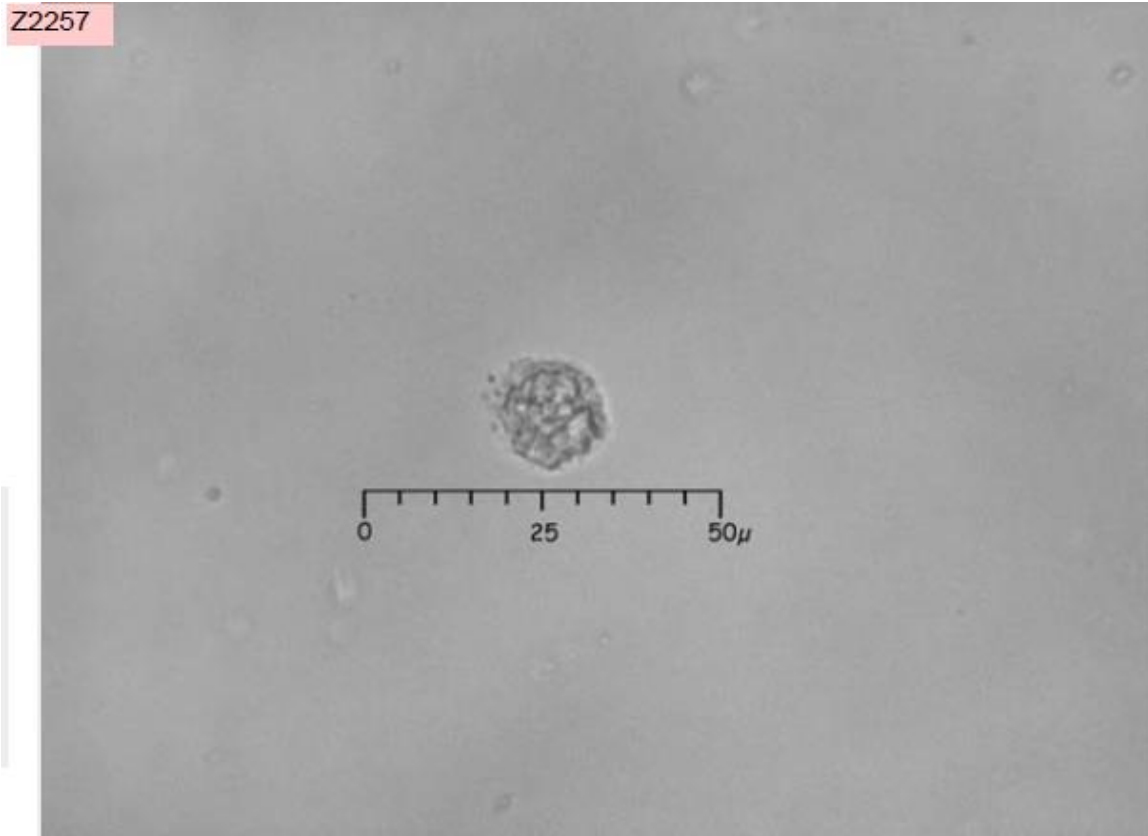


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax sp.

## Phytolith

PC1388 fruit Moderate  
Diagnostic level under study



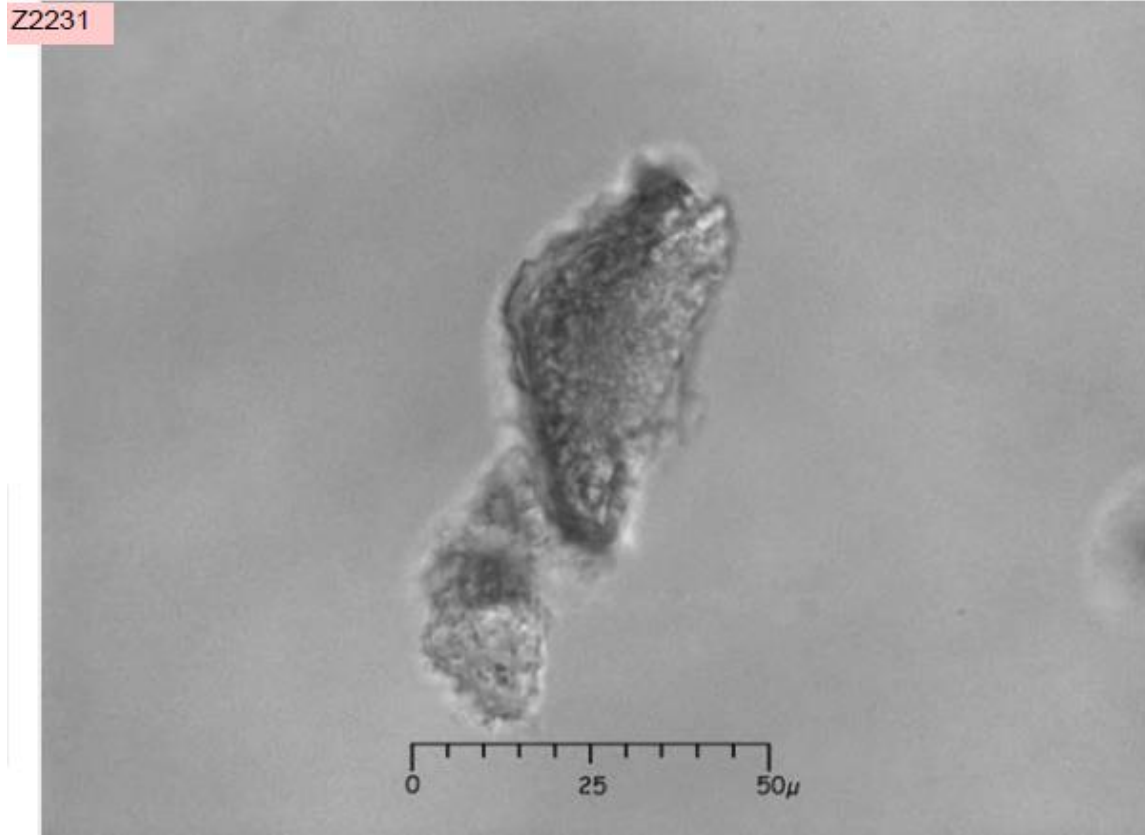
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Donax arundastrum

## Phytolith

PC280, inflorescence  
Can look like a very large conical body  
Diagnostic to genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax arundastrum

## Phytolith

PC280 inflorescence Type first defined in *Costus*.

Side view of conical form. Sometimes the projections break off, leaving flat rugulose/nodular bodies

Diagnostic level: under study

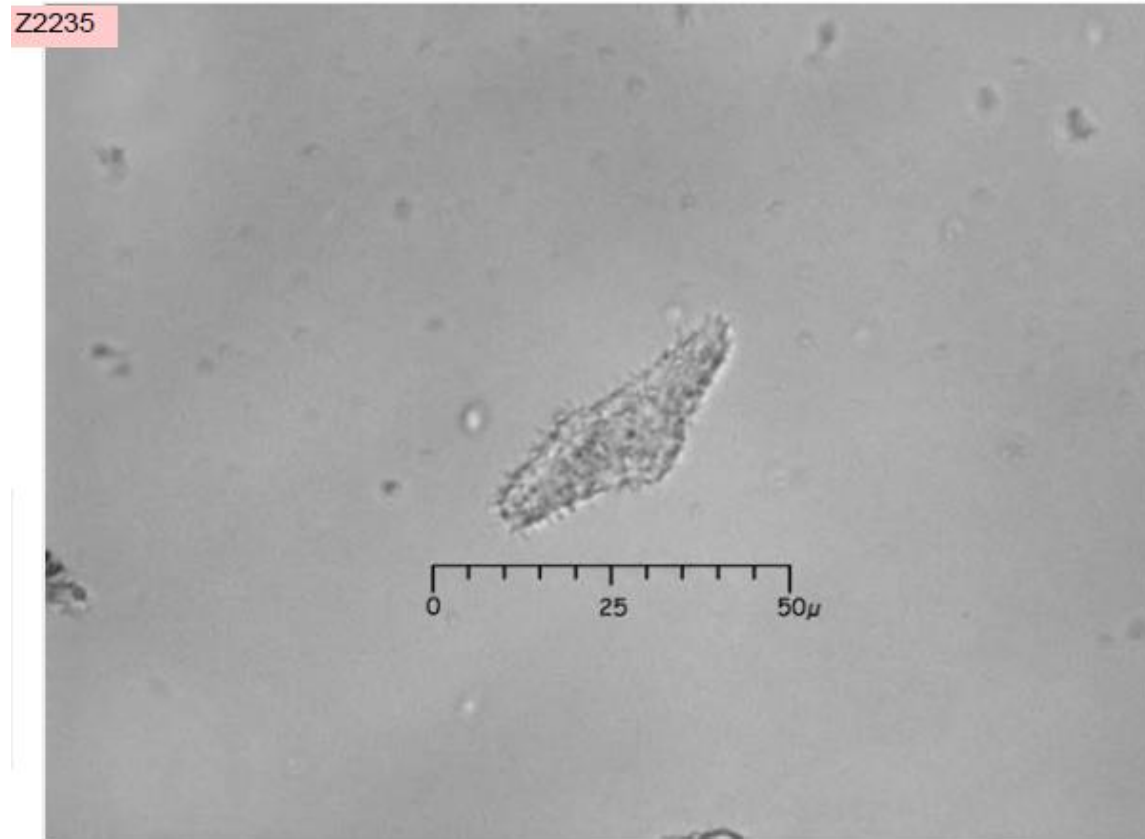


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax arundastrum

## Phytolith

PC280 inflorescence, common  
Diagnostic level: under study

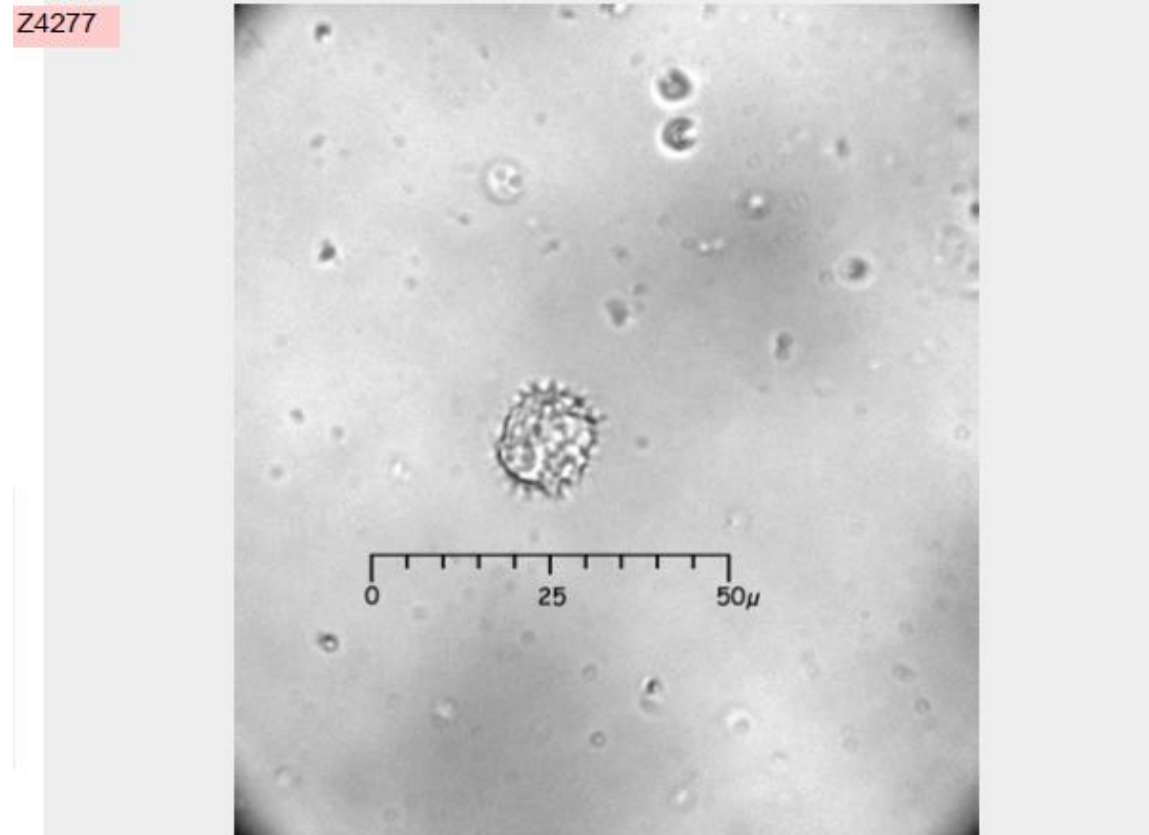


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax arundastrum

## Phytolith

PC280 inflorescence  
Diagnostic level under study

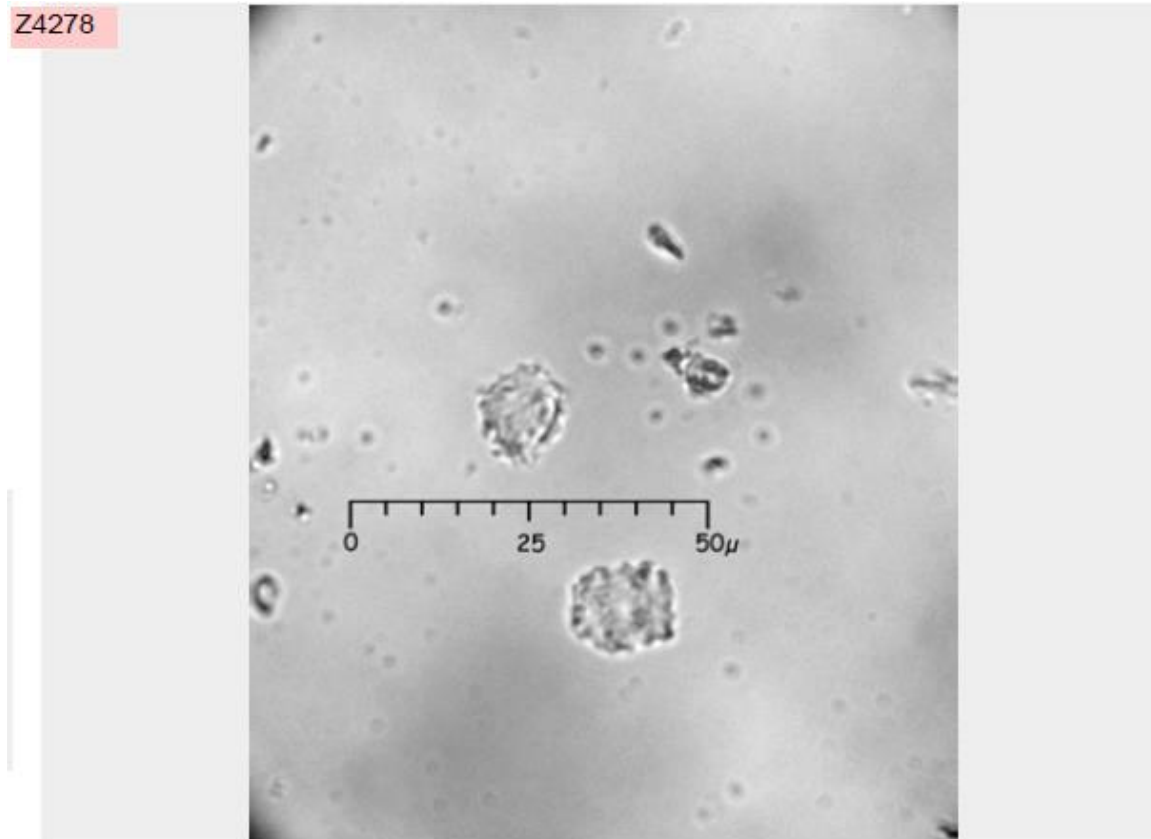


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax arundastrum

## Phytolith

PC280 inflorescence Diagnostic level  
under study  
Body below scale bar is conical (80IIIB)  
viewed from top

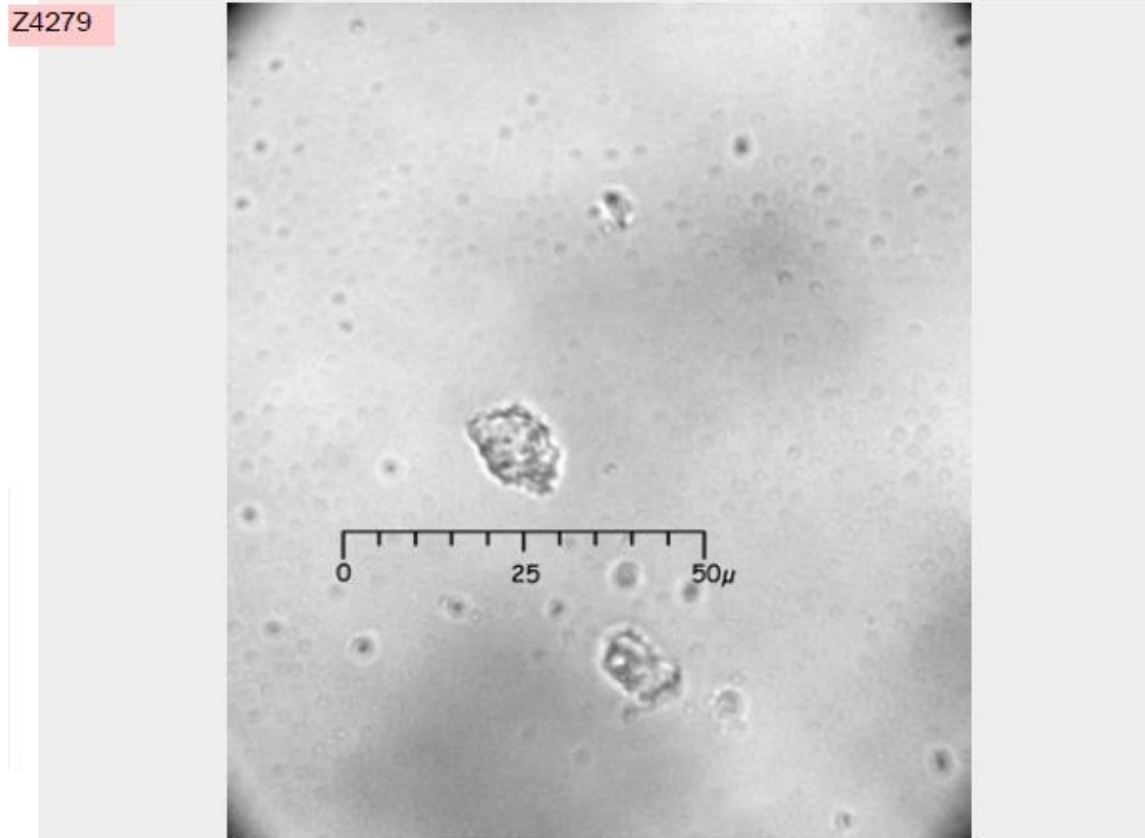


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax arundastrum

## Phytolith

PC280 inflorescence  
Diagnostic level under study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

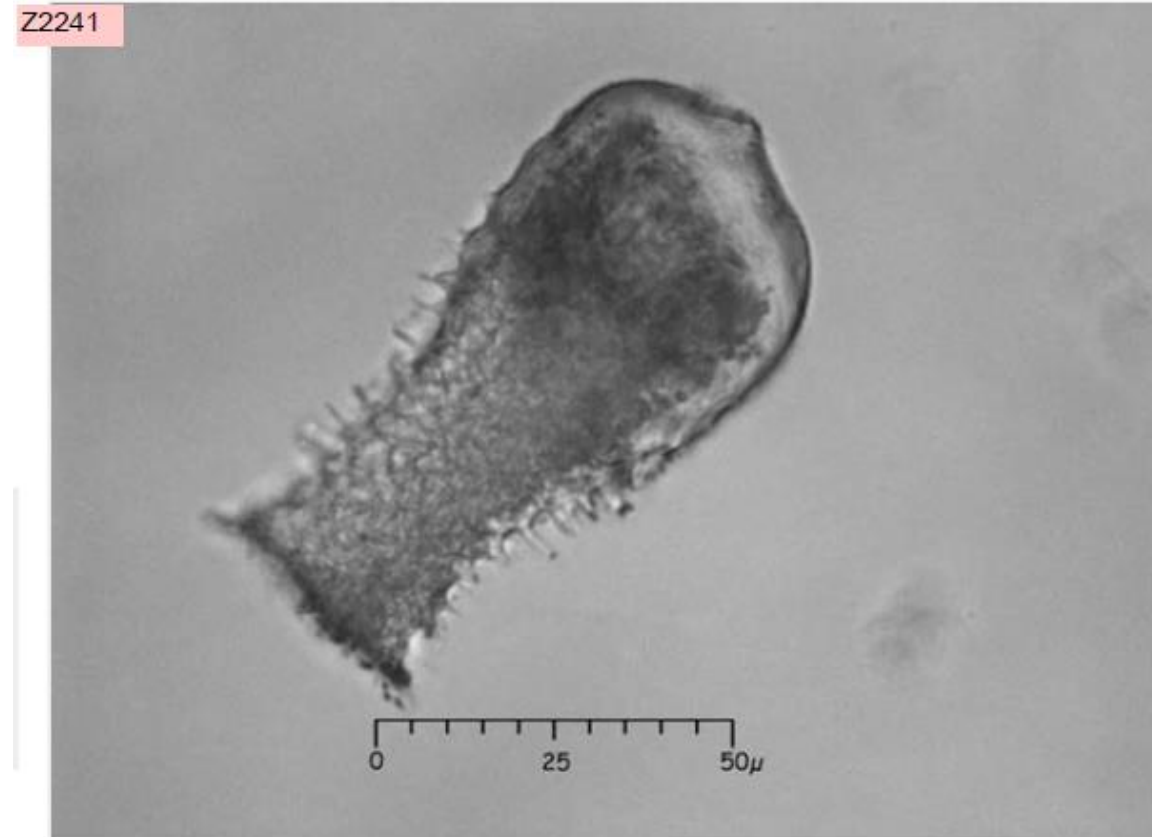
# Donax arundastrum

## Phytolith

PC280, inflorescence

Note variation in size, shown in following records.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

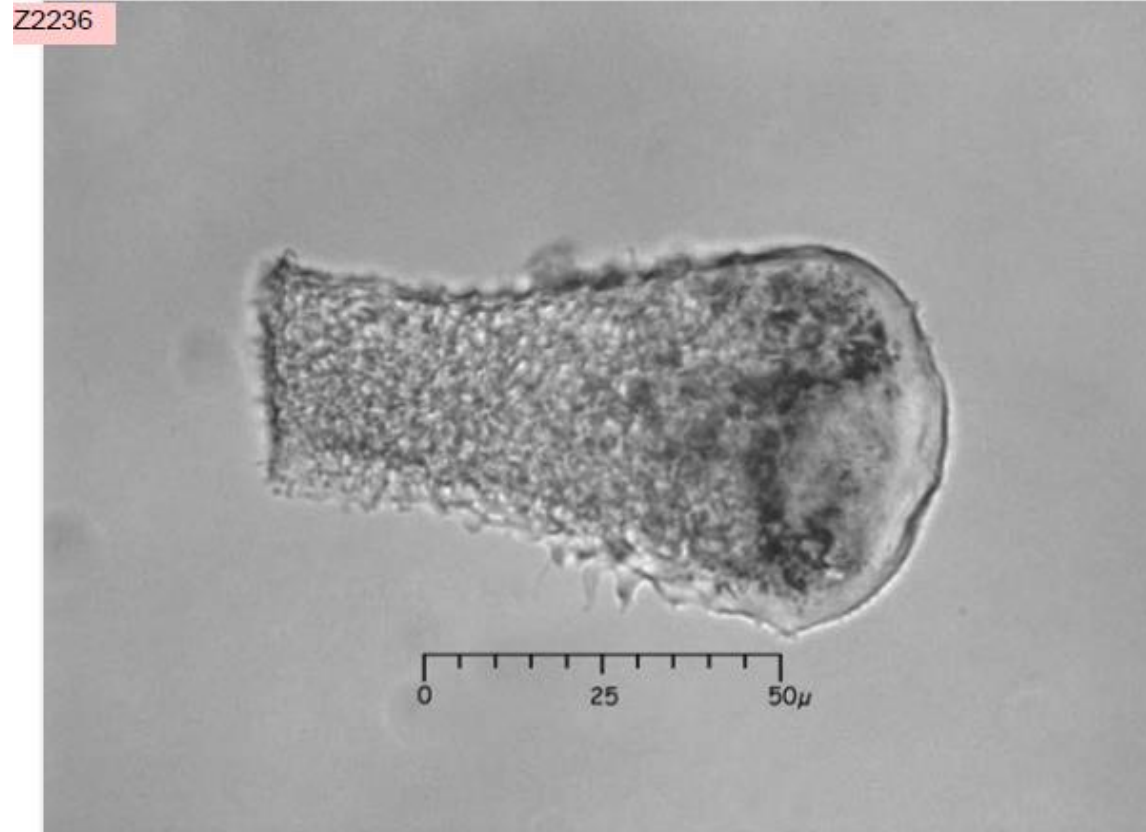
# Donax arundastrum

## Phytolith

PC280, inflorescence

Note variation in size, shown in following records.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



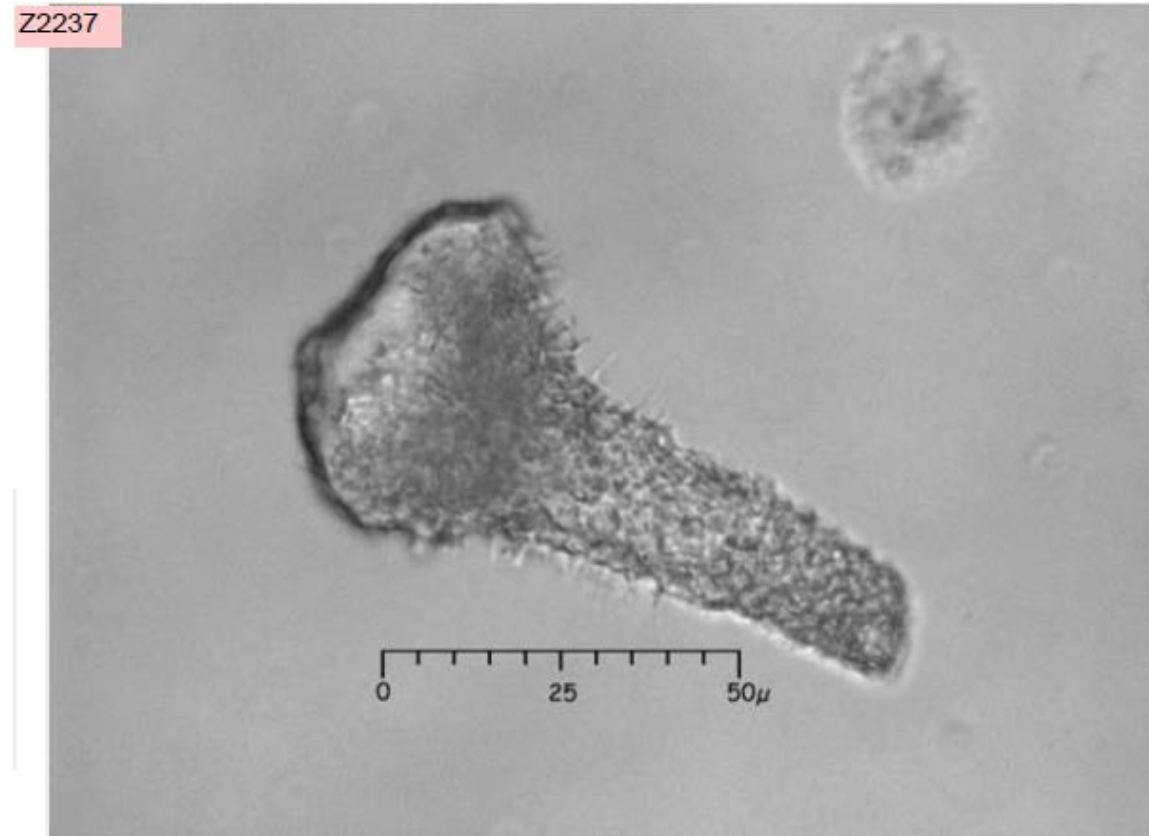
# Donax arundastrum

## Phytolith

PC280, inflorescence

Note variation in size, shown in following records.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

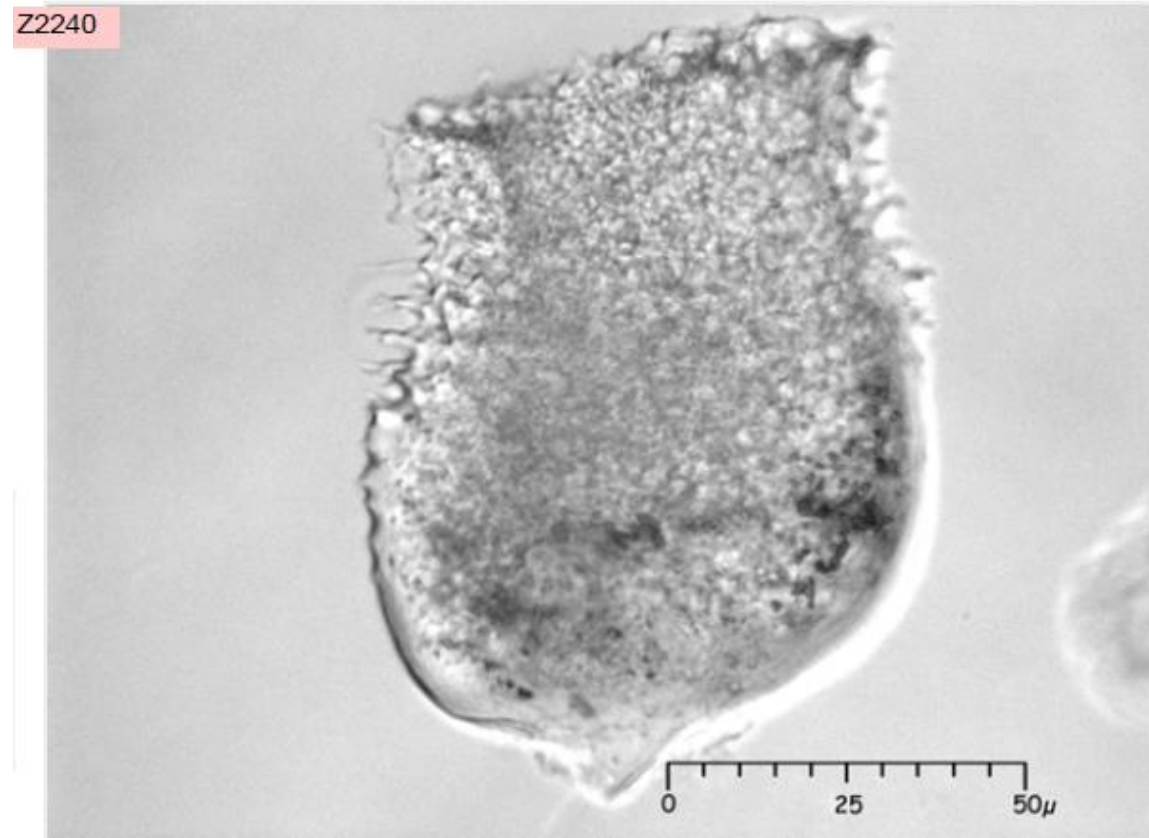
# Donax arundastrum

## Phytolith

PC280, inflorescence

Note variation in size, shown in following records.

Diagnostic level: genus

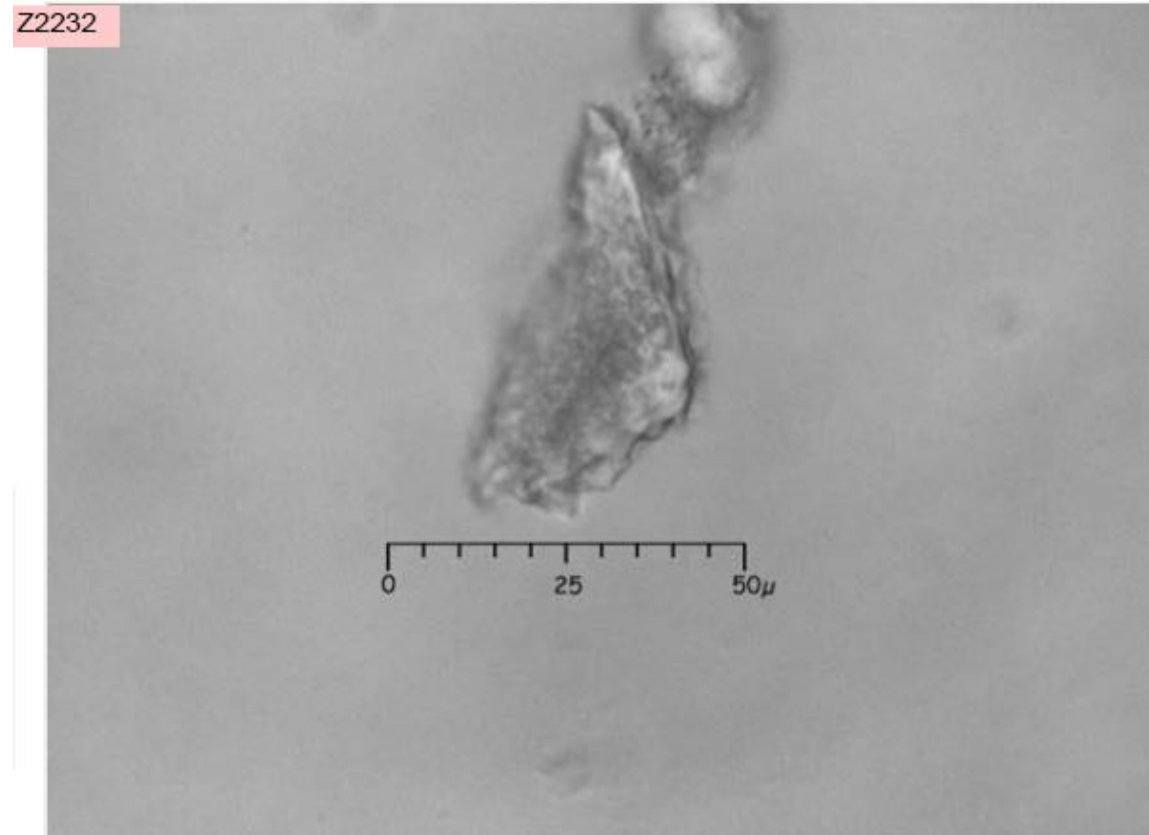


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax arundastrum

## Phytolith

PC280, inflorescence  
May look like a large conical body  
Diagnostic level: genus



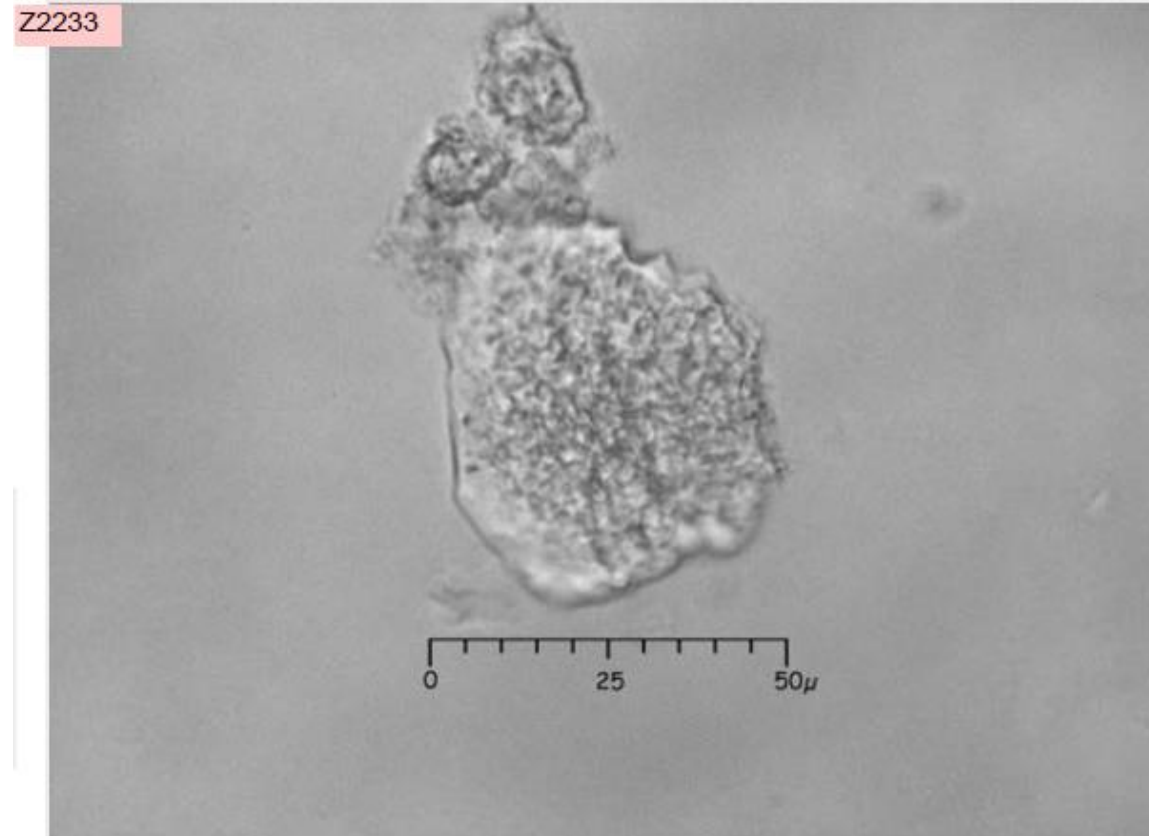
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax arundastrum

## Phytolith

PC280, inflorescence

Diagnostic level: Marantaceae



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

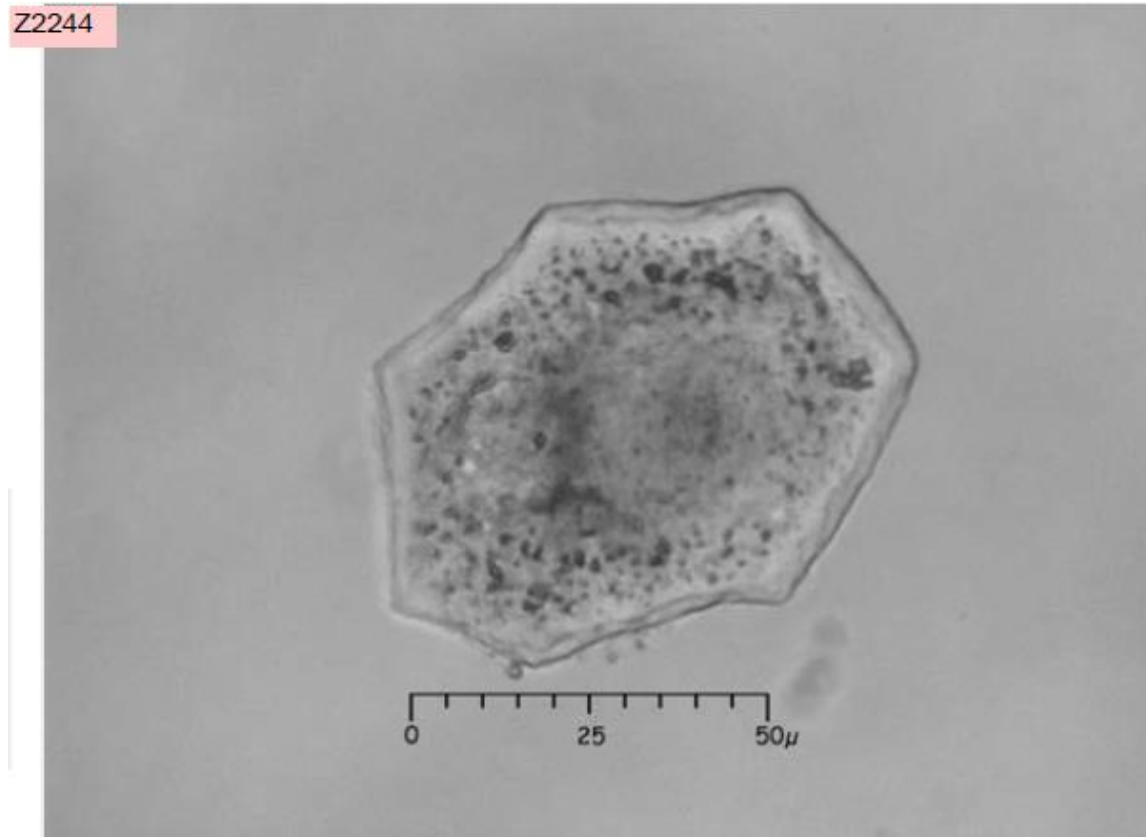
# Donax arundastrum

## Phytolith

PC280, inflorescence

When very broad are difficult to roll  
and appear in bottom view, as seen  
here

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax arundastrum

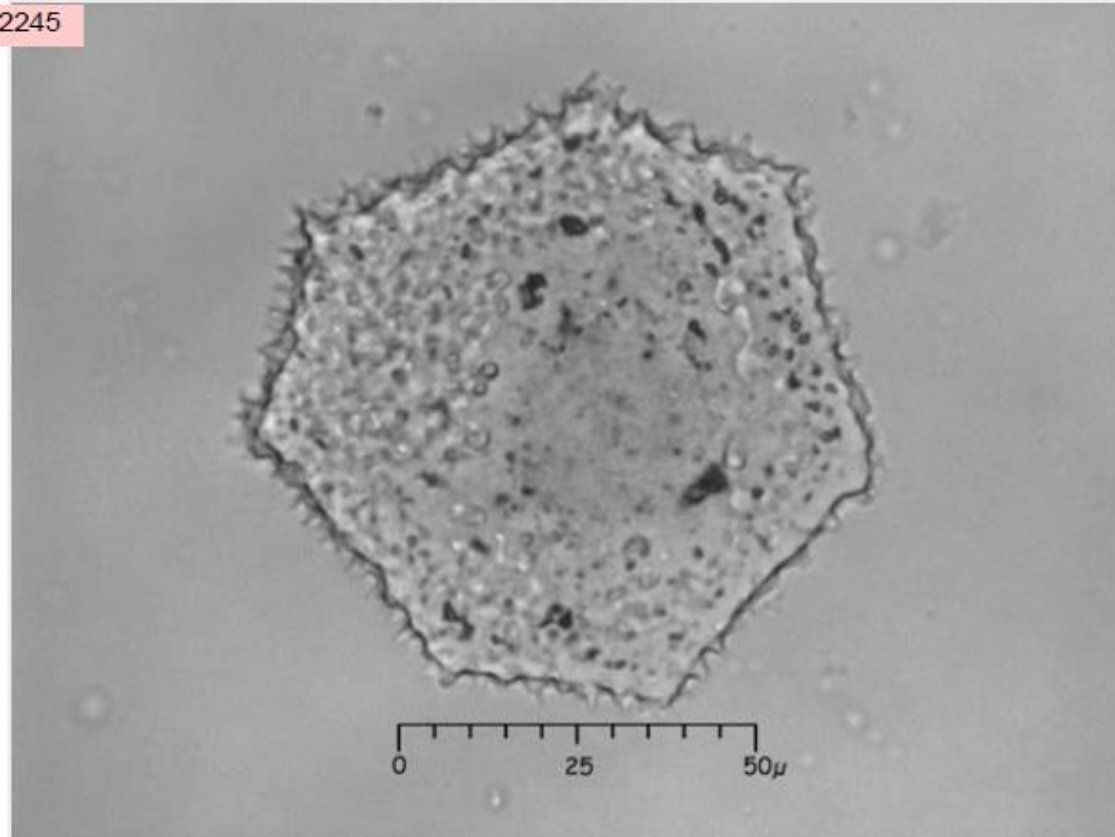
## Phytolith

PC280, inflorescence

When very broad are difficult to roll  
and appear in bottom view, as seen  
here

Diagnostic level: genus

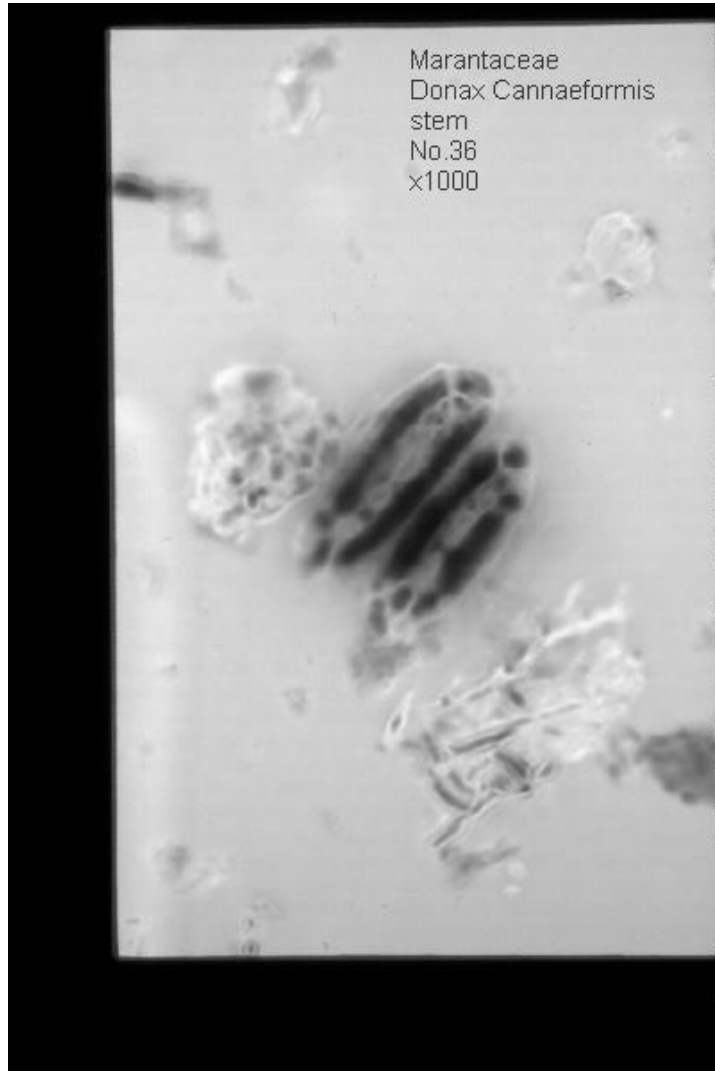
Z2245



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Donax cannaeformis

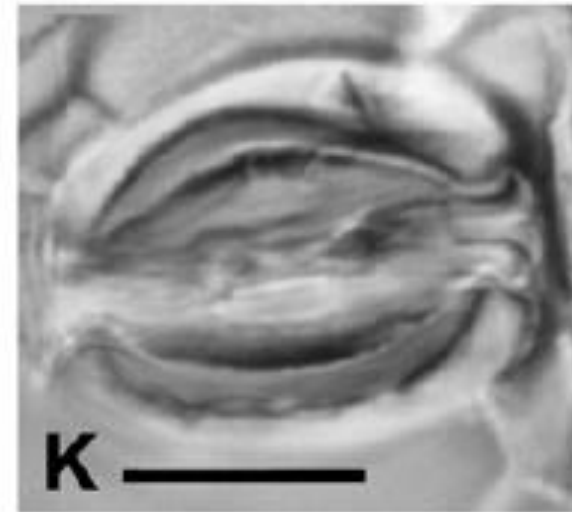
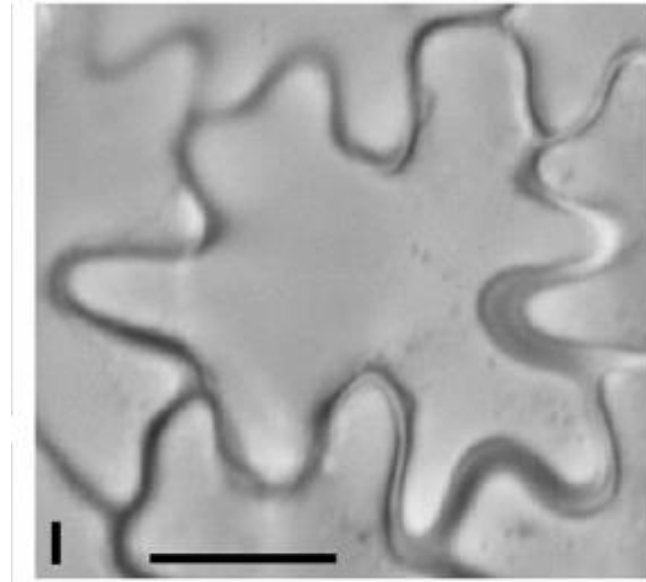
Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Donax grandis

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). I, tabular-jigsaw from *Donax grandis* leaf. J, rugose hat-shape from *Donax grandis* leaf. K, stomatal complex from *Donax grandis* leaf. Scale bars=12  $\mu\text{m}$ .



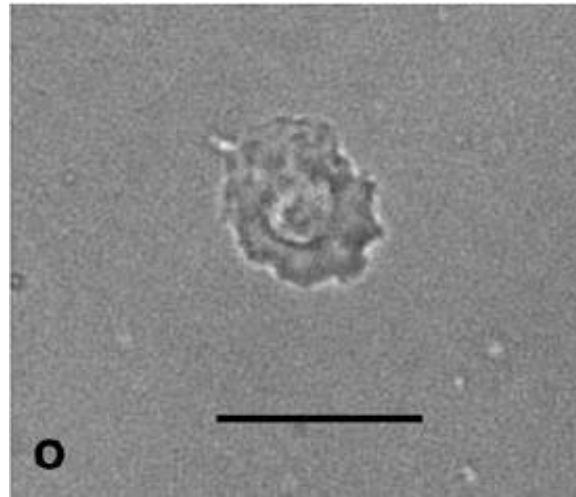
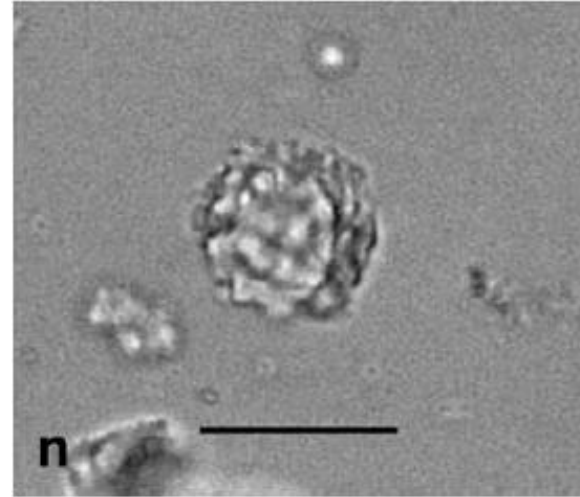
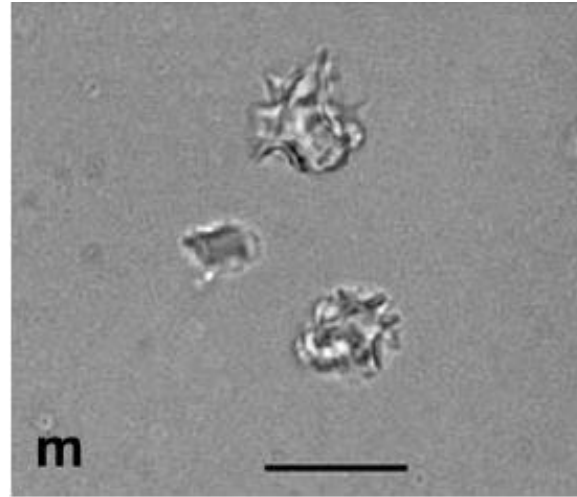
Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.



# Ichnosiphon arouma

## Phytolith

Fig. 3. Phytoliths from non-grass monocots. m) Irregularly angled/folded bodies from *Ichnosiphon arouma*, n) Nodular sphere from *I. arouma*, o) Conical body from *I. arouma*



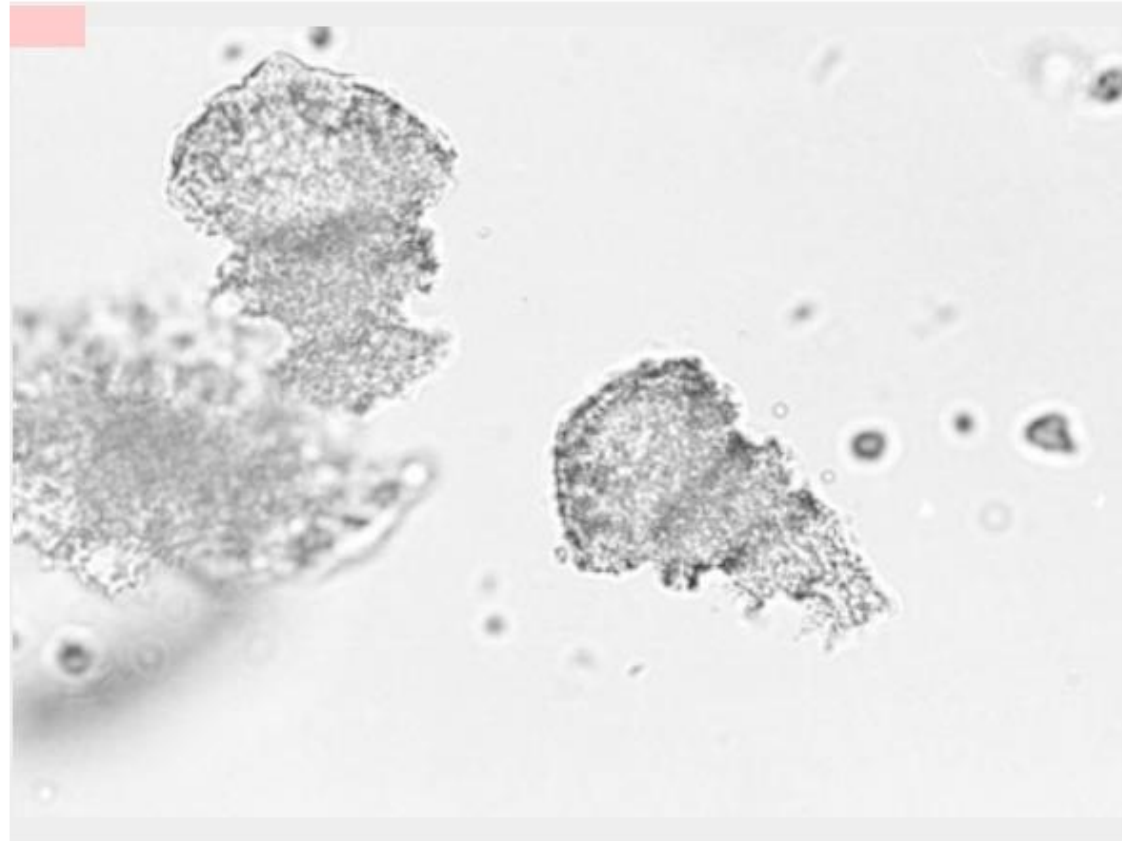
# Ischnosiphon inflatus

## Phytolith

seed bodies.

Show range of variation in wild types.

Diagnostic level: Marantaceae, wild taxa



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Ischnosiphon inflatus

## Phytolith

seed bodies, Note how body continues to narrow below tip.

Diagnostic level: family, wild taxa

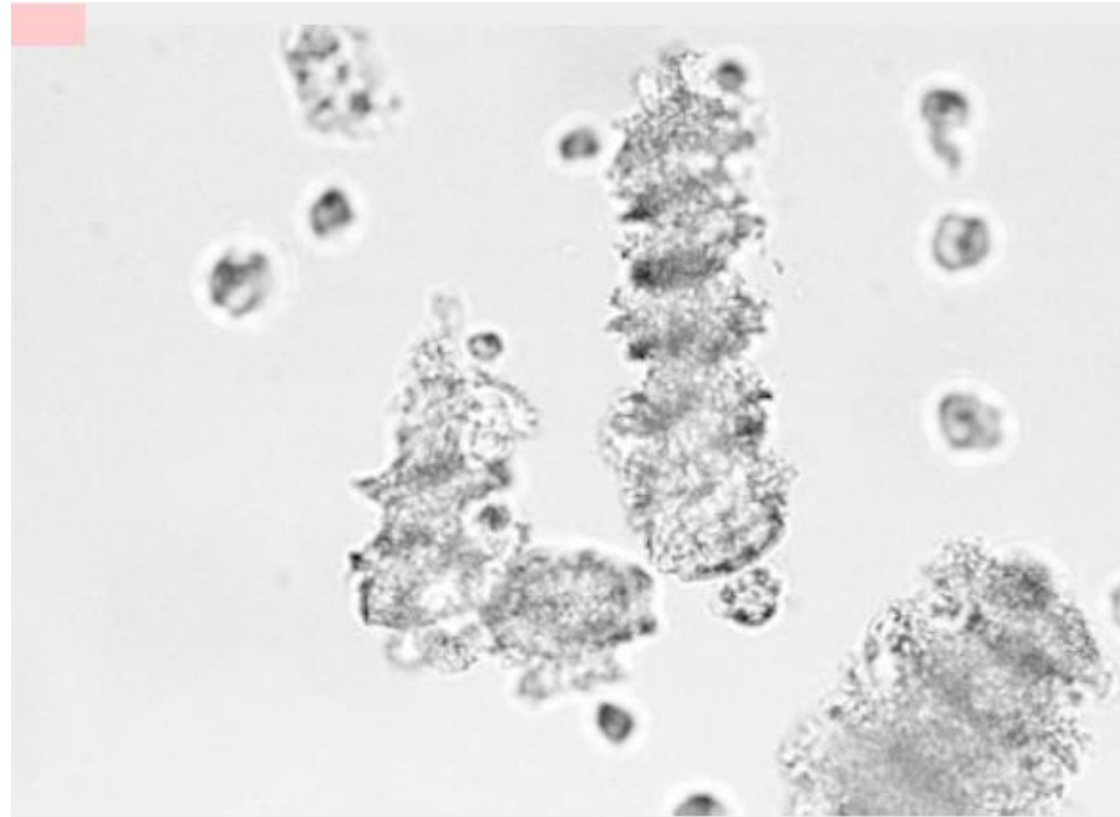


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Ischnosiphon inflatus

## Phytolith

Spiralling of “corkscrew” along shaft  
very apparent in body right of center.  
Diagnostic level: family, wild taxa



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta sp.

## Starch



Figure 3. Light micrographs of archaeological starch granules representative of the recovered assemblage. b: Starch granule of *Maranta* sp. recovered from flake 2.

Perry, Linda. 2002. Starch Analyses Reveal Multiple Functions of quartz “manioc” Grater Flakes from the Orinoco Basin, Venezuela. *Interciencia* 27 (11):635–39.

# Maranta arundinacea

## Phytolith

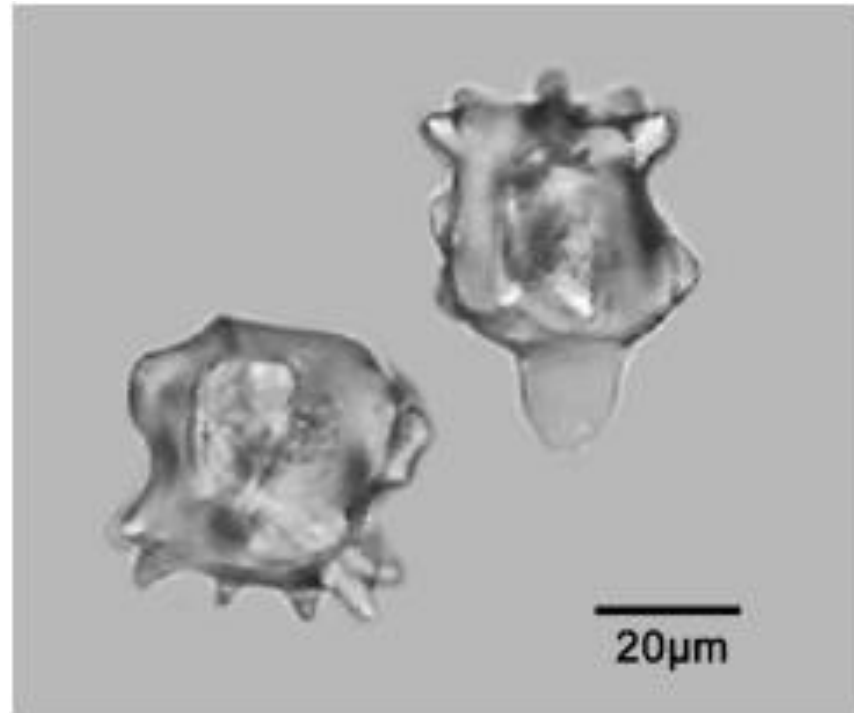


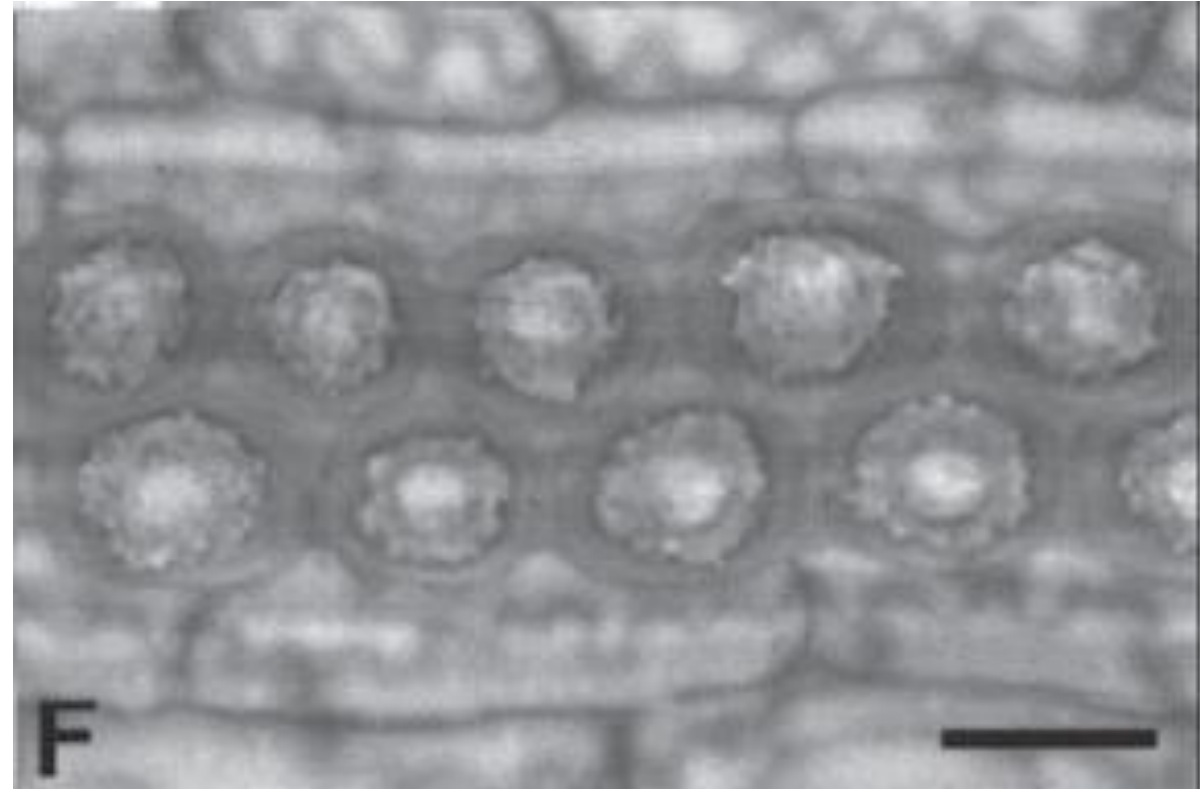
Fig. 7. Seed phytoliths from arrowroot. From Piperno, 2006.

Ball, Terry B., Karol Chandler-Ezell, Ruth Dickau, Neil Duncan, Thomas C. Hart, José Iriarte, Carol Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <http://dx.doi.org/10.1016/j.jas.2015.08.010>.

# Maranta arundinacea

## Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. F. *Maranta arundinacea* (Marantaceae), costal silica bodies in mesophyll cells (bar = 10  $\mu\text{m}$ ).

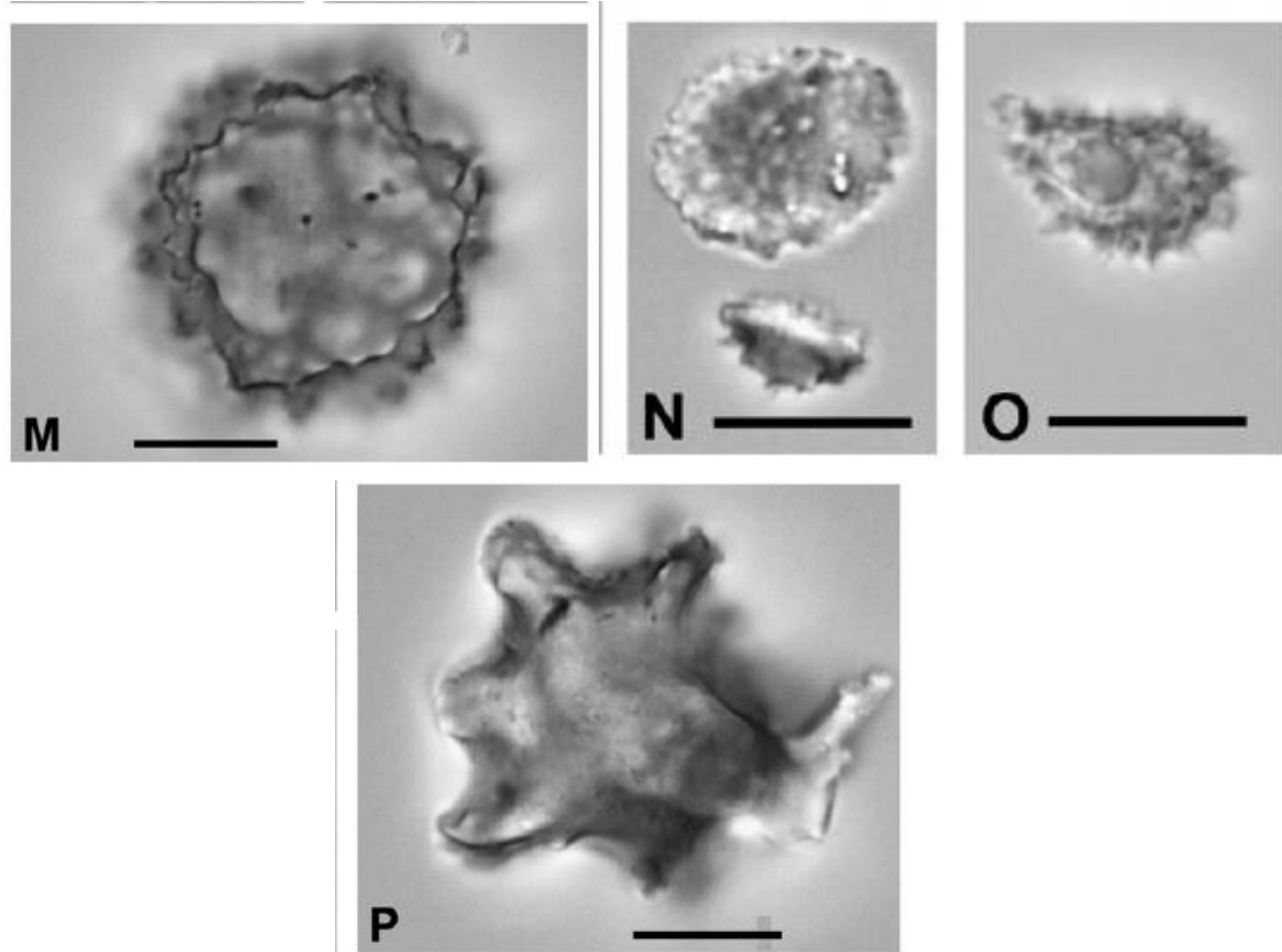


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Maranta arundinacea

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynum clade (T–U), Stachyphrynum clade (V–AA). M, globular-rugulate from *Maranta arundinacea* leaf. N, rugose hat-shapes with crenate margins from *Maranta arundinacea* leaf. O, globular-papillate with concavity from *Maranta arundinacea* seed. P, Kn2 knobby from *Maranta arundinacea* seed. Scale bars=12  $\mu\text{m}$ .



Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.



# Maranta arundinacea

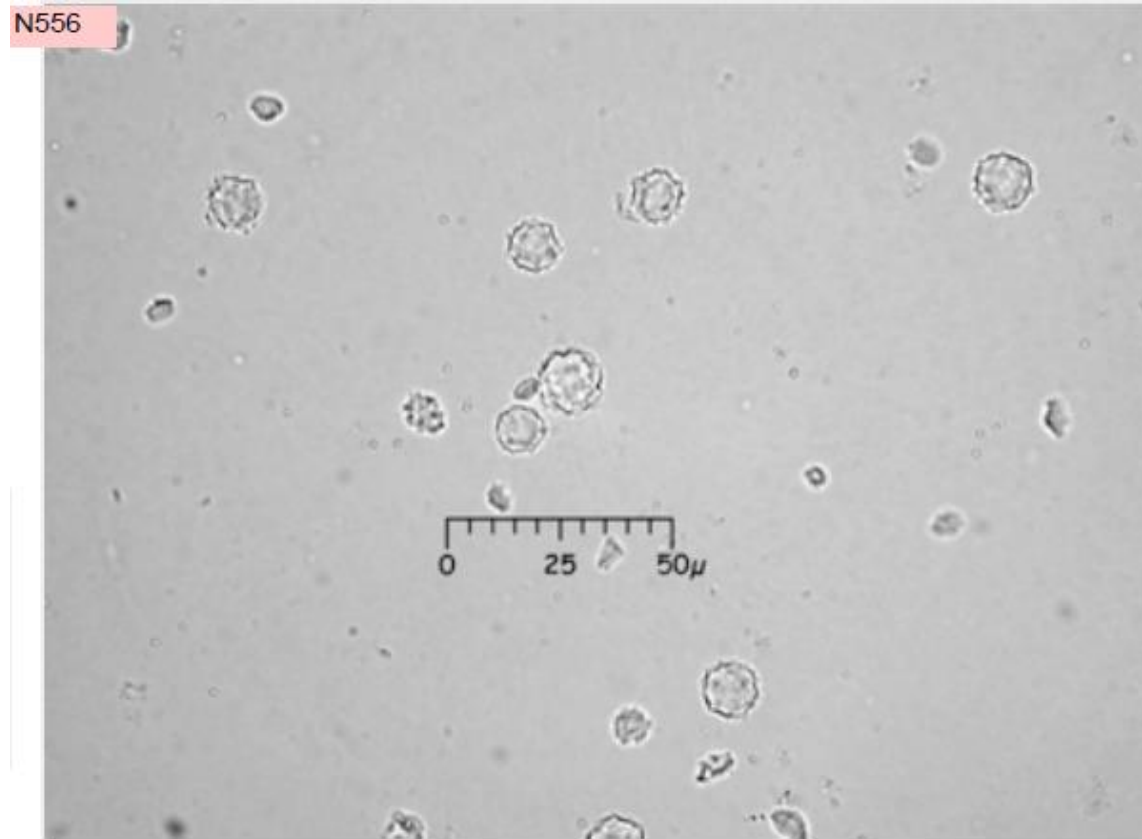
## Phytolith

Note both conical (hat-shaped) bodies and nodular spheres in this field. Both appear in Marantaceae. 80IIIB looks like rugulose or nodular sphere in flat view, but side view shows conical shape.

Diagnostic level, 80IIIB: family

Diagnostic level, 80ICa1:

Marantaceae/Bombacaceae



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

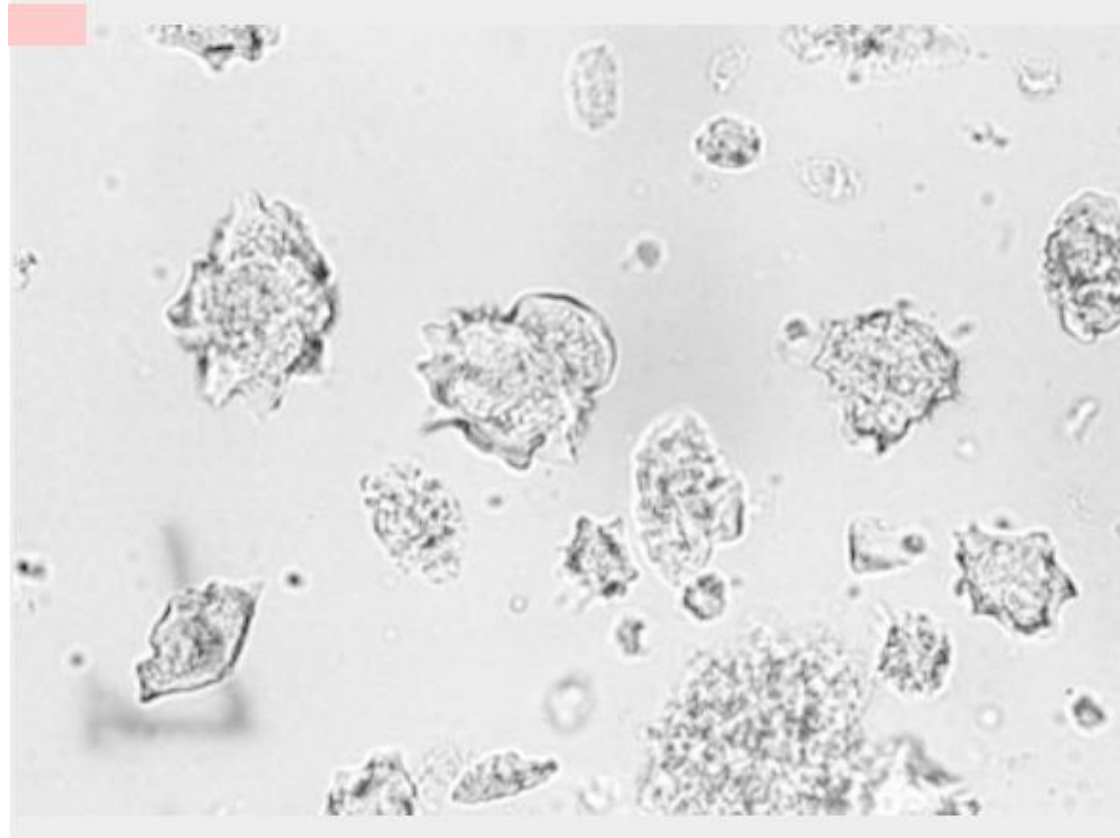
# Maranta arundinacea

## Phytolith

Note the “bottom” view of the bodies, since this is the typical side up. Often it looks like an irregular star- shape or a granular textured disk with irregular margins.

Note in bottom left and far right “tip” only bodies. see below.

Diagnostic level: species

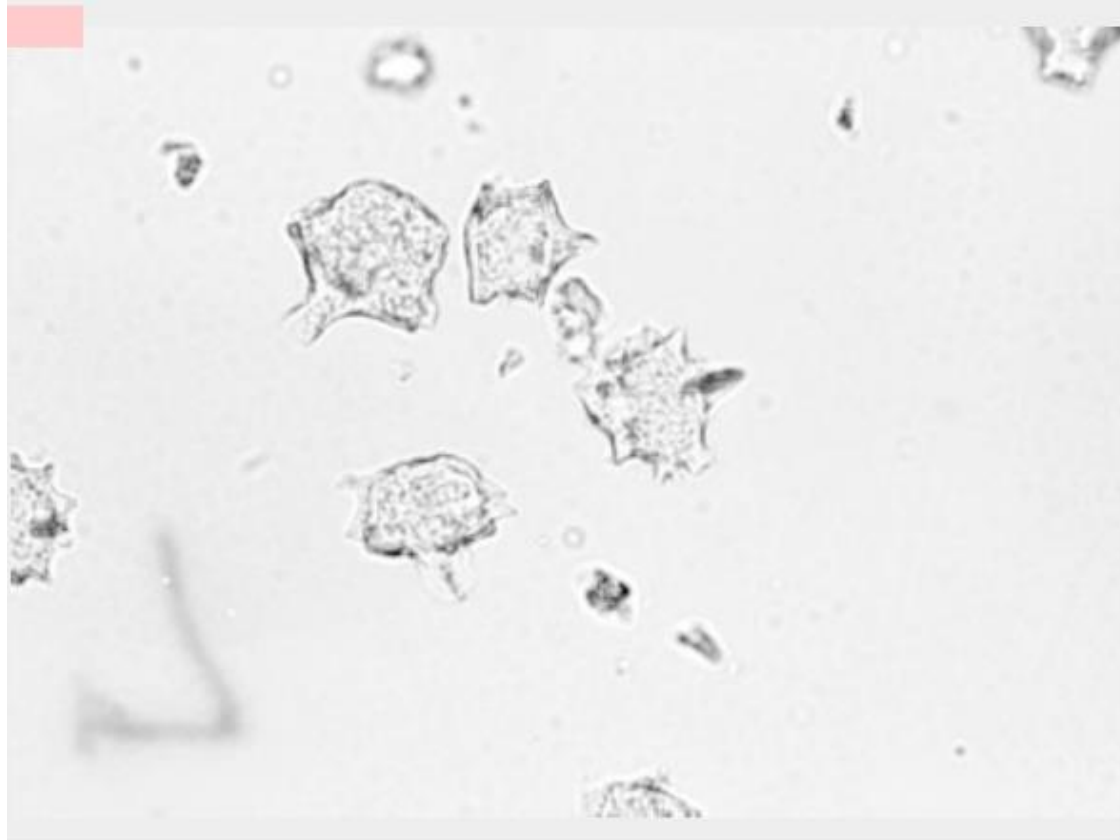


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

Note how much shorter in length  
cylinders are compared to *Maranta* spp.  
type -- yet "tips" are larger  
Compare to other photos of this type  
for variation.  
Diagnostic level: species

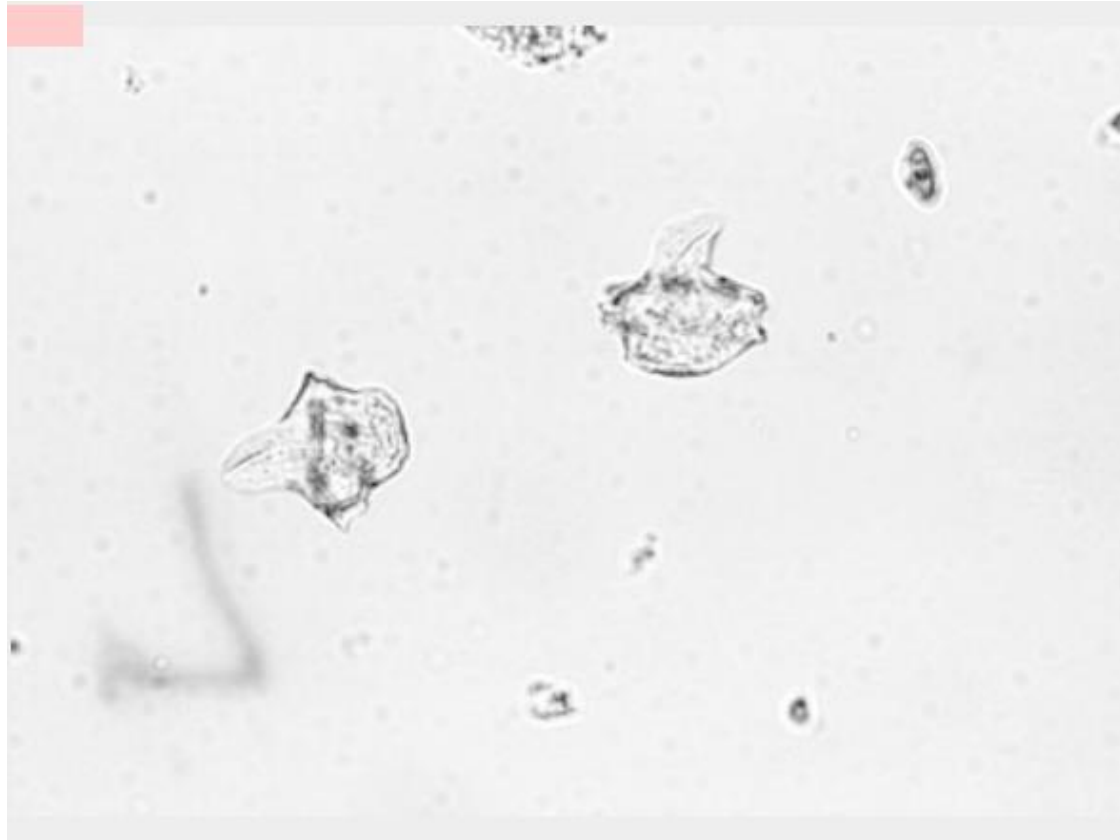


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

Note shortness of cylinder compared to  
“tip” and Maranta sp. type.  
Diagnostic level; species

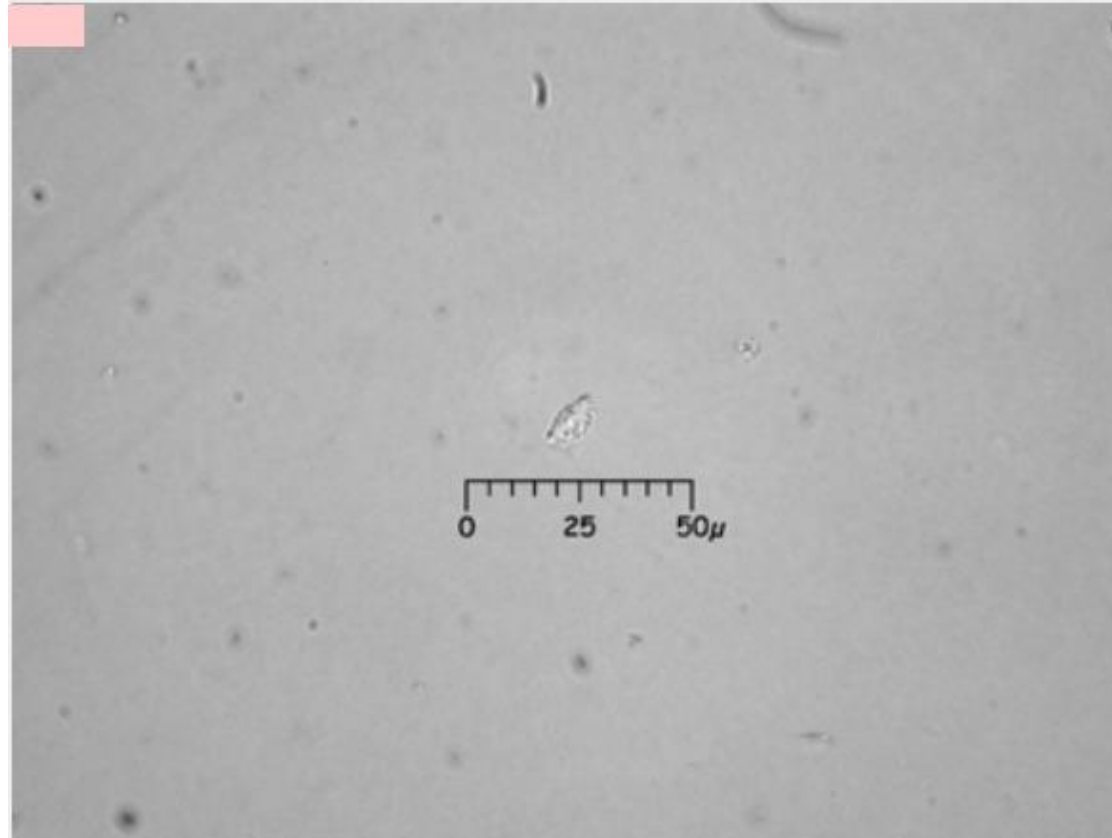


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

Type established by Karol Chandler-Ezell, 2004  
Diagnostic level: Maranta/Calathea  
rhizomes

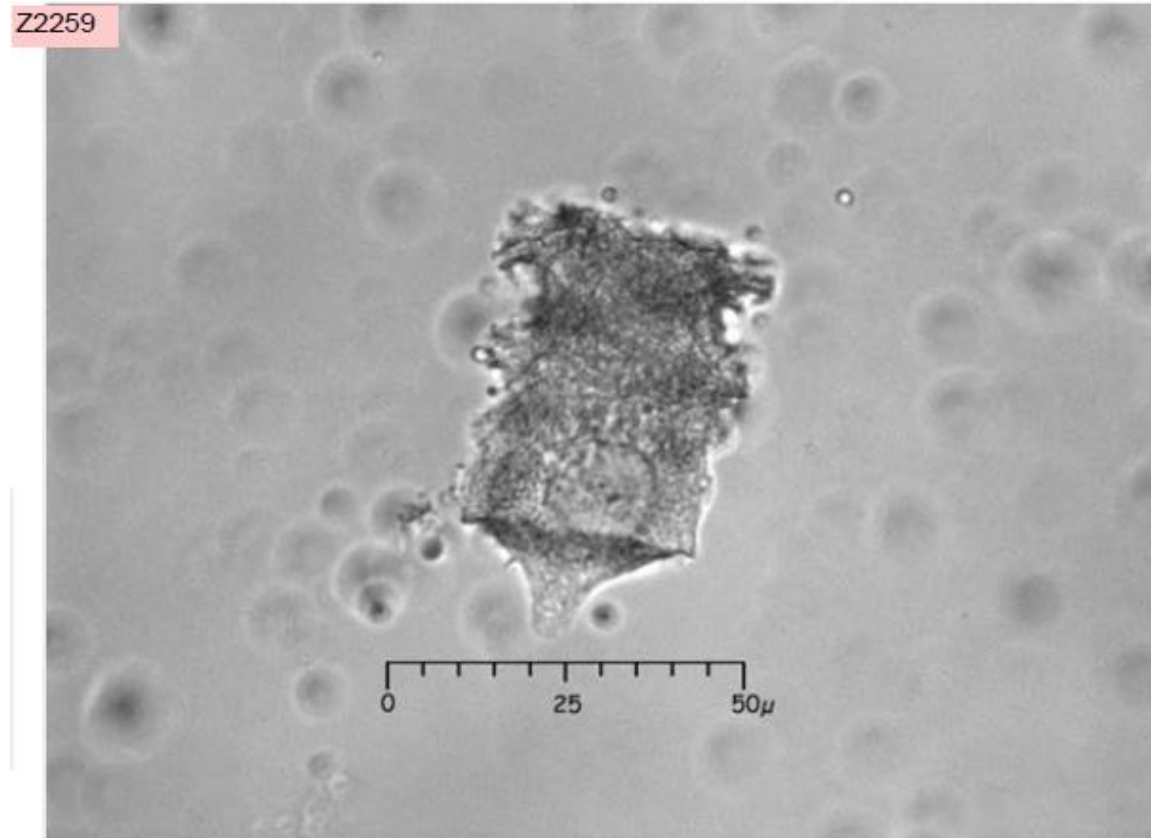


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

PC2670, fleshy rhizome, moderate  
A seed body type,  
Diagnostic level: family, wild taxa;  
occurs in one specimen of arrowroot  
rhizome

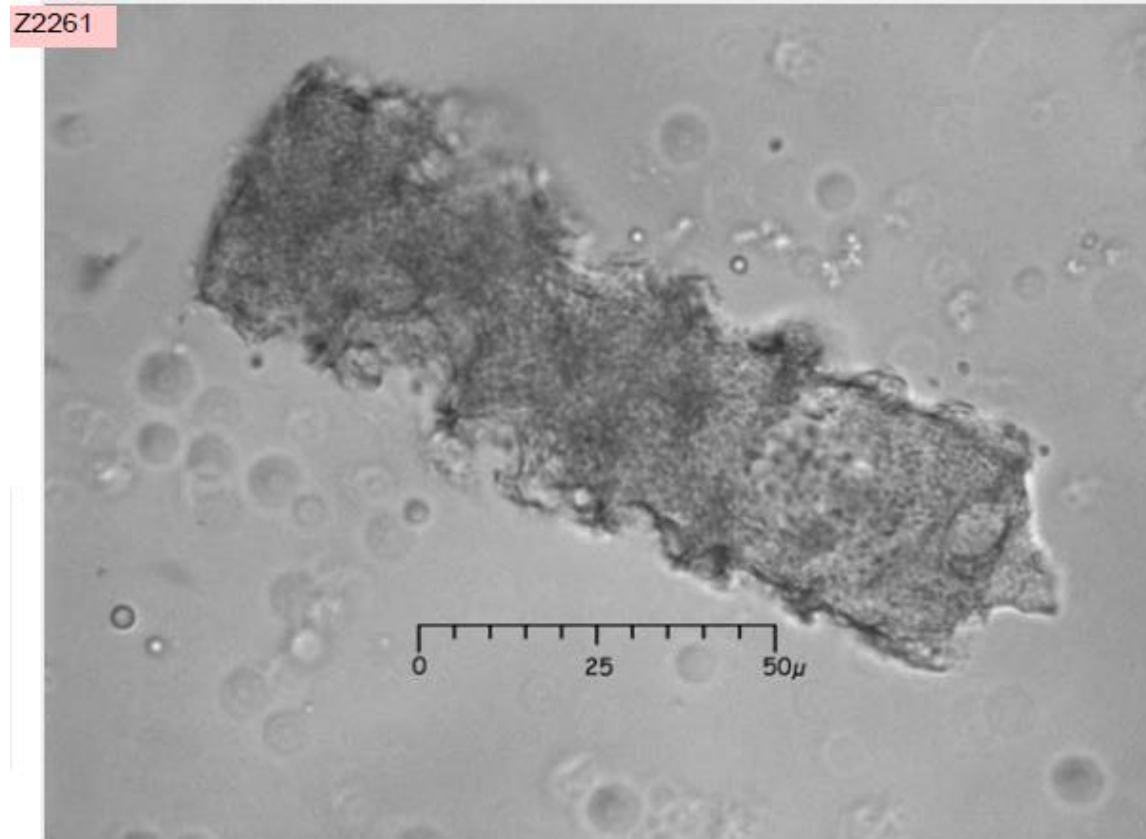


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

PC2670, fleshy rhizome, moderate  
A seed body type,  
Diagnostic level: family, wild taxa;  
occurs in one specimen of arrowroot  
rhizome

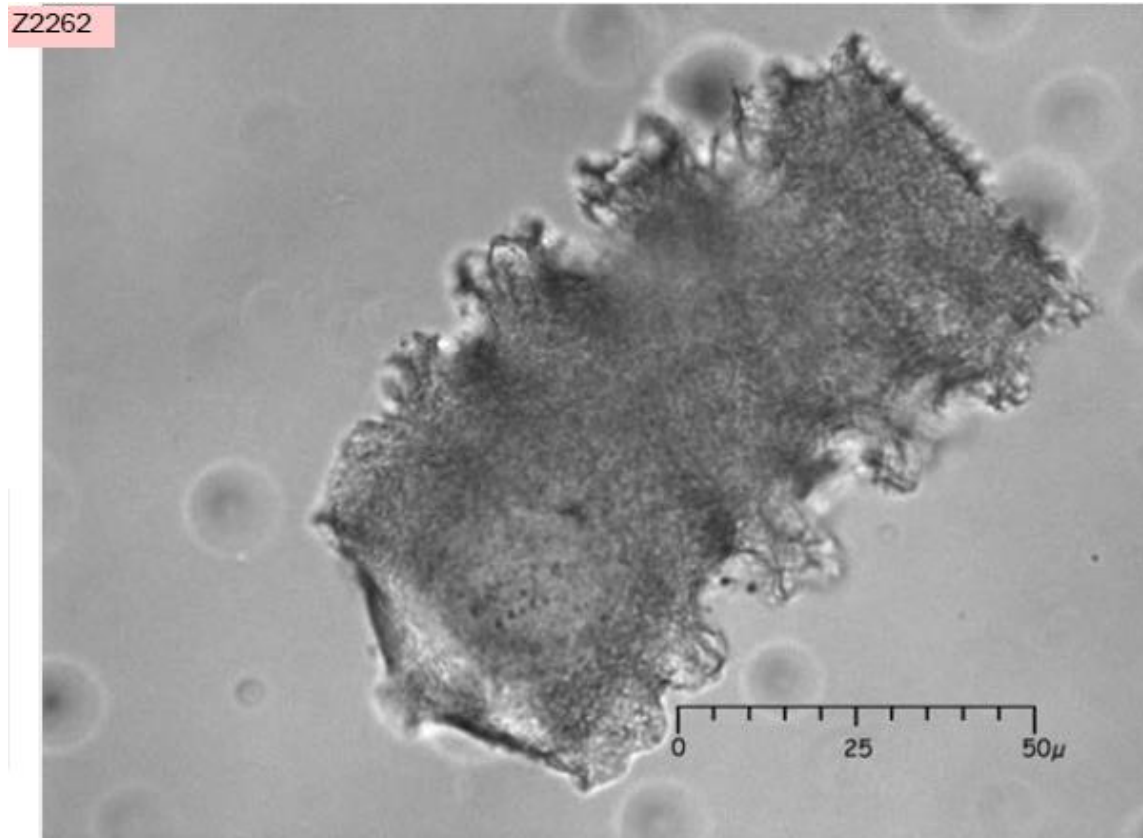


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

PC2670, fleshy rhizome, moderate A  
seed body type,  
Diagnostic level: family, wild taxa;  
occurs in one specimen of arrowroot  
rhizome



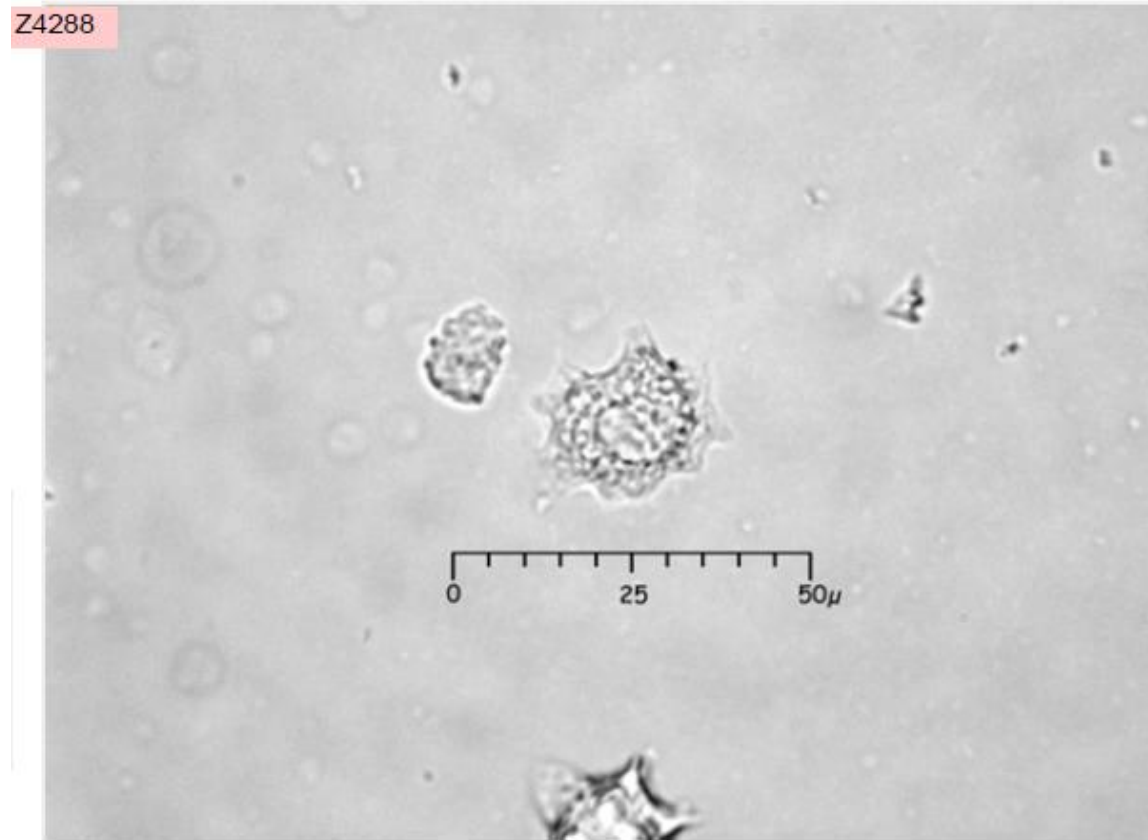
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Maranta arundinacea

## Phytolith

PC2038, inflorescence  
Diagnostic level: species  
This image is a view from the bottom  
(often in this rotation)

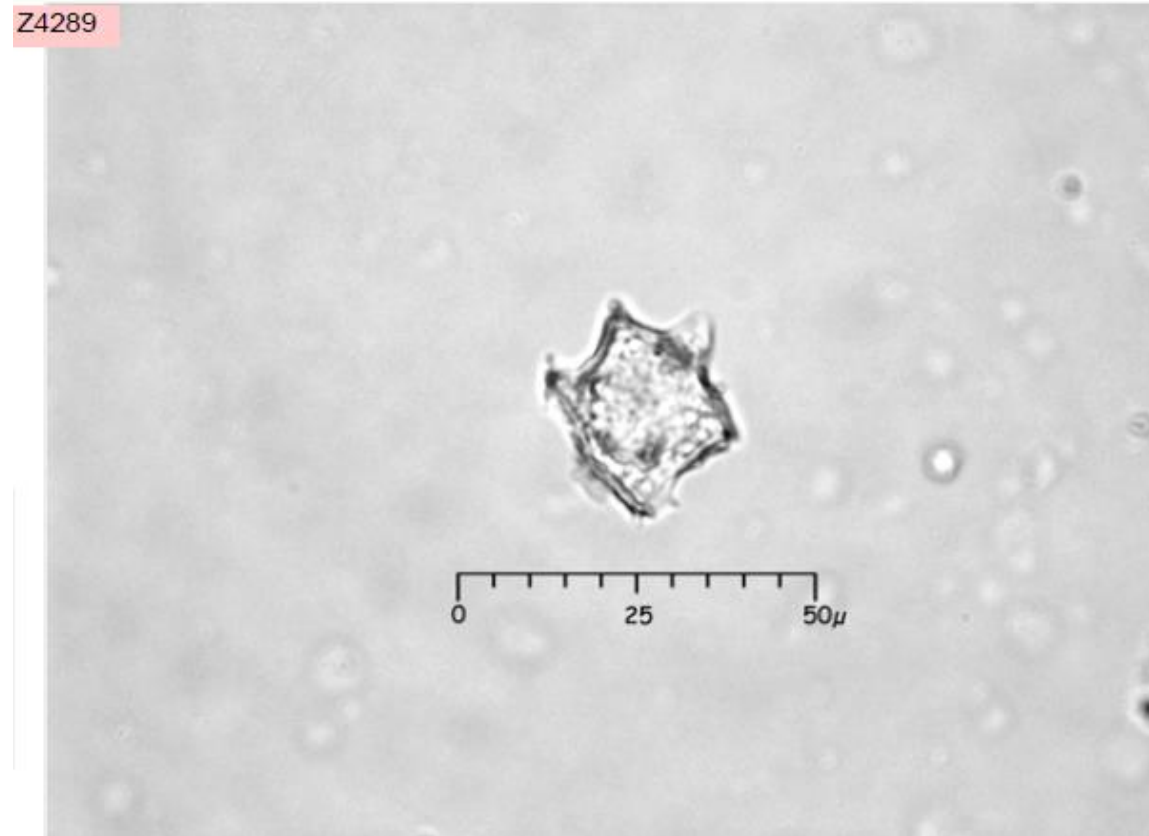


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

PC2038, inflorescence  
Diagnostic level: species

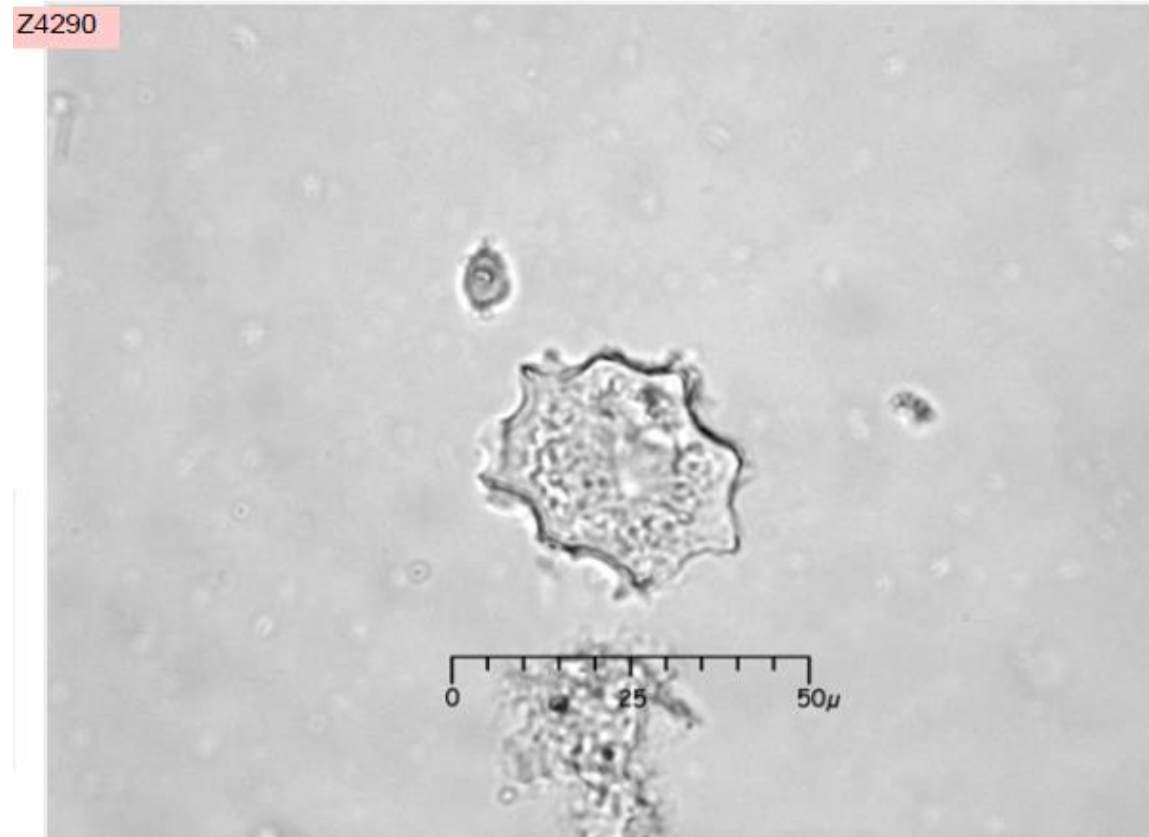


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

PC2038, inflorescence  
Diagnostic level: species  
View from the bottom

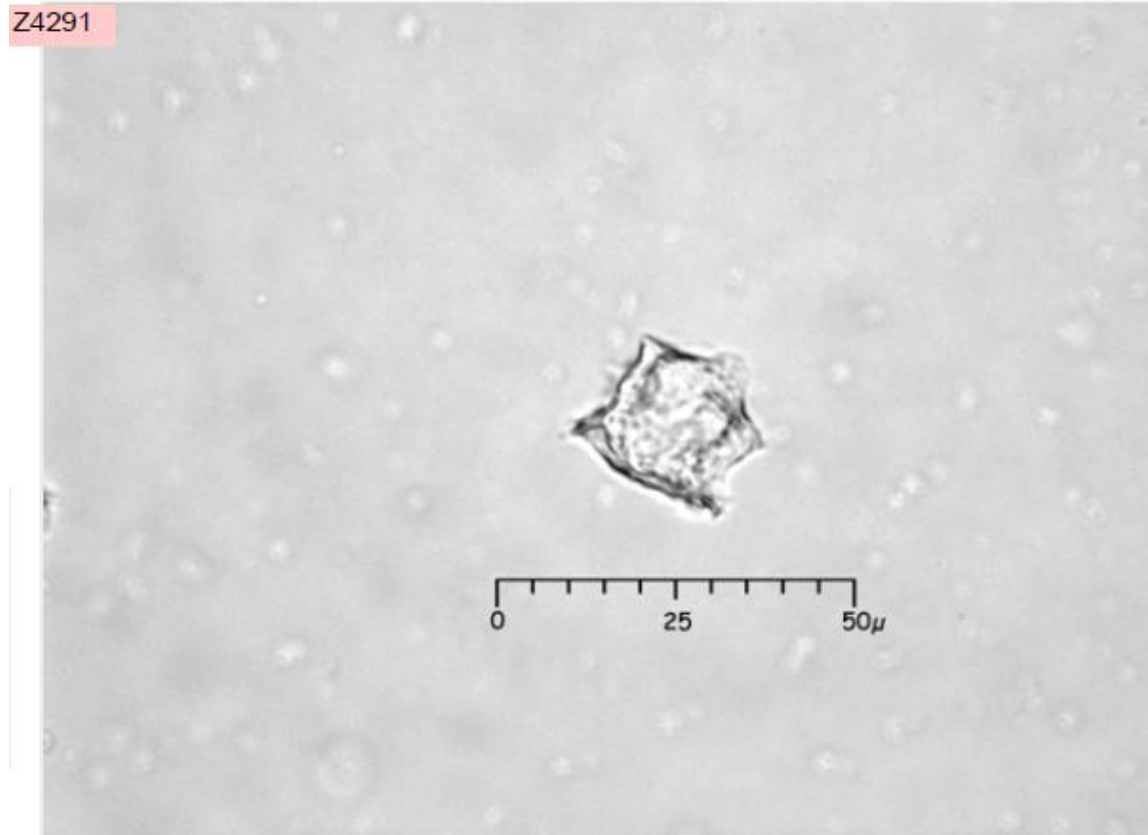


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

PC2038, inflorescence  
Diagnostic level: species

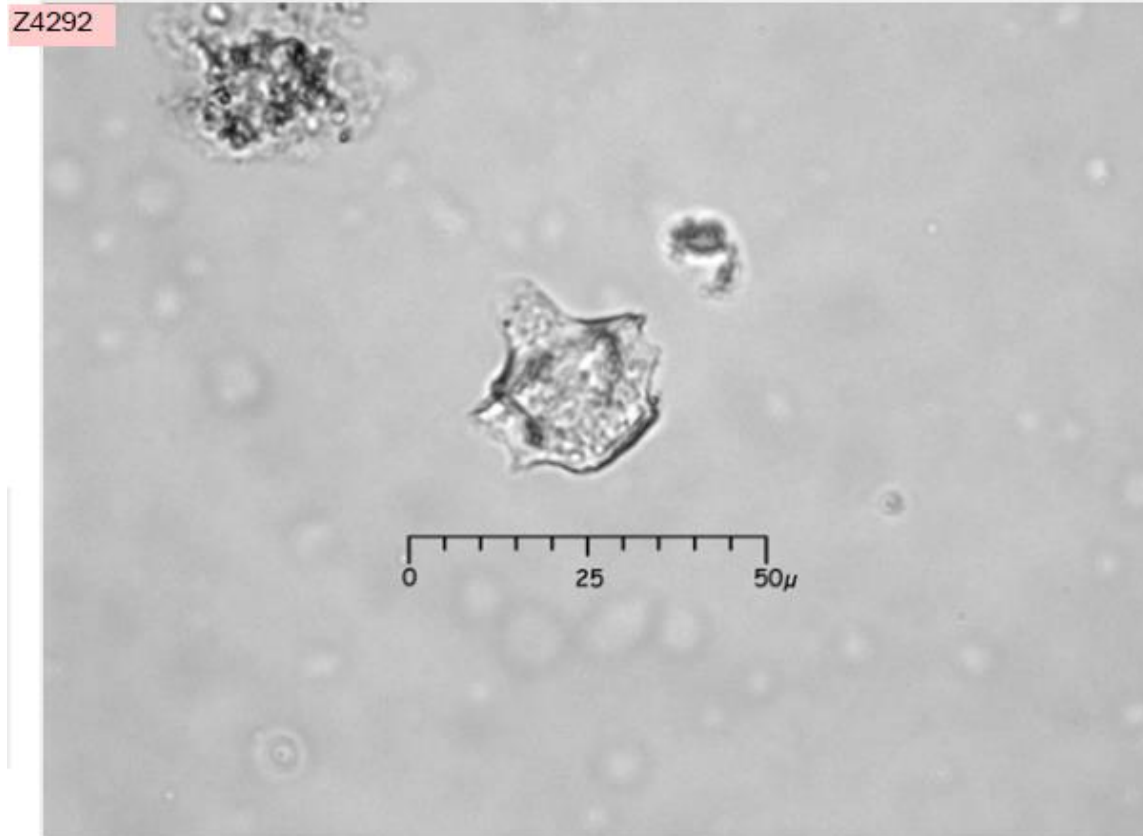


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

PC2038, inflorescence  
Diagnostic level: species

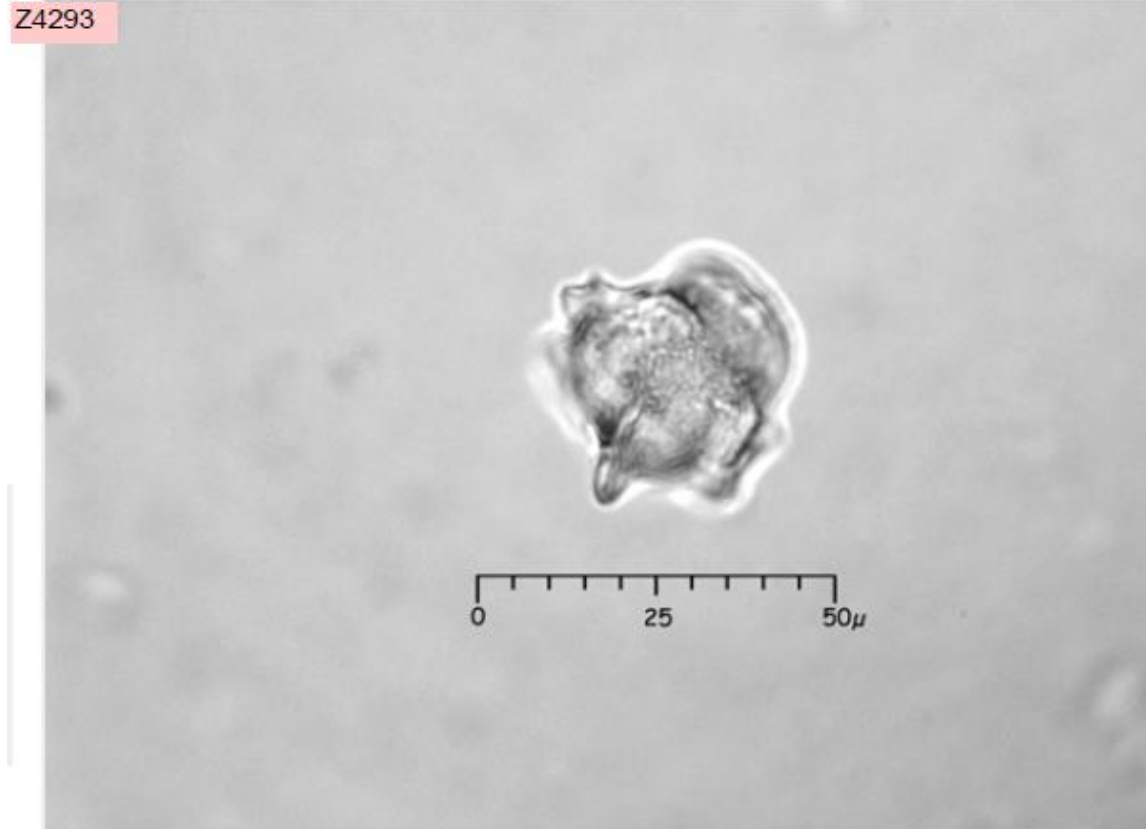


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

PC2038, inflorescence  
Diagnostic level: species  
View is of partially rotated body

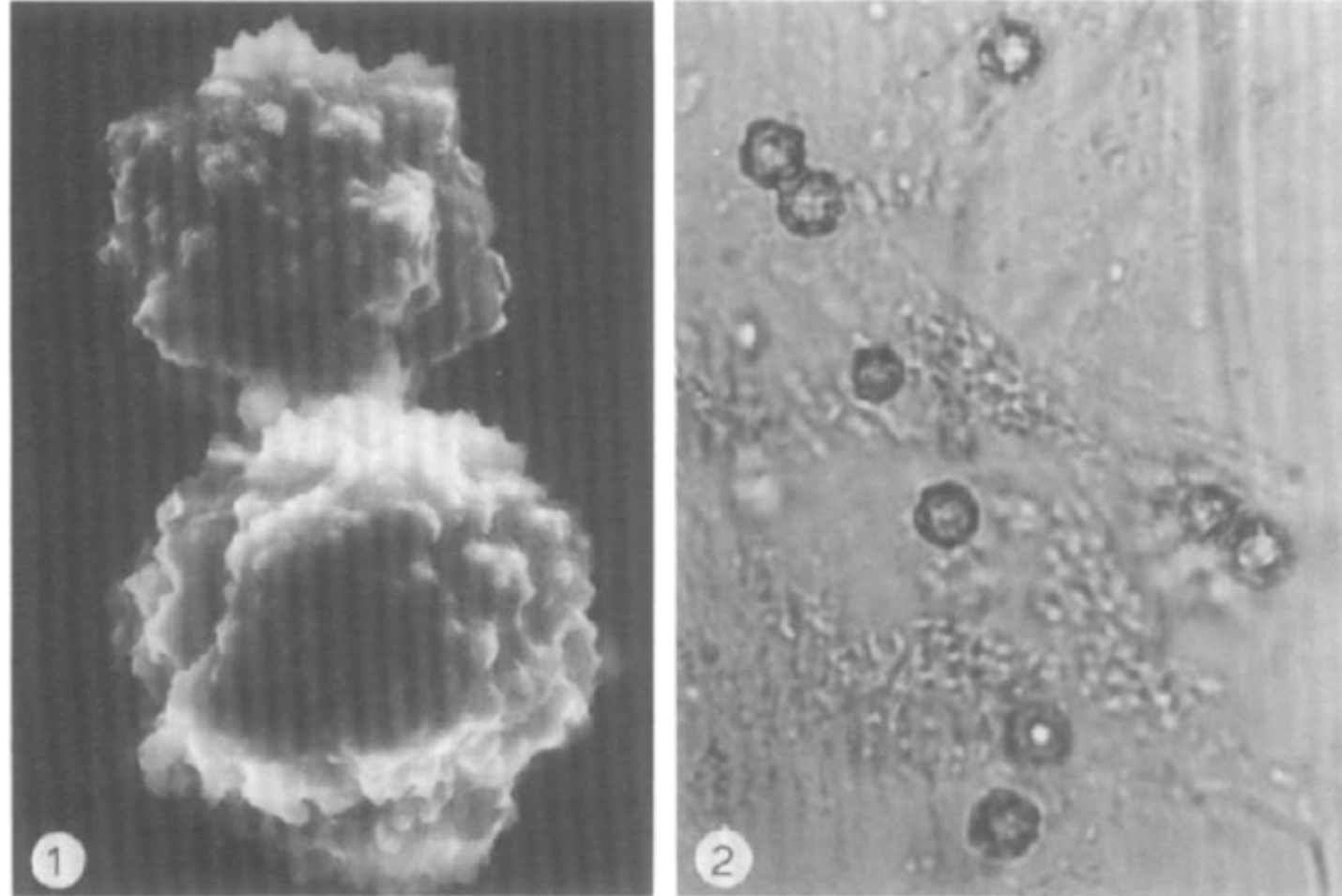


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta arundinacea

## Phytolith

1. SEM photograph of spherical, nodular phytoliths from *Maranta arundinacea* (3000x).
2. Spherical, rugulose phytoliths from *Maranta arundinacea* (200x).

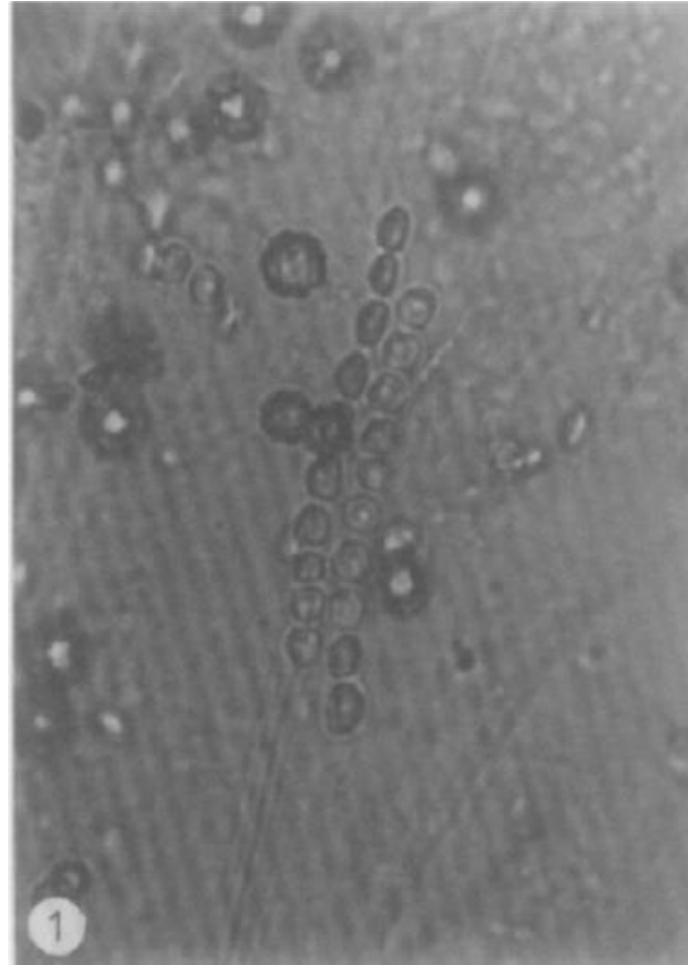


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Maranta arundinacea

## Phytolith

1. Center, two rows of hat-shaped phytoliths from *Maranta arundinacea* (200×).

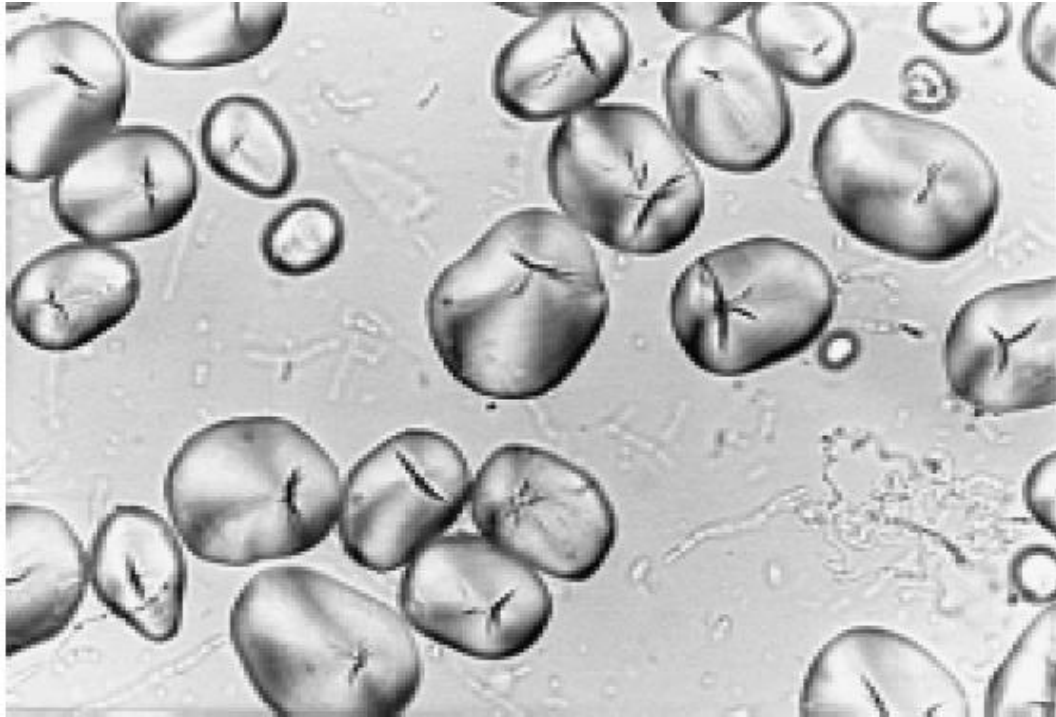


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.



# Maranta arundinacea

## Starch



Starch grains from a modern tuber of arrowroot. 80x

### APPENDIX:

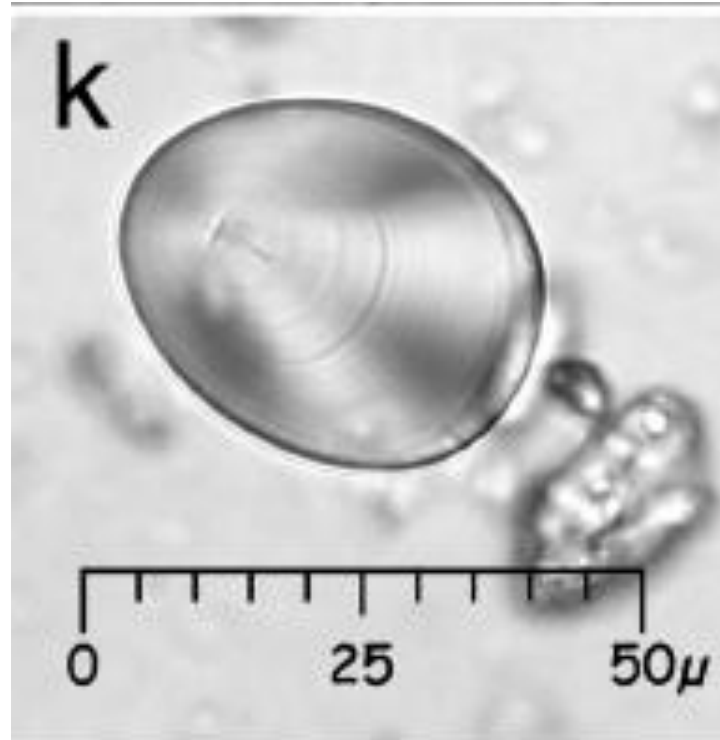
Maranta arundinacea (arrowroot) (Figure 5). Simple, oval grains, with one or two indentations, laminated. The hilum is eccentric and often has one fissure or a y fissure placed on the proximal edge of the grain. Size: 10–50 microns long

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Maranta arundinacea

## Starch

Fig. 5. Selected phytoliths and starch granules recovered from tools. See MU Phytolith website (<http://www.missouri.edu/~phyto>) for other photographs. k. *Maranta arundinacea* starch granule, SS42 FS3294-B



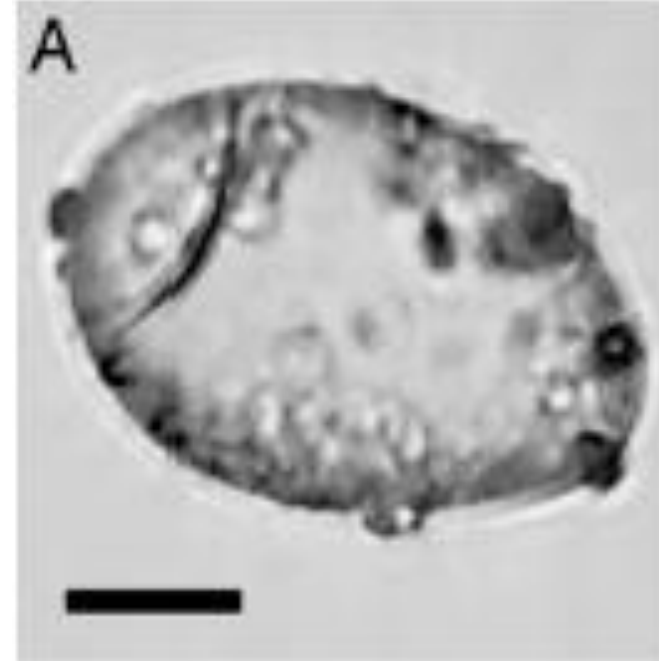
Chandler-Ezell, Karol, Deborah Marie Pearsall, and James A. Zeidler. 2006. Root and Tuber Phytoliths and Starch Grains Document Manioc (*Manihot Esculenta*), Arrowroot (*Maranta Arundinacea*), and Llerén (*Calathea Sp.*) at the Real Alto Site, Ecuador. *Economic Botany* 60 (2):103–20.

[http://www.bioone.org/doi/abs/10.1663/0013-0001\(2006\)60%5B103:RATPAS%5D2.0.CO%3B2](http://www.bioone.org/doi/abs/10.1663/0013-0001(2006)60%5B103:RATPAS%5D2.0.CO%3B2).

# Maranta arundinacea

## Starch

Fig. 2. Selected archaeological starch grains. (A) Arrowroot (*Maranta arundinacea*) starch from Casita de Piedra, flakeknife 101/15, ?7400cal BP. (Scale bar: 10  $\mu$ m) Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8.

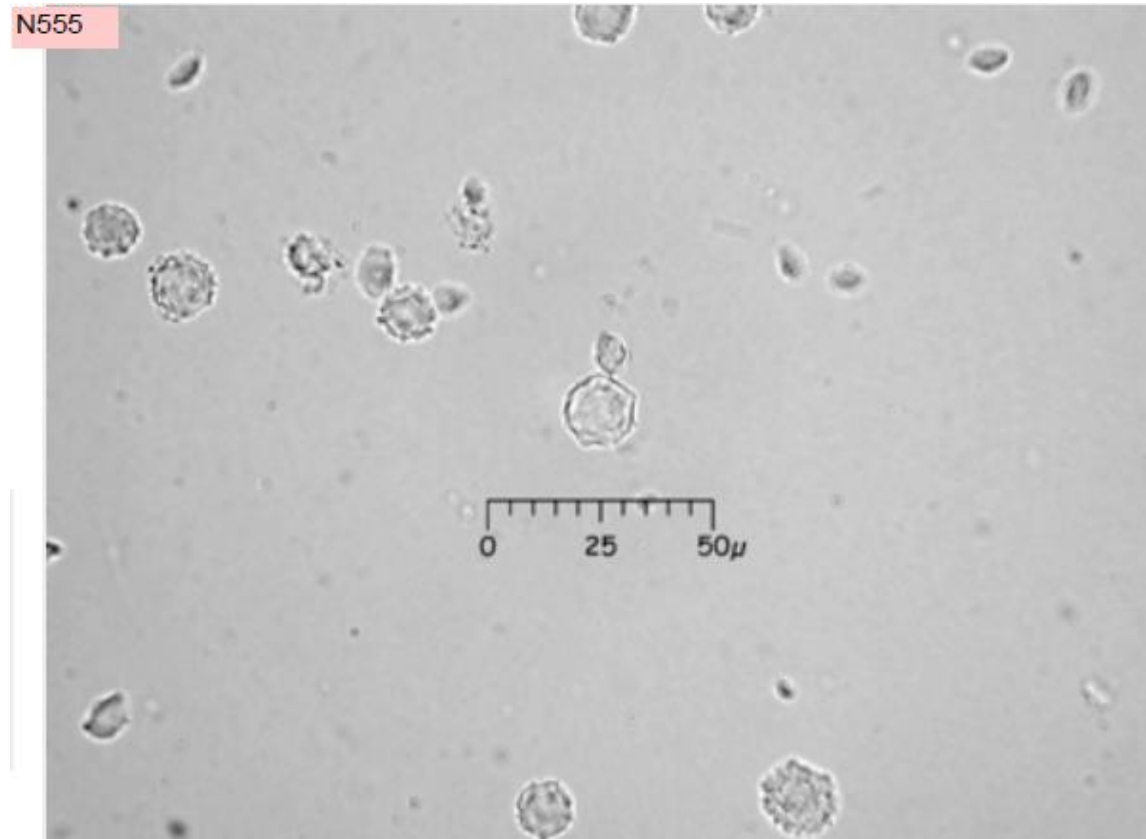


Dickau, Ruth, Anthony J. Ranere, and Richard G. Cooke. 2007. Starch Grain Evidence for the Preceramic Dispersals of Maize and Root Crops into Tropical Dry and Humid Forests of Panama. *Proceedings of the National Academy of Sciences of the United States of America* 104 (9):3651–56.

# Maranta gibba

## Phytolith

Large (10-30 microns) rugulose spheres. Rugulose spheres occur in many taxa, very common in Marantaceae, Bombacaceae, Cannaceae, Heliconiaceae, and Chrysobalanaceae. Small rugulose spheres (< 10 microns) that are well silicified (i.e., opaque) are, according to Iriarte and Piperno, characteristic of woody dicots. Large spheres (10-30



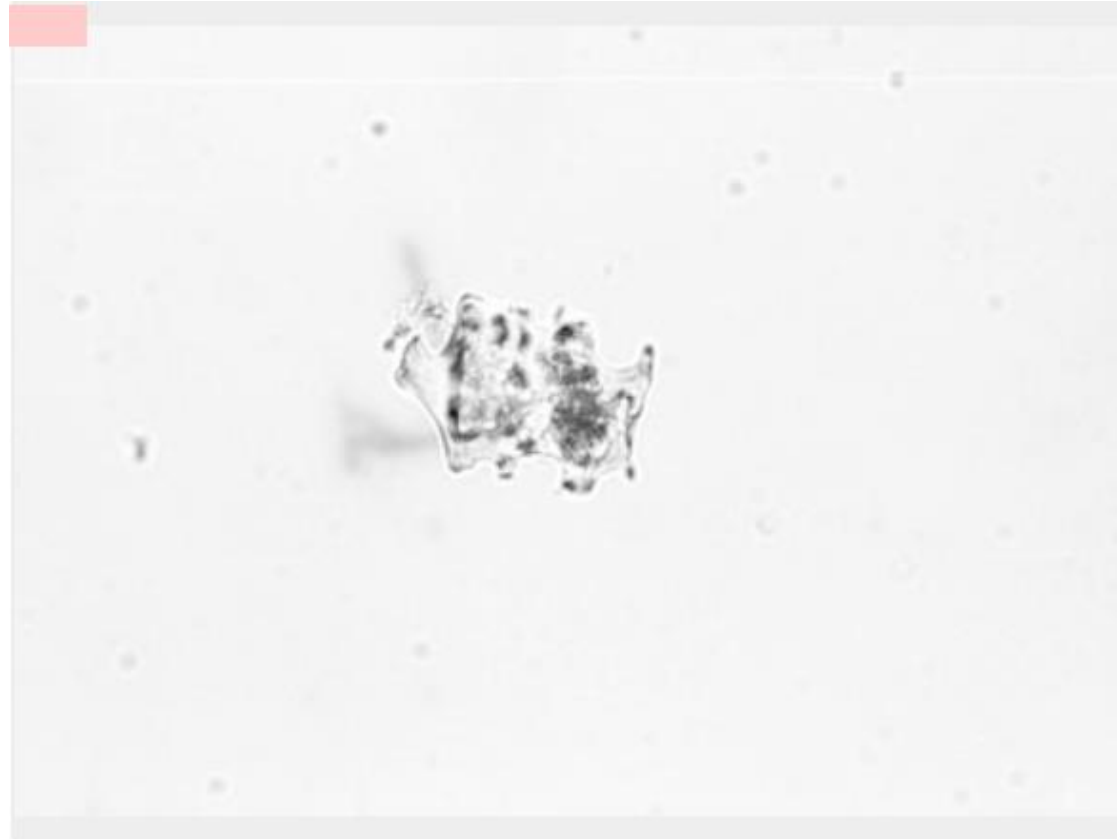
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta gibba

## Phytolith

Maranta spp. inflorescence body,  
Diameter of central cylinder is  
37microns wide

Note: may occur in all Maranta spp.,  
including Maranta arundinacea  
Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

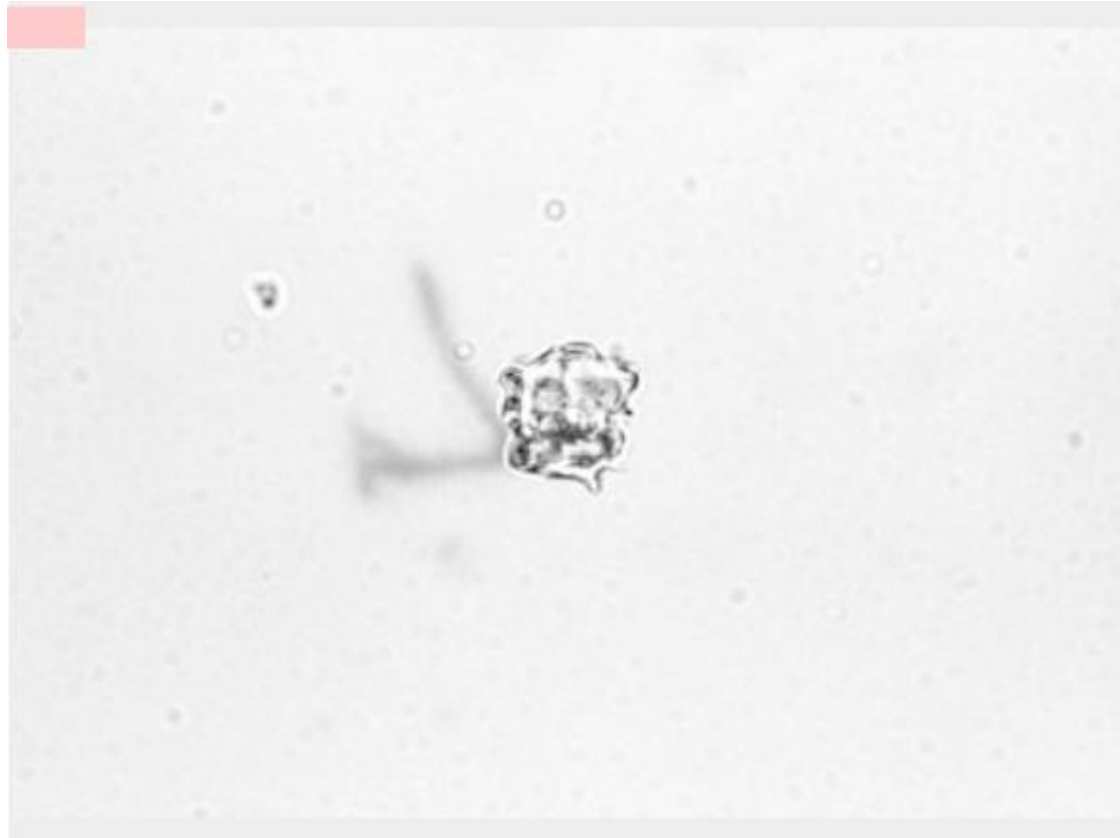
# Maranta gibba

## Phytolith

Small, "incomplete" seed body. Note absence of "tip" or "stalk" typical of the body...only a tiny or vestigial stalk at bottom of body.

This photo is to illustrate the extreme end of the type.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

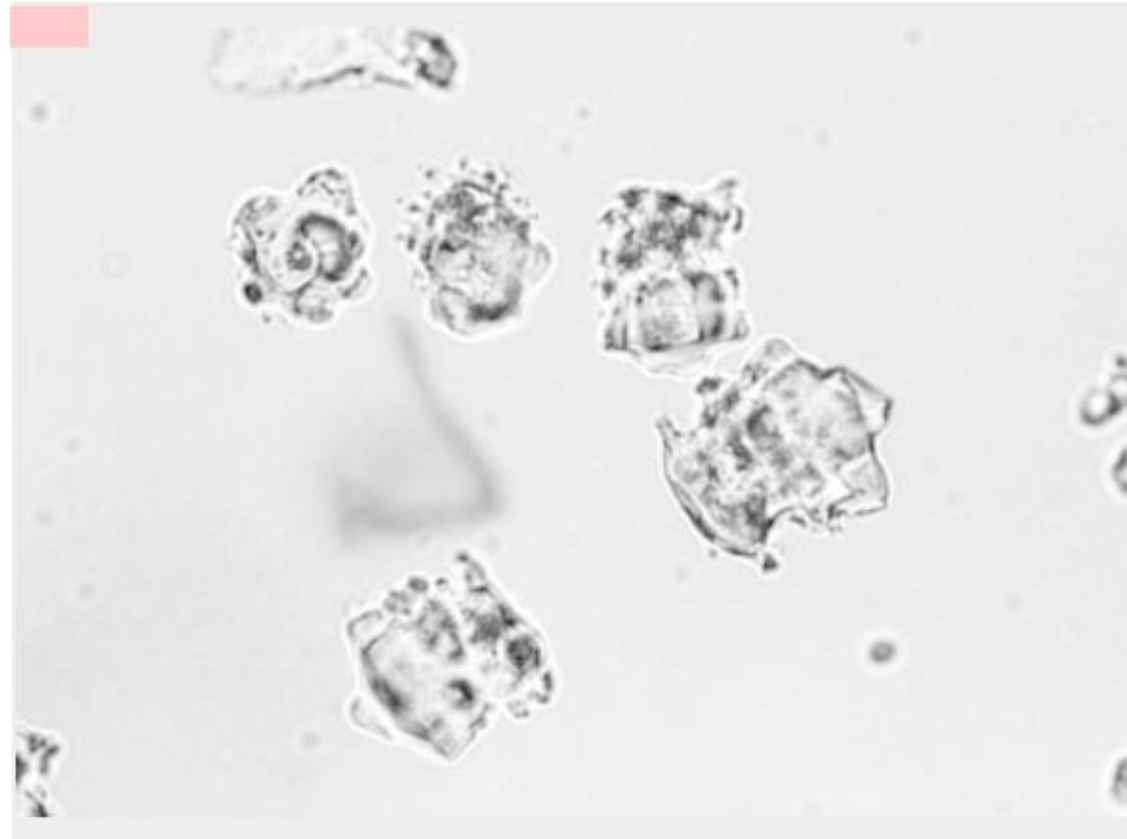
# Maranta gibba

## Phytolith

Size range in length: 25 - 55 microns

Note: may occur in all *Maranta* spp.,  
including *Maranta arundinacea*

Diagnostic level: genus

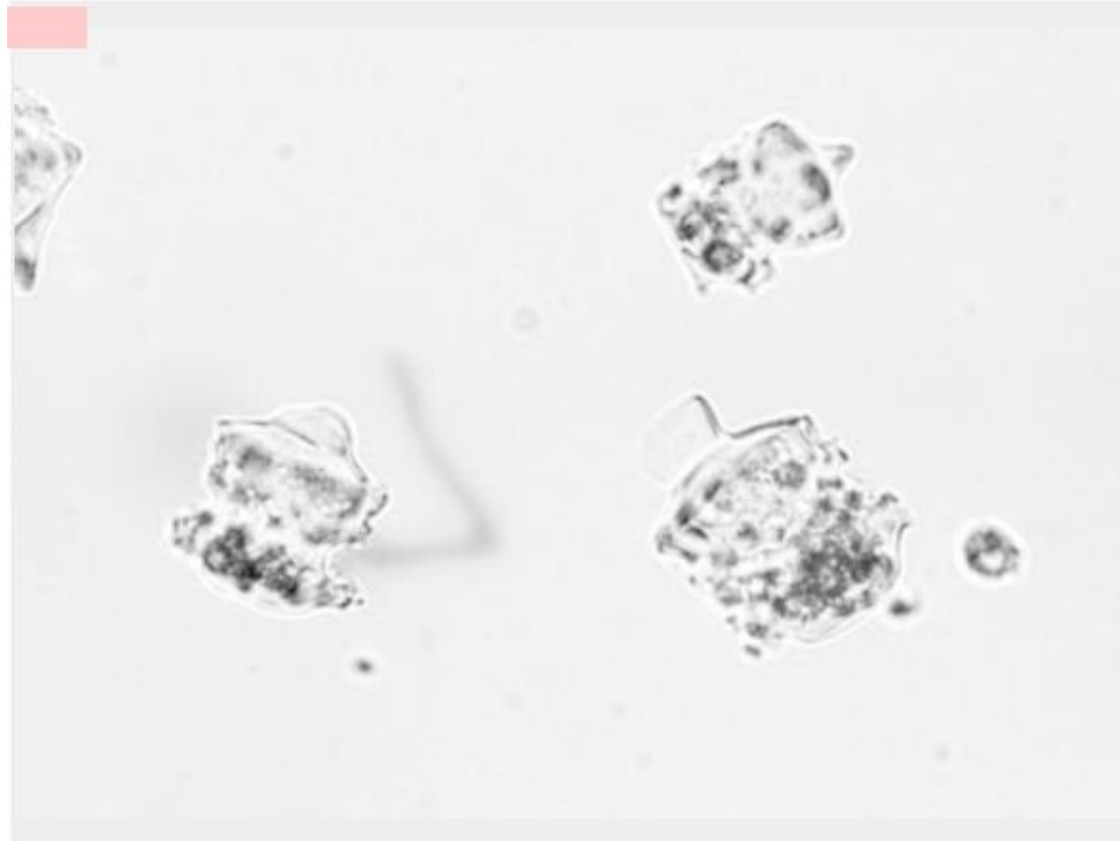


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta gibba

## Phytolith

Note smooth stalks on wide tips of bodies. Cylinders are covered in projections and surface decoration.  
Note: may occur in all *Maranta* spp., including *Maranta arundinaceae* NOTE: In some samples, you may see JUST the tip of the body -- 22VII Ca Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



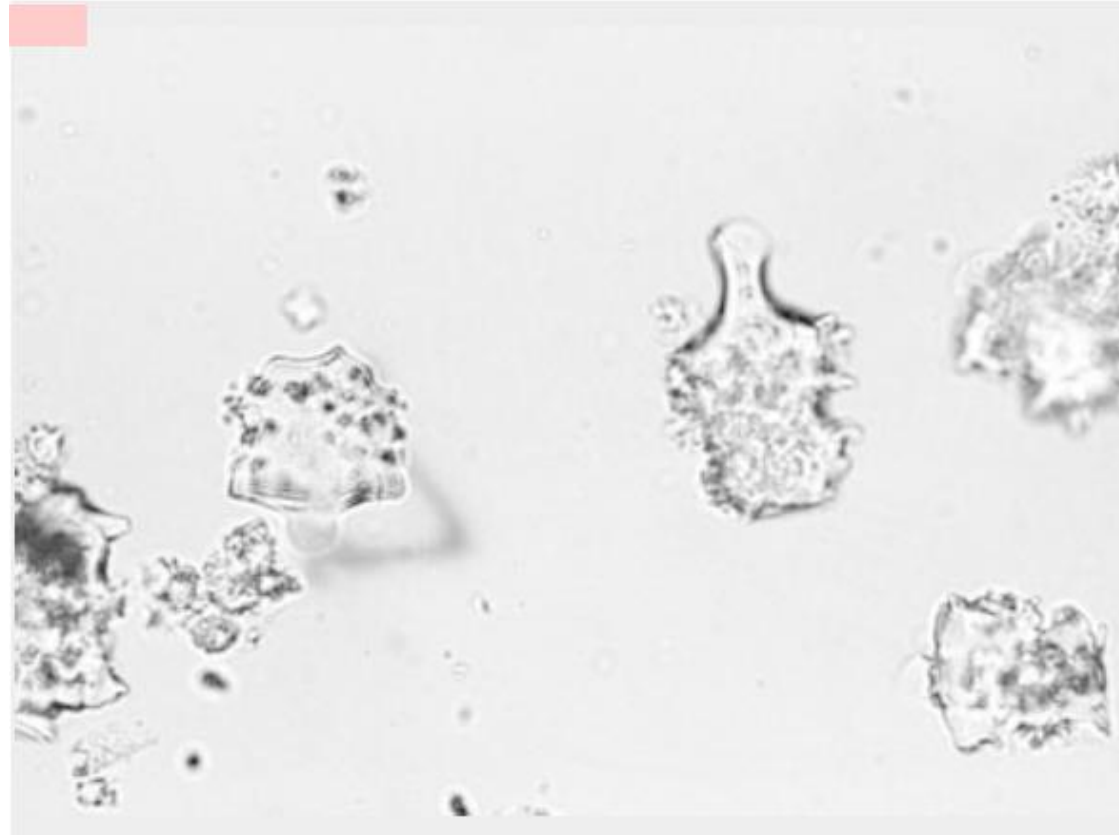
# Maranta gibba

## Phytolith

Note range of variation in size, nature of decoration on cylinders, and proportional length of bodies between bodies on the right and left.

Note: may occur in all *Maranta* spp., including *Maranta arundinaceae*. Note: you may encounter the “tip” of the body only: see below

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta gibba

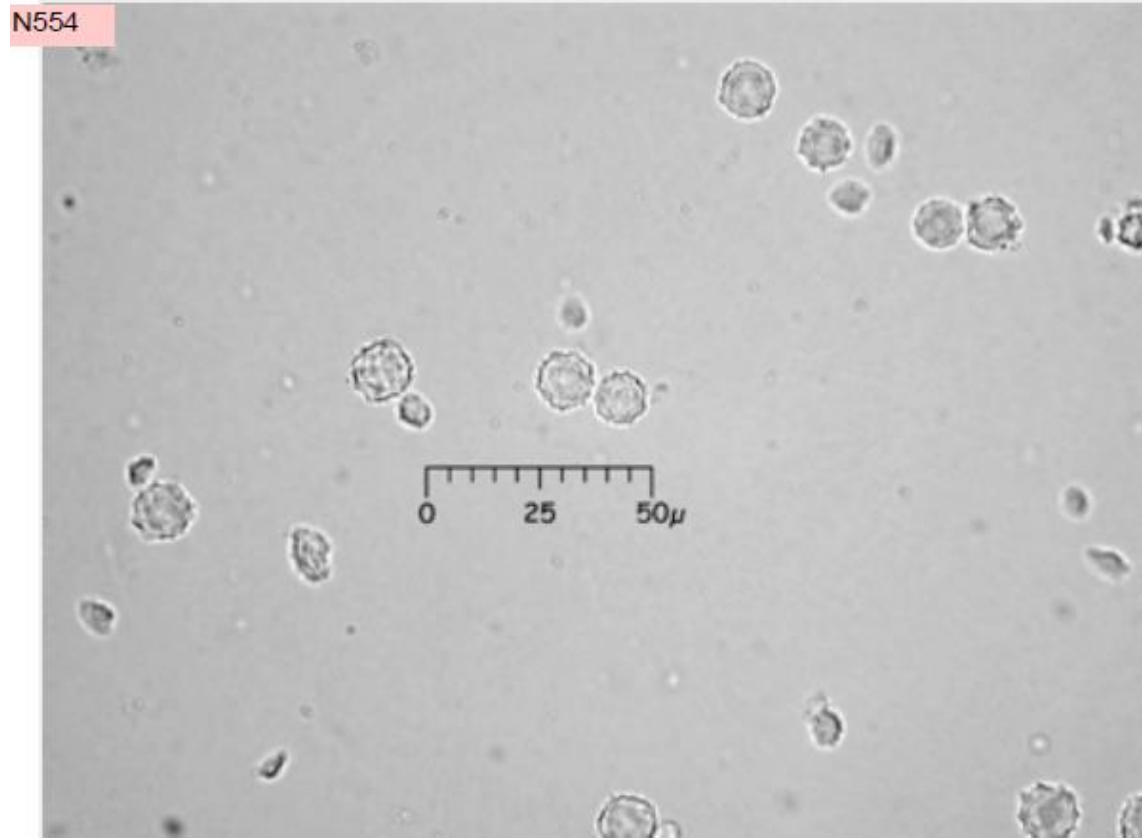
## Phytolith

Typical of leaf samples, both 80IIIB and 80ICa also appeared in the inflorescence sample of this taxon.

Diagnostic level, 80IIIB: family

Diagnostic level, 80ICa:

Marantaceae/Bombacaceae

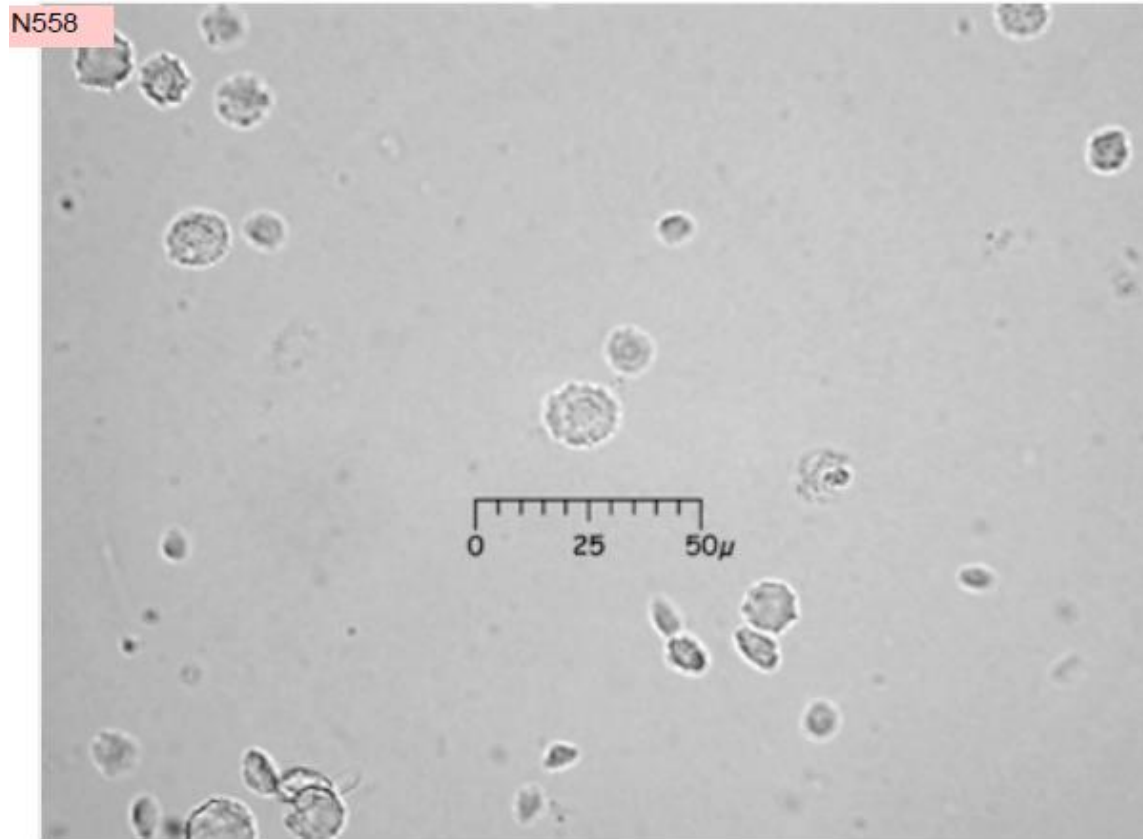


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta gibba

## Phytolith

rugulose conical bodies, Leaf sample  
Diagnostic level: family

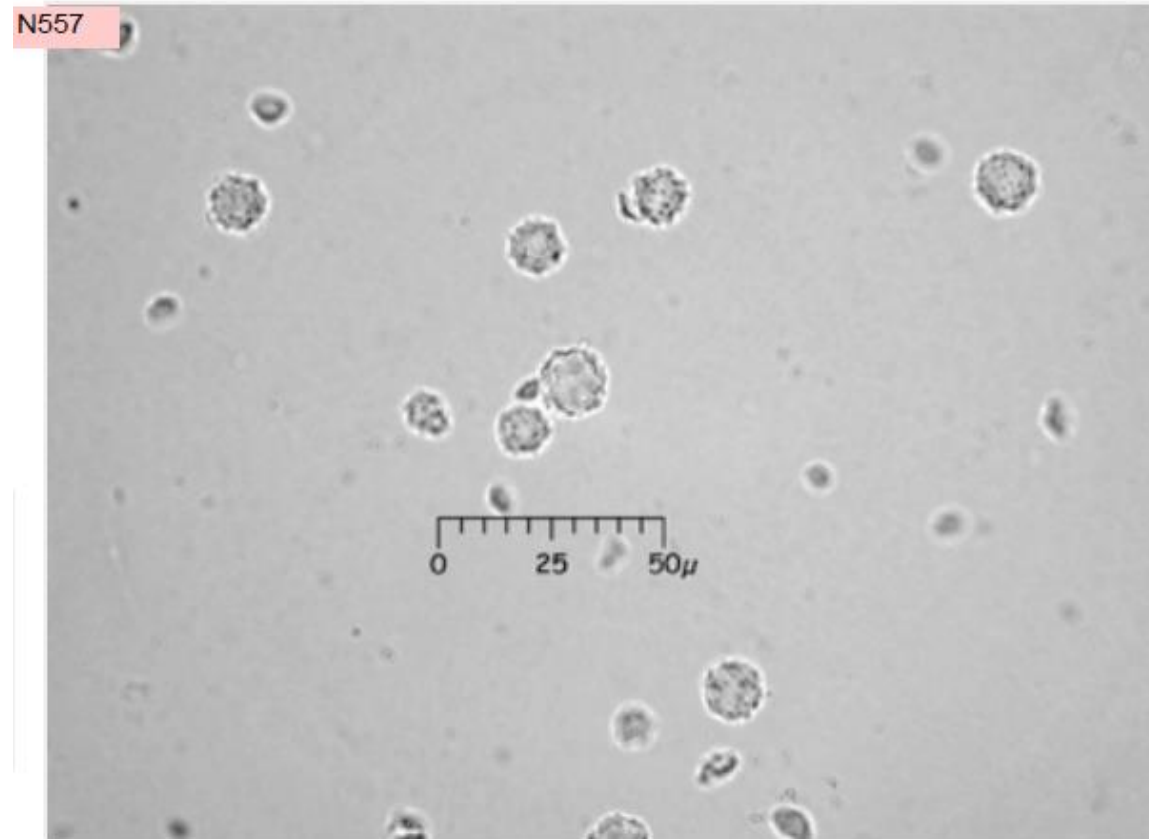


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta gibba

## Phytolith

Very elongate end of range for this type. Nodular spheres  
Diagnostic level:  
Marantaceae/Bombacaceae



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta gibba

## Phytolith

PC2036, inflorescence  
Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

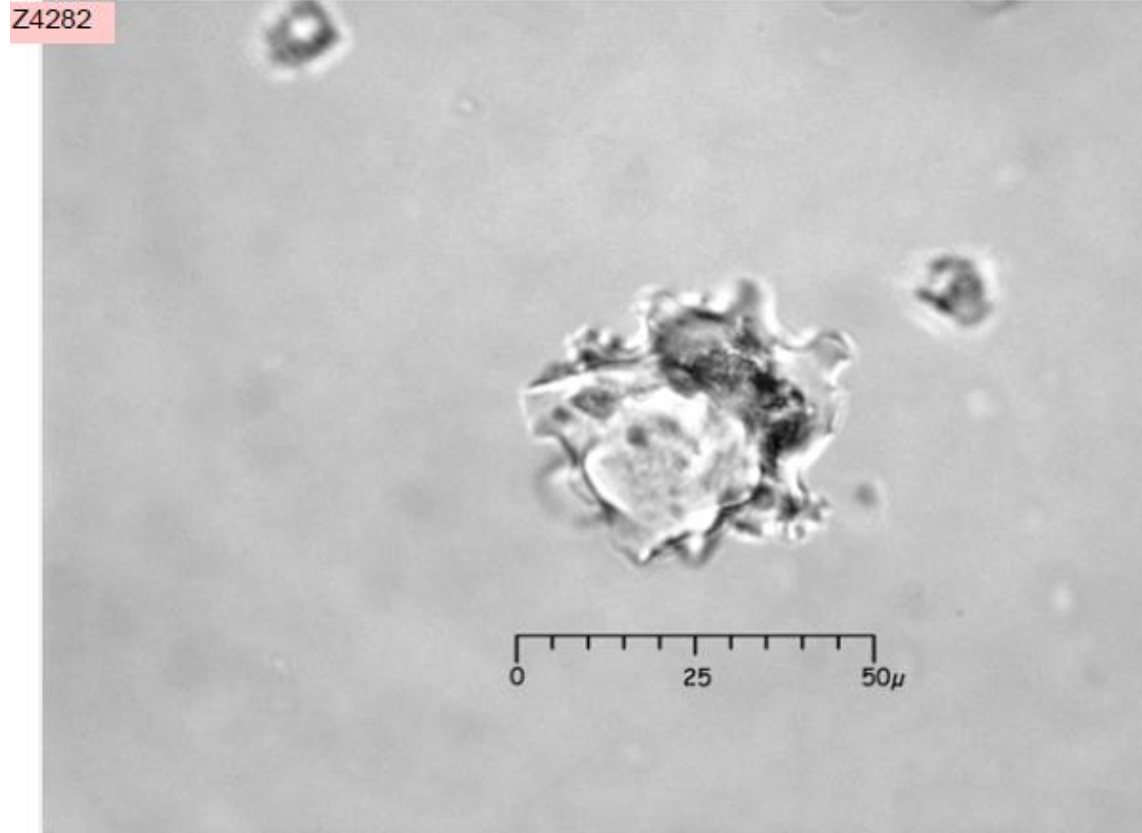
# Maranta gibba

## Phytolith

PC2036, inflorescence

Diagnostic level: genus

View shows the large irregular scallops

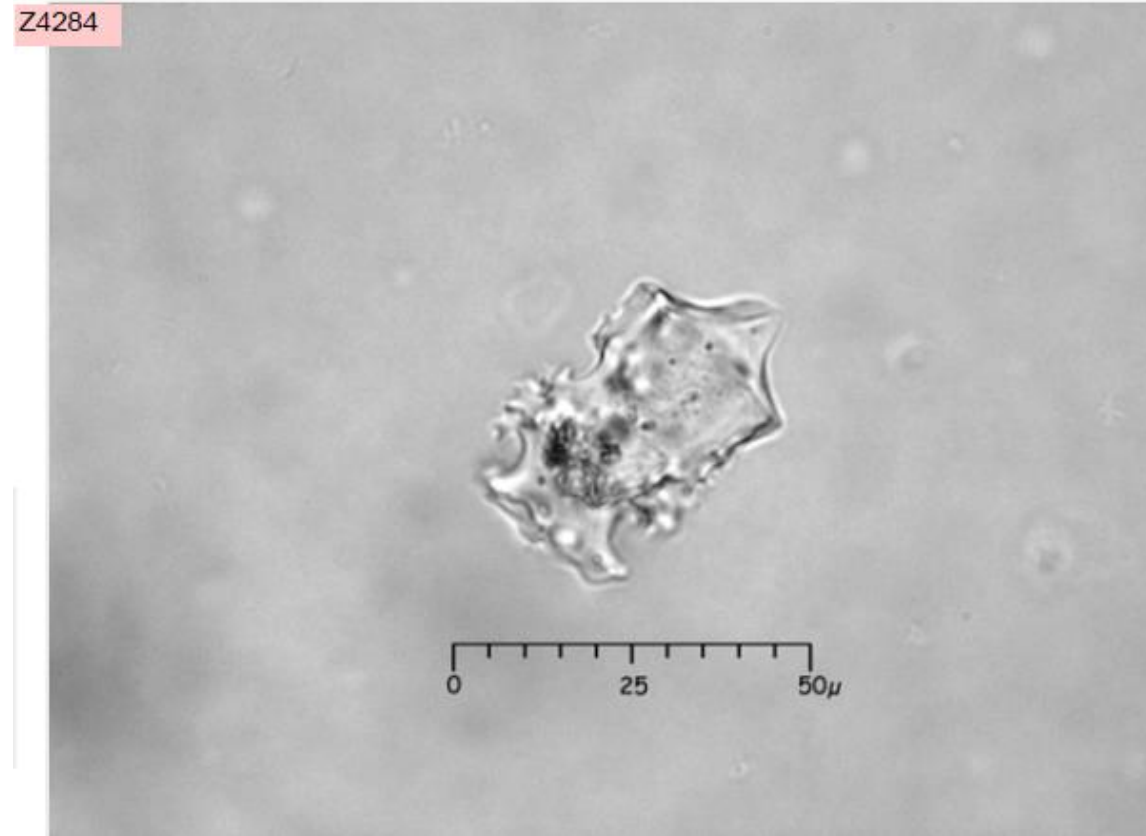


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta gibba

## Phytolith

PC2036, inflorescence  
Diagnostic level: genus

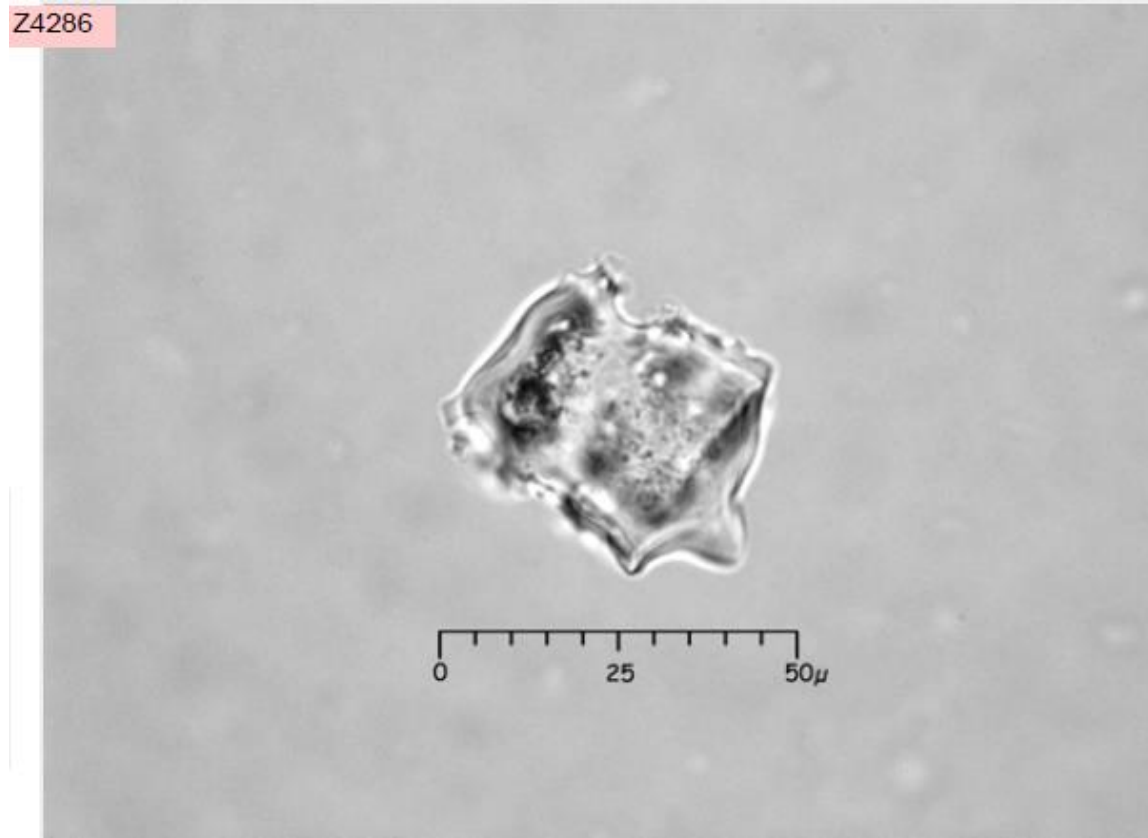


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta gibba

## Phytolith

PC2036, inflorescence  
Diagnostic level: genus



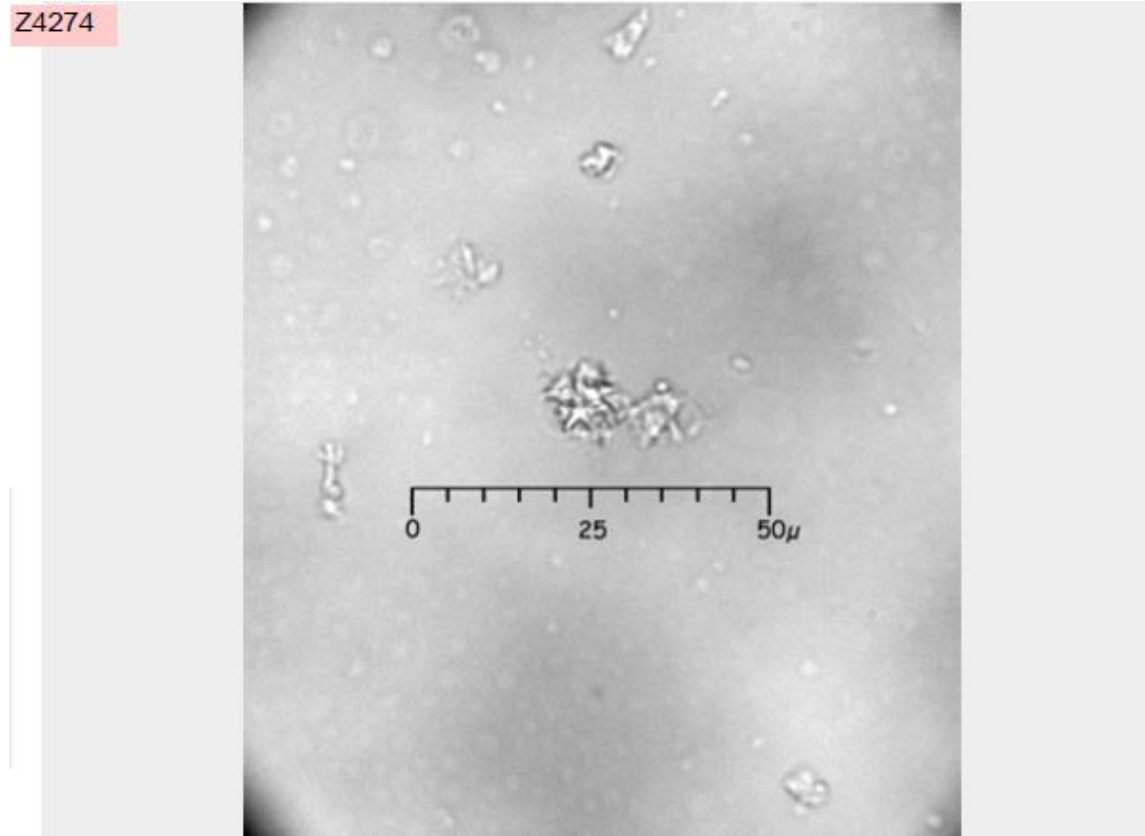
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Maranta gibba

## Phytolith

type established by Karol Chandler-Ezell  
PC2732 Maranta gibba stem base  
Diagnostic level: Calathea/Maranta



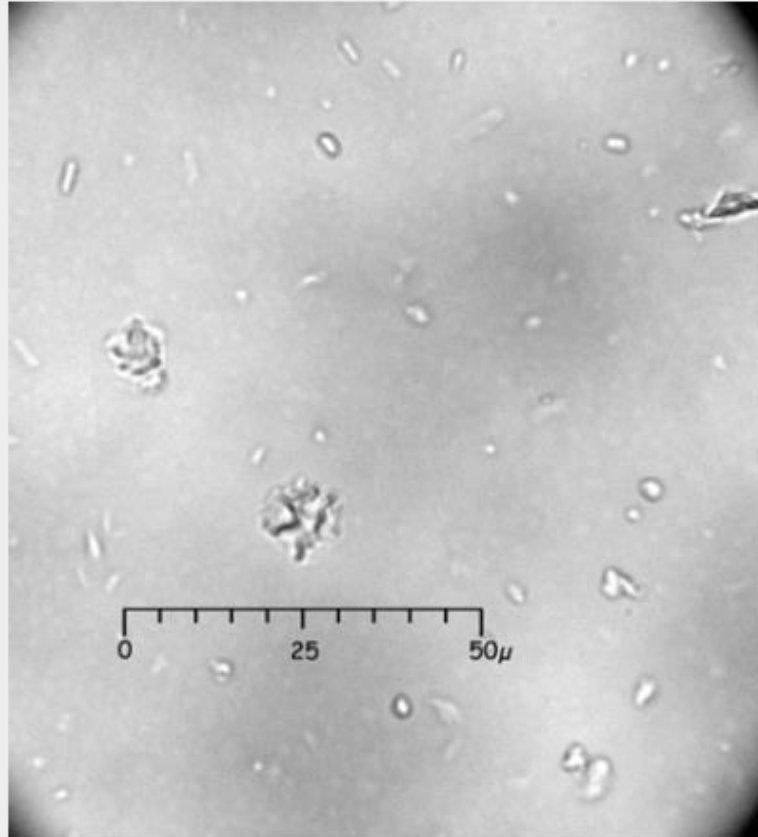
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Maranta gibba

## Phytolith

type established by Karol Chandler-Ezell  
PC2732 Maranta gibba stem base  
Diagnostic level: Calathea/Maranta

Z4275

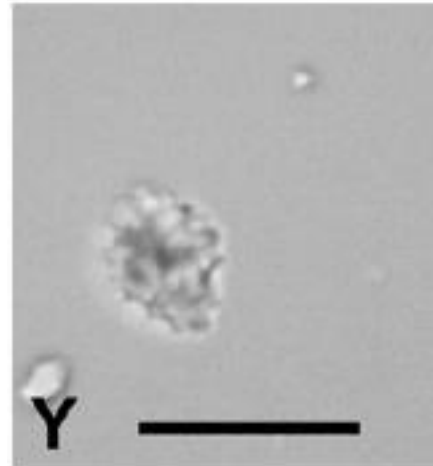


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Marantochloa hirsuta

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). Y, thin rugose hat-shape from *Marantochloa hirsuta* leaf+stem. Scale bars=12  $\mu$ m.

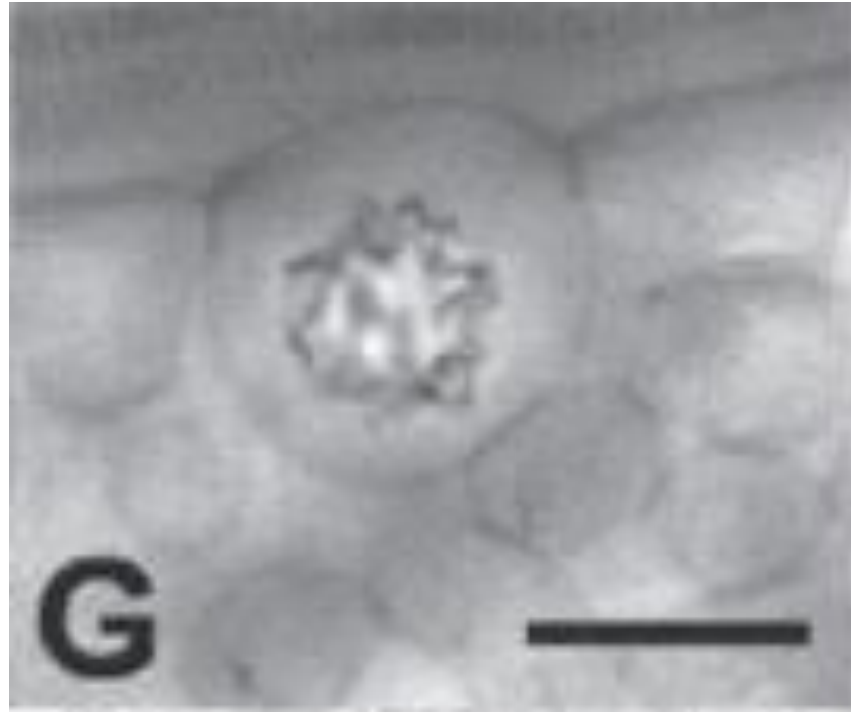


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Marantochloa purpurea

## Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. G. *Marantochloa purpurea* (Marantaceae), a druse-like intercostal silica body in a mesophyll cell (bar = 20  $\mu\text{m}$ ).

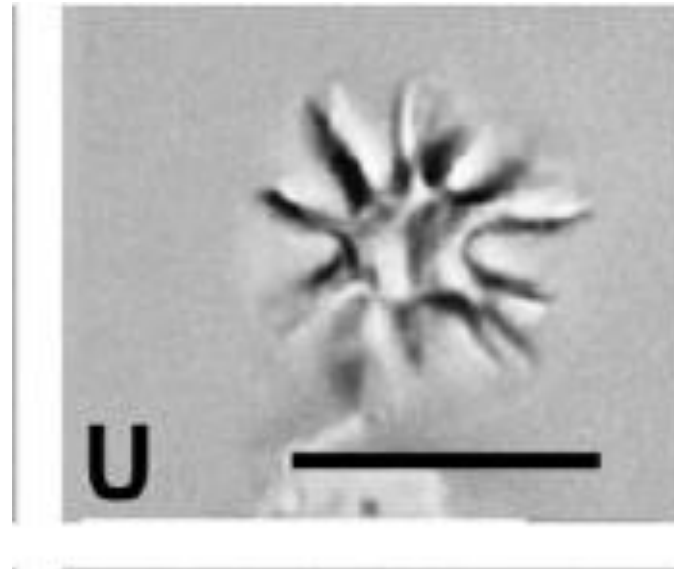


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Megaphrynium macrostachyum

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). U, globular-echinate with thin, long echinae from *Megaphrynium macrostachyum* leaf. Scale bars=12  $\mu\text{m}$ .



Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Myrosma sp.

## Starch

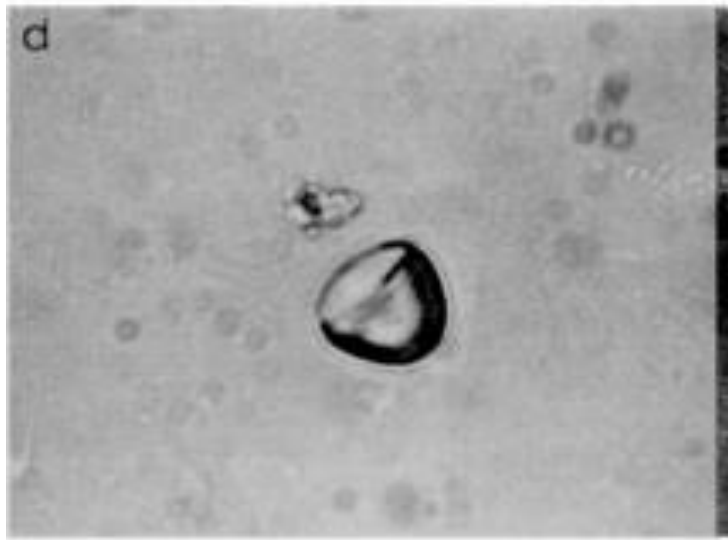


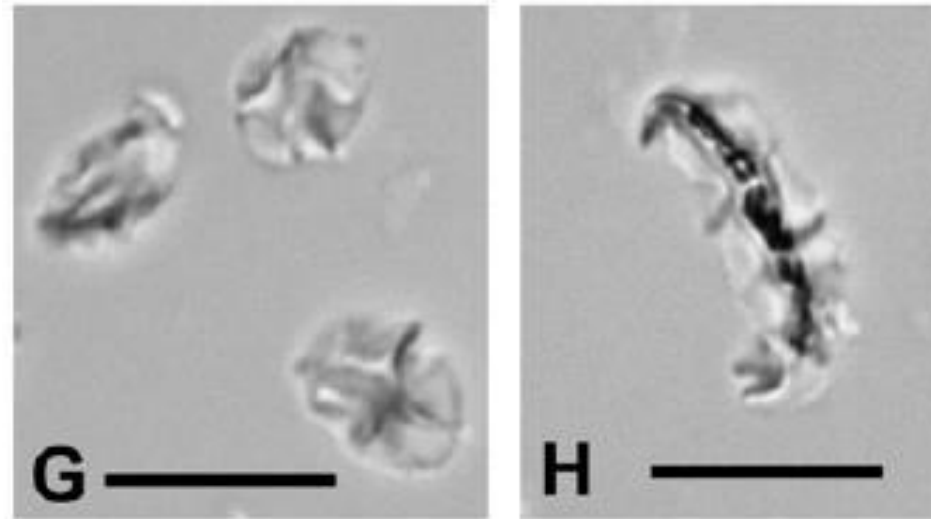
Figure 3. Light micrographs of archaeological starch granules representative of the recovered assemblage. d: Starch granule of *Myrosma* sp. recovered from flake 3.

Perry, Linda. 2002. Starch Analyses Reveal Multiple Functions of quartz “manioc” Grater Flakes from the Orinoco Basin, Venezuela. *Interciencia* 27 (11):635–39.

# Pleiostachya pruinosa

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). G, D1 fringed druses from *Pleiostachya pruinosa* leaf. H, D3 druse with an elongate axis and three main ridges in cross section from *Pleiostachya pruinosa* leaf. Scale bars=12  $\mu\text{m}$ .

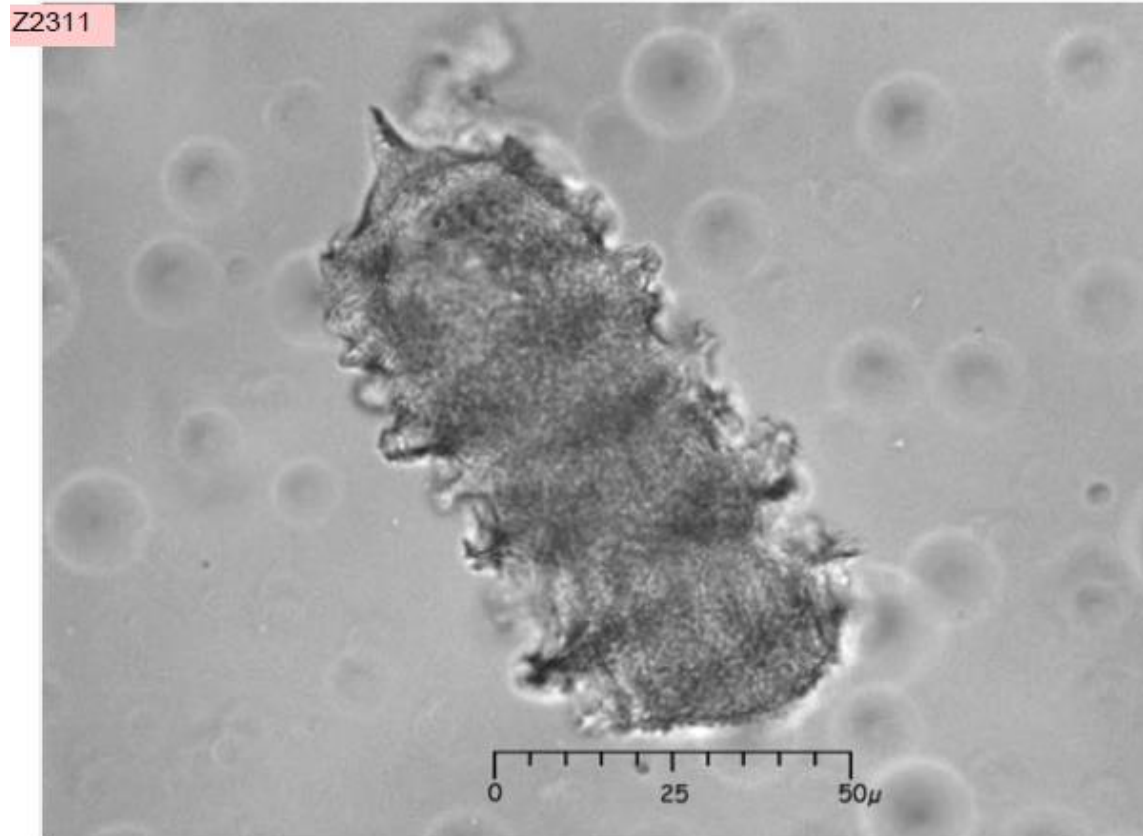


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Pleistochoya morlaei

## Phytolith

PC1826 inflorescence  
Diagnostic level: family



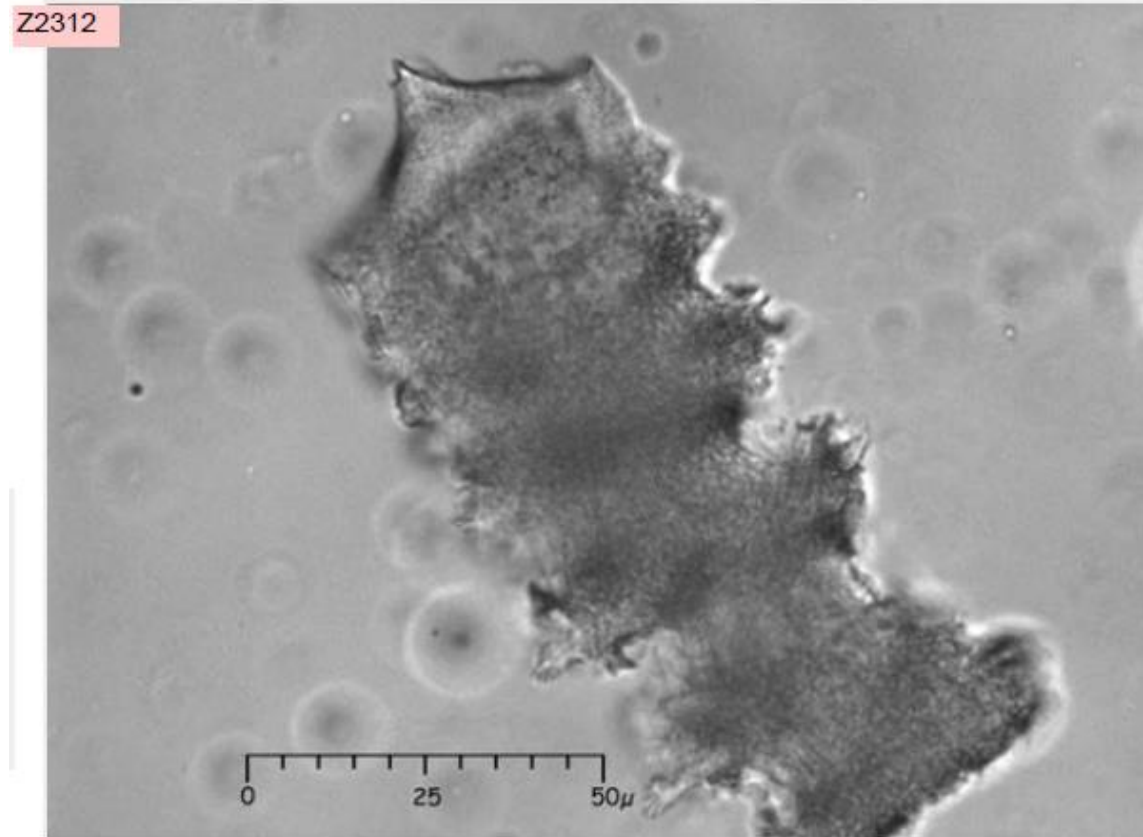
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Pleistochoya morlaei

## Phytolith

PC1826 inflorescence  
Diagnostic level: family

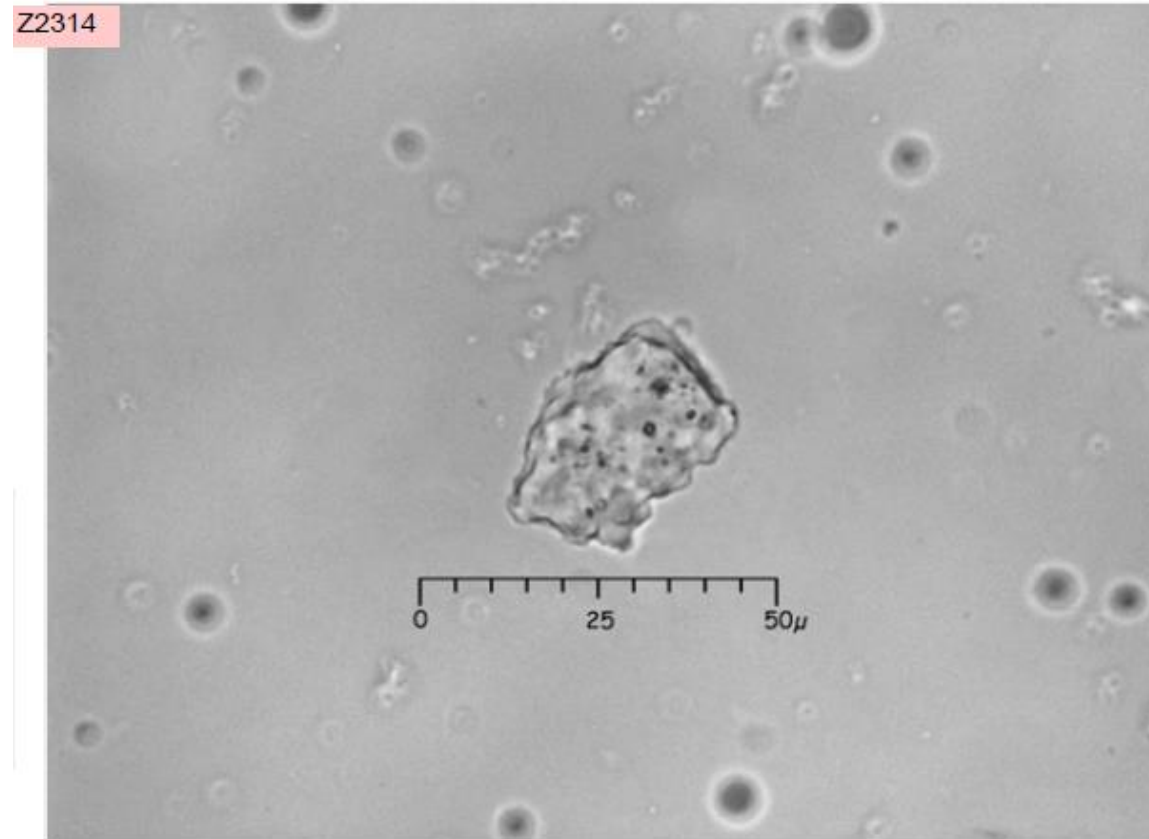


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pleistochoya morlaei

## Phytolith

PC1826, inflorescence  
Diagnostic level: under study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Pleistochoya morlaei

## Phytolith

PC1825, leaf

In this specimen the bodies are smoother, and sometimes have small projections.

Diagnostic level: family

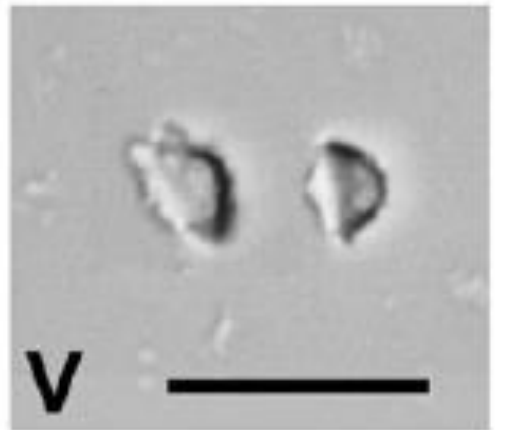


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Sarcophrynum sp.

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynum clade (T–U), Stachyphrynum clade (V–AA). V, psilate hat-shapes from *Sarcophrynum* sp. leaf. Scale bars=12  $\mu$ m.

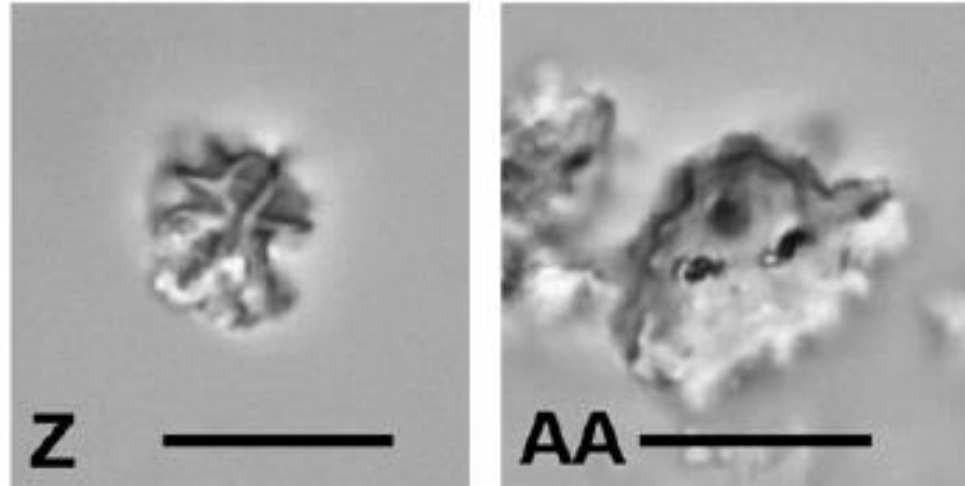


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Stachyphrynium sp.

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). Z, D1 fringed druse from Stachyphrynium sp. leaf. AA, large rugose hat-shape from Stachyphrynium sp. leaf. Scale bars=12  $\mu\text{m}$ .

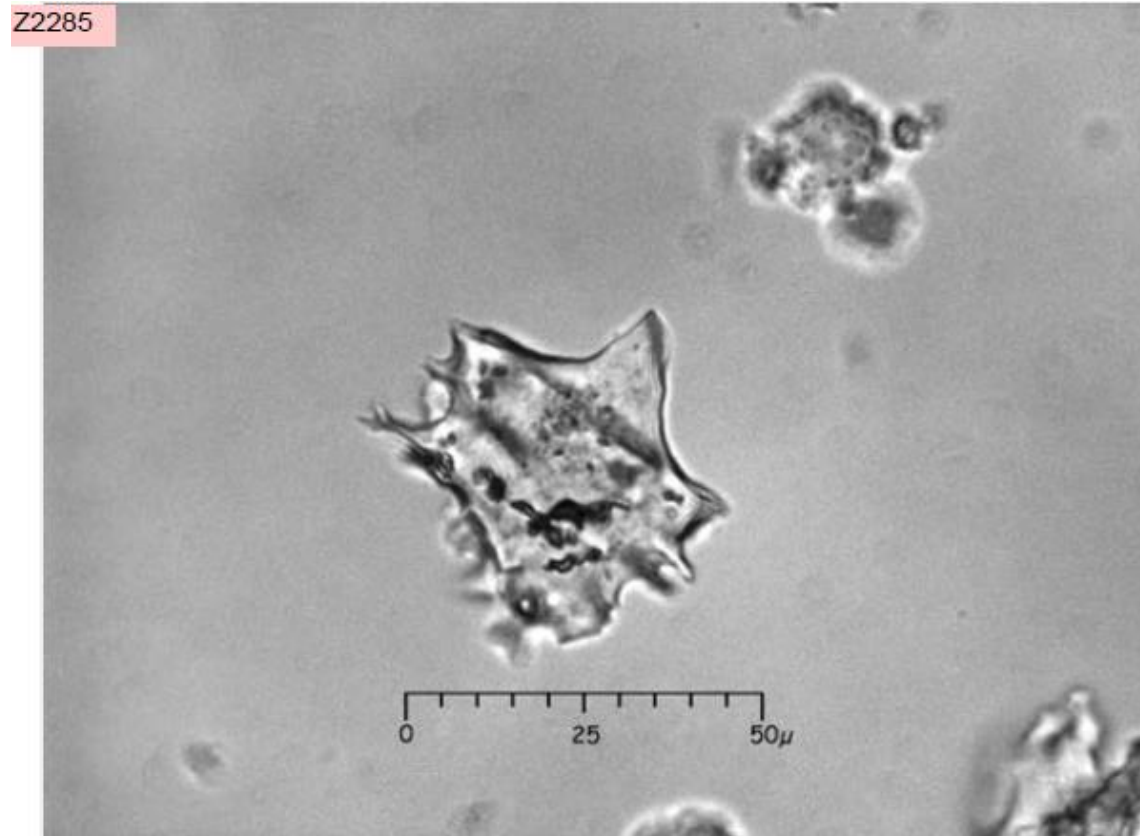


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Stromanthe jarquinii

## Phytolith

PC1822, inflorescence  
Diagnostic level: genus

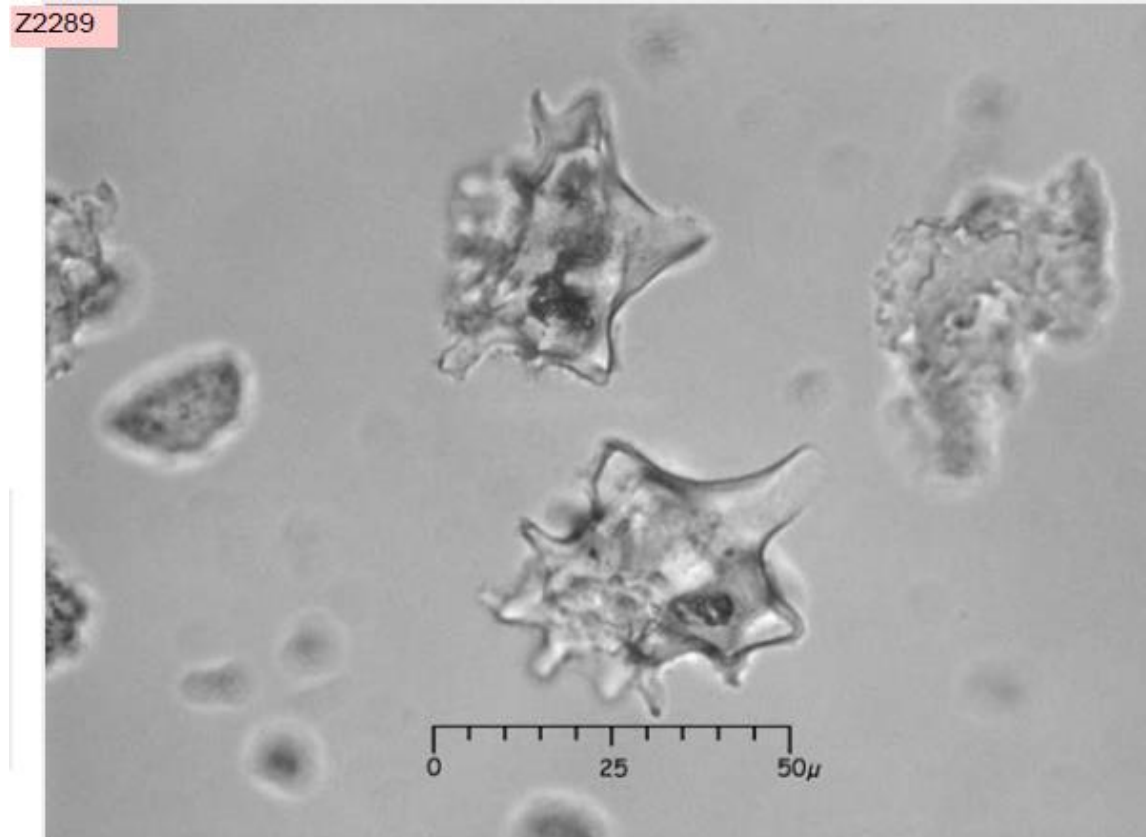


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stromanthe jarquinii

## Phytolith

PC1822, inflorescence  
Diagnostic level: genus

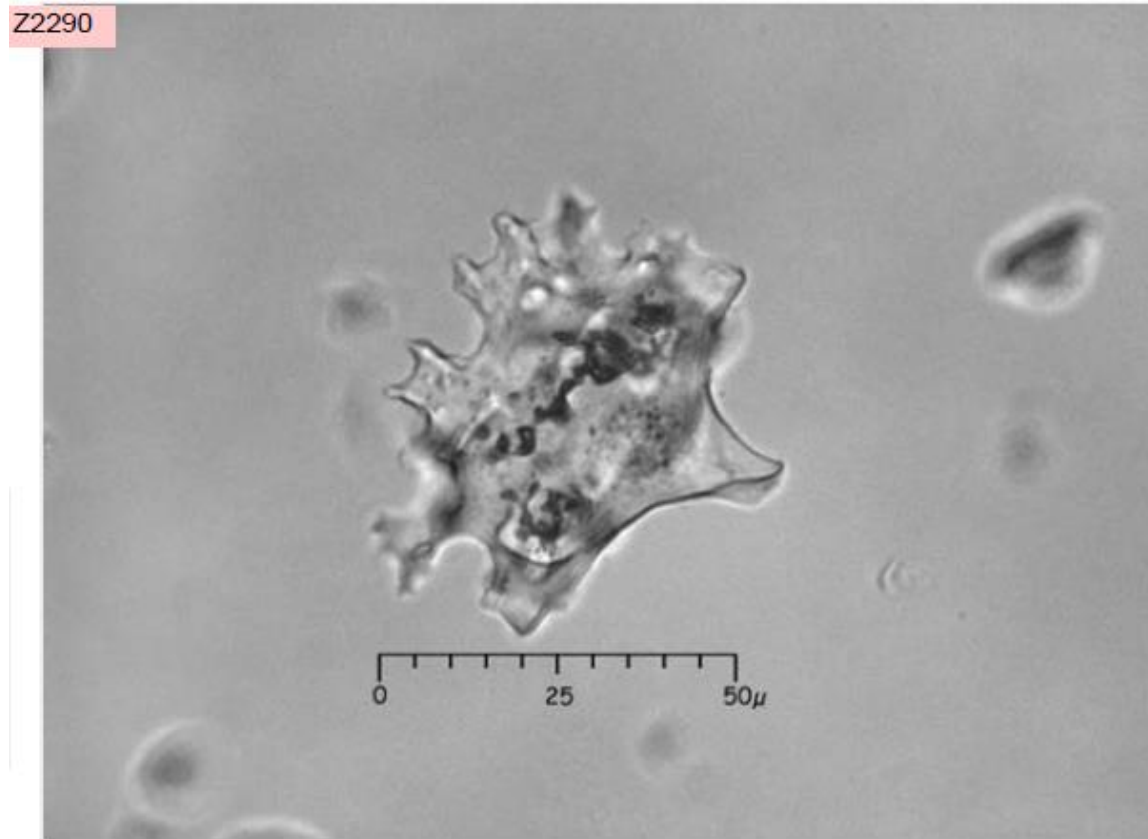


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stromanthe jarquinii

## Phytolith

PC1822, inflorescence  
Diagnostic level: genus



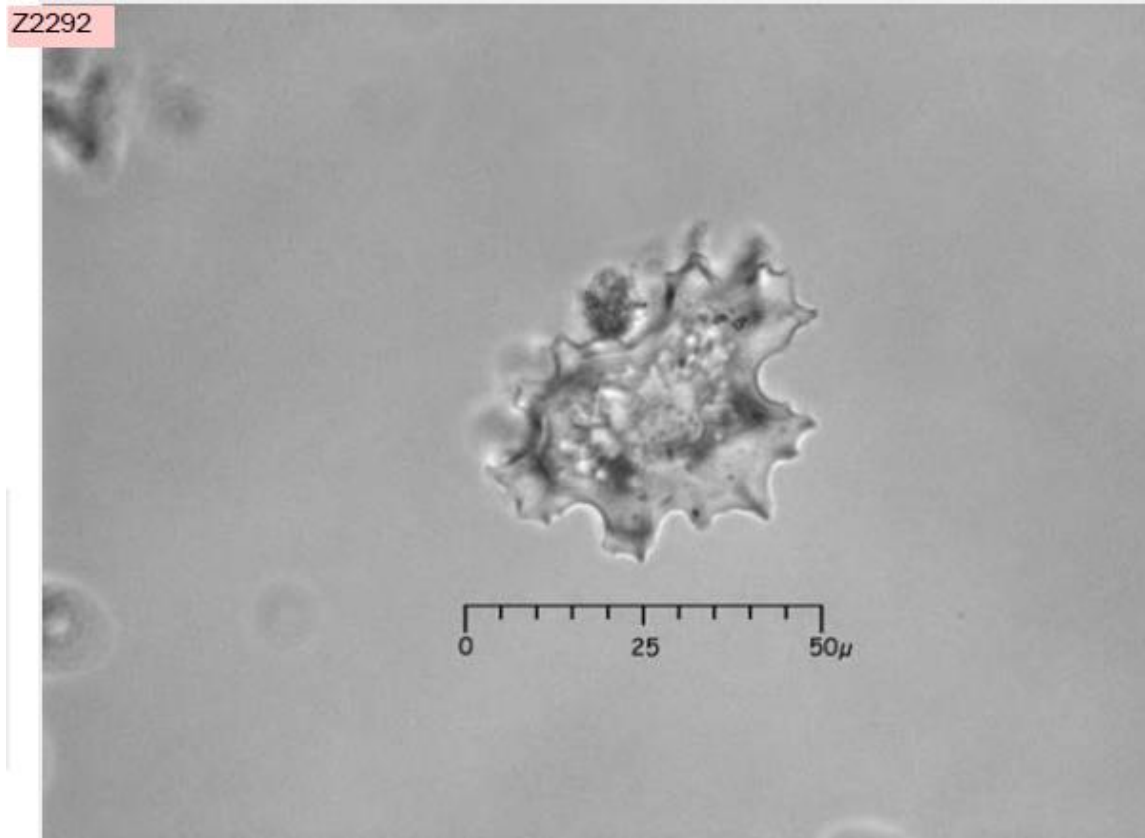
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Stromanthe jarquinii

## Phytolith

PC1822, inflorescence  
Diagnostic level: genus  
View is from base

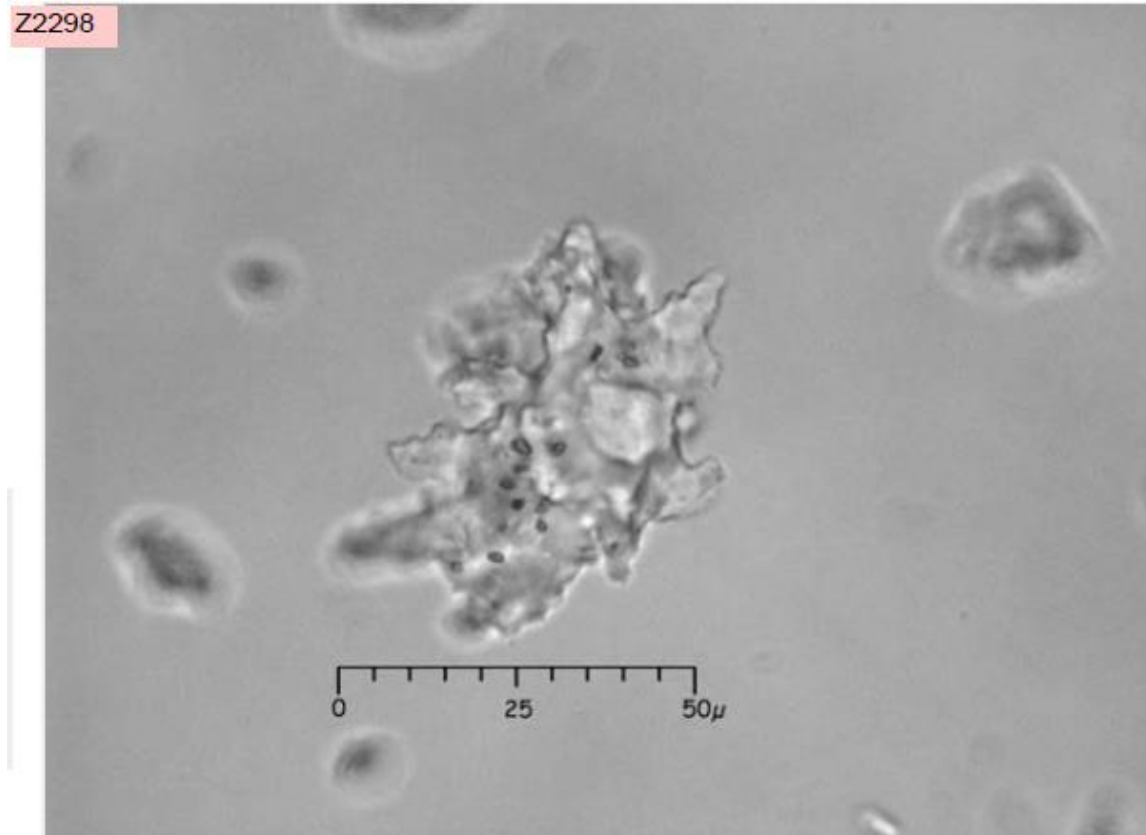


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stromanthe jarquinii

## Phytolith

PC1822, inflorescence  
Diagnostic level: genus

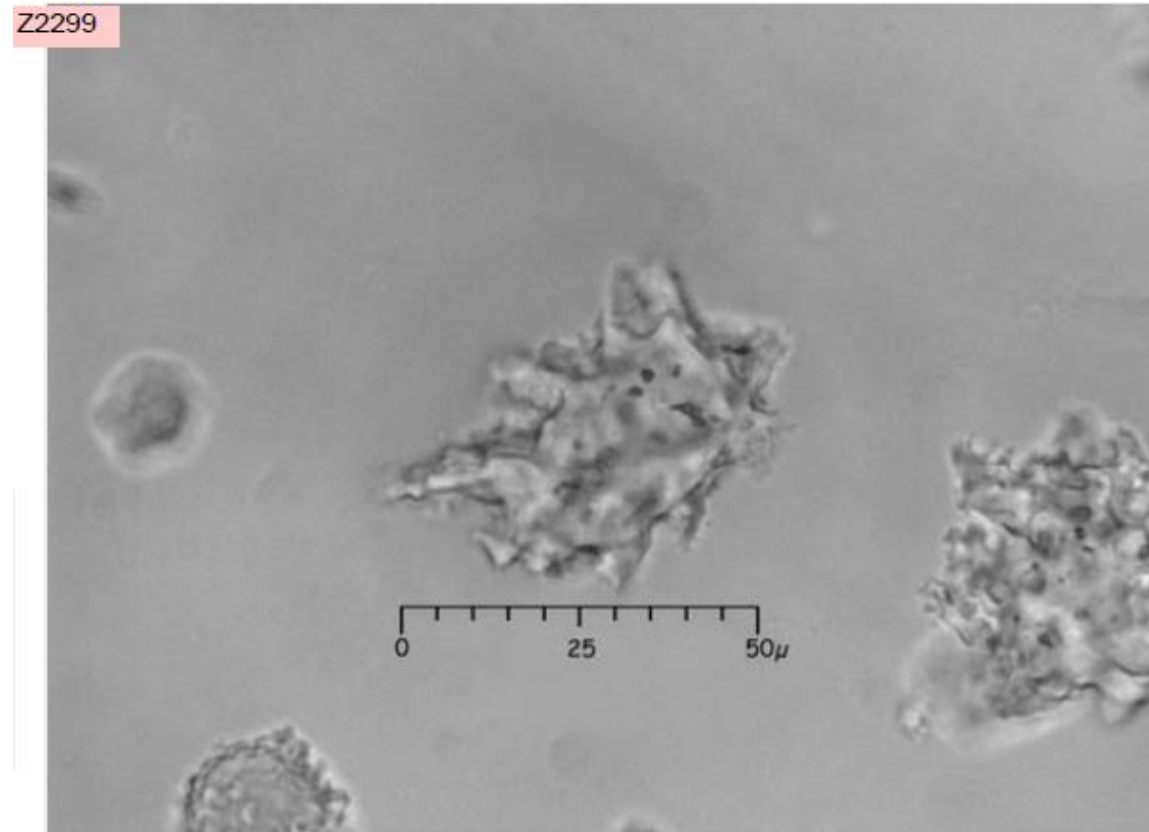


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stromanthe jarquinii

## Phytolith

PC1822, inflorescence  
Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

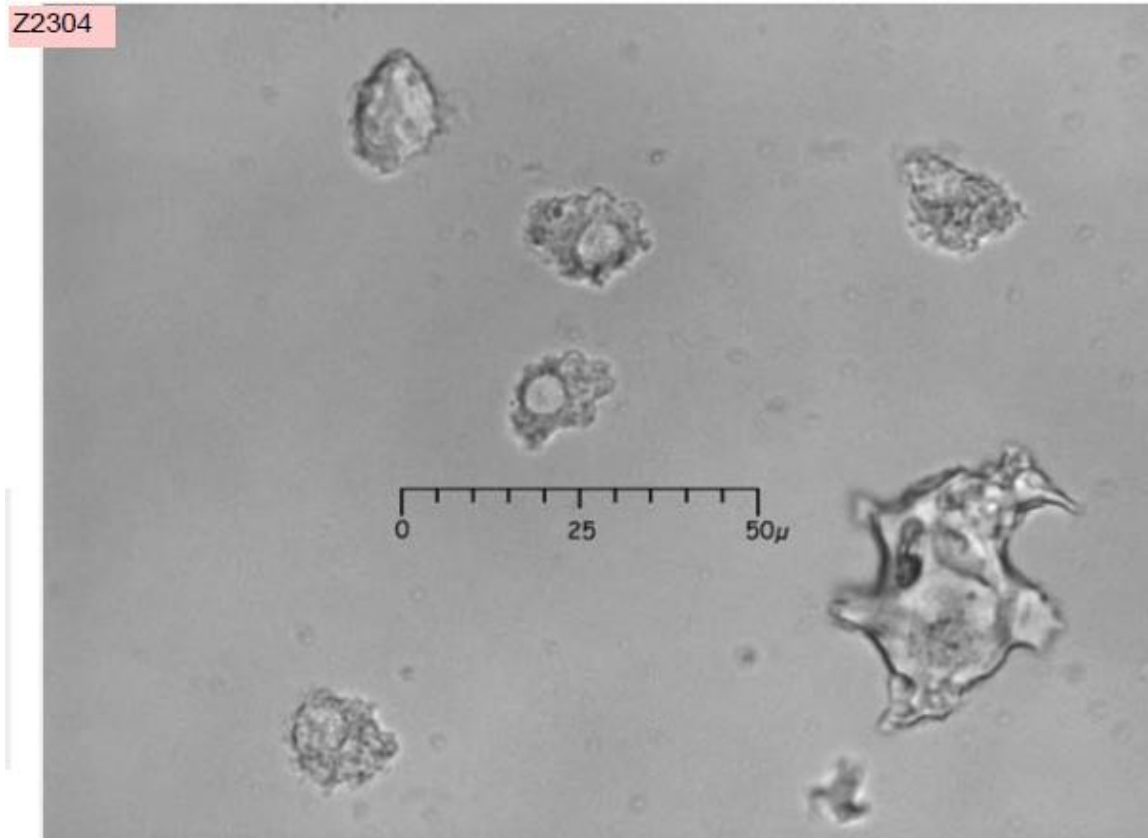
# Stromanthe jarquinii

## Phytolith

PC1822, inflorescence

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: not diagnostic



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

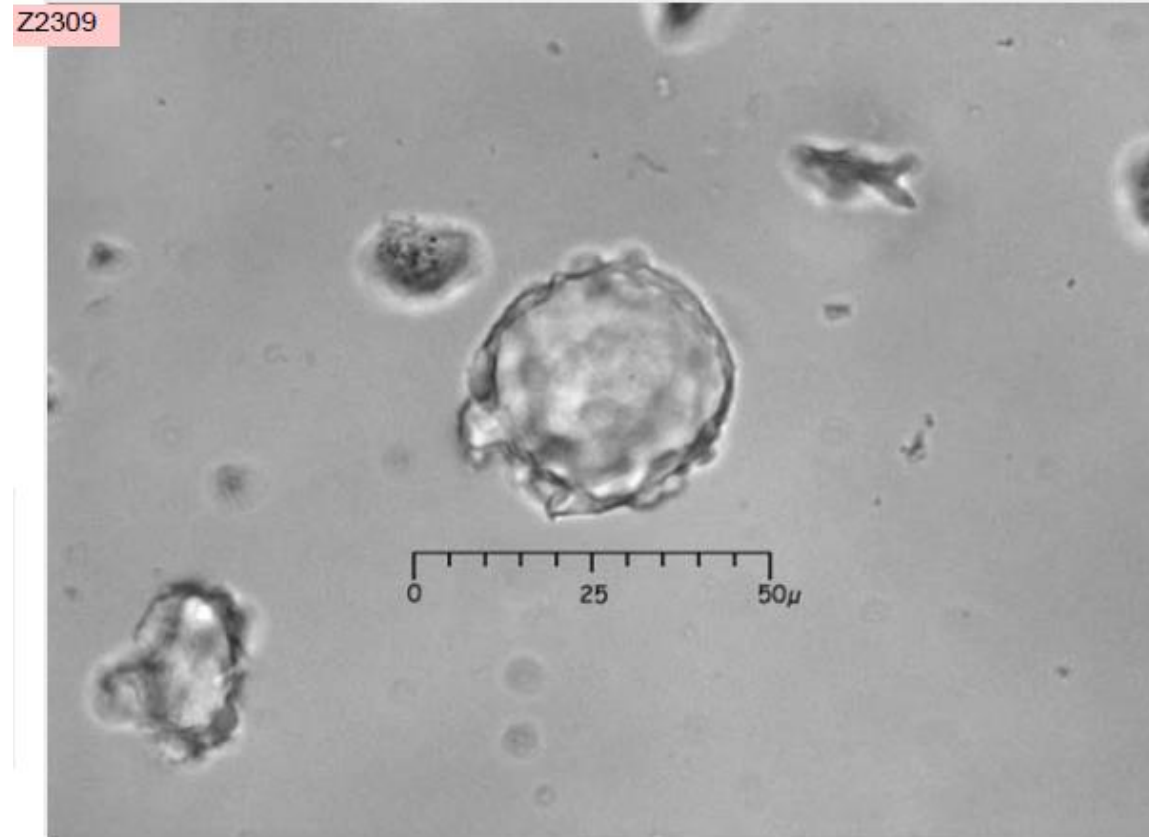
# Stromanthe jarquinii

## Phytolith

PC1822, inflorescence

Diagnostic level: under study

This view shows the round concavities

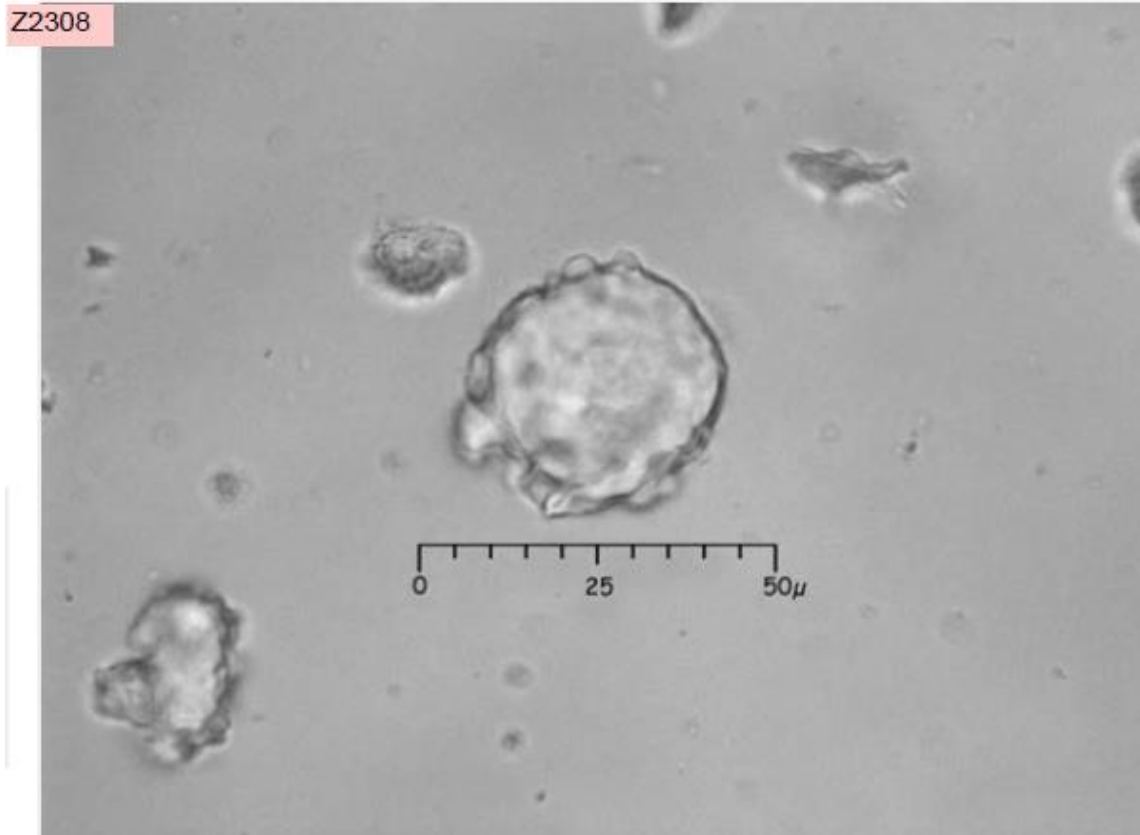


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stromanthe jarquinii

## Phytolith

PC1822, inflorescence  
Diagnostic level: under study  
This view shows the rounded  
projections



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stromanthe jarquinii

## Phytolith

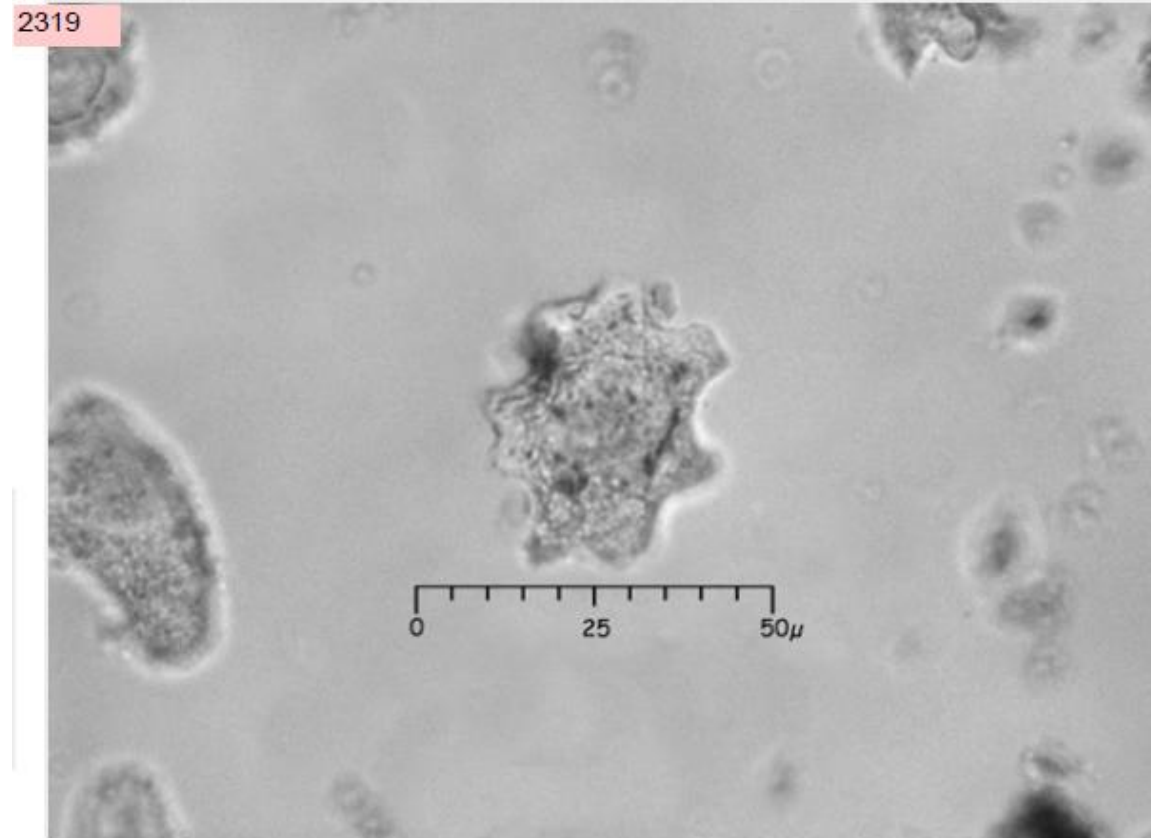
PC2622, inflorescence

Diagnostic level: Stromanthe, Thalia

This specimen had only short cylinders.

Bottom view

Compare to 22VIIDd, Donax



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stromanthe jarquinii

## Phytolith

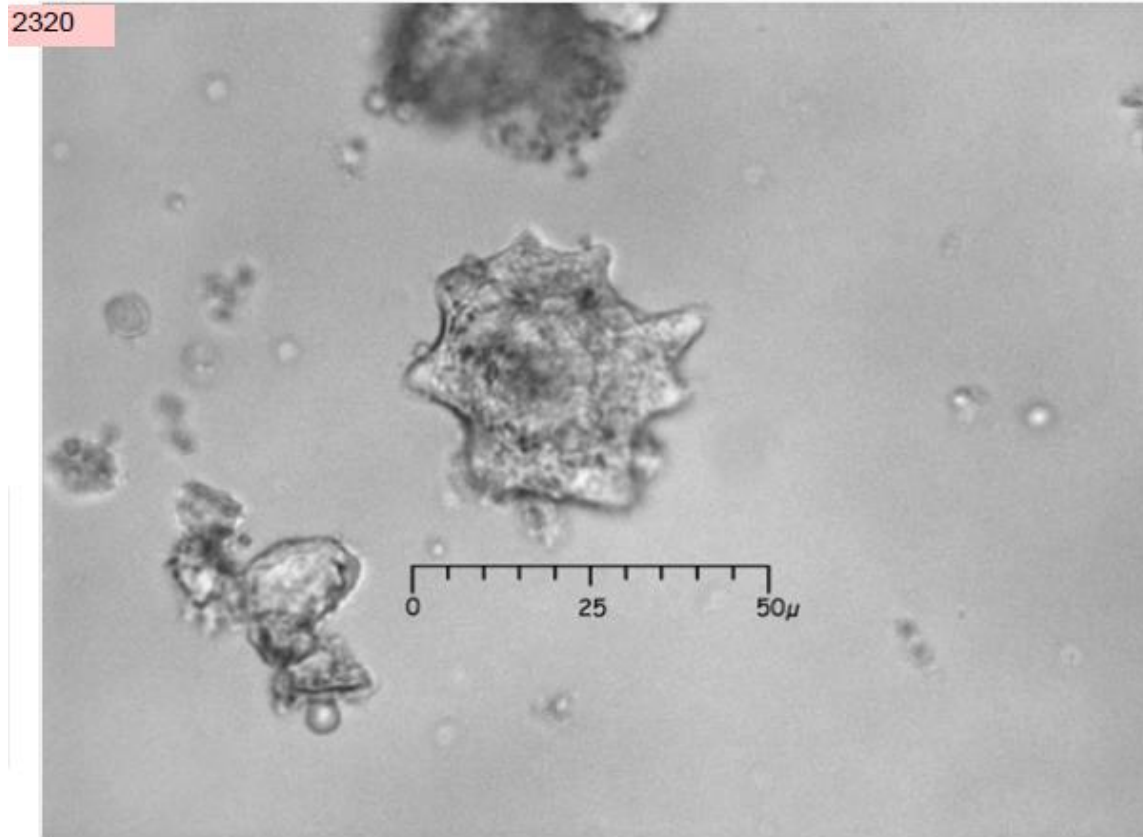
PC2622, inflorescence

Diagnostic level: Stromanthe, Thalia

This specimen had only short cylinders.

Bottom view

Compare to 22VIIDd, Donax



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Stromanthe jarquinii

## Phytolith

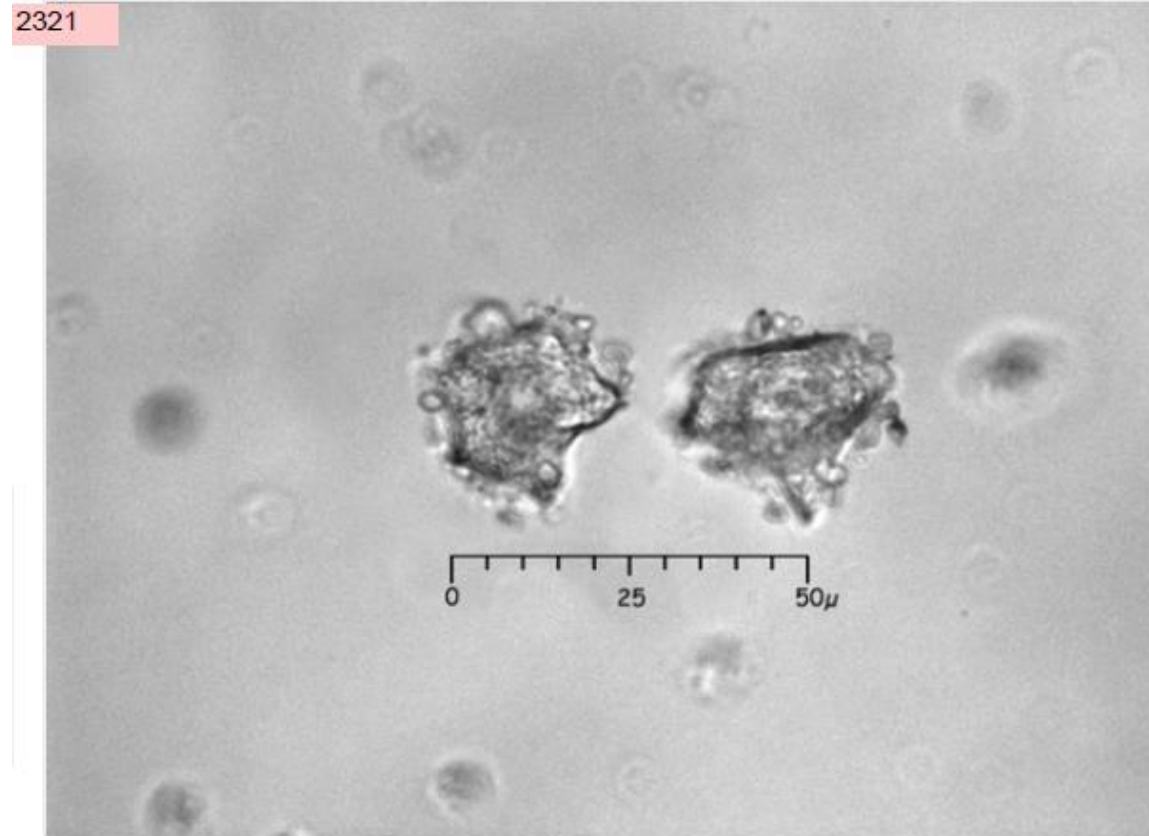
PC2622, inflorescence

Diagnostic level: Stromanthe, Thalia

This specimen had only short cylinders.

Body on right shows the side view

Compare to 22VIIDd, Donax

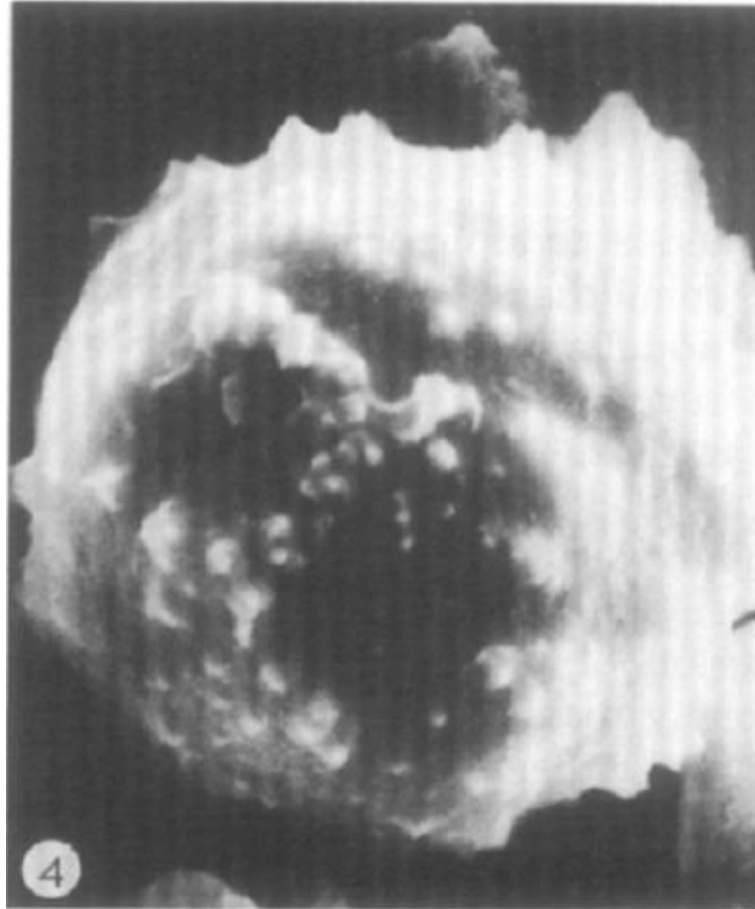


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stromanthe lutea

## Phytolith

4. SEM photograph of a spherical nodular phytolith from *Stromanthe lutea* (2500 x ).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Stromanthe stromanthoides

## Phytolith

PC1824, inflorescence

Type established by Karol Chandler-Ezell, 2004

Diagnostic level: not diagnostic

Image shows variation in size and shape; note very elongated example

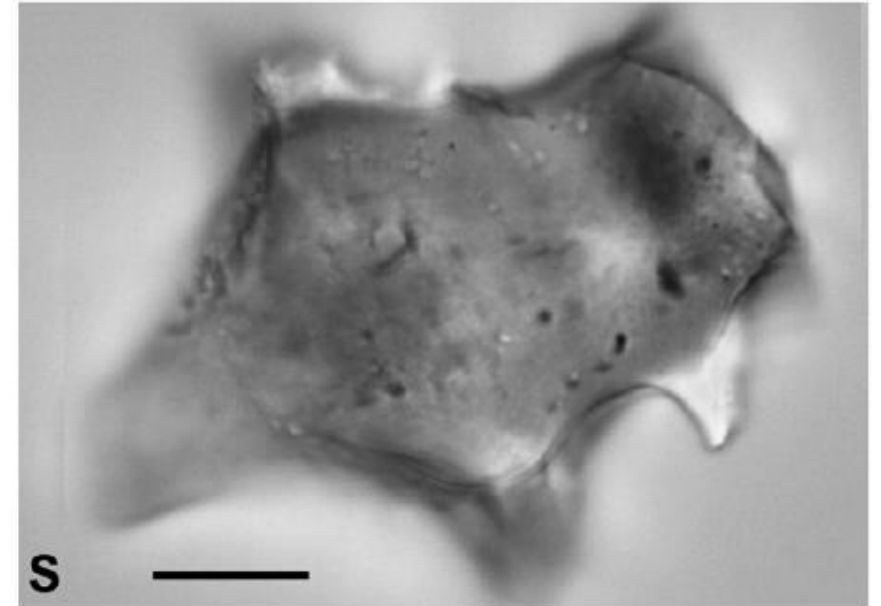
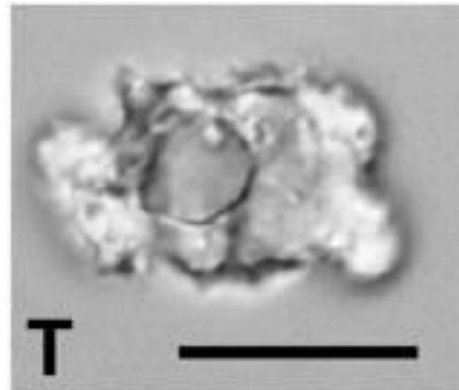
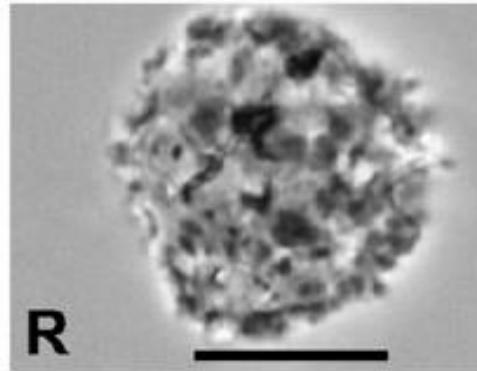


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Stromanthe stromanthades

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). R, flattened globular-granulate from *Stromanthe stromanthades* fruit bract. S, Kn2 knobby from *Stromanthe stromanthades* seed. T, Ta5 (irregularly thickened, more or less rectangular with a granulate surface and non-raised central concavity) from *Stromanthe stromanthades* seed. Scale bars=12  $\mu\text{m}$ .

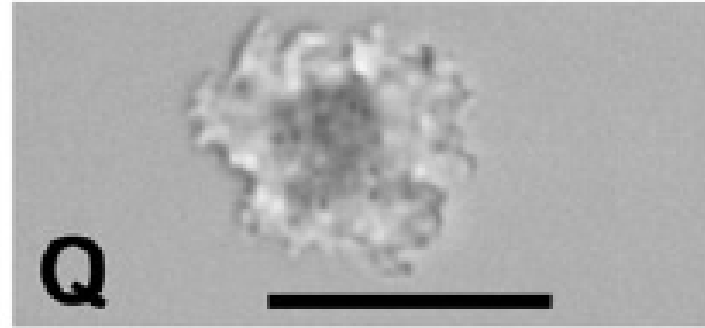


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Stromanthe tonckat

## Phytolith

Fig. 3. Marantaceae; Calathea clade (A–H, L), Donax clade (I–K), Maranta clade (M–S), Sarcophrynium clade (T–U), Stachyphrynium clade (V–AA). Q, rugose hat-shape with crenate margins from *Stromanthe tonckat* leaf. Scale bars=12  $\mu\text{m}$ .



Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Thalia geniculata

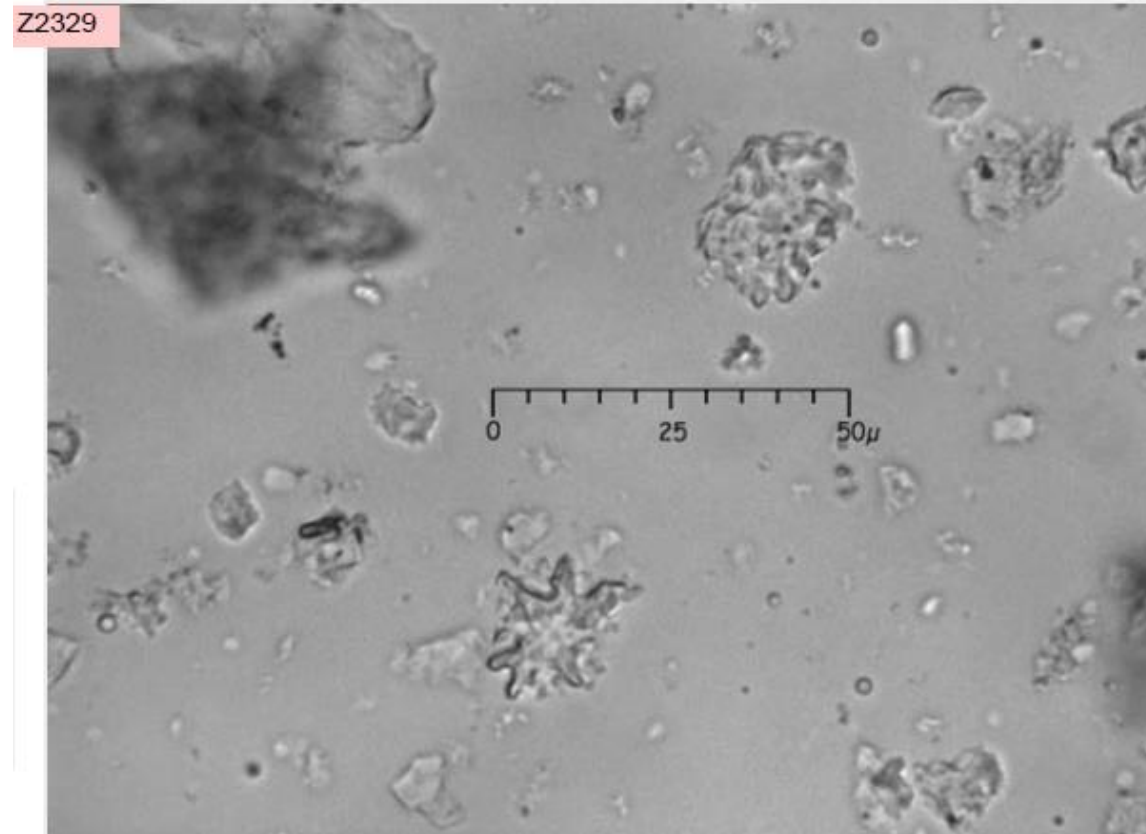
## Phytolith

PC1156, fruit

Diagnostic level: under study

This specimen had some examples with longer projections; see body below the scale and compare to one above the scale

Rarely observed in *Thalia multiflora* leaf

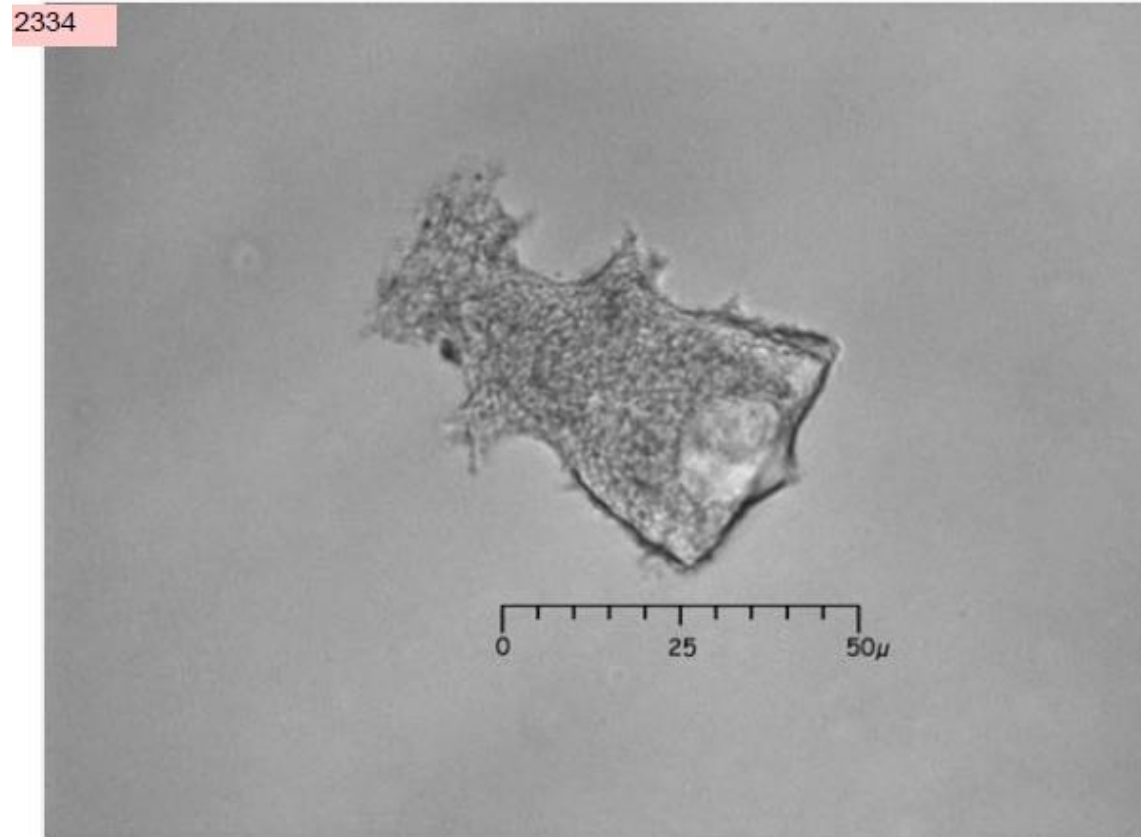


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Thalia geniculata

## Phytolith

PC1818, inflorescence  
Diagnostic level: Stromanthe, Thalia  
This specimen has long cylinders  
Compare to 22VIIDd, Donax



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Thalia geniculata

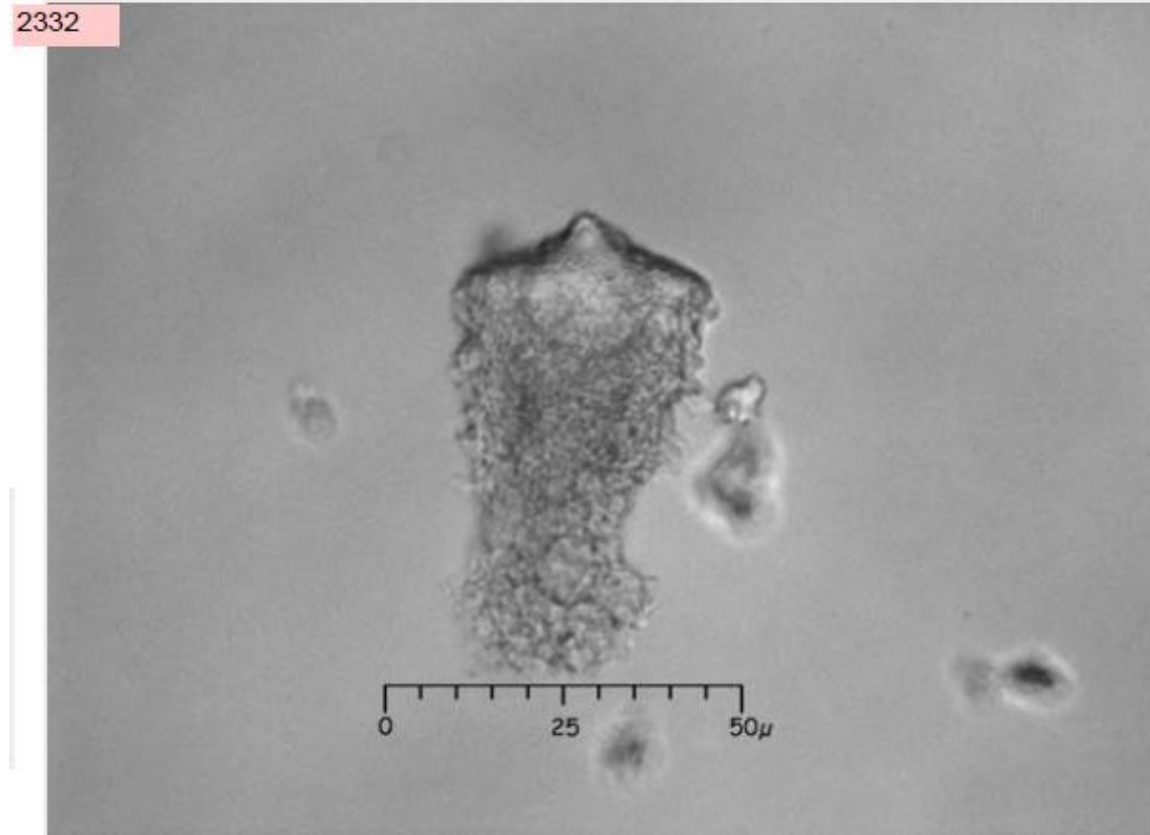
## Phytolith

PC1818, inflorescence

Diagnostic level: Stromanthe, Thalia

This specimen has long cylinders

Compare to 22VIIDd, Donax



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Thalia geniculata

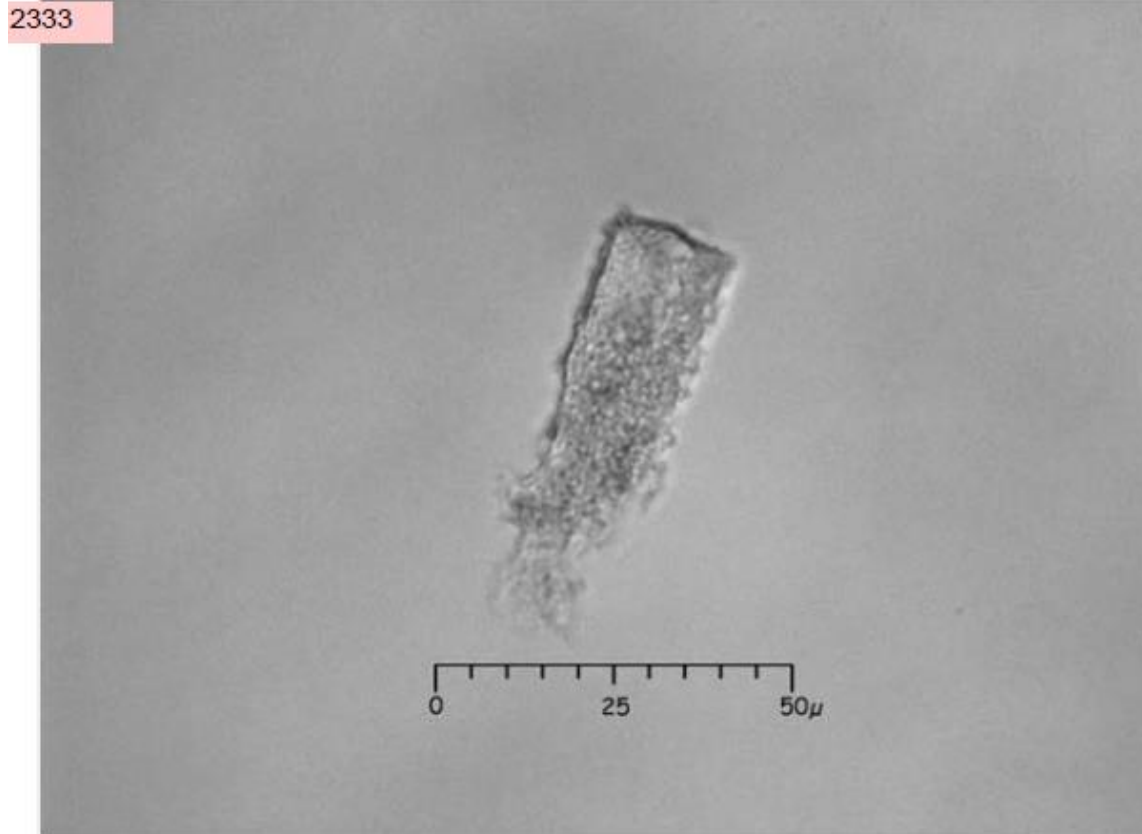
## Phytolith

PC1818, inflorescence

Diagnostic level: Stromanthe, Thalia

This specimen has long cylinders. Image shows an example which lacks projecting tip

Compare to 22VIIDd, Donax



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

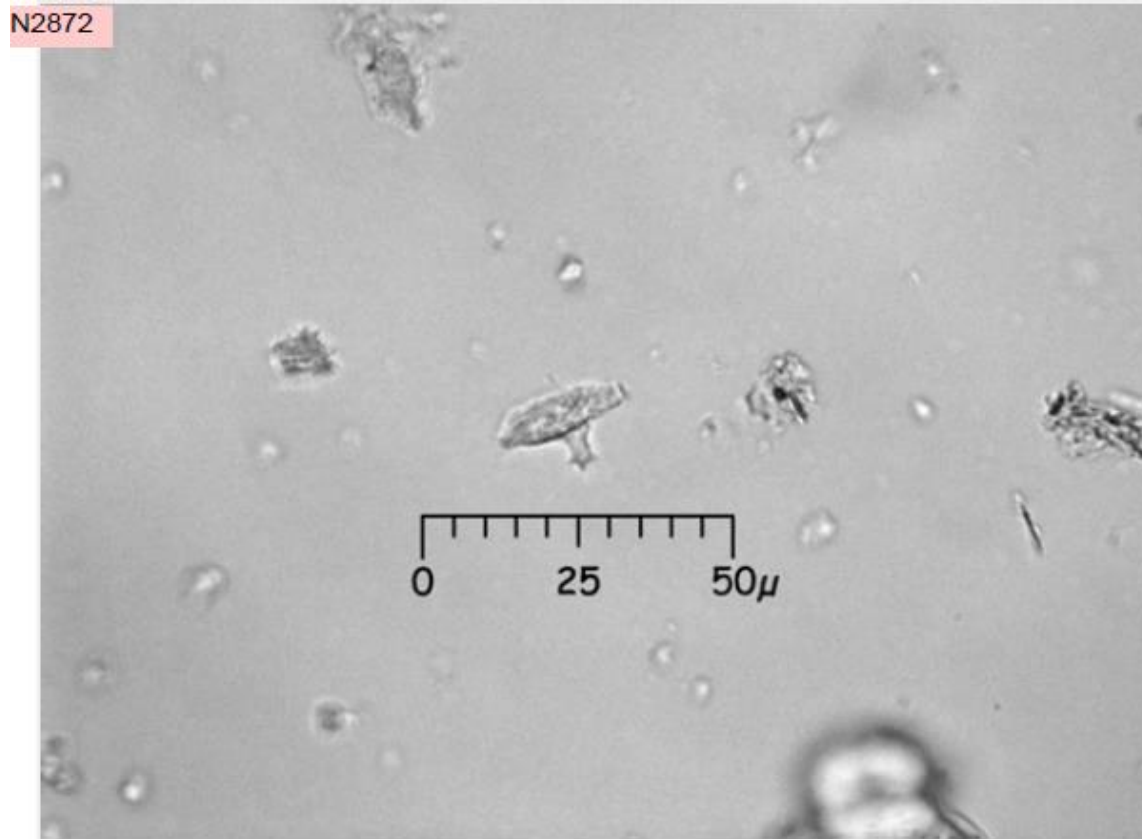
# Thalia geniculata

## Phytolith

PC1740, root, common.

Type defined by Karol Chandler-Ezell,  
11/2004

Diagnostic level: under study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

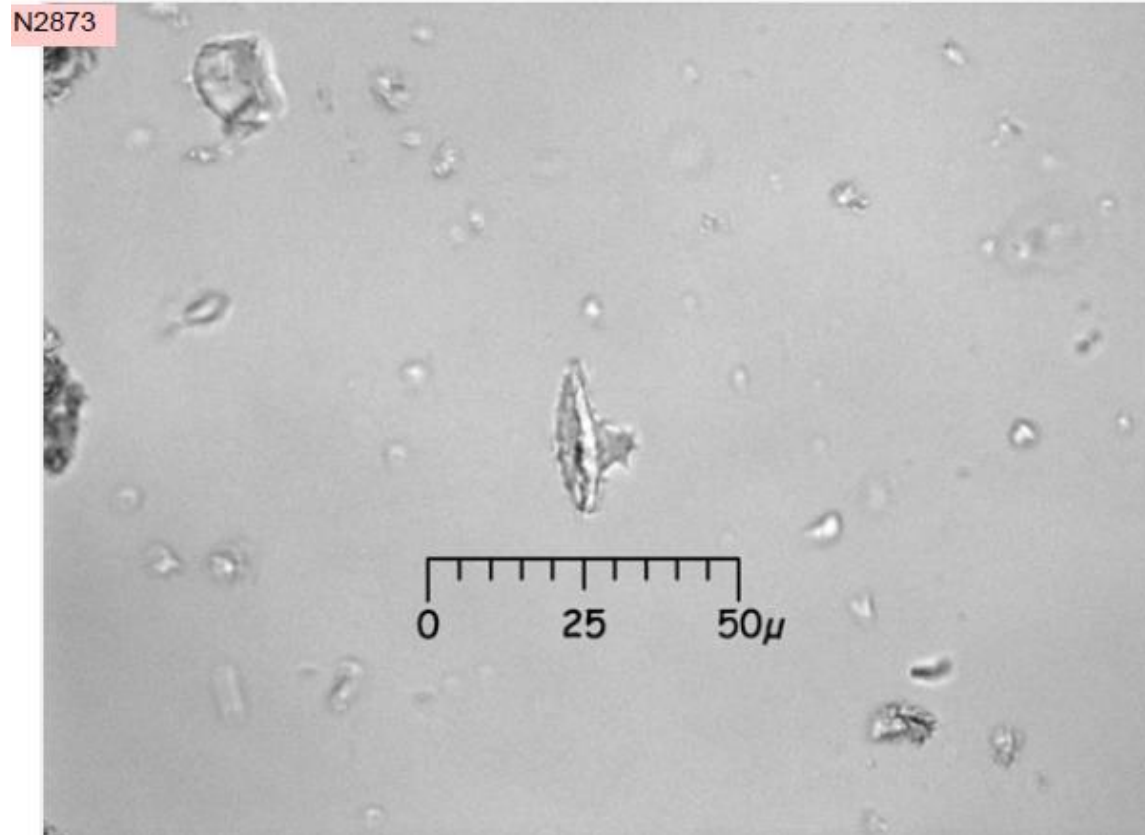
# Thalia geniculata

## Phytolith

PC1740, root, common.

Type defined by Karol Chandler-Ezell,  
11/2004

Diagnostic level: under study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

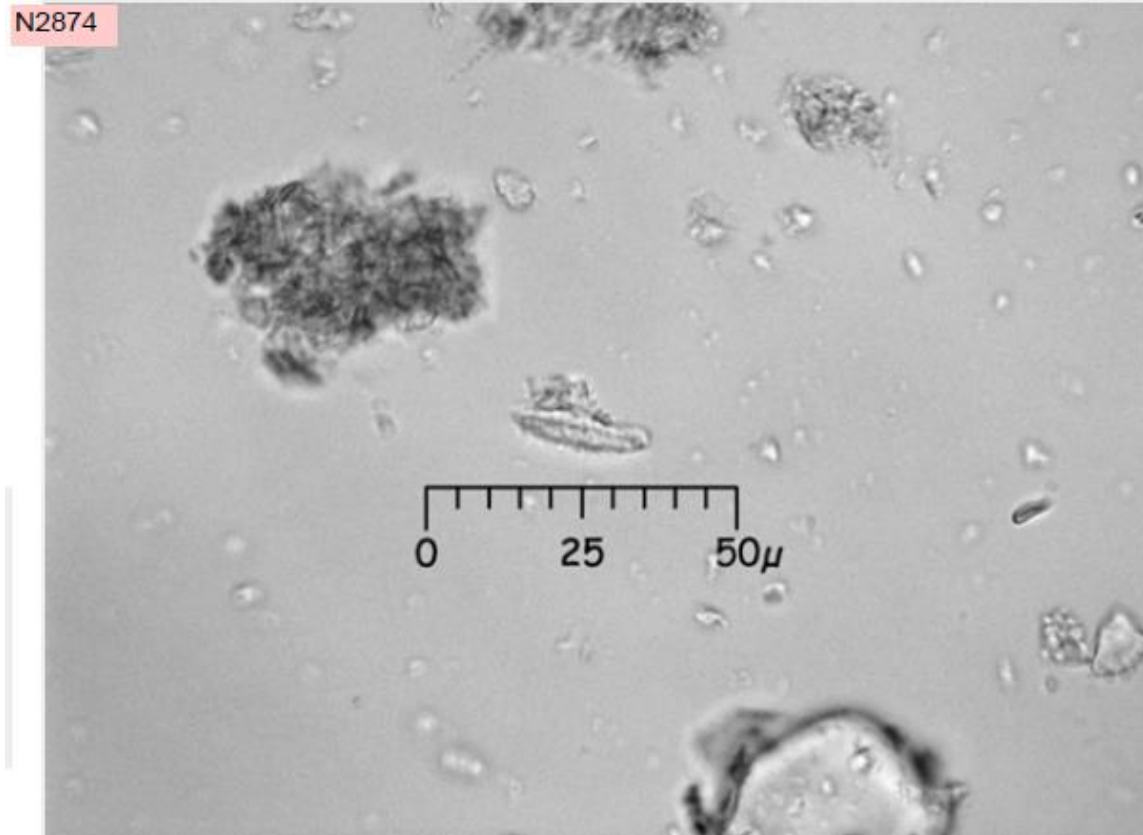
# Thalia geniculata

## Phytolith

PC1740, root, common.

Type defined by Karol Chandler-Ezell,  
11/2004

Diagnostic level: under study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

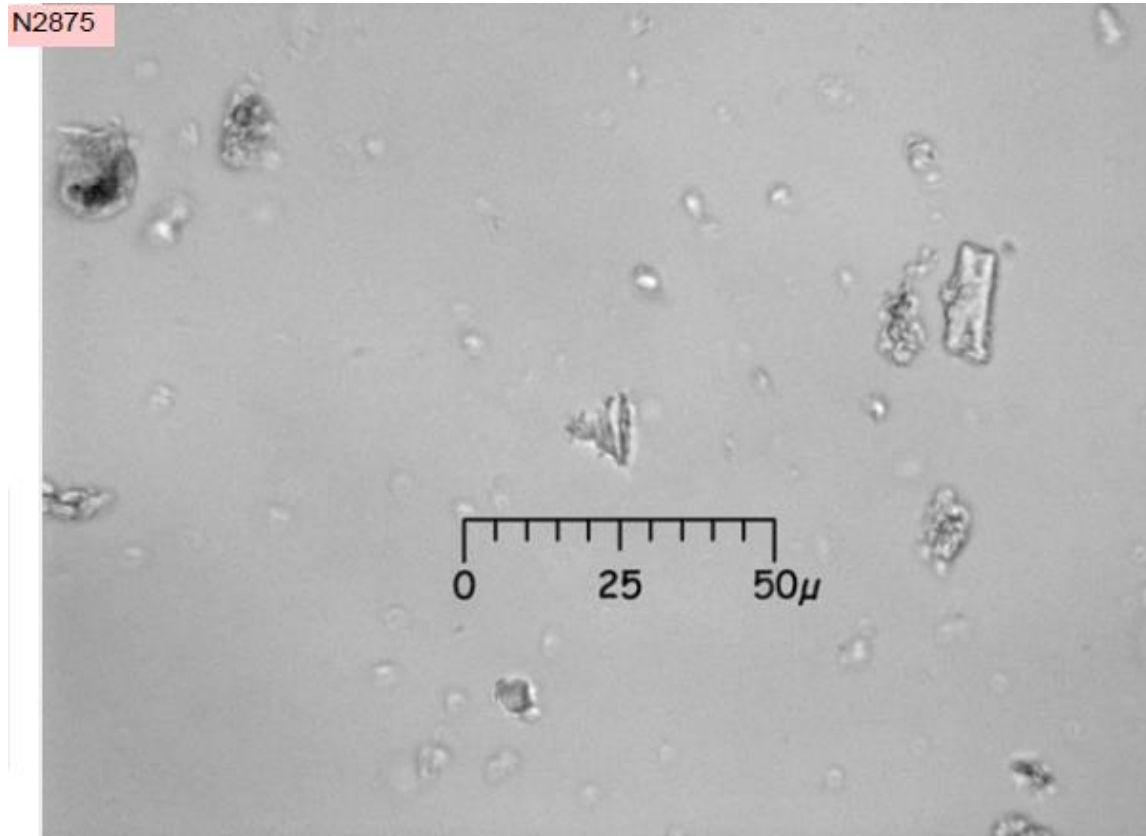
# Thalia geniculata

## Phytolith

PC1740, root, common.

Type defined by Karol Chandler-Ezell,  
11/2004

Diagnostic level: under study



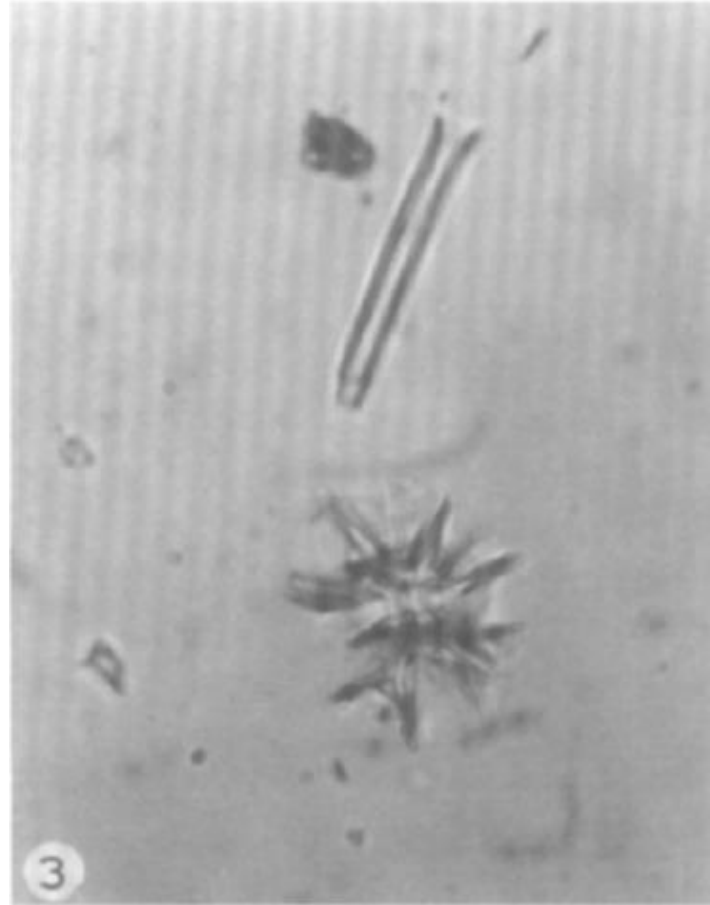
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

MENISPERMACEAE

# Odontocarya tarnoides

## Phytolith

3. Bottom, an irregular pointed phytolith from *Odontocarya tarnoides* (400 × )



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

MORACEAE

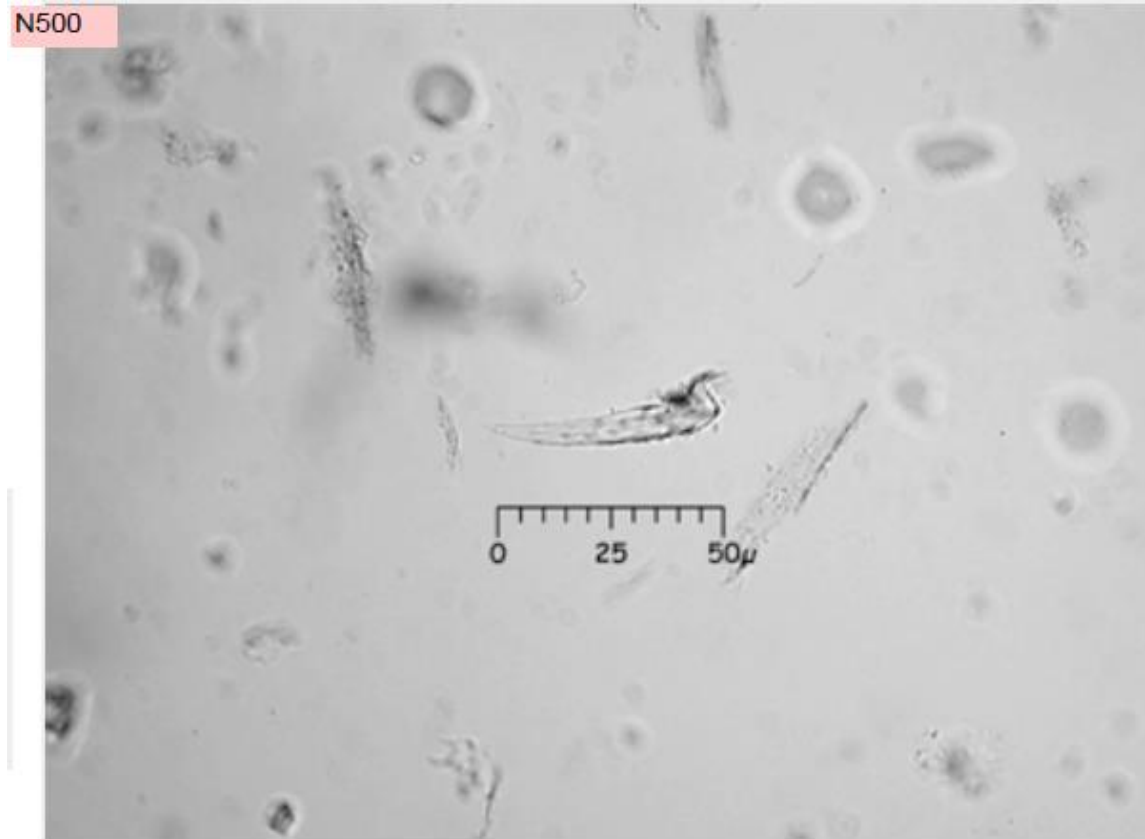


# Artocarpus altilis

## Phytolith

Armed hair; hair is bent in a right angle from base, rather than curving as in Boraginaceae *Cordia lutea* 40IIIAb100. Often has a piece of attached epidermal tissue at base with a “torn” appearance. Distinct multiple outline appearance helps to separate it from similar types.

Diagnostic level: family



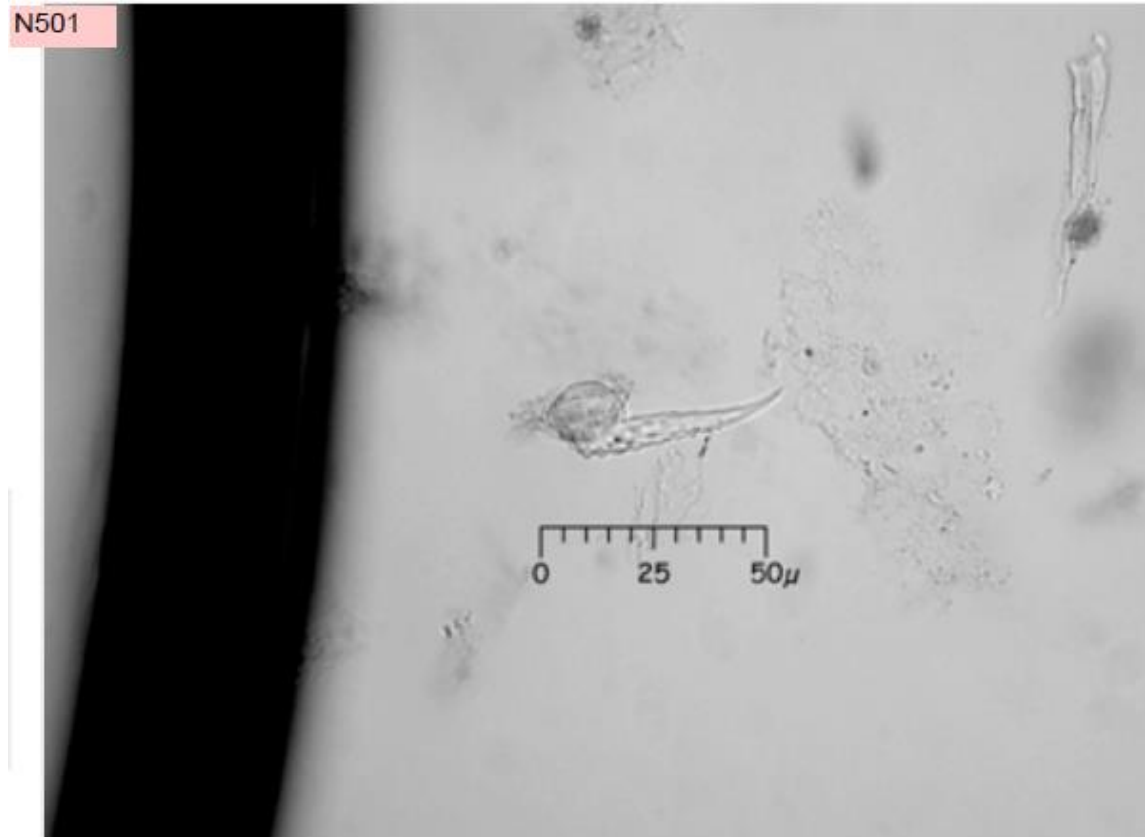
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Artocarpus altilis

## Phytolith

Armed hair; hair is bent in a right angle from base, rather than curving as in Boraginaceae *Cordia lutea* 40IIIAb100. Often has a piece of attached epidermal tissue at base with a “torn” appearance. Distinct multiple outline appearance helps to separate it from similar types.

Diagnostic level: family

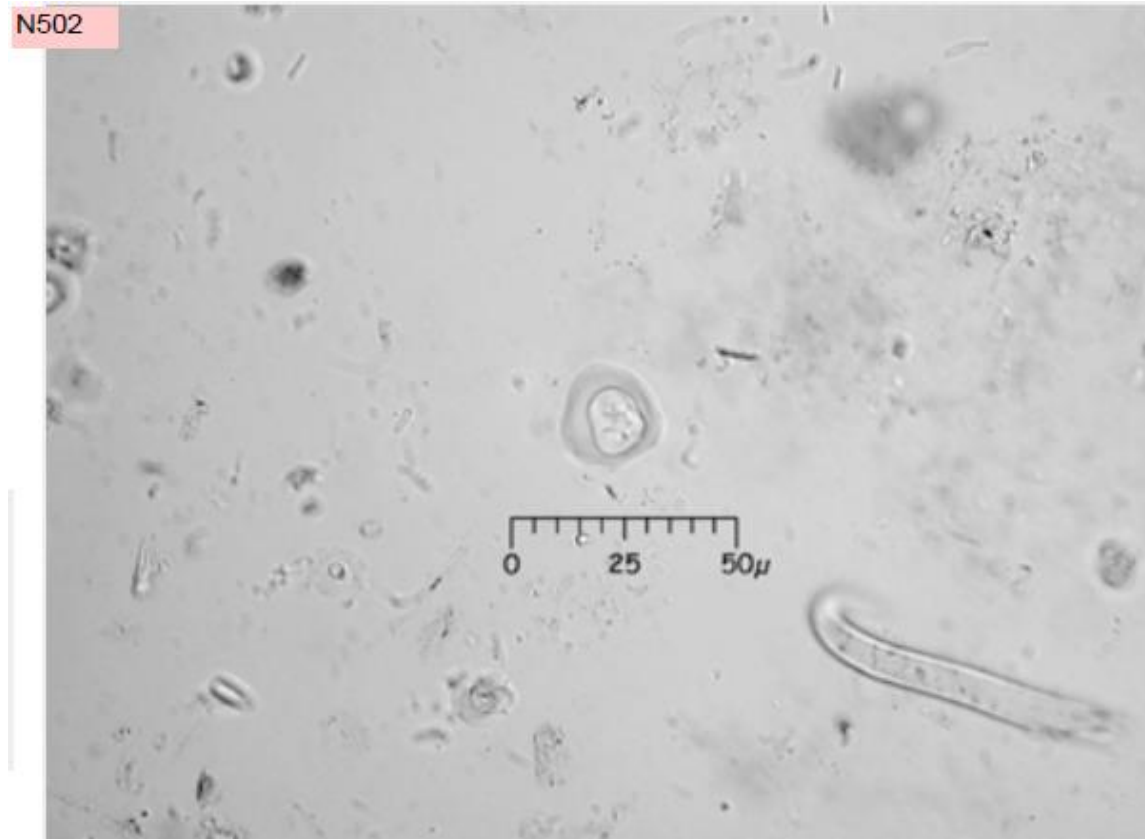


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Artocarpus altilis

## Phytolith

Diagnostic level: family

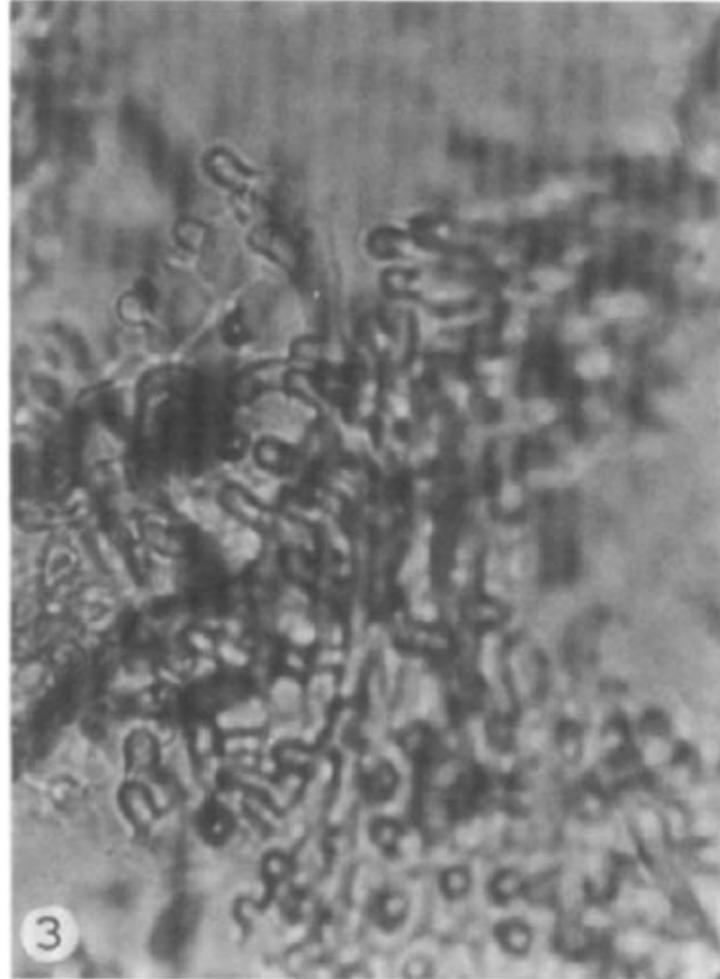


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Brosimum discolor

## Phytolith

3. Non-segmented hairs with rounded tips from *Brosimum discolor* (250 x)

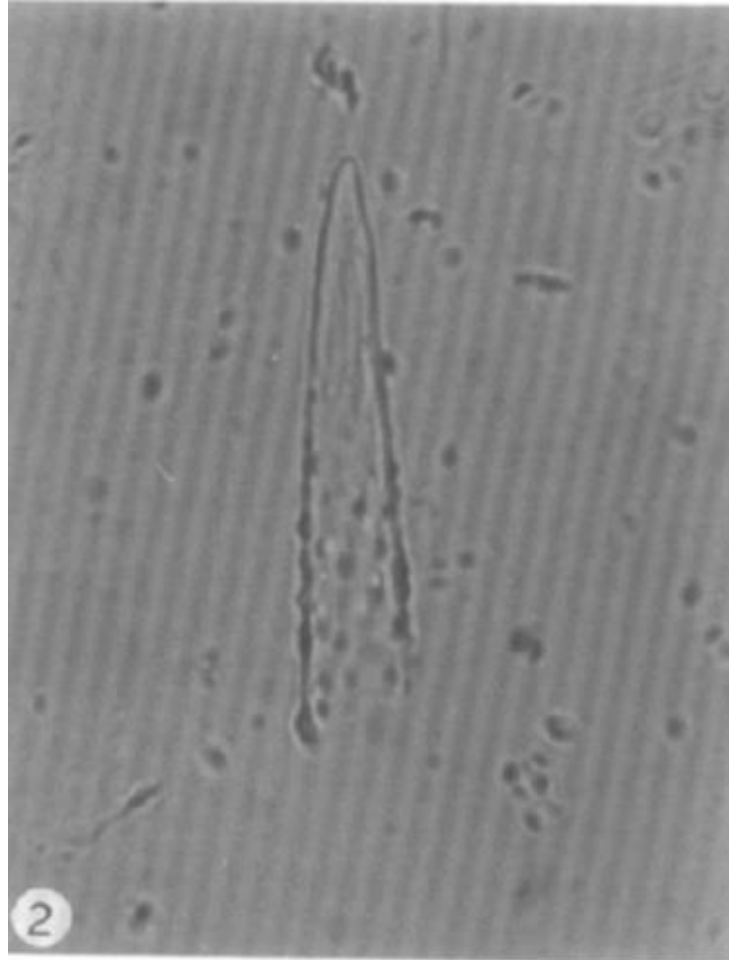


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Castilla elastica

## Phytolith

2. A non-segmented armed hair with an unarmed apex from *Castilla elastica* (250 × )

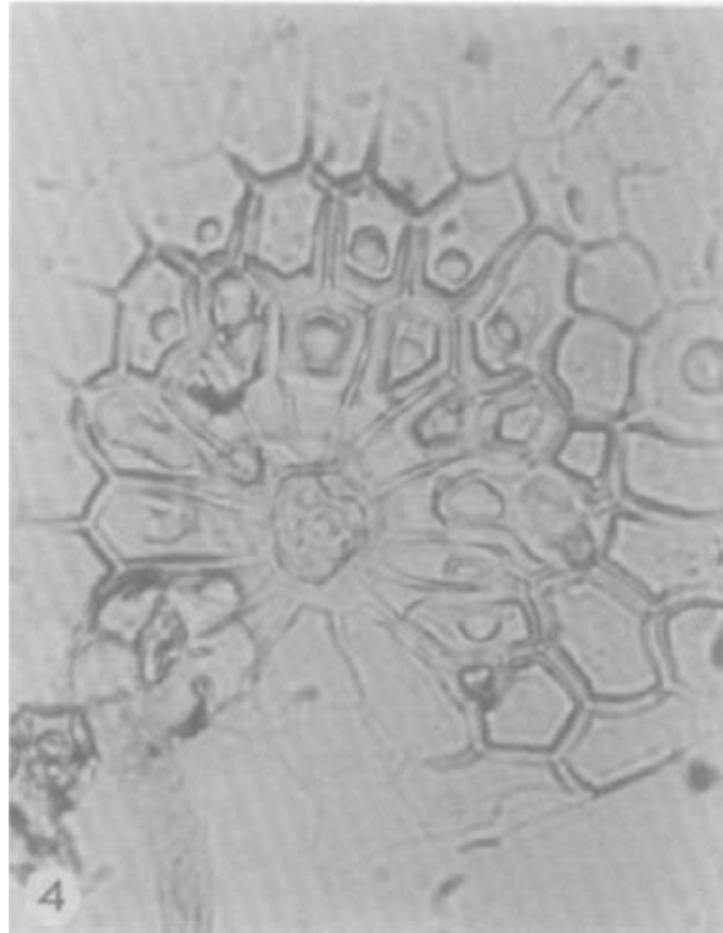


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Chlorophora tinctoria

## Phytolith

4. Stellate-shaped hair base from *Chlorophora tinctoria*. It is surrounded by epidermis with spherical inclusions (200 x).



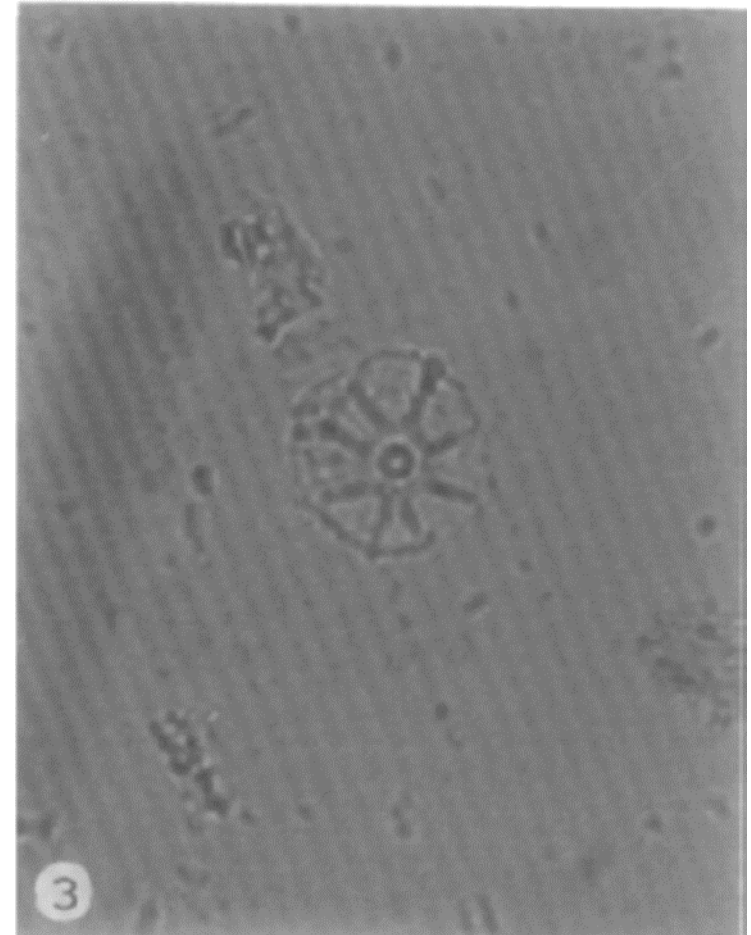
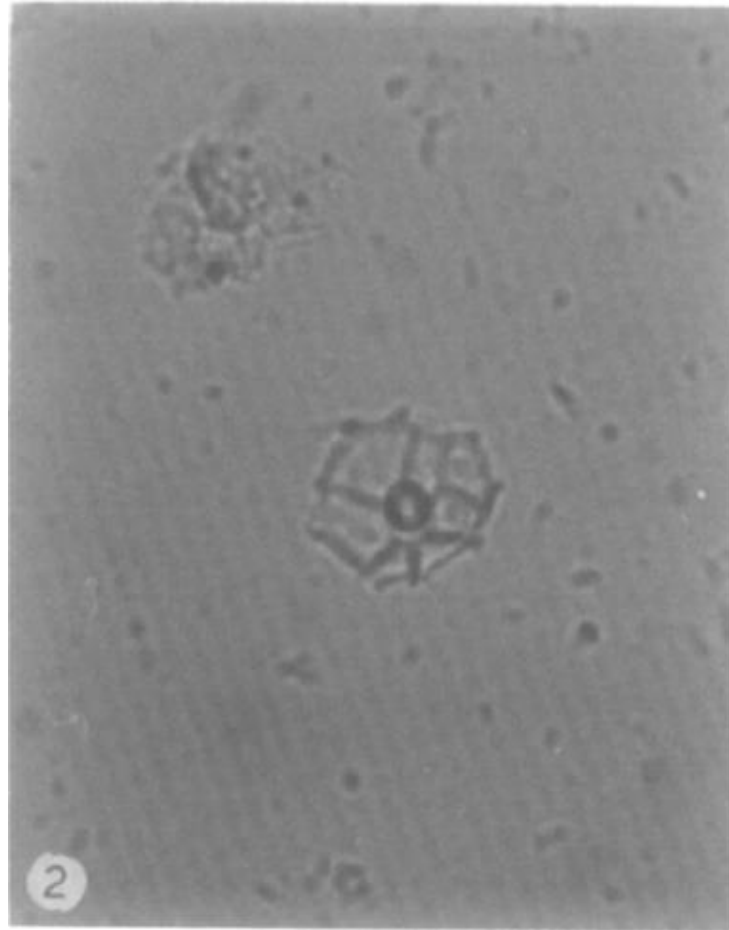
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Ficus americana

## Phytolith

2. Hair base with irregular striations radiating from the center of the cell from *Ficus americana* (250 x ).

3. Hair base with a regular striated pattern inside of the base from *Ficus americana* (250x ).



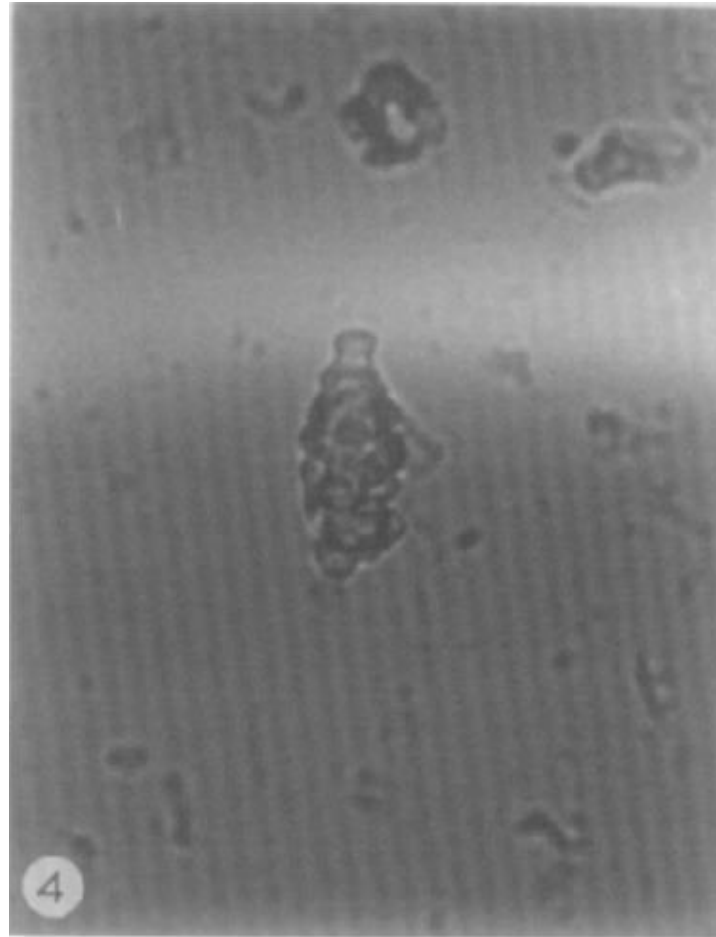
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Ficus americana

## Phytolith

4. Torpedo-shaped cystolith with a stalk and a rugulose surface pattern from *Ficus americana* (250 x).

1. Ellipsoidal-shaped cystolith with a rugulose surface pattern from *Ficus americana* (250 x).

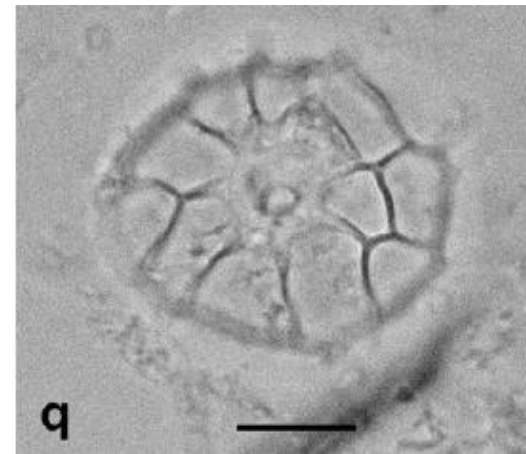
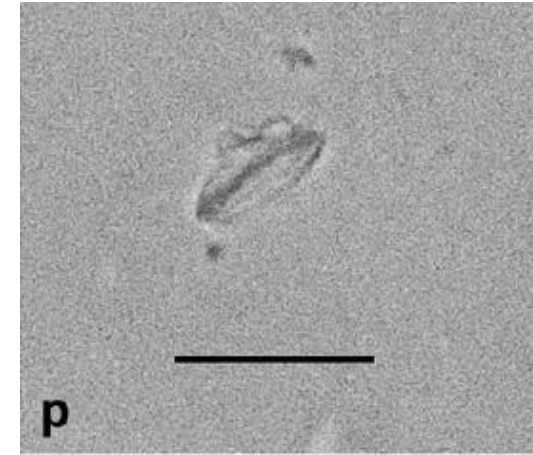
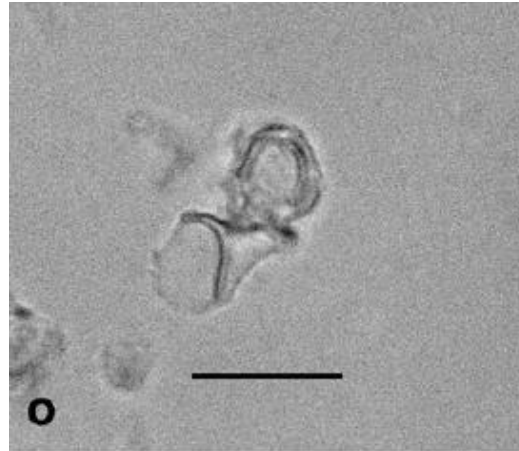




# Ficus guianensis

## Phytolith

Fig. 5. Phytoliths from dicotyledons.  
o) Trichomes from *Ficus guianensis*,  
p) Squat trichome from *F.*  
*guianensis*, q) Hair base from *F.*  
*guianensis* leaf.

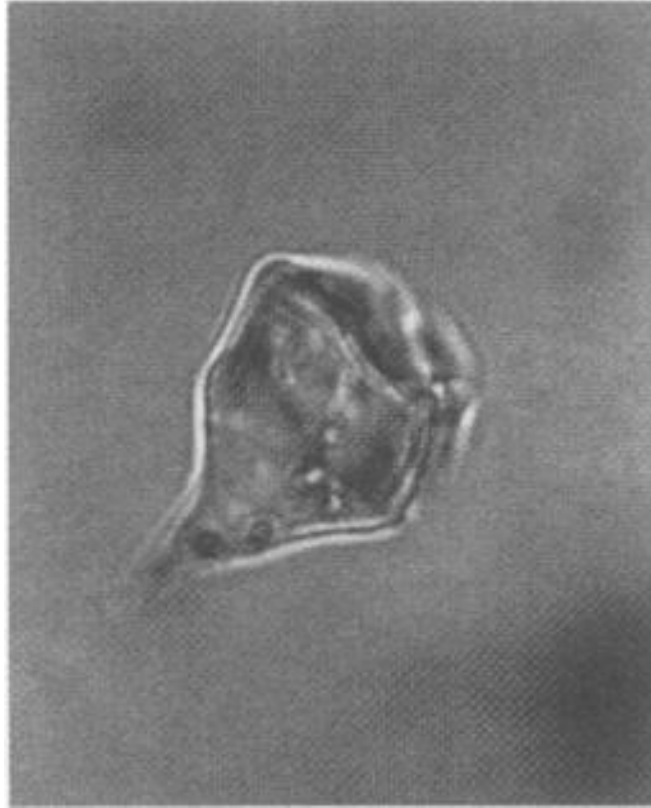


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Perebea xanthochyma

## Phytolith

Fig. 3. A probable genus-specific phytolith from the leaves of *Perebea xanthochyma* (Moraceae). Palynologists often cannot discriminate genera in this family.

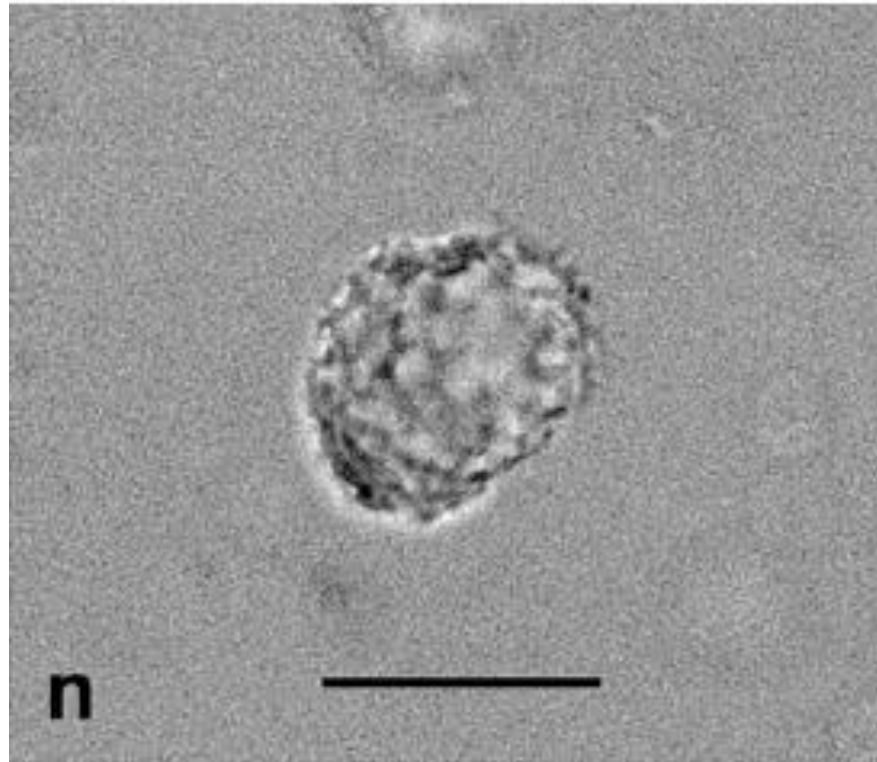


Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449.  
<http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Sorocea muriculata

## Phytolith

Fig. 5. Phytoliths from dicotyledons.  
n) Cystolith from *Sorocea muriculata*



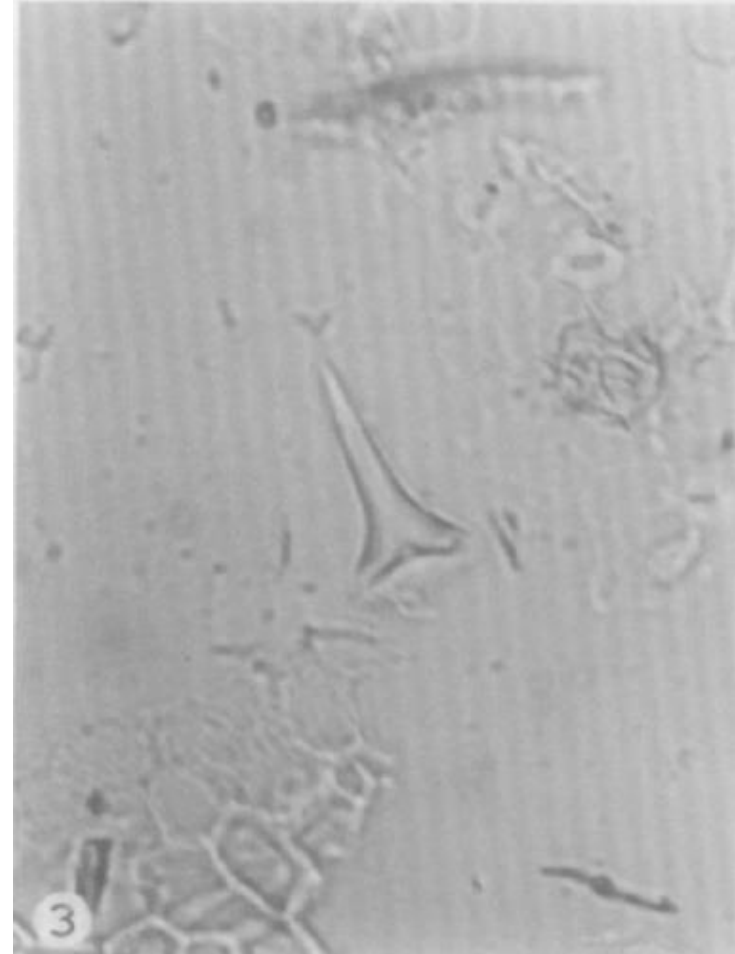
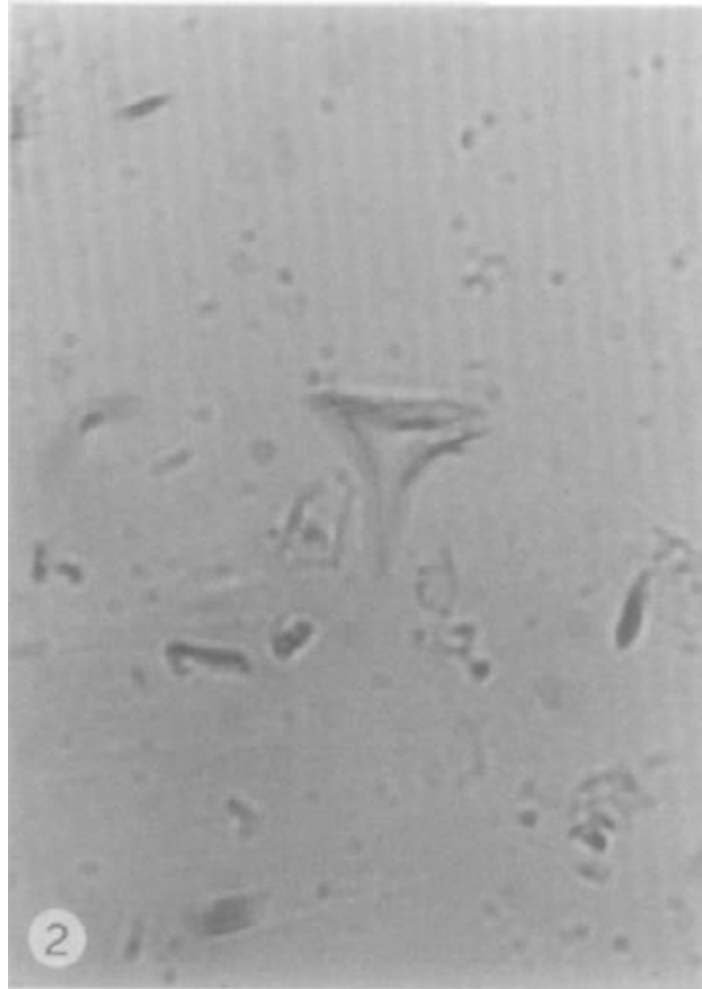
Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Trophis racemosa

## Phytolith

2. Non-segmented hair with an elongated flat base from *Trophis racemosa* (200 ×).

3. Non-segmented hair with an elongated indented base from *Trophis racemosa* (200 ×).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

MUSACEAE

# Musa sp. and Ensete sp.

## Phytolith

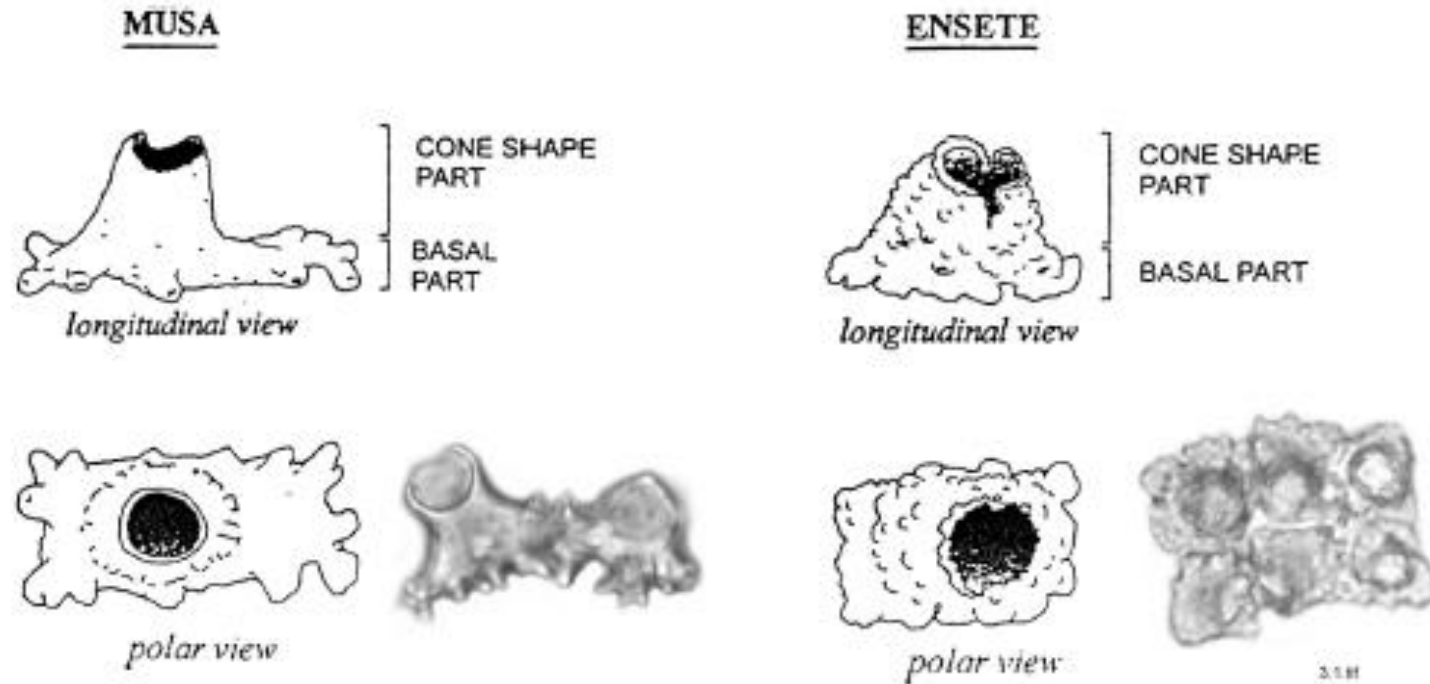


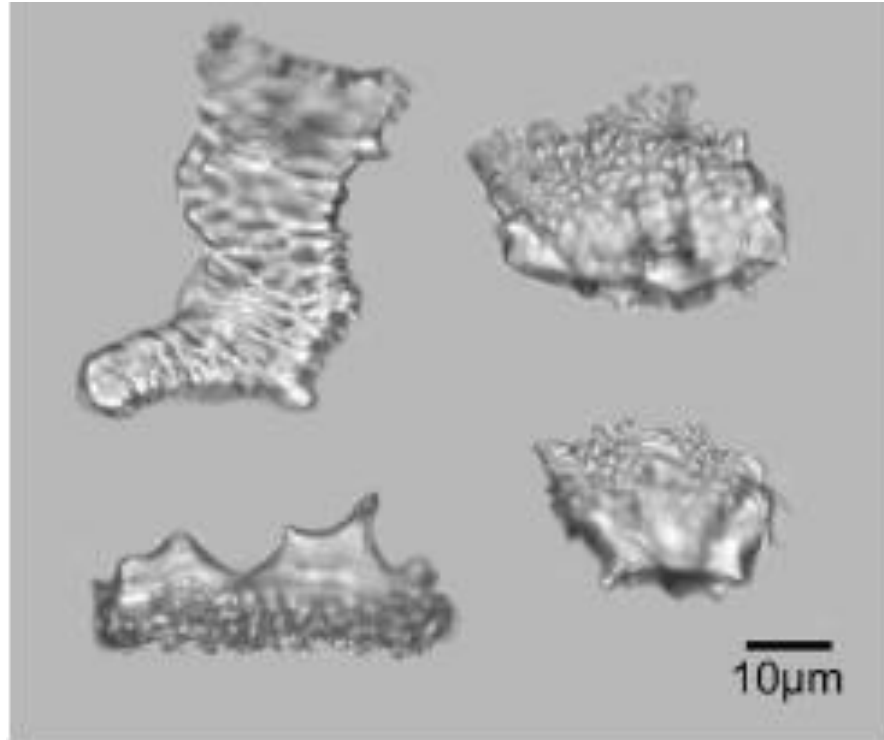
Fig. 17. A comparison of leaf phytoliths from Ensete and Musa. From Piperno, 2006. The schematic drawings were originally from Mbida et al., 2001 and the photographs were courtesy of Carol Lentfer

Ball, Terry B., Karol Chandler-Ezell, Ruth Dickau, Neil Duncan, Thomas C. Hart, José Iriarte, Carol Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <http://dx.doi.org/10.1016/j.jas.2015.08.010>.

# Musa acuminata banksii and Ensete sp.

## Phytolith

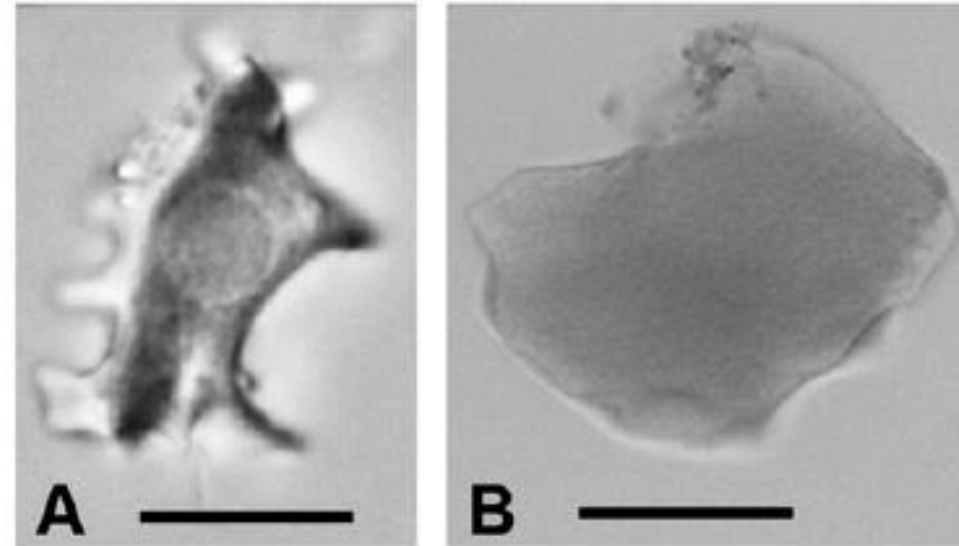
Fig. 15. Seed phytoliths from *Musa acuminata* subsp. *banksii* (left) and *Ensete*, right. From Piperno, 2006; originally courtesy of Carol Lentfer.



# Ensete sp.

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). A, T2 trough with papillae edges from Ensete sp. leaf. B, tabular-microgranulate from Ensete sp. leaf. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .



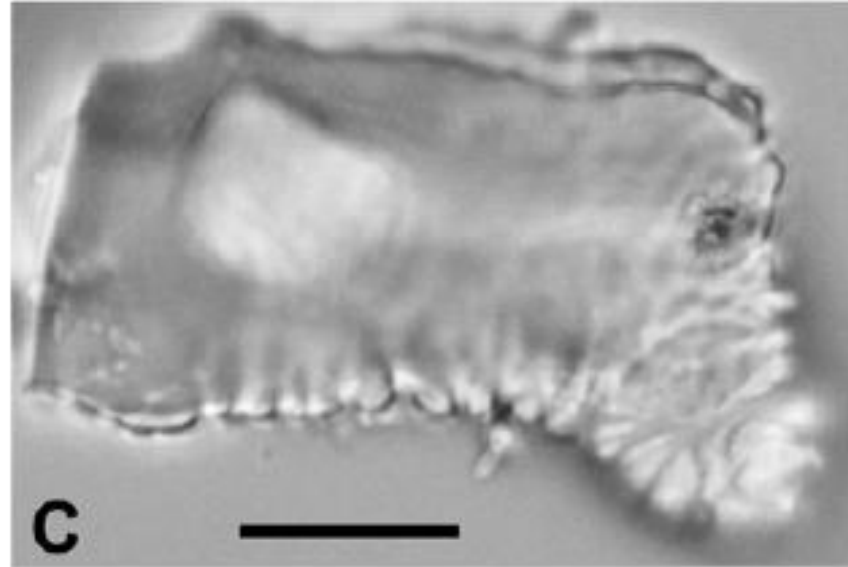
Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.



# Ensete glaucum

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). C, Ta6 (with central processes which dividing and anastomosing ridges radiate out from) from *Ensete glaucum* seed. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .



Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Ensete glaucum

## Phytolith

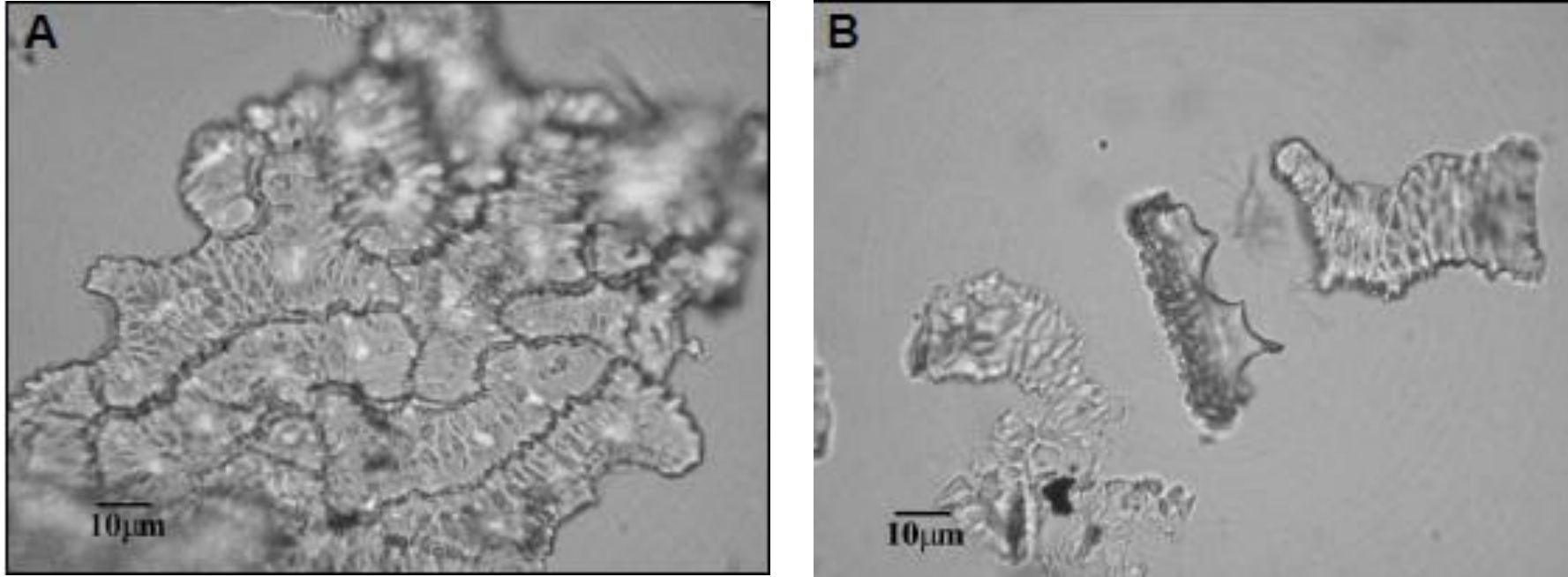
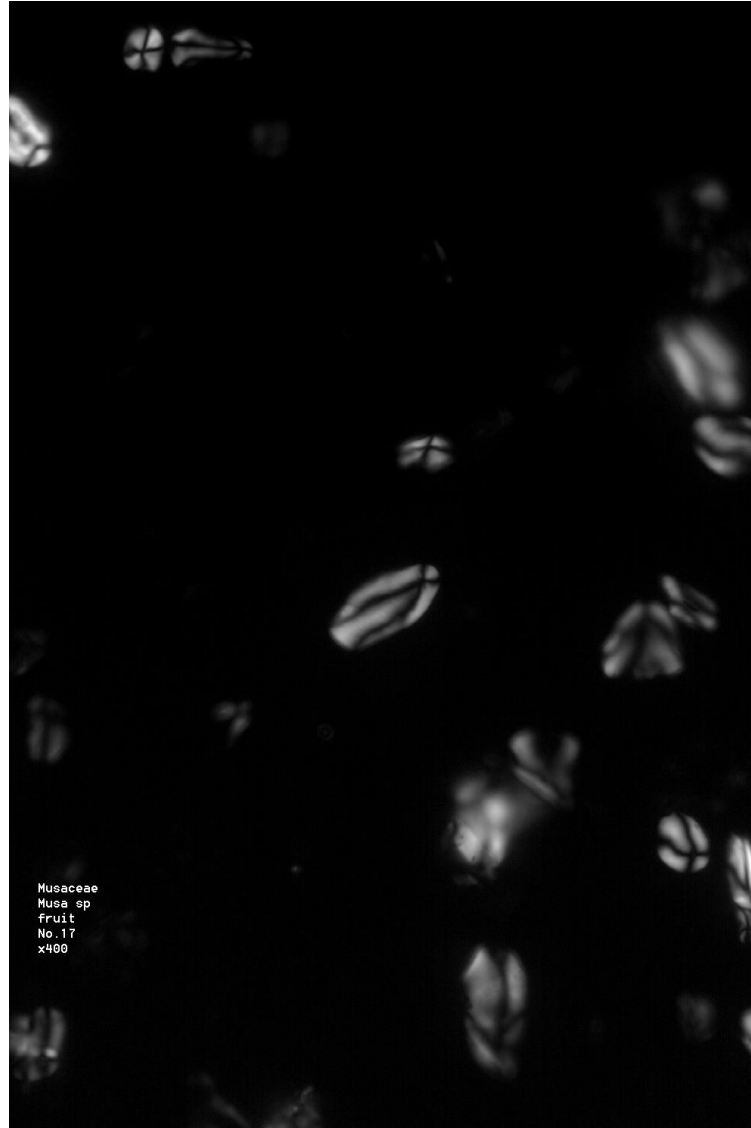
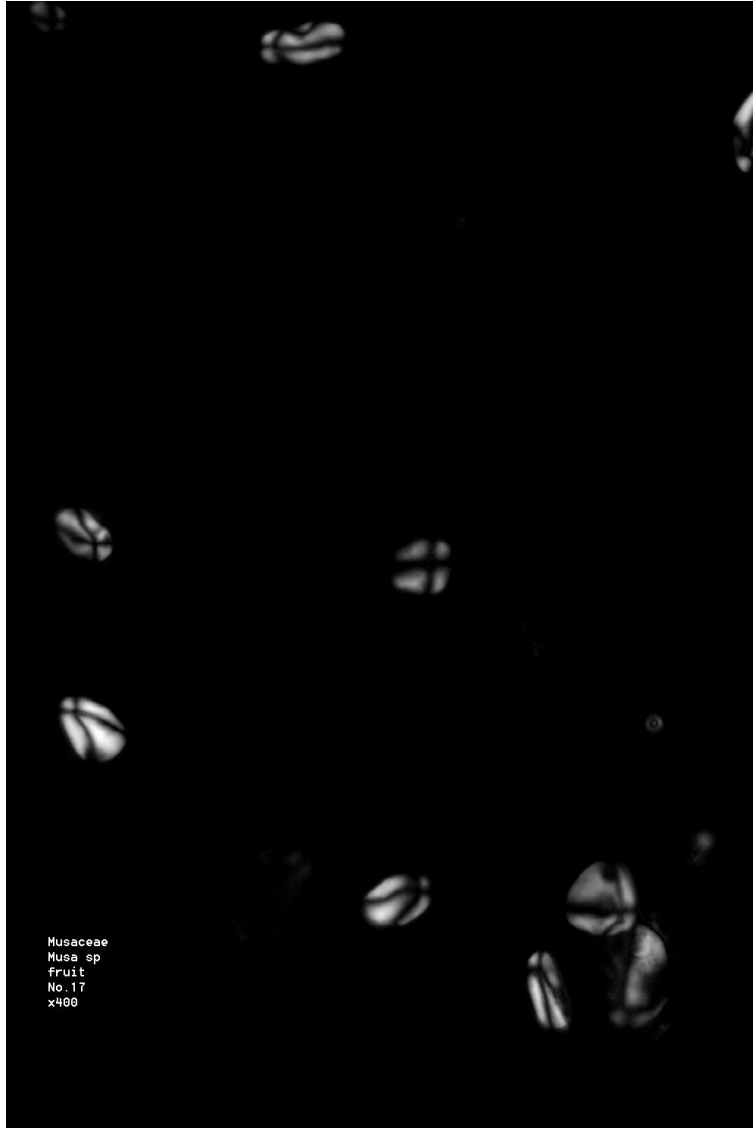


Figure 1. Diagnostic seed morphotypes of wild *Musa* bananas and *Ensete* from Papua New Guinea. A-B. *Ensete glaucum* (Accession No. QH28807)

Lentfer, Carol J. 2009. Tracing Domestication and Cultivation of Bananas from Phytoliths: An Update from Papua New Guinea. *Ethnobotany Research and Applications* 7:247–70.

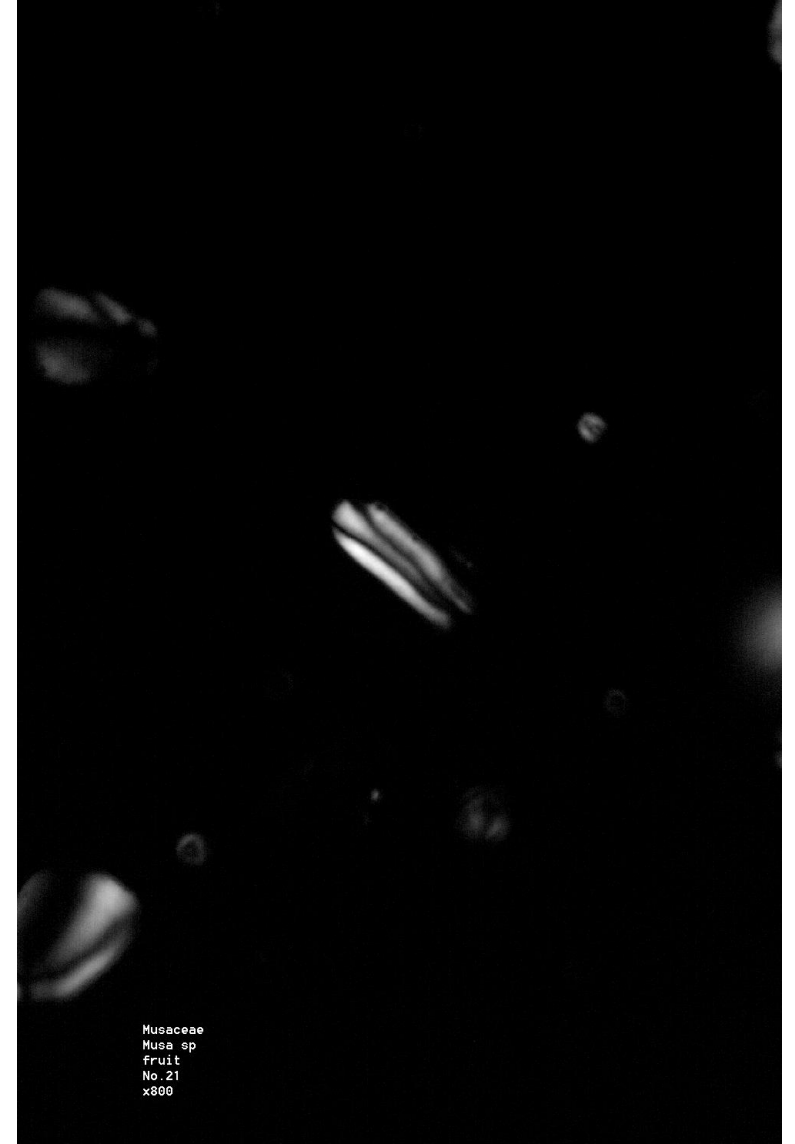
# Musa sp.

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



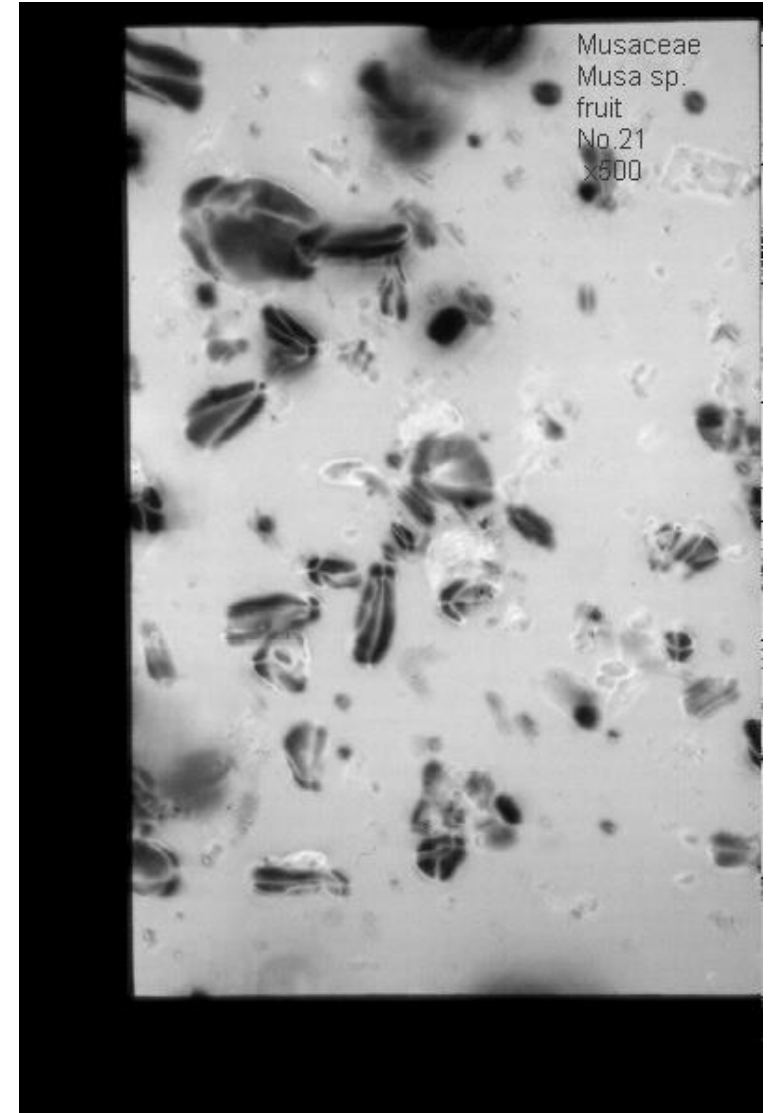
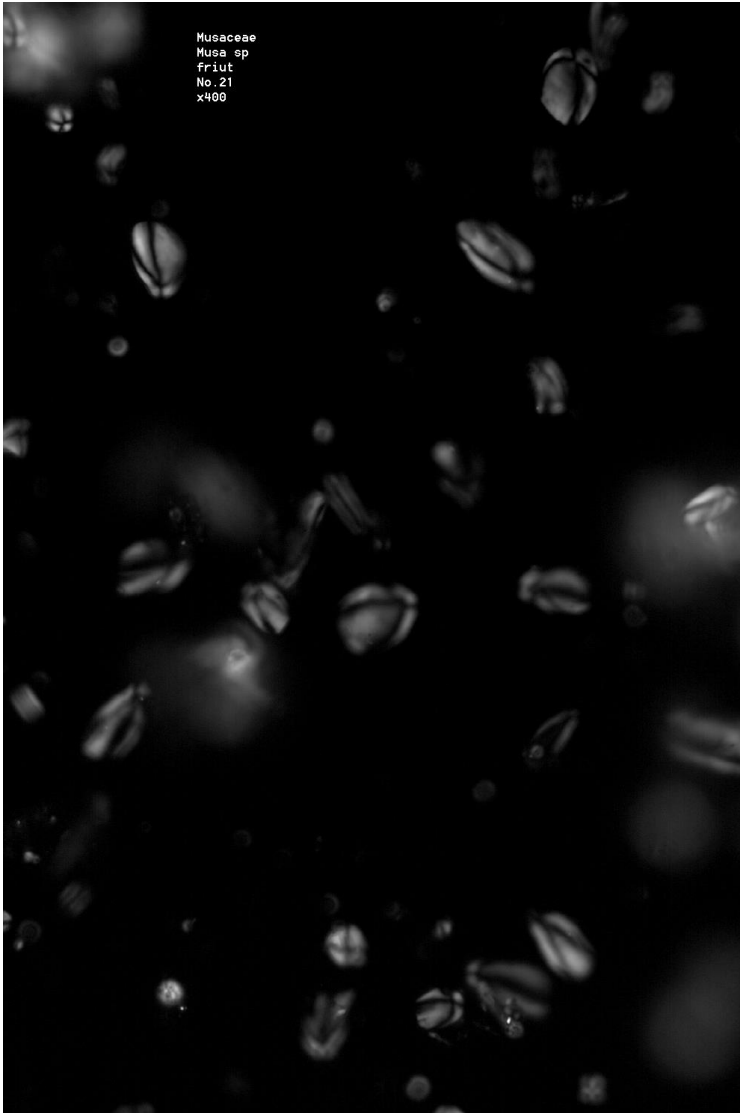
# Musa sp.

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



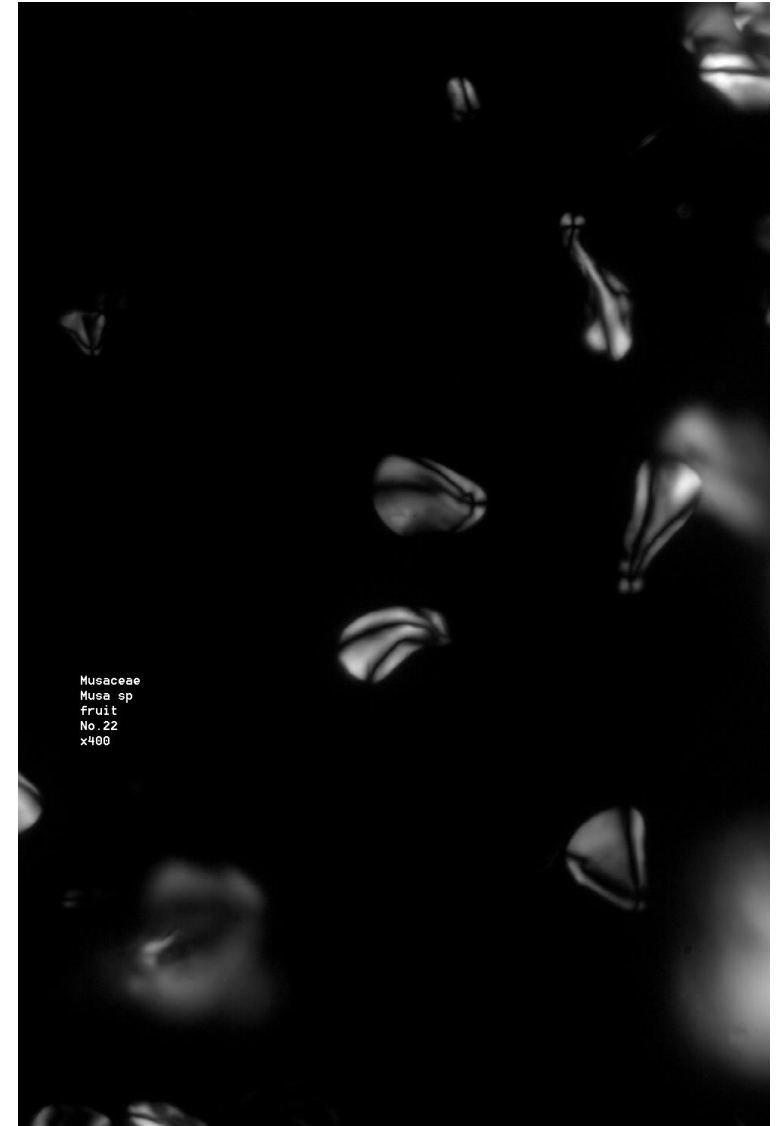
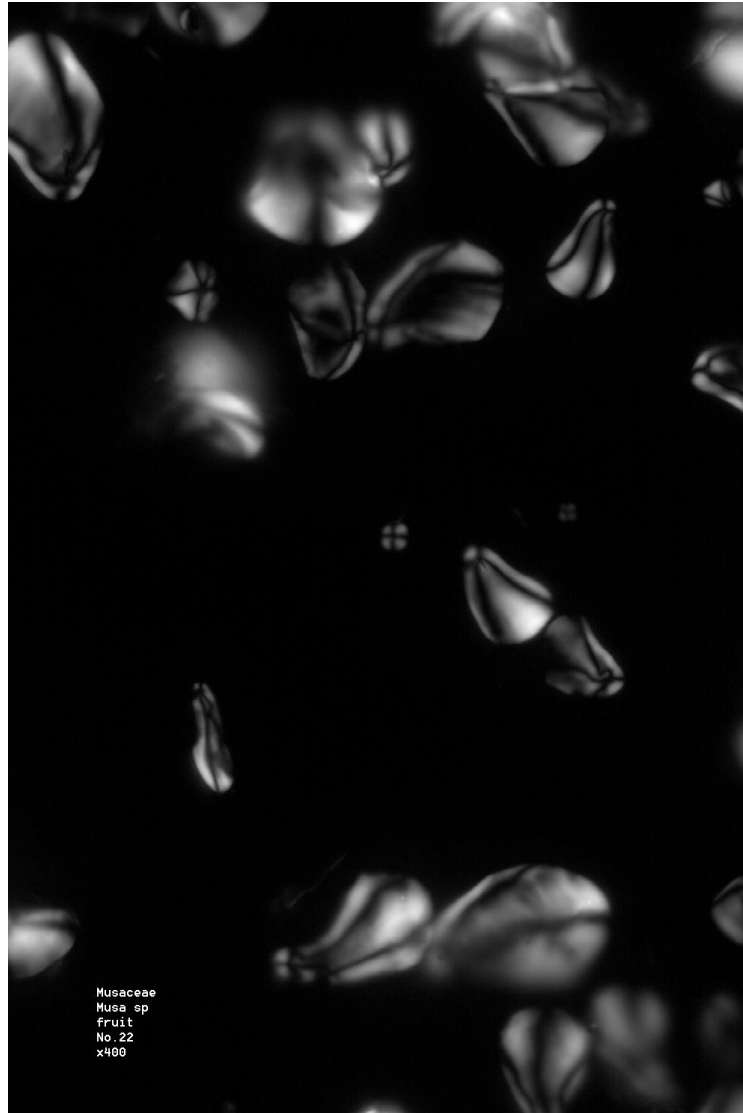
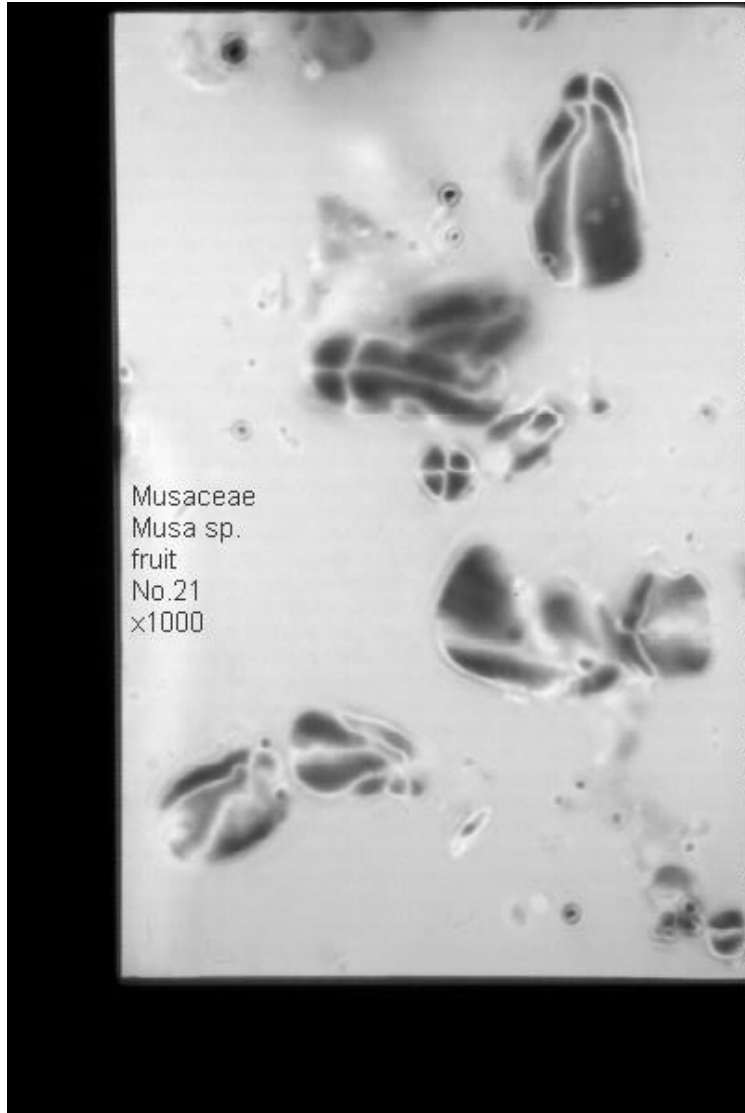
# Musa sp.

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



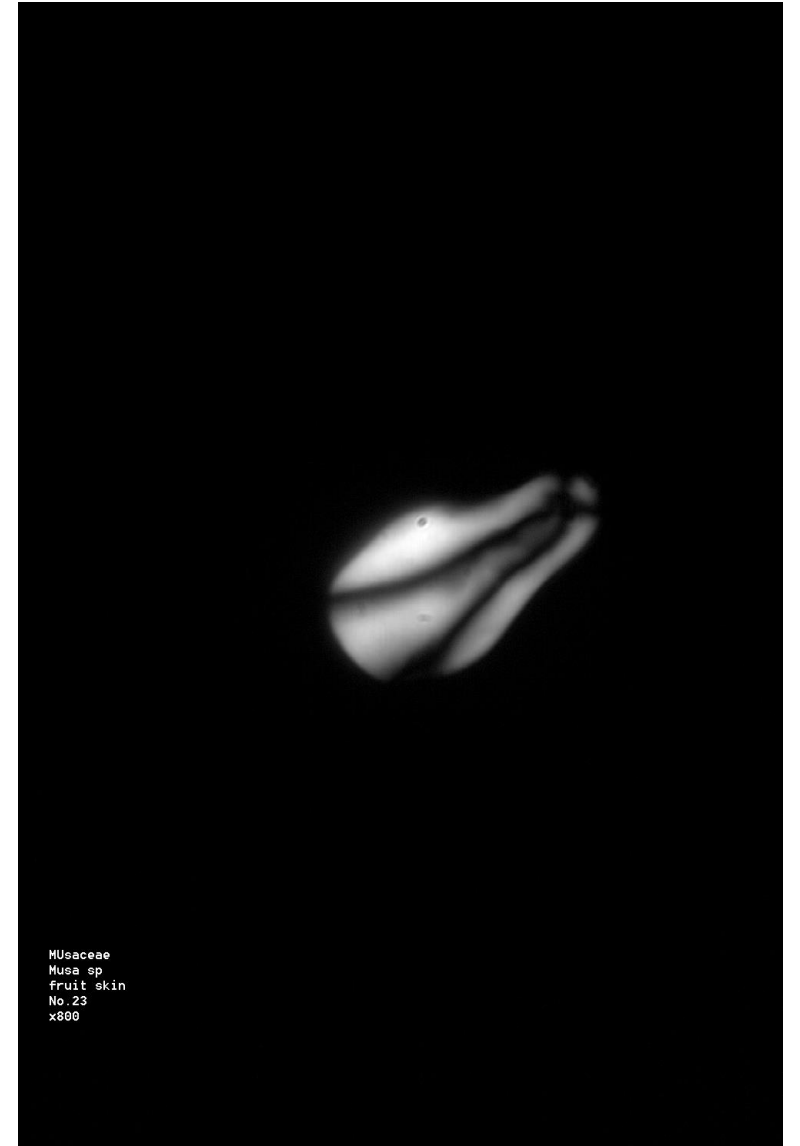
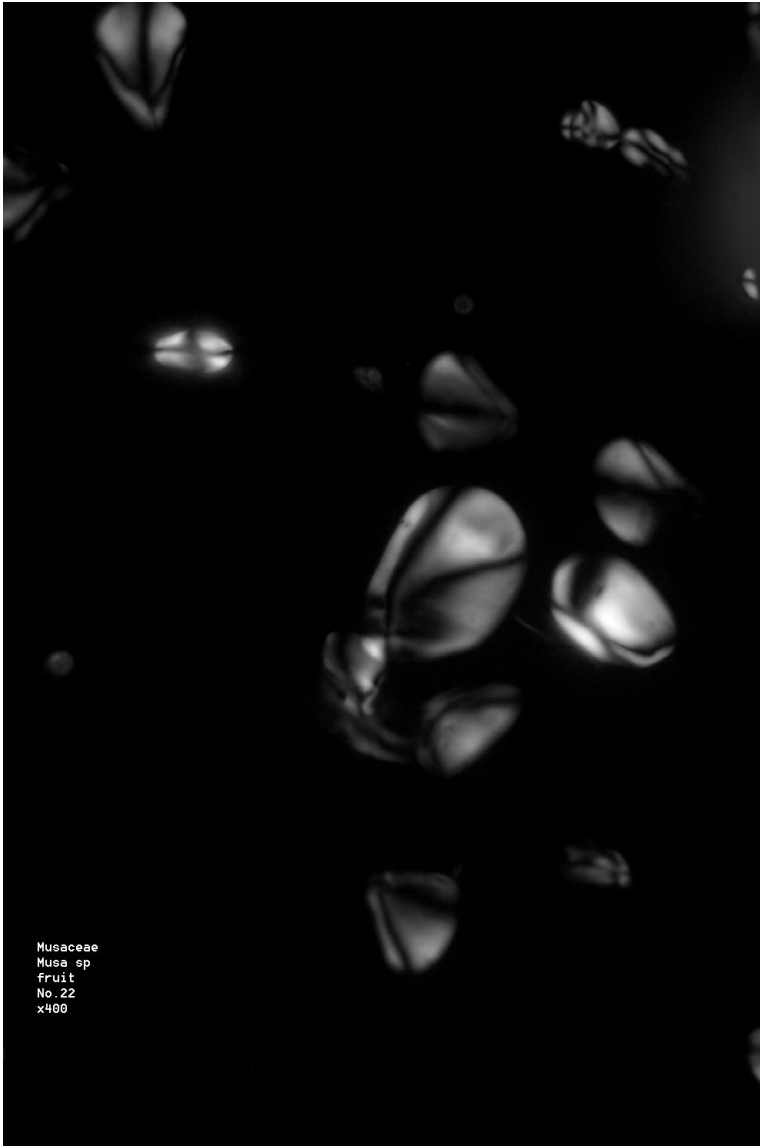
# Musa sp.

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



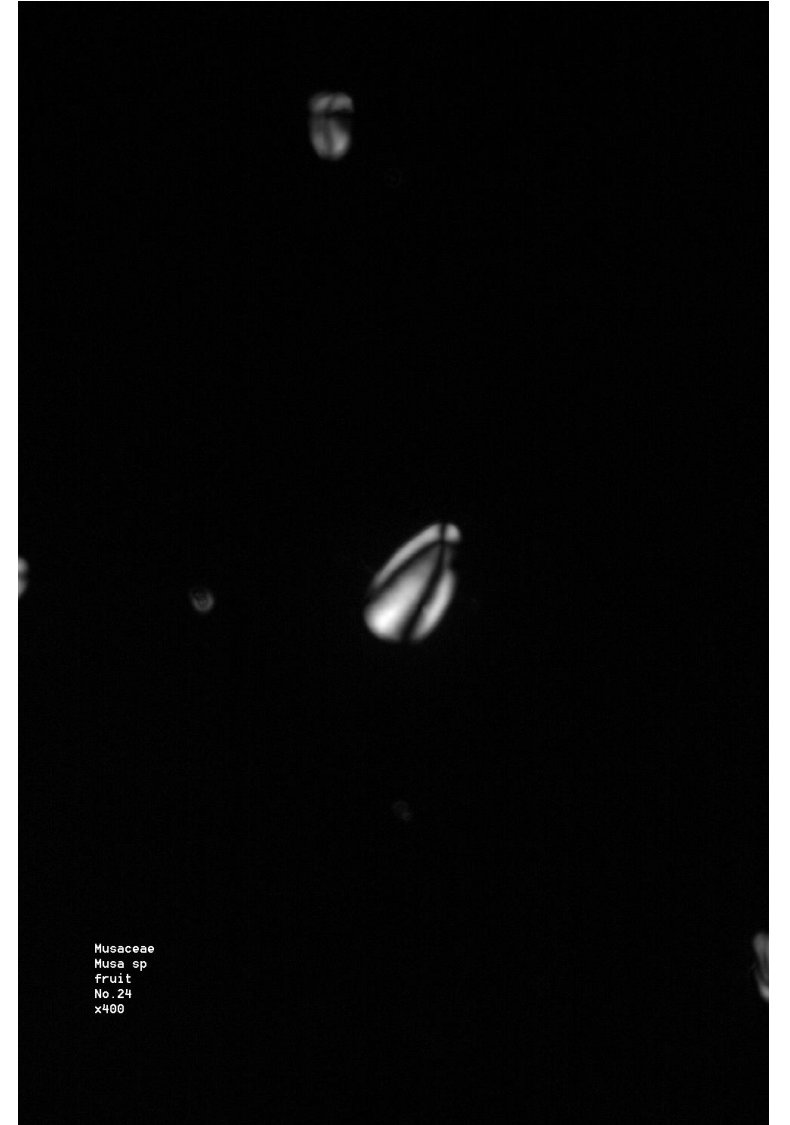
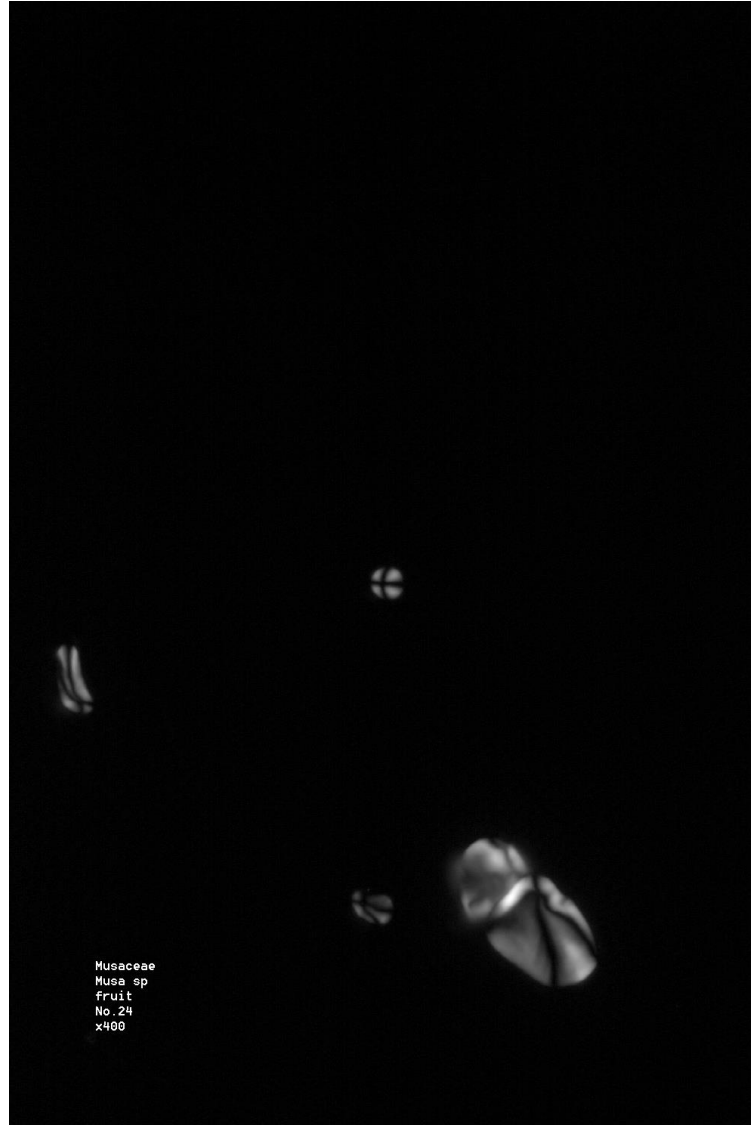
# Musa sp.

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Musa sp.

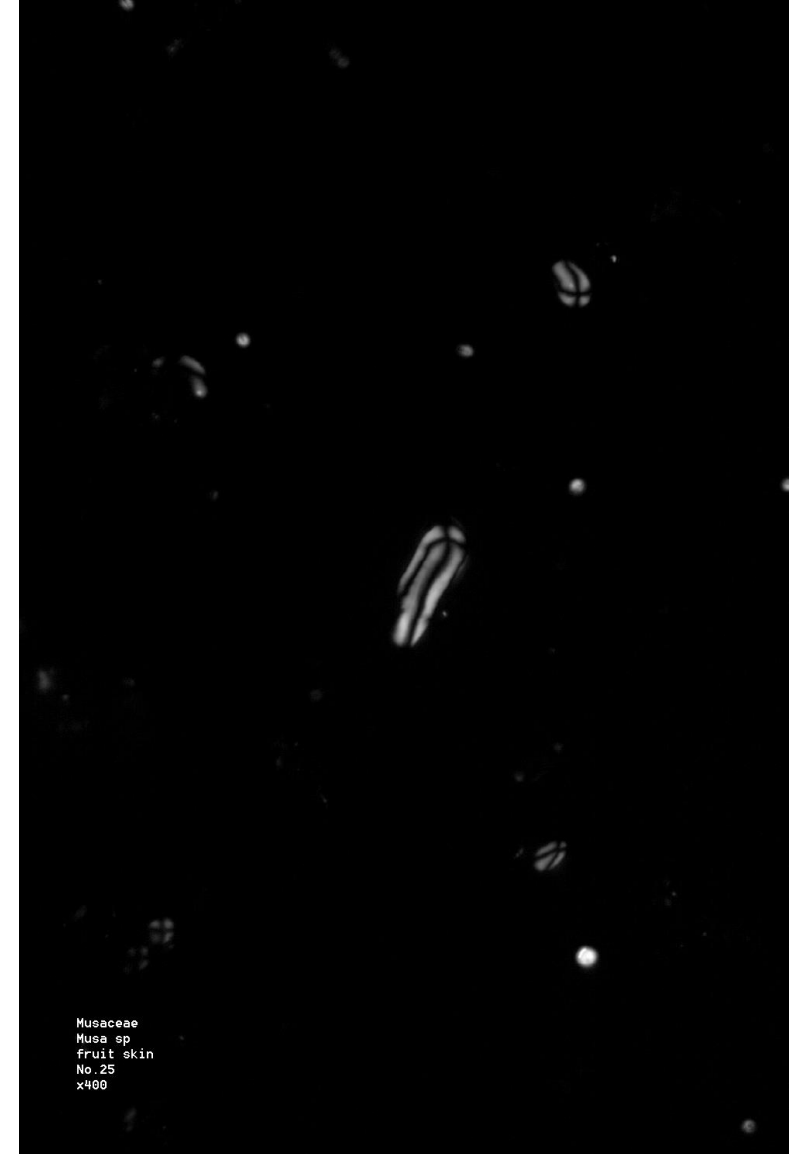
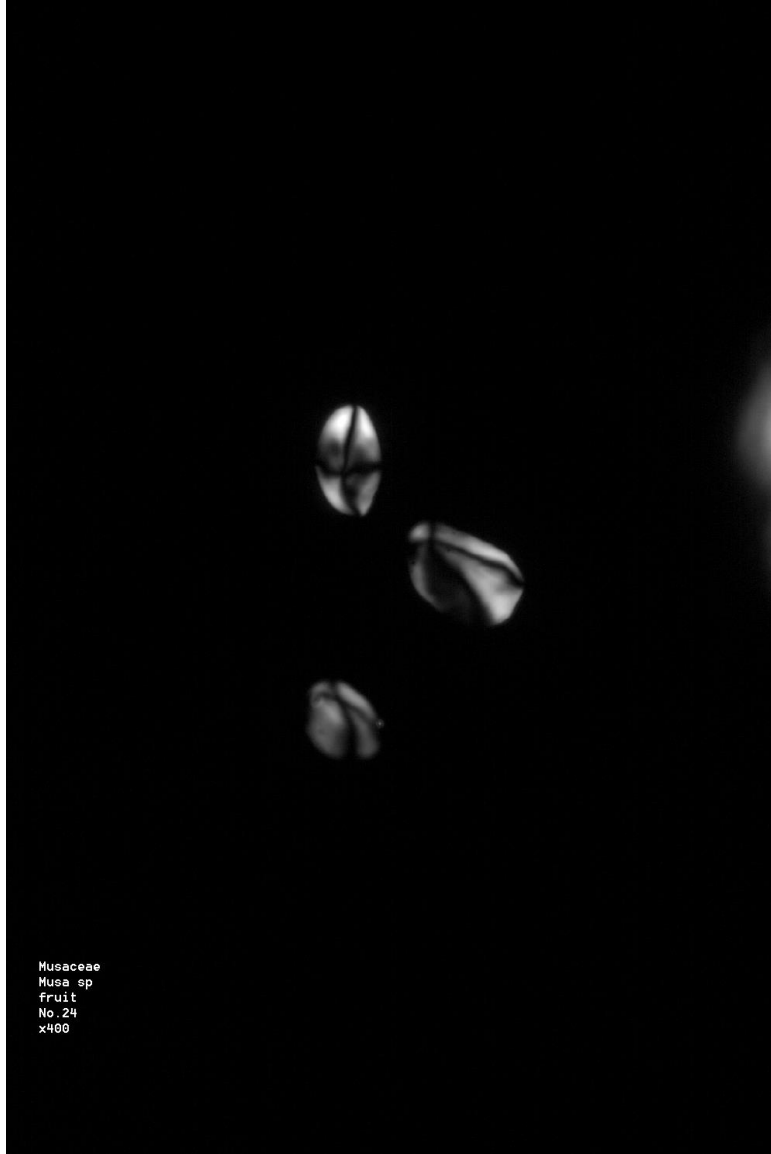
Australian Museum,  
McCown Archaeobotany  
Laboratory Collection





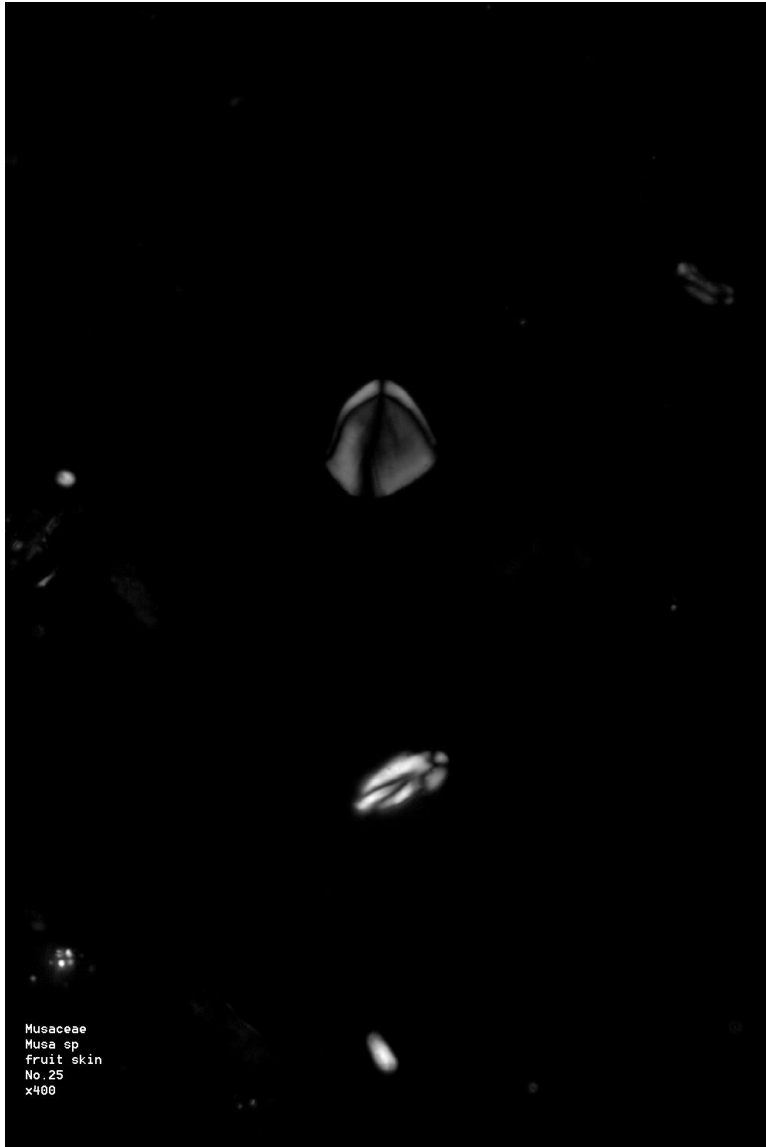
# Musa sp.

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Musa sp.

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection

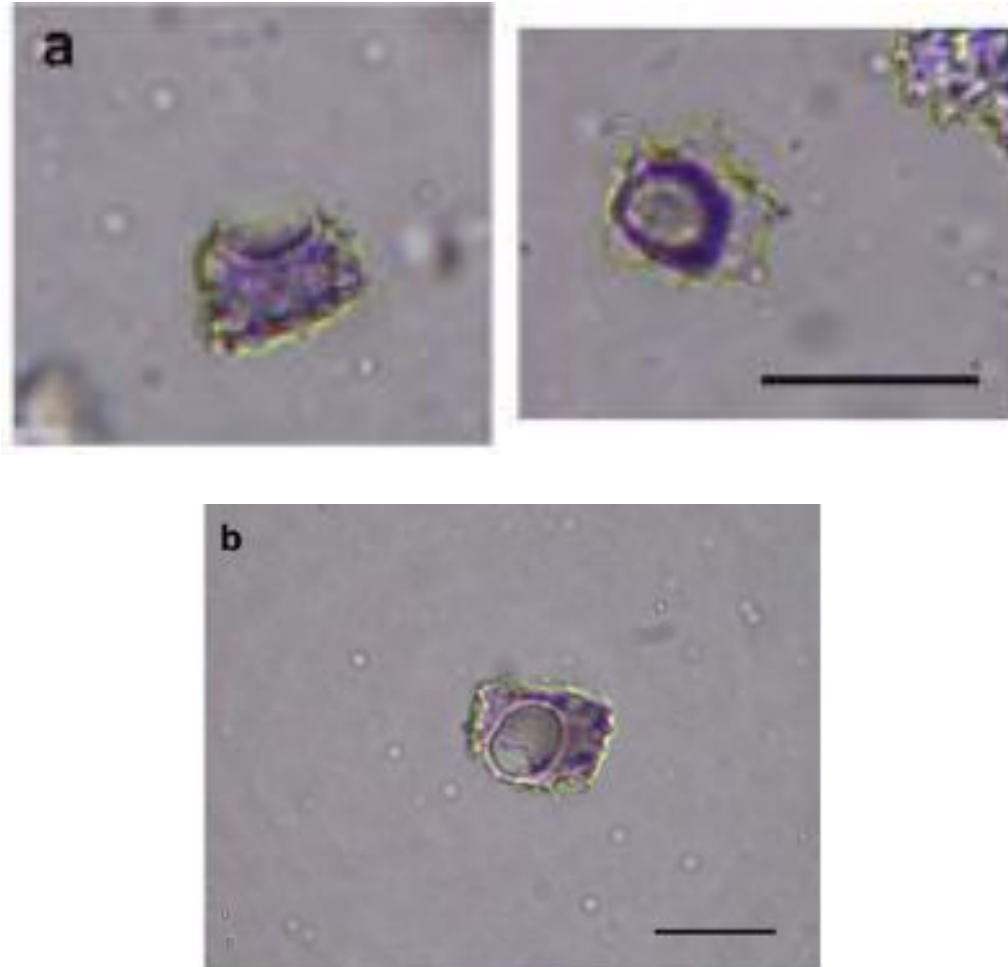


# Musa sp.

## Phytolith

Fig. 7. Plant microfossils from Kona (a, b mounted in Caedax; c–h mounted in glycerol jelly; 100x, 400x or 600x; scale bars: 20 μm).

(a, b) Musa leaf phytoliths showing rectangular/squarish base with protuberances all along the sides of the base and truncated cone (c.f. Fig. 8a, b). Of the three examples shown here, two are viewed looking down into the cone (a, right panel; b) and the other (a, left panel) looking at the cone side-on.

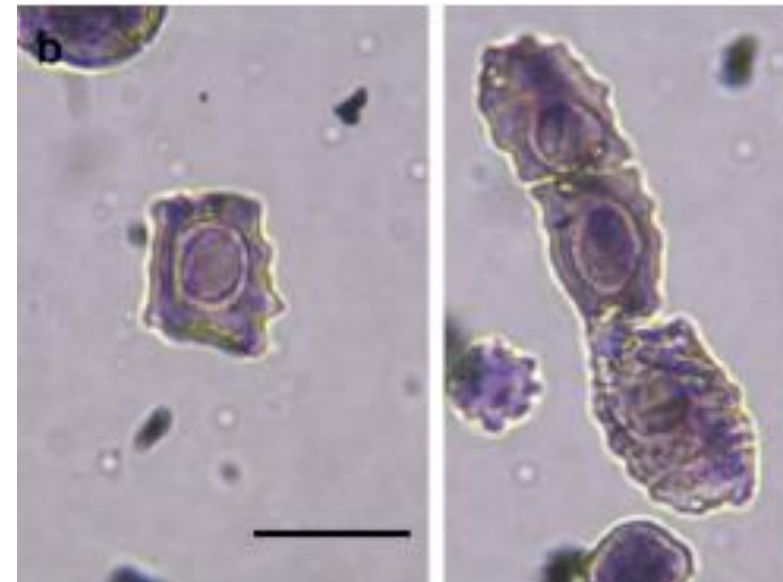


Horrocks, Mark, and Robert B. Rechtman. 2009. Sweet Potato (*Ipomoea Batatas*) and Banana (*Musa Sp.*) Microfossils in Deposits from the Kona Field System, Island of Hawaii. *Journal of Archaeological Science* 36 (5). Elsevier Ltd:1115–26. <http://dx.doi.org/10.1016/j.jas.2008.12.014>.

# Musa sp.

## Phytolith

Fig. 8. Modern reference samples ((a, b mounted in Caedax; c–f mounted in glycerol jelly; 400x or 600x; scale bars: 20 μm). (a, b) Musa (AAB group) leaf phytoliths. For detailed descriptions see Mindzie et al. (2001) and Ball et al. (2006). Musa leaf phytoliths consist of a base (mostly rectangular or squarish) with protuberances all along the sides of the base and a raised truncated cone or sub-cylinder (crater). Right panel of (b) shows three phytoliths in a chain, as they form in the leaf. Of the five examples shown here, four are viewed looking down into the crater (b) and the other (a) looking at the crater side-on.

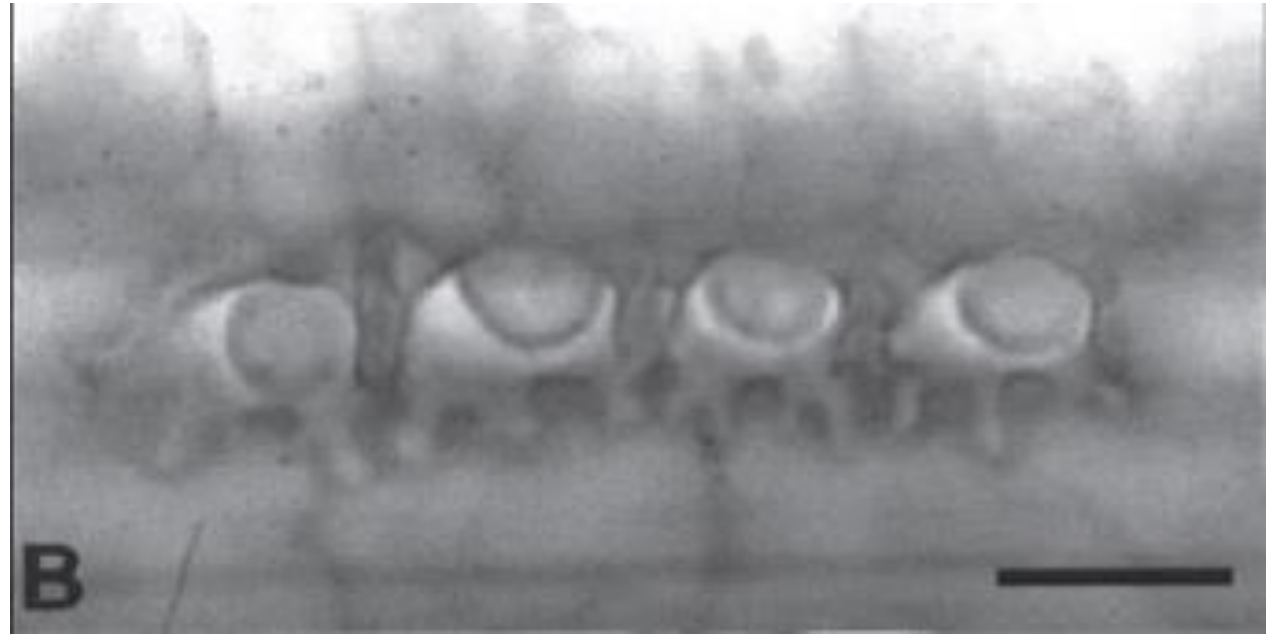


Horrocks, Mark, and Robert B. Rechtman. 2009. Sweet Potato (*Ipomoea Batatas*) and Banana (*Musa Sp.*) Microfossils in Deposits from the Kona Field System, Island of Hawaii. *Journal of Archaeological Science* 36 (5). Elsevier Ltd:1115–26. <http://dx.doi.org/10.1016/j.jas.2008.12.014>.

# Musa sp.

## Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. B. *Musa* sp. (Musaceae), trough-shaped silica bodies with silica fingers projecting from the base into cell-wall pits (bar = 10 $\mu$ m).

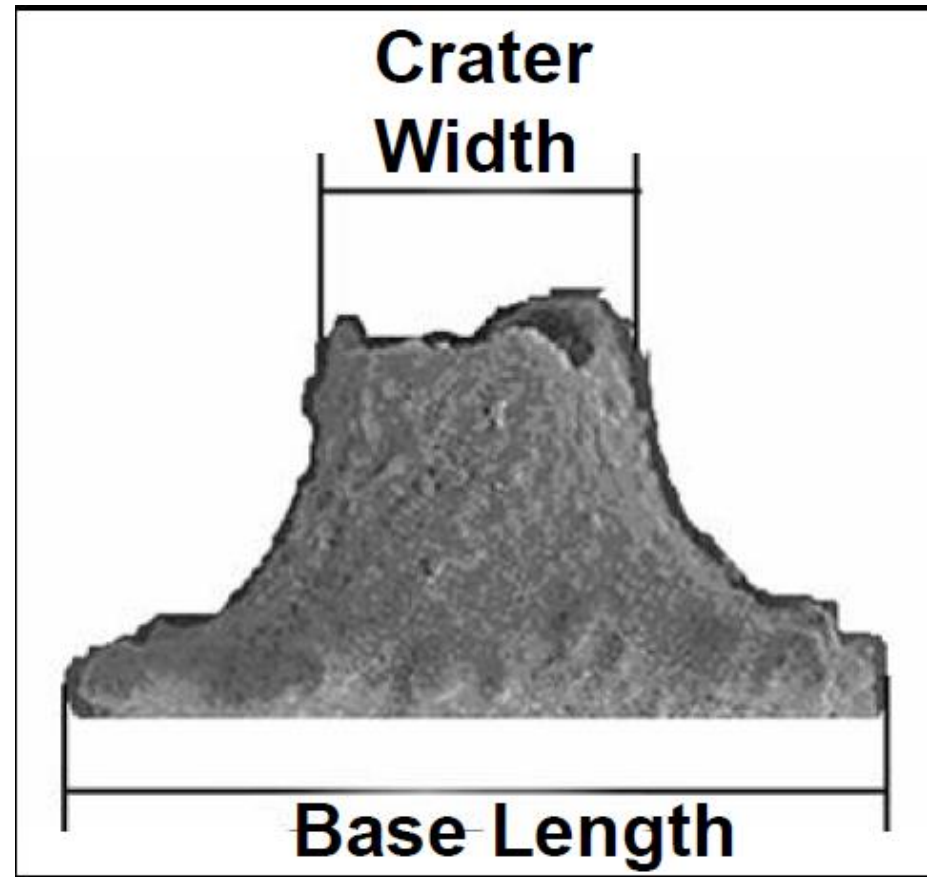


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Musa sp.

## Phytolith

Figure 1. Parameters used for morphometric analysis of volcaniform banana phytoliths



Vrydaghs, L., Terry B. Ball, H. Volkaert, I. Van Den Houwe, J. Manwaring, and E. De Langhe. 2009. Differentiating the Volcaniform Phytoliths of Bananas: *Musa Acuminata*. *Ethnobotany Research and Applications* 7:239–46.

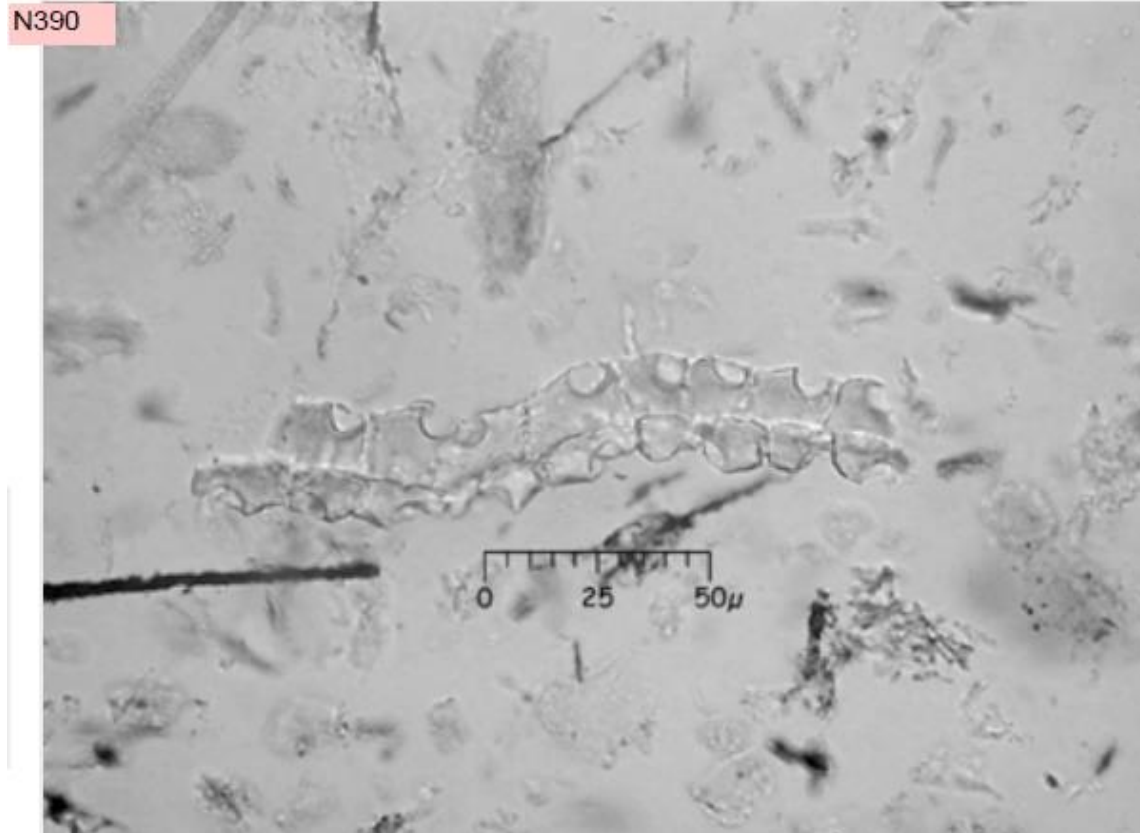
Ball, Terry B., L. Vrydaghs, I. Van Den Hauwe, J. Manwaring, and E. De Langhe. 2006. Differentiating Banana Phytoliths: Wild and Edible *Musa Acuminata* and *Musa Balbisiana*. *Journal of Archaeological Science* 33 (9):1228–36.

# Musa sp.

## Phytolith

Musa, cultivated banana leaf. Check depth of trough to separate from just extremely rugulose spheres. Should be thick and blocky.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Musa sp.

## Phytolith

Musa, cultivated banana leaf. Often occur in chains. Should be thick and blocky.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Musa sp.

## Phytolith

Musa, cultivated banana leaf. Should be thick and blocky.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

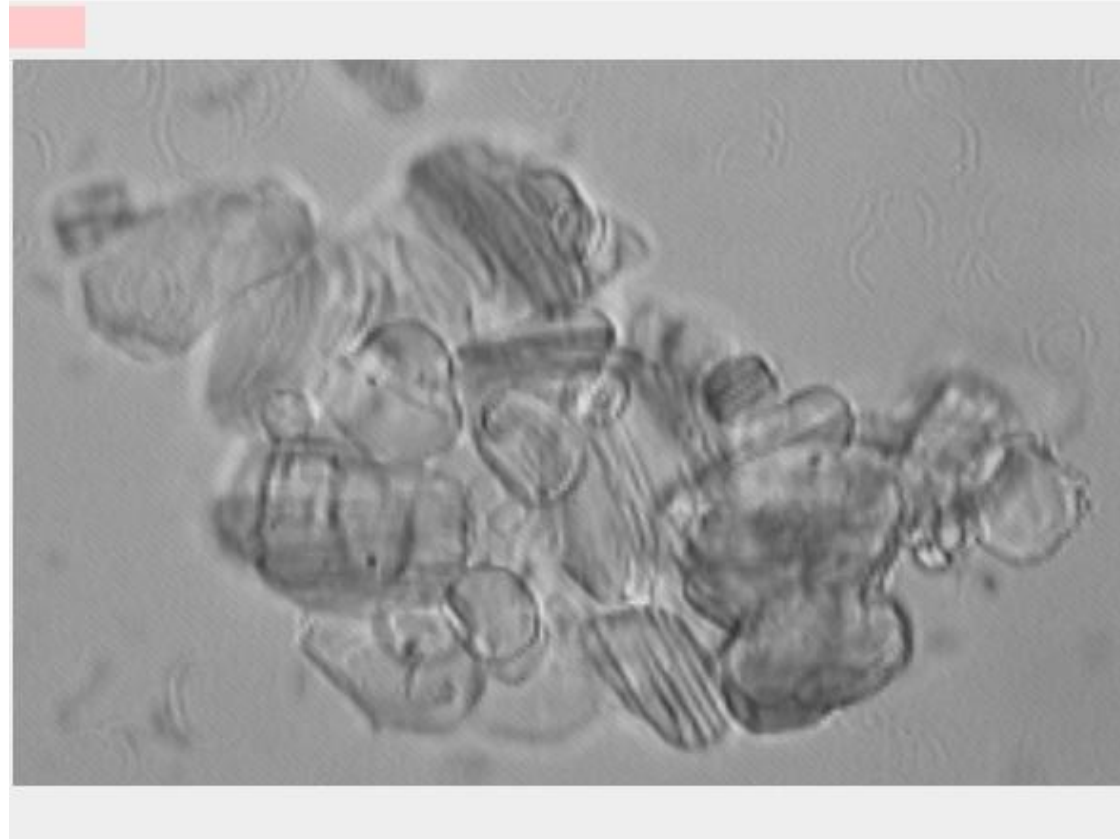
# Musa sp.

## Phytolith

probably calcium carbonate ( $\text{CaCO}_3$ ) crystals.

Also observed in Fabaceae, Flacortiaceae, and Bombacaceae families.

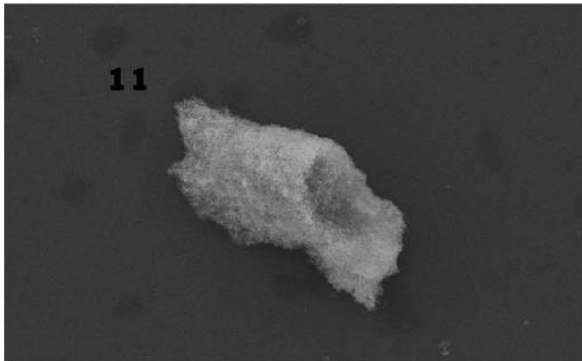
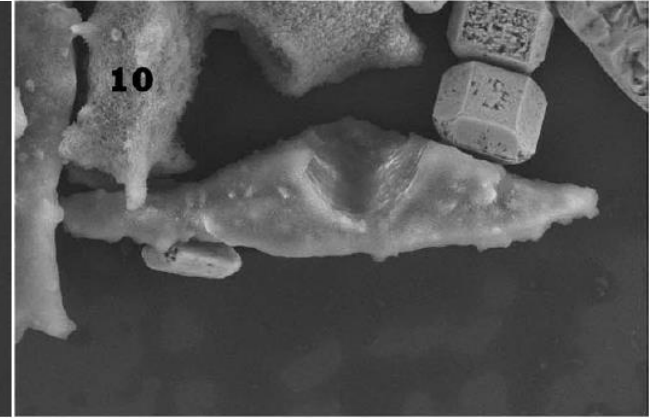
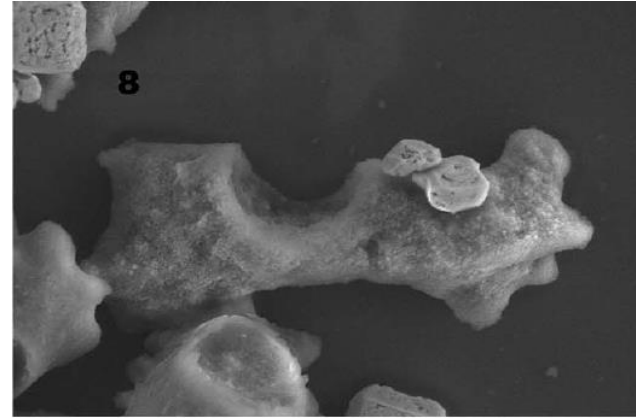
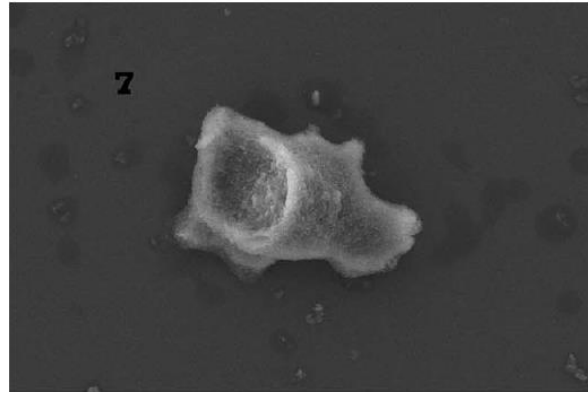
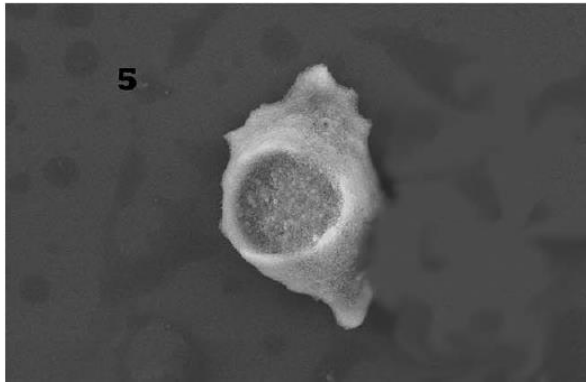
Diagnostic level: not diagnostic



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Musa sp. (ITC 0614, a triploid variety)

## Phytolith



Figs. 1-6. (5) SEM of phytolith produced by ITC 0614, a triploid variety: Variant 2 volcaniform irregular base central concave cone, top view.

Figs. 7-12. (7) SEM of phytolith produced by ITC 0614, a triploid variety: Variant 4 volcaniform irregular base acentric concave cone, top view. (8) SEM of phytolith produced by ITC 0614, a triploid variety:

Variant 5 volcaniform regular base central convex cone, side view. (10) SEM of phytolith produced by ITC 0614, a triploid variety: Variant 7 volcaniform irregular base central convex cone, side view. (11)

SEM of phytolith produced by ITC 0614, a triploid variety: Variant 8 volcaniform irregular base acentric convex cone, side view.

# Musa acuminata ssp.banksii

## Phytolith

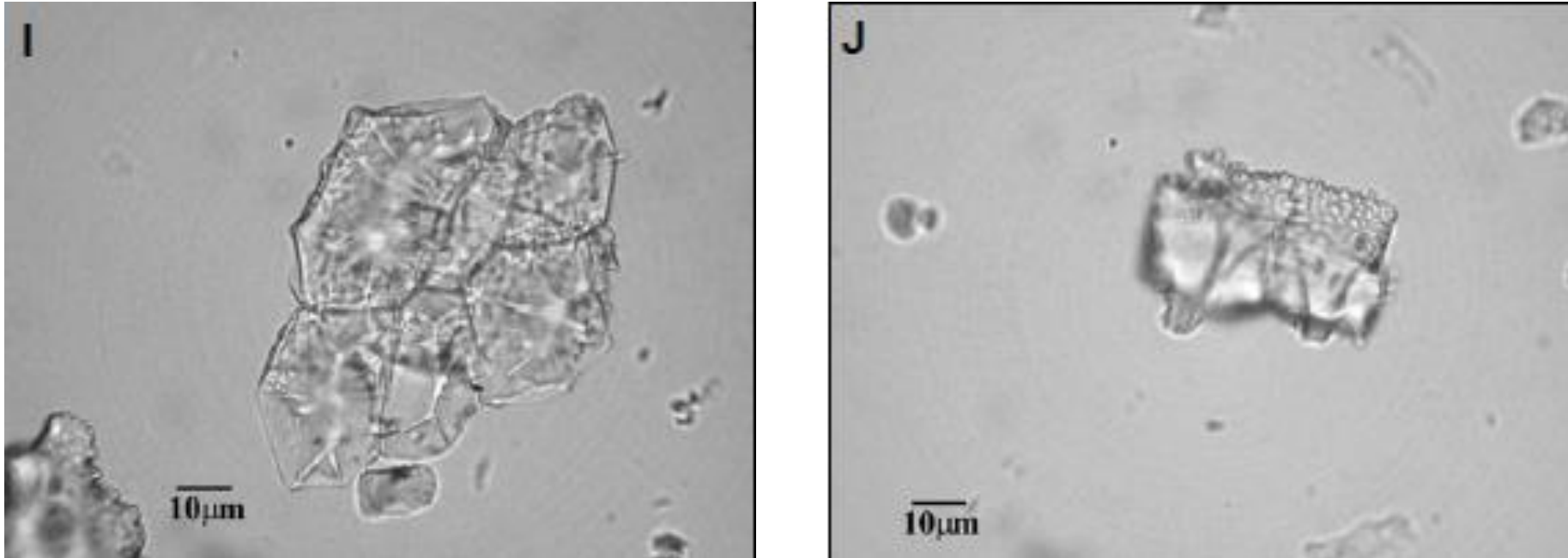


Figure 1. Diagnostic seed morphotypes of wild *Musa* bananas and *Ensete* from Papua New Guinea. I-J. *Musa acuminata* ssp.banksii, Section Eumusa (Accession No. QH067962)

Lentfer, Carol J. 2009. Tracing Domestication and Cultivation of Bananas from Phytoliths: An Update from Papua New Guinea. *Ethnobotany Research and Applications* 7:247–70.

# Musa acuminata ssp. banksii

## Phytolith

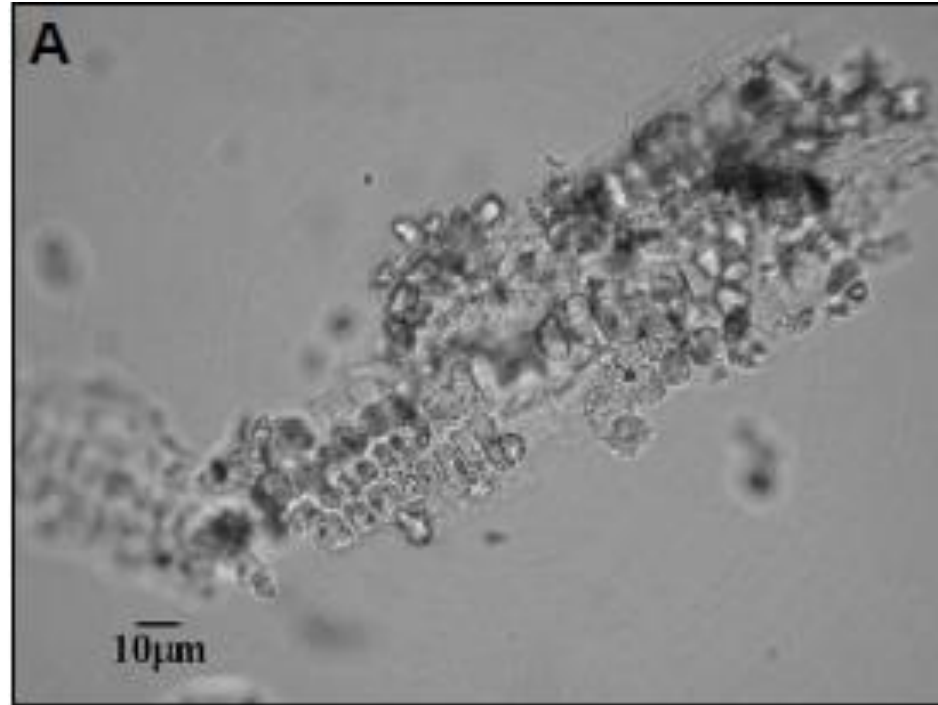
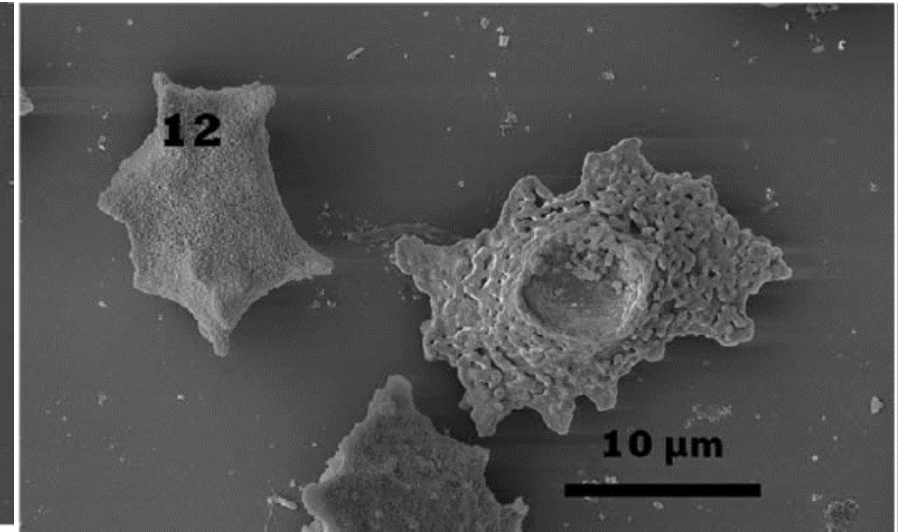
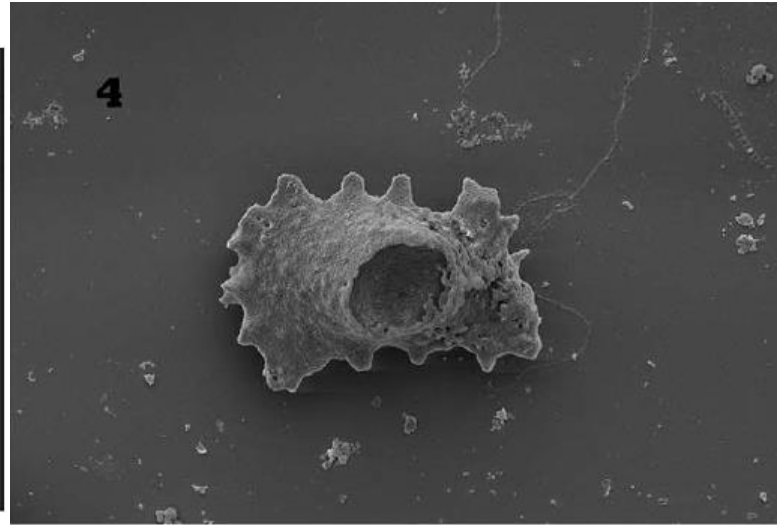
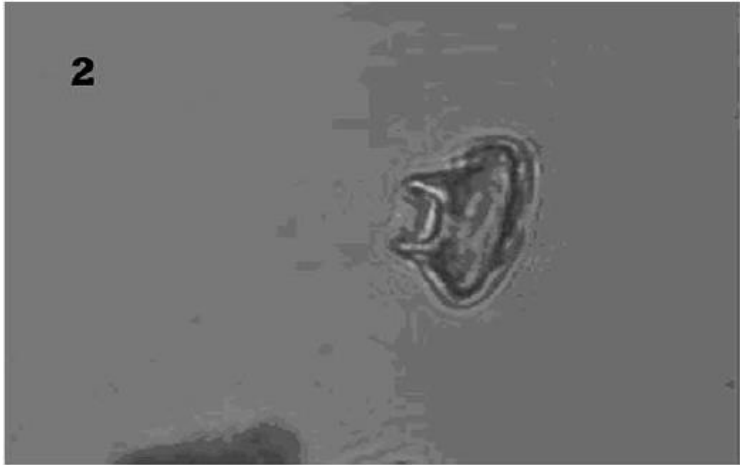


Figure 2. A. Sheet of polygonal and globular seed phytoliths from *Musa acuminata* ssp. *banksii*. These morphotypes have craters and were included in the analysis. The plant material was obtained from the Queensland Herbarium (Accession No. QH067962).

Lentfer, Carol J. 2009. Tracing Domestication and Cultivation of Bananas from Phytoliths: An Update from Papua New Guinea. *Ethnobotany Research and Applications* 7:247–70.

# Musa acuminata ssp. banksii

## Phytolith



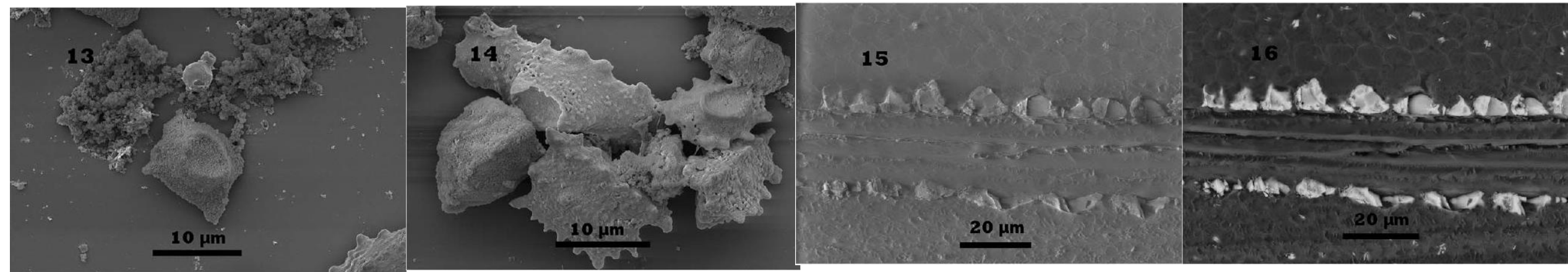
Figs. 1-6. (2) Light micrograph of volcaniform phytolith produced by *M. acuminata* ssp. *banksii*: side view. (4) SEM of phytolith produced by *M. acuminata* ssp. *banksii*: Variant 1 volcaniform regular base central concave cone, top view.

Figs. 7-12. (12) SEM of volcaniform phytoliths produced by *M. acuminata* ssp. *banksii* illustrating granulate to verrucate surface texture.

Ball, Terry B., L. Vrydaghs, I. Van Den Hauwe, J. Manwaring, and E. De Langhe. 2006. Differentiating Banana Phytoliths: Wild and Edible *Musa Acuminata* and *Musa Balbisiana*. *Journal of Archaeological Science* 33 (9):1228–36.

# Musa acuminata ssp. banksii

## Phytolith

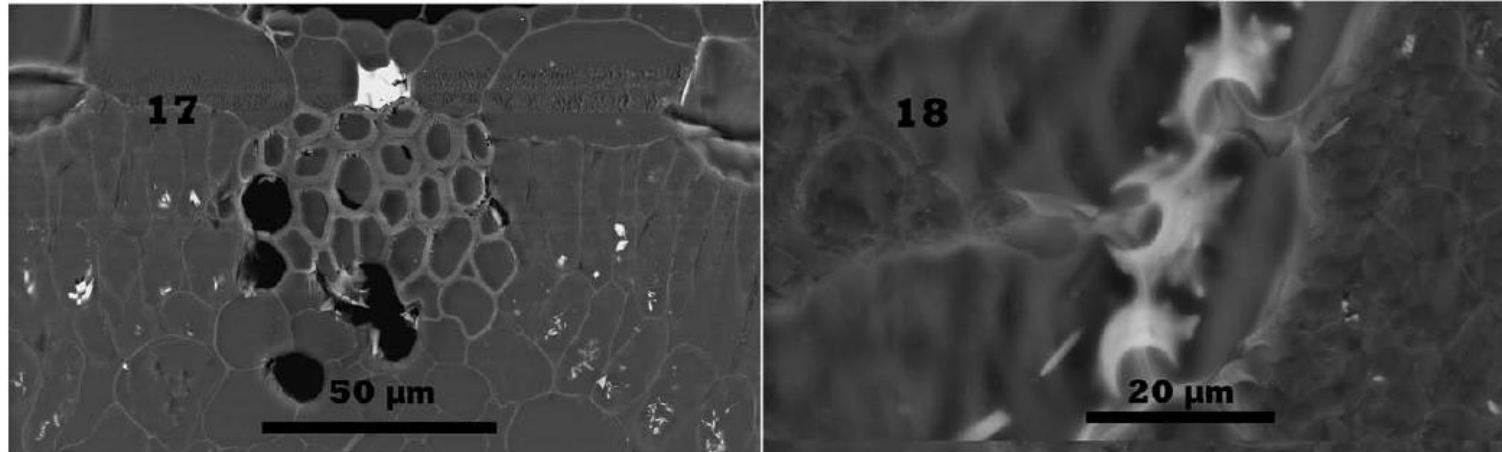


Figs. 13-18. (13) SEM of volcaniform phytolith produced by *M. acuminata* ssp. *banksii* with entire base margins. (14) SEM of volcaniform phytoliths produced by *M. acuminata* ssp. *banksii* illustrating ornamented bases. (15) SEM of in situ volcaniform phytoliths from *Musa acuminata* ssp. *banksii* illustrating their arrangement along the fibers of the vascular bundle sheath. Secondary Electron Image. (16) SEM of in situ volcaniform phytoliths from *Musa acuminata* ssp. *banksii* illustrating their arrangement along the fibers of the vascular bundle sheath. Phytoliths are the bright structures. Note how they were fractured in sectioning. Back-scattered Electron Image. Phytoliths are the bright structures. Backscattered Electron Image.

Ball, Terry B., L. Vrydaghs, I. Van Den Hauwe, J. Manwaring, and E. De Langhe. 2006. Differentiating Banana Phytoliths: Wild and Edible *Musa Acuminata* and *Musa Balbisiana*. *Journal of Archaeological Science* 33 (9):1228–36.

# Musa acuminata ssp. banksii

## Phytolith

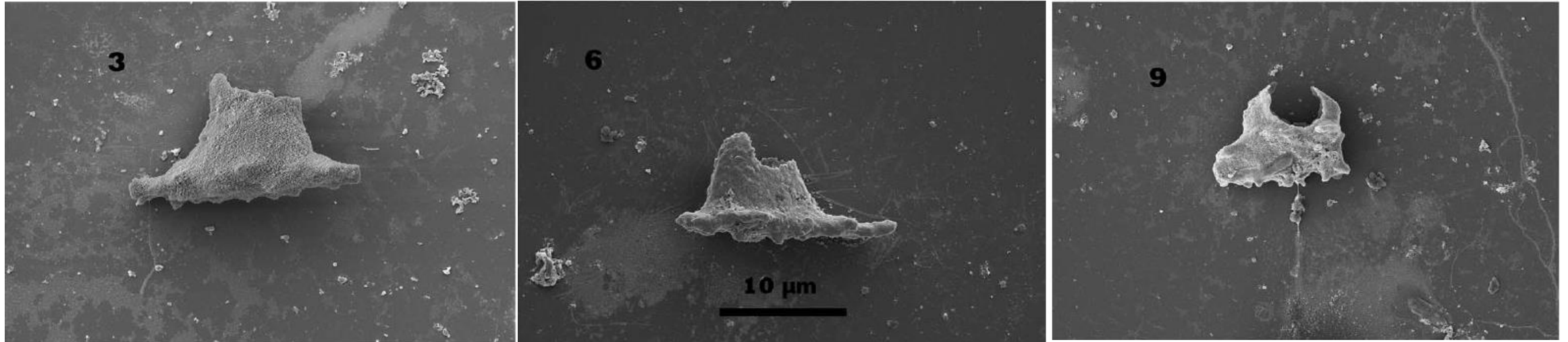


Figs. 13-18. (17) SEM of in situ volcaniform phytolith in cross section from *Musa acuminata* ssp. *banksii* illustrating orientation along the fibers of the vascular bundle cap. Phytolith is the large bright structure on top of the thick-walled fibers. Backscattered Electron Image. (18) SEM of in situ volcaniform phytoliths from *Musa acuminata* ssp. *banksii* illustrating their attachment to surrounding parenchyma cells. Phytoliths are the bright structures. Backscattered Electron Image.



# Musa balbisiana

## Phytolith



Figs. 1-6. (3) SEM of volcaniform phytolith produced by *M. balbisiana*: side view. (6) SEM of phytolith produced by *M. balbisiana*: Variant 3 volcaniform regular base acentric concave cone, side view.

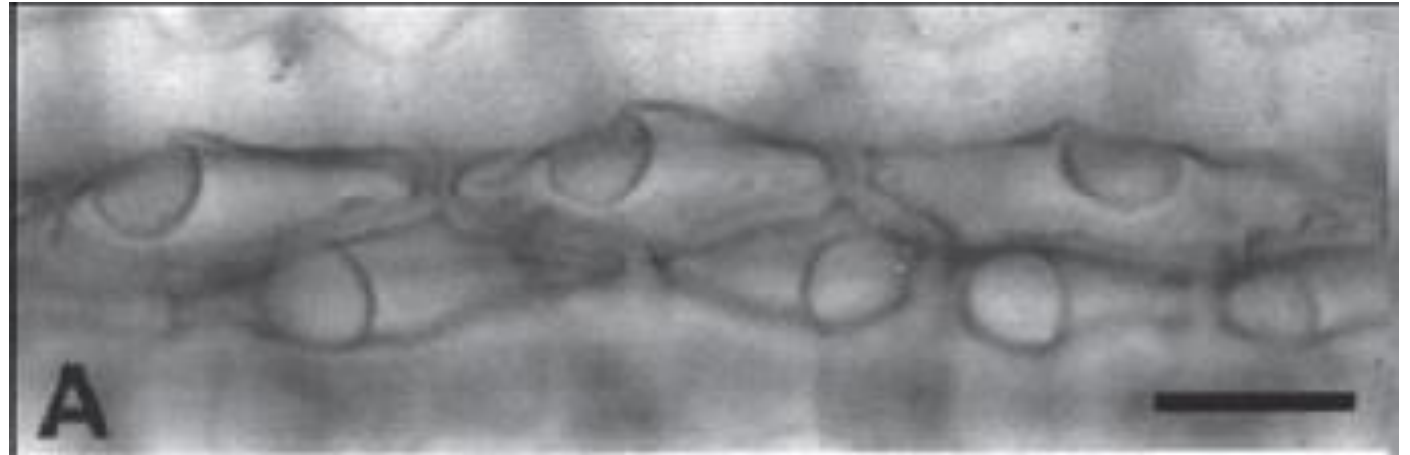
Figs. 7-12. (9) SEM of phytolith produced by *M. balbisiana*: Variant 6 volcaniform regular base acentric convex cone, side view.

Ball, Terry B., L. Vrydaghs, I. Van Den Hauwe, J. Manwaring, and E. De Langhe. 2006. Differentiating Banana Phytoliths: Wild and Edible *Musa Acuminata* and *Musa Balbisiana*. *Journal of Archaeological Science* 33 (9):1228–36.

# Musa coccinea

## Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. A. *Musa coccinea* (Musaceae), trough-shaped silica bodies overlying a vascular bundle (bar = 10 $\mu$ m).

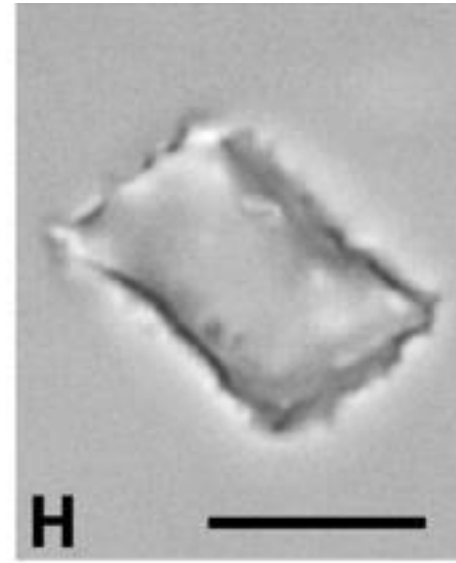
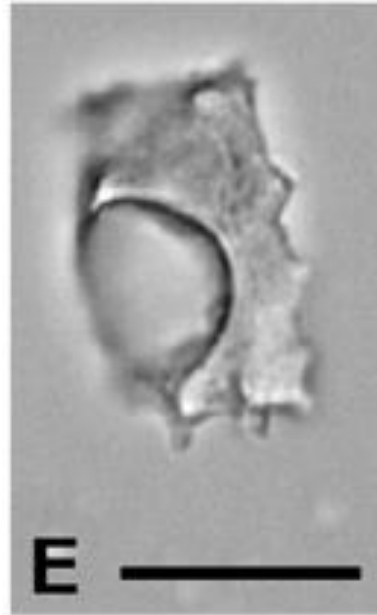


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Musa flava

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). E, T2 trough with papillae on margins from *Musa flava* sheath. H, cylindrical-rugulate from *Musa flava* fruit. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .



Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Musa ingens

## Phytolith

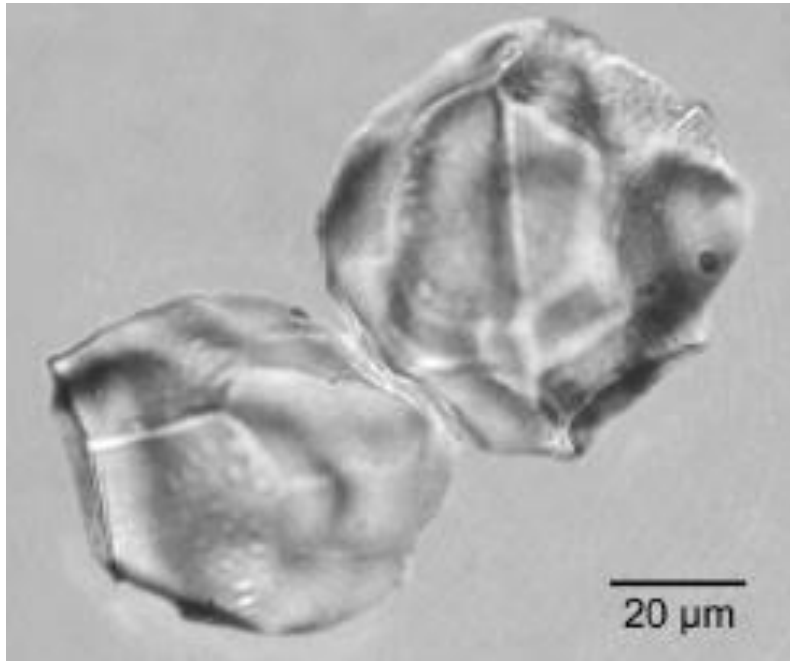


Fig. 16. Seed phytoliths from *Musa ingens*. From Piperno, 2006; originally courtesy of Carol Lentfer.

Ball, Terry B., Karol Chandler-Ezell, Ruth Dickau, Neil Duncan, Thomas C. Hart, José Iriarte, Carol Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <http://dx.doi.org/10.1016/j.jas.2015.08.010>.

# Musa ingens

## Phytolith

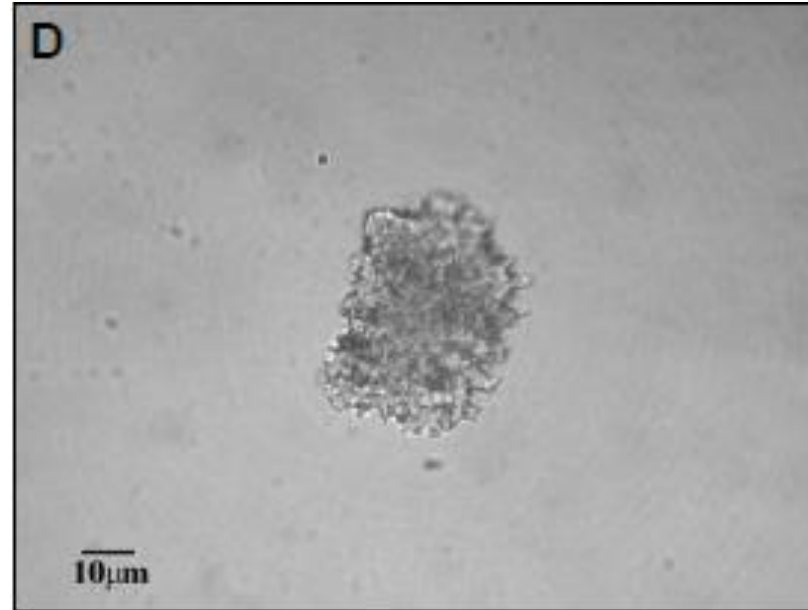


Figure 1. Diagnostic seed morphotypes of wild *Musa* bananas and *Ensete* from Papua New Guinea. C-D. *Musa ingens*, Section Ingentimusa (Accession No. WH1)

Lentfer, Carol J. 2009. Tracing Domestication and Cultivation of Bananas from Phytoliths: An Update from Papua New Guinea. *Ethnobotany Research and Applications* 7:247–70.

# Musa maclayi

## Phytolith

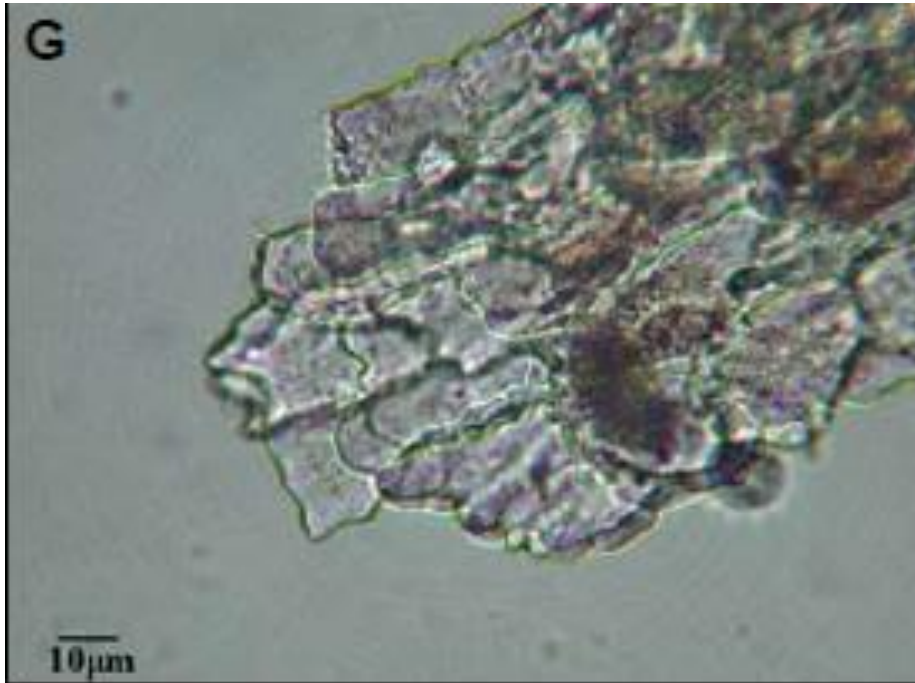


Figure 1 cont. Diagnostic seed morphotypes of wild Musa bananas and Ensete from Papua New Guinea. G-H. *Musa maclayi*, Section Australimusa (Accession No. MB6)

Lentfer, Carol J. 2009. Tracing Domestication and Cultivation of Bananas from Phytoliths: An Update from Papua New Guinea. *Ethnobotany Research and Applications* 7:247–70.

# Musa maclayi

## Phytolith

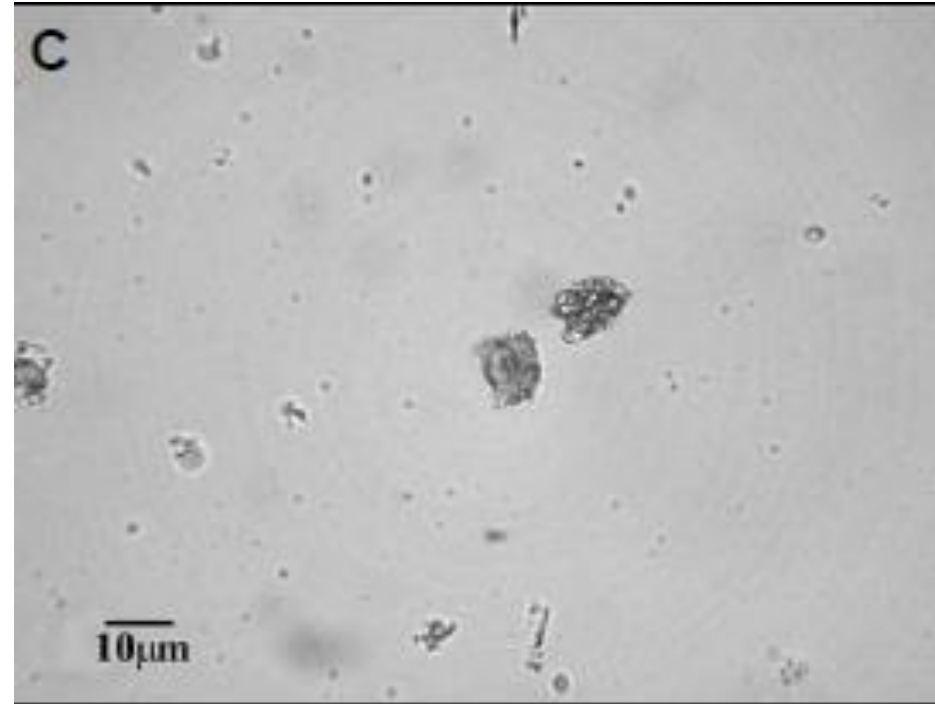
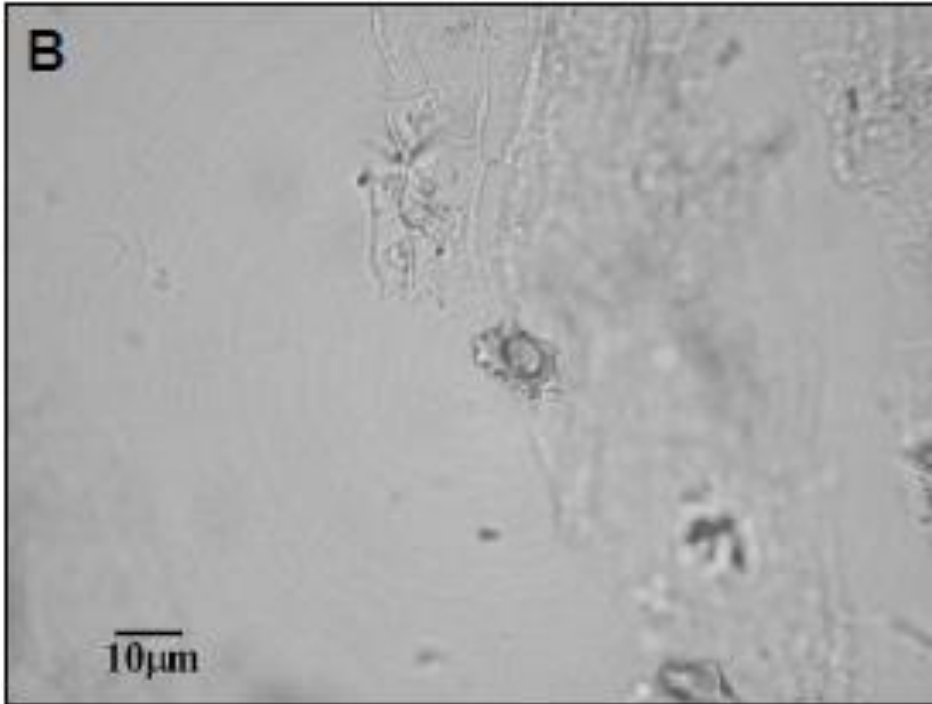


Figure 2. B-C. Examples of volcaniform and globular leaf morphotypes from *Musa maclayi* (Accession No. NB487) examined in the analysis.

Lentfer, Carol J. 2009. Tracing Domestication and Cultivation of Bananas from Phytoliths: An Update from Papua New Guinea. *Ethnobotany Research and Applications* 7:247–70.

# Musa peekelii

## Phytolith

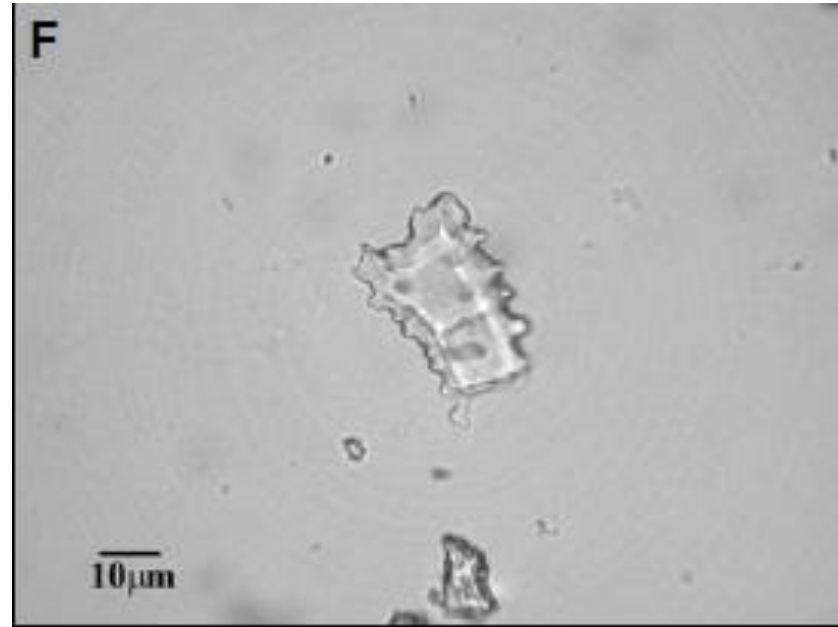
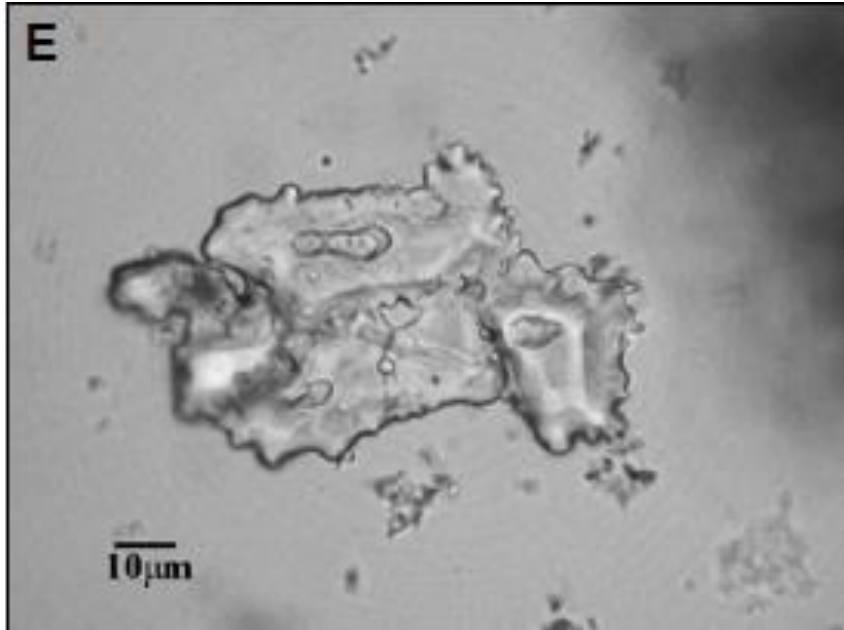


Figure 1. Diagnostic seed morphotypes of wild *Musa* bananas and *Ensete* from Papua New Guinea. E-F. *Musa peekelii*, Section Australimusa (Accession No. WNB488).

Lentfer, Carol J. 2009. Tracing Domestication and Cultivation of Bananas from Phytoliths: An Update from Papua New Guinea. *Ethnobotany Research and Applications* 7:247–70.



# Musa sapientum

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). D, T2 trough with papillae on margins from *Musa sapientum* leaf. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .

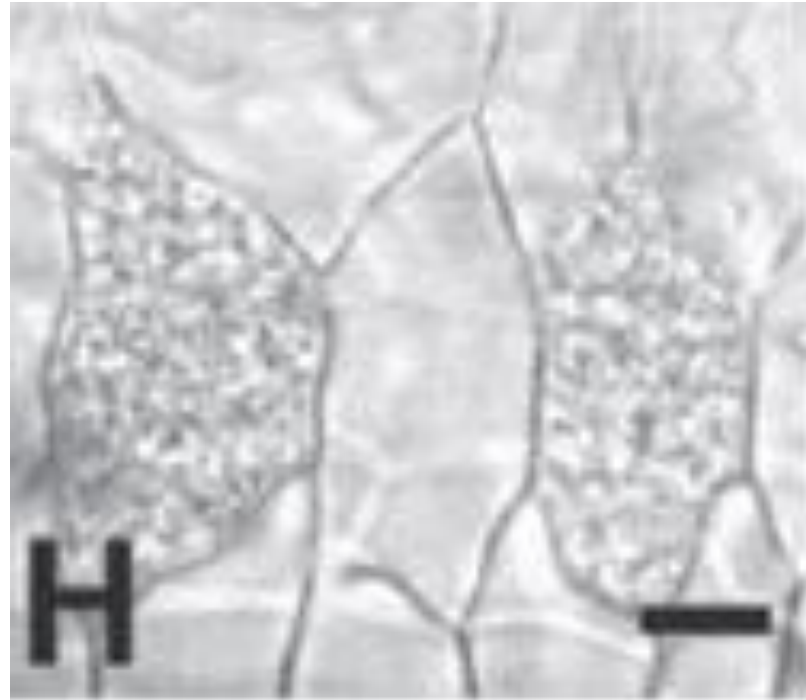


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Musa schizocarpa

## Phytolith

Fig. 3. Various silica body morphologies found in the order Zingiberales. H. *Musa schizocarpa* (Musaceae), intercostal, epidermal silica sand (bar = 10  $\mu\text{m}$ ).



Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Musa schizocarpa

## Phytolith

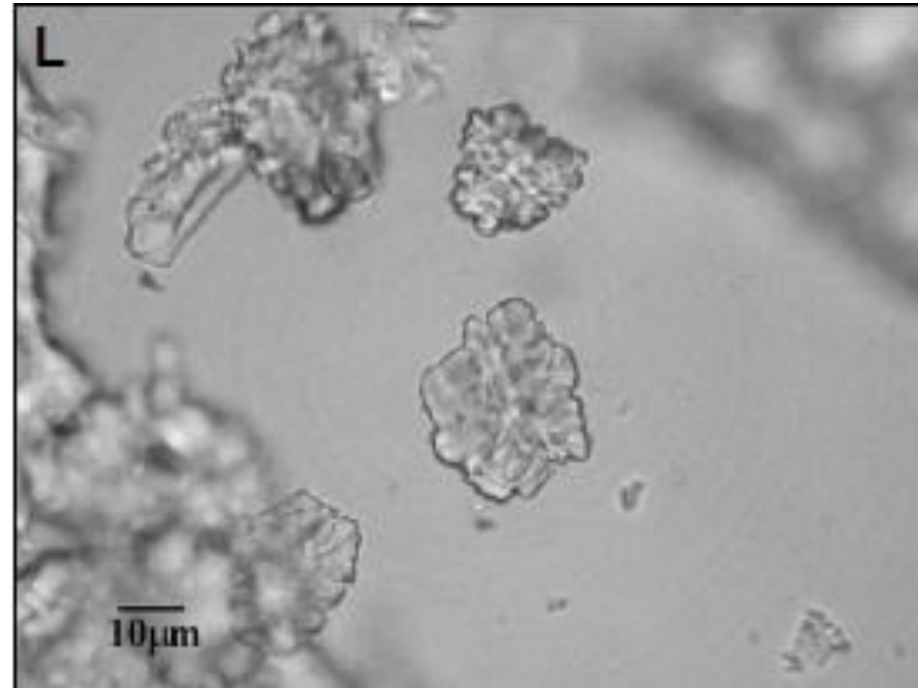
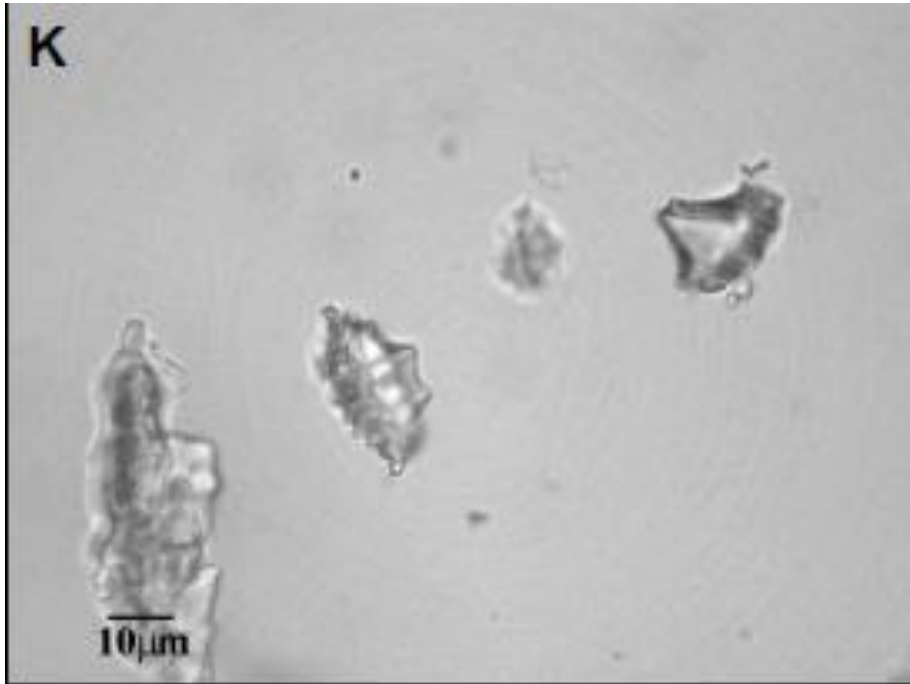


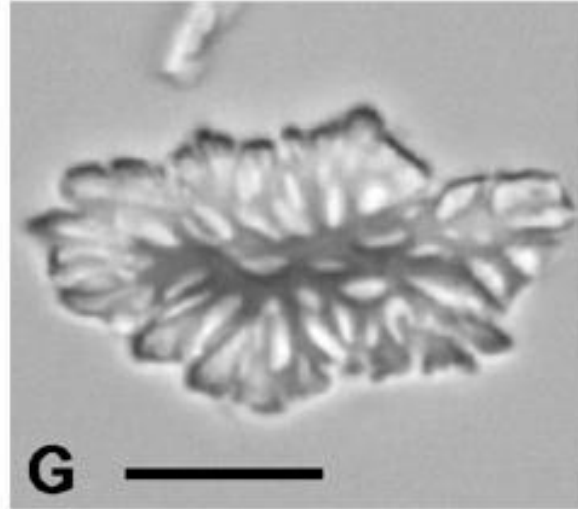
Figure 1. Diagnostic seed morphotypes of wild *Musa* bananas and *Ensete* from Papua New Guinea. K-L. *Musa schizocarpa*, Section Eumusa (Accession No. NB489).

Lentfer, Carol J. 2009. Tracing Domestication and Cultivation of Bananas from Phytoliths: An Update from Papua New Guinea. *Ethnobotany Research and Applications* 7:247–70.

# Musa velutiva

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). G, Ta6 tabular from *Musa velutiva* seed. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .

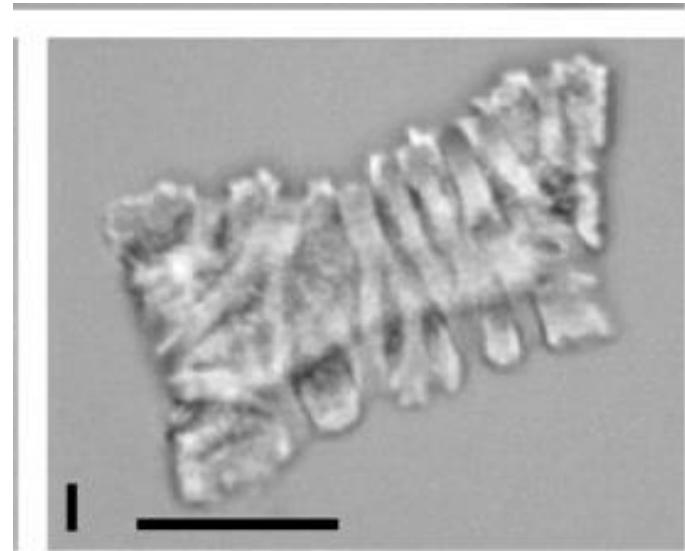


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Musella lasiocarpa

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). I, Tabular with scalariform ridges and internal outline of phytolith shape, similar to Ta6, from *Musella lasiocarpa* seed. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .

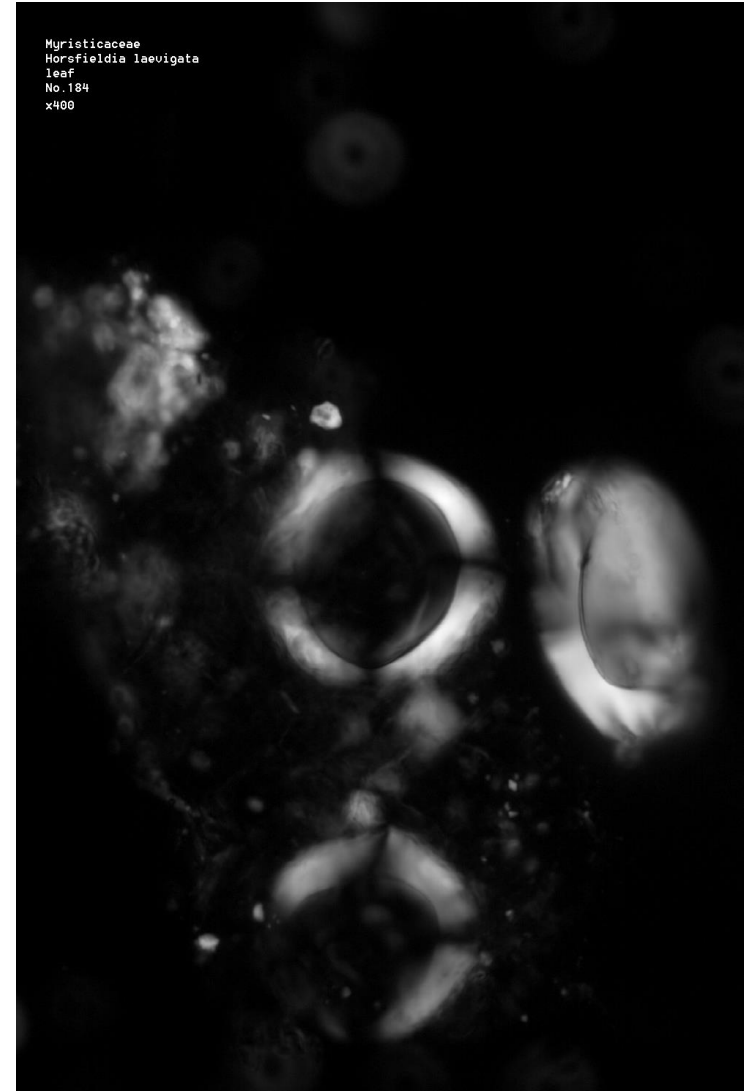
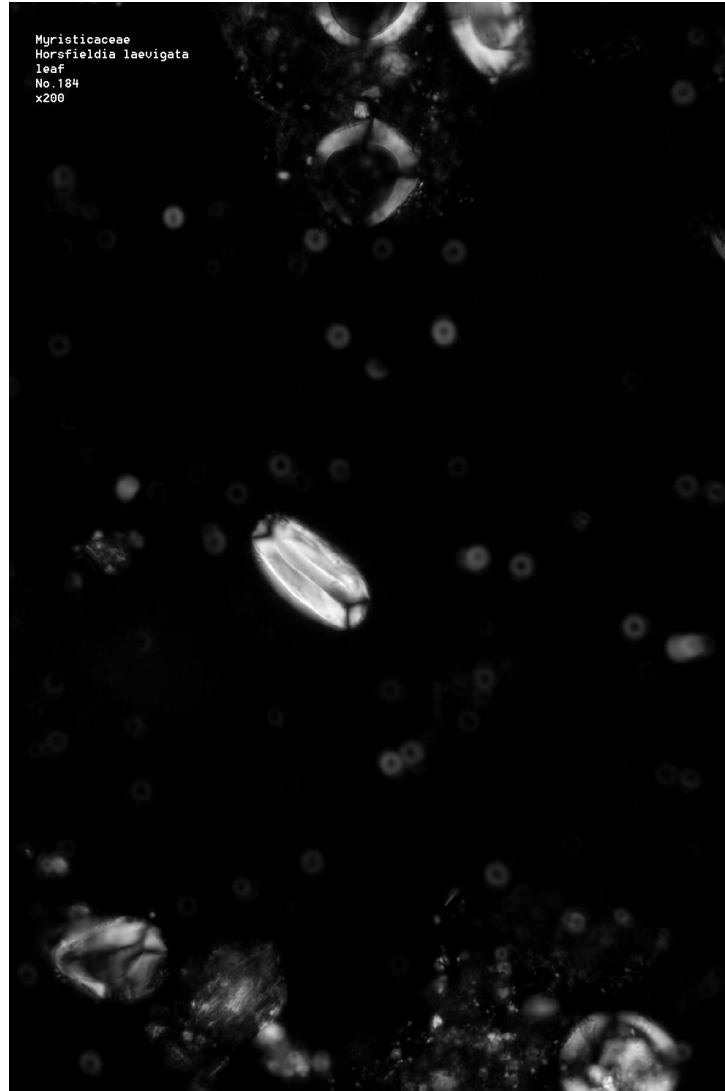
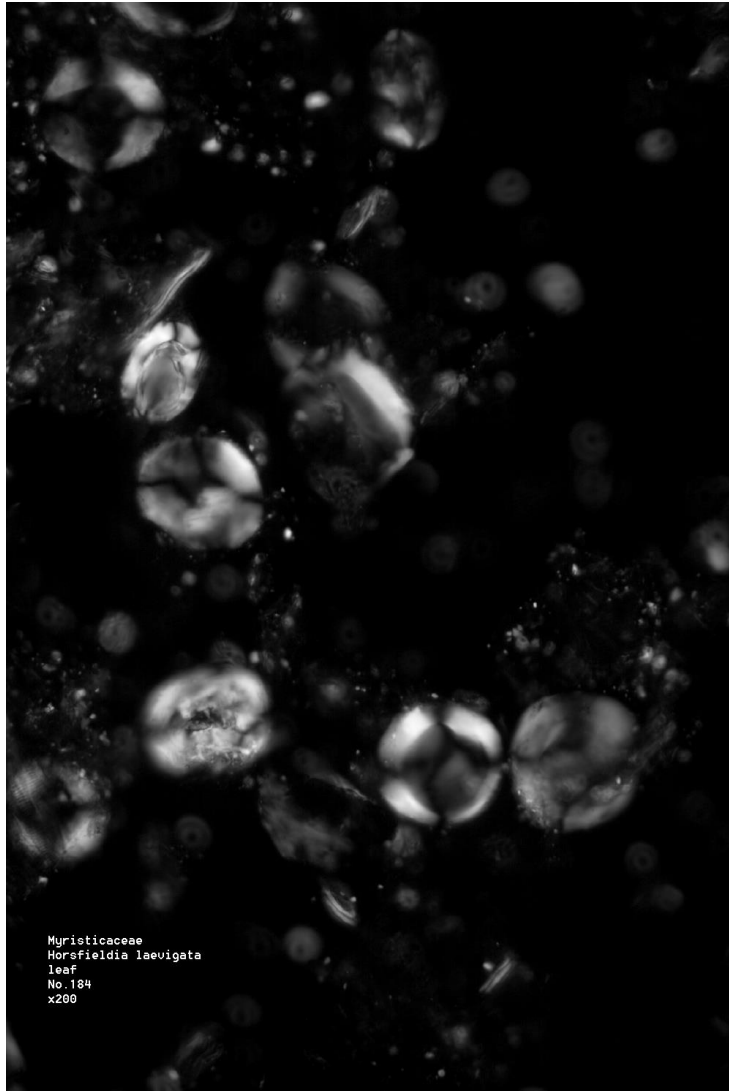


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

MYRISTICACEAE

# Horsfieldia laevigata

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection

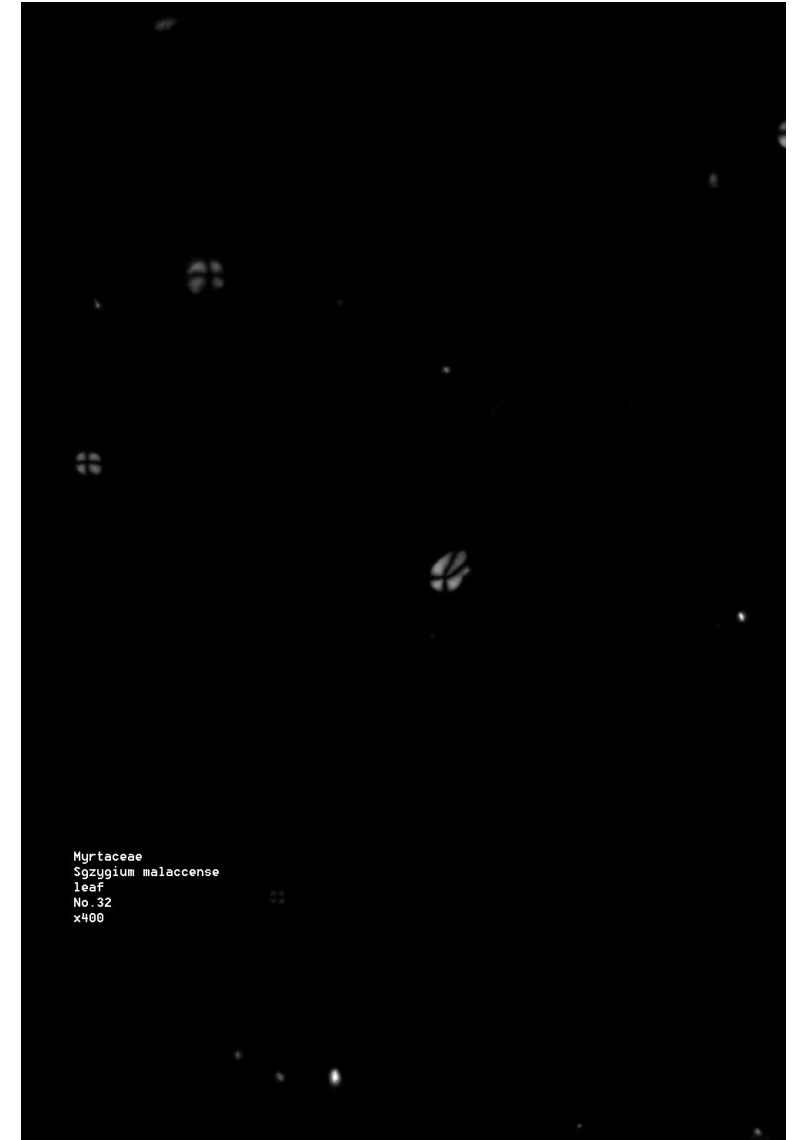
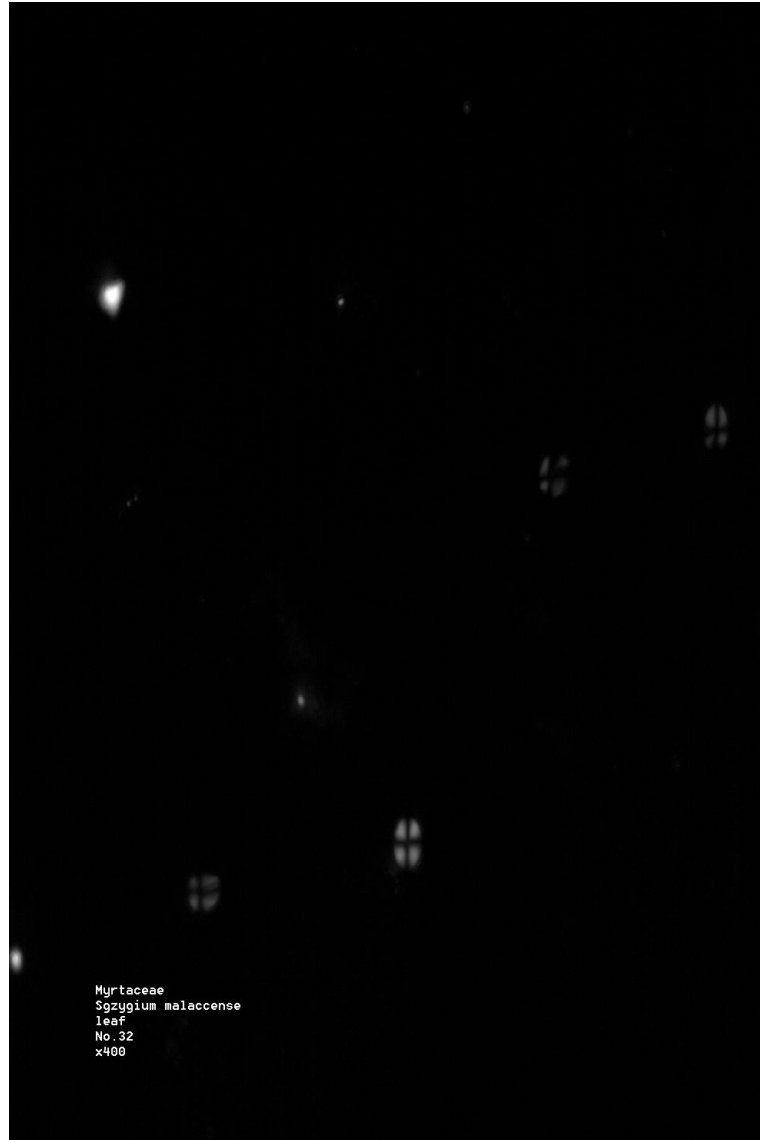


MYRTACEAE



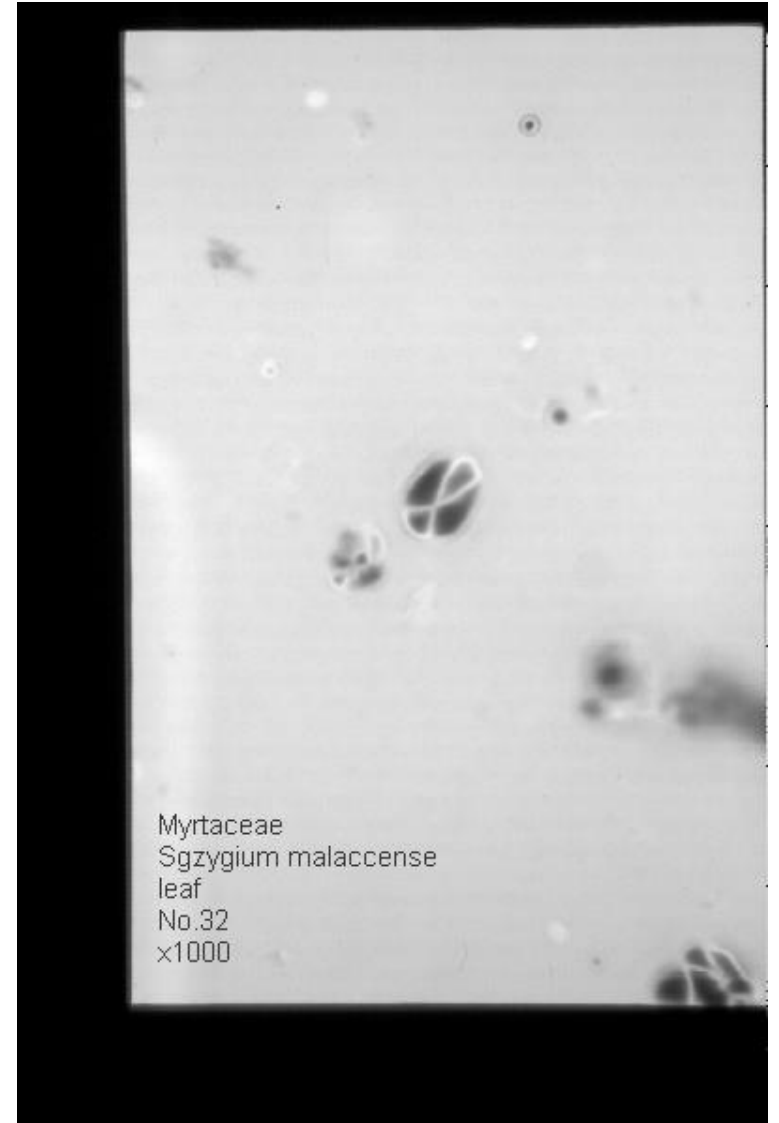
# Syzygium malaccense

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Syzygium malaccense

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



ORCHIDACEAE

# Angraecum chevalieri

## Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. B. *Angraecum chevalieri* (Orchidaceae), spherical bodies overlying sclerenchymatous bundle-sheath cells (bar = 10  $\mu\text{m}$ ).

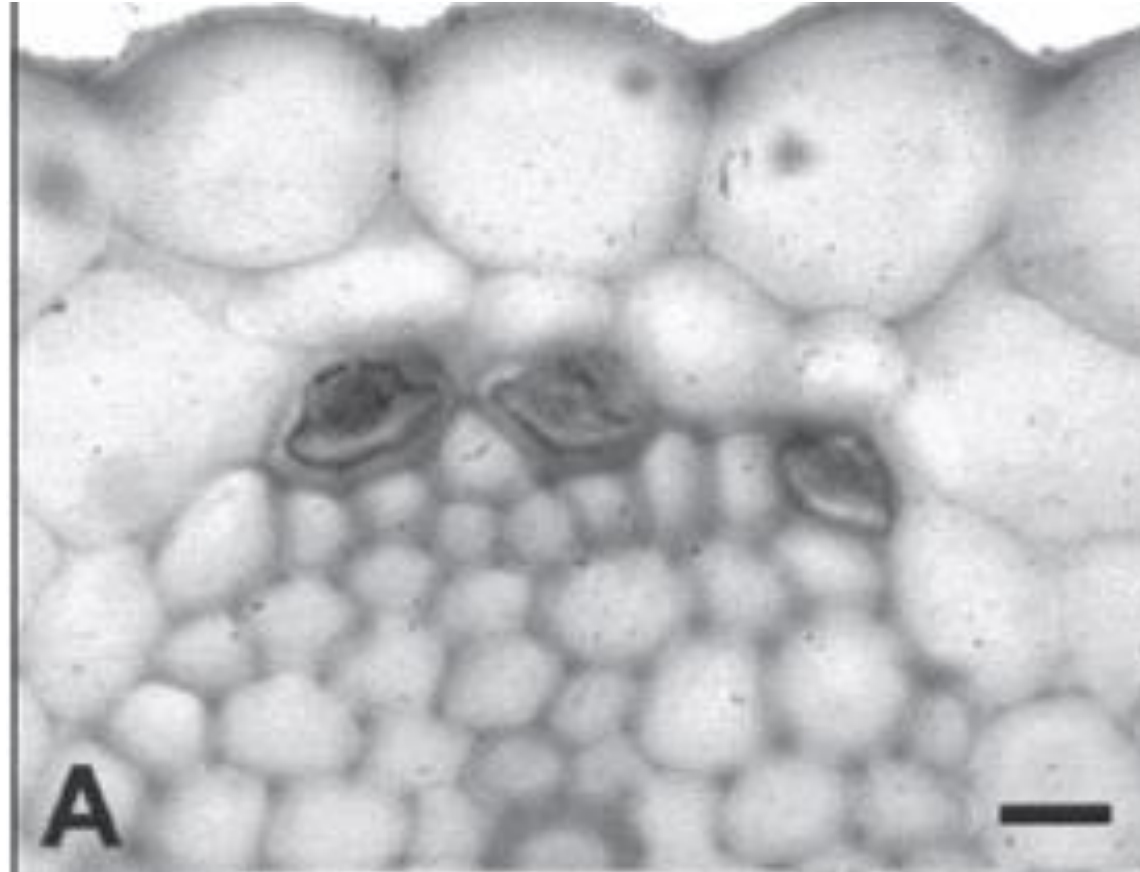


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Cephalanthera pallens

## Phytolith

Fig. 2. Various silica body morphologies found in Orchidaceae, Arecaceae and the order Commelinales. A. *Cephalanthera pallens* (Orchidaceae), conical silica bodies with truncated tops (hat shaped) adjacent to phloem cells (bar = 10  $\mu$ m).



Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

OXALIDACEAE

# Hypsocharis pimillifolia

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

Oxalidaceae *Hypseocharis pimillifolia* "soldaque", wild specie

## Phytolith assemblage characterization

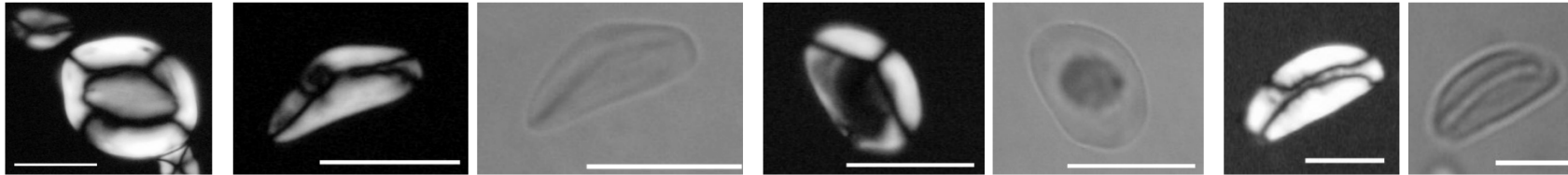
No opal phytoliths (\*).

tuber

**References:** Reported as a family where phytoliths have been found to be not present, rare or not taxonomically significant in Pearsall 2000:371.

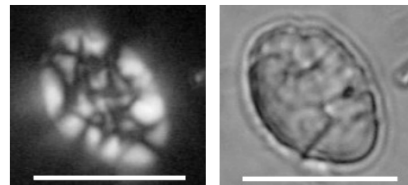
## Starch assemblage characterization

a) Mainly single grains, oval, sausage-shaped, and triangulate with round sides and vertex; variable in size commonly from 15 $\mu$ m to 25 $\mu$ m, but also more than 40 $\mu$ m long length; not visible hilum; sometimes very distinct lamella; sometimes a fissure in a regular line, or a central circular to oval hollow; distinct, mainly centric but variable placed cross, with four arms visible, equal or two long and two short, intersecting in a line or meeting two by two. A few subspheric grains with a central circle formed by the arms of the cross.



tuber

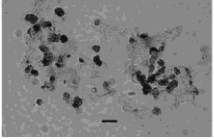
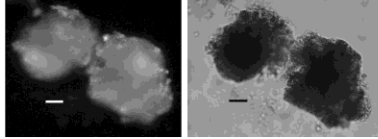

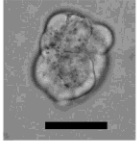
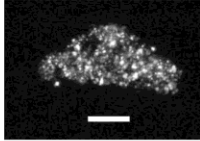
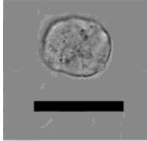
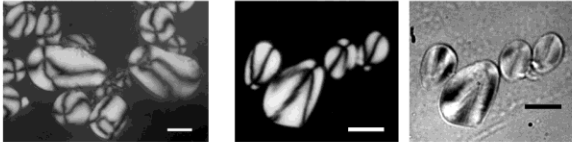
b) Rarely compound grains, oval, from 20 $\mu$ m-22 $\mu$ m, compounded by variable number of granula. Granula different in shape and size.



Scale bar = 20 $\mu$ m.

# Oxalis tuberosa

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

Oxalidaceae <i>Oxalis tuberosa</i> "oca"	
Phytolith assemblage characterization	
seed	<p>No phytoliths (*).</p> <p><b>References:</b> Reported as a family where phytoliths have been found to be: not present, rare or not taxonomically significant (Pearsall 2000:371).</p>
leaf	<p>No diagnostic phytoliths and oxalates (*):</p> <p>a) Sub-spherical irregularly granulate opal phytoliths. Common. (5-10µm).</p>  <p>b) Amorphous granulate oxalates. Common.</p>  <p><b>References:</b> Reported as a family where phytoliths have been found to be: not present, rare or not taxonomically significant (Pearsall 2000:371).</p>
flower	<p>No diagnostic phytoliths. (*):</p> <p>a) Round with a central density silica phytolith. Rare.</p>  <p><b>References:</b> Reported as a family where phytoliths have been found to be: not present, rare or not taxonomically significant (Pearsall 2000:371).</p>
tuber	<p>Some non diagnostic phytoliths (*) and oxalates (*):</p> <p>a) Globose irregularly lobated silica phytolith. Rare.</p>  <p>b) Sub-spherical irregularly shaped oxalates. Common.</p>  <p>c) Round planar silica phytolith. Rare.</p> 
Starch assemblage characterization	
tuber	<p>a) Single grains, globular or subglobular; less than 7µm.</p> <p>b) Single grains, generally asymmetrical, irregular, pear-shaped, prismatic, ovoid, oval and spherical, sometimes with a partially truncate-rounded end; from 10µm to 60µm long length; distinct highly eccentric hilum as a circle or line; very distinct lamella; radiating lines from the hilum to the border of grain; sometimes a centric fissure; distinct eccentric cross to one end, with irregular, broken dark arms intersecting at more than one point, fibrous appearance.</p>  <p><b>References:</b> Partially based on Cortella and Pochettino 1995.</p> <p>c) Compound grains compounded by two-five granula. Granula, generally unequal and asymmetrical.</p>

Scale bar = 20µm.

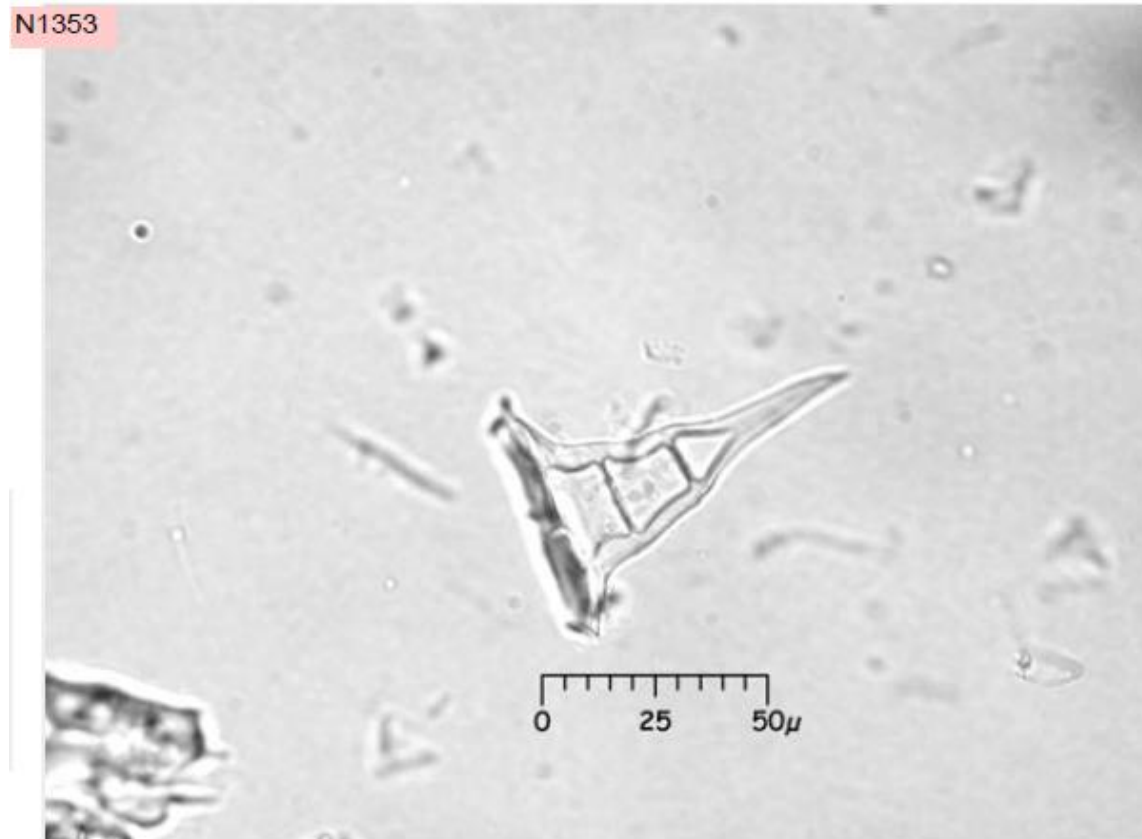


PIPERACEAE

# Piper aduncum

## Phytolith

Slide 1397a; Leaf

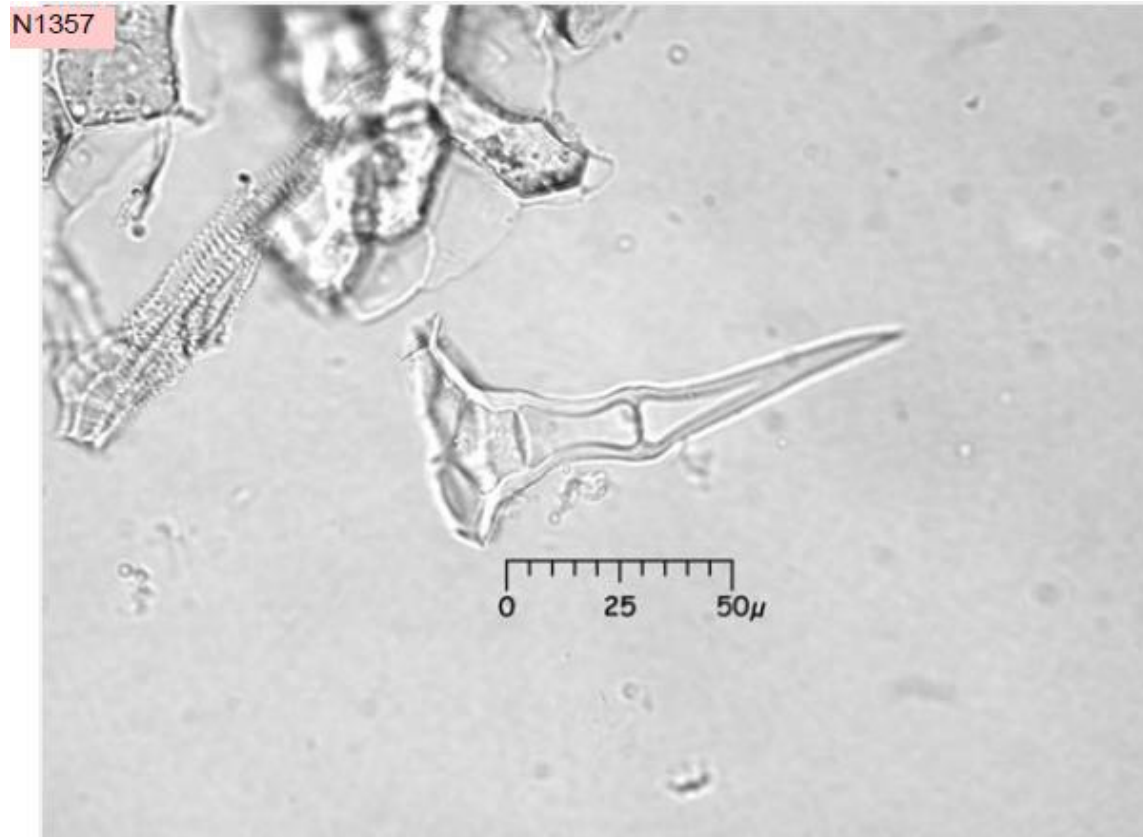


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1397a; Leaf



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1397a; Leaf

Picture shows a broken hair without the tip



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1397a; Leaf

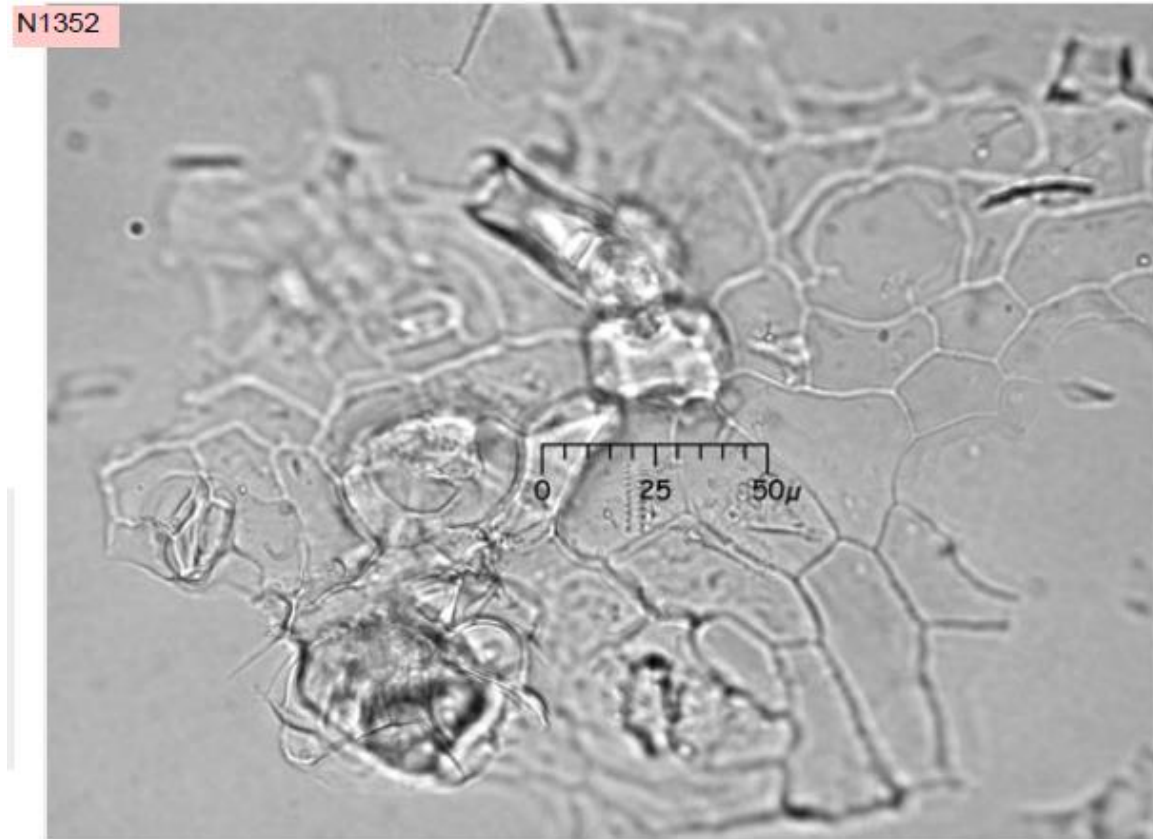


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1397a; Leaf  
Hair shaft still attached to base



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1397a; Leaf

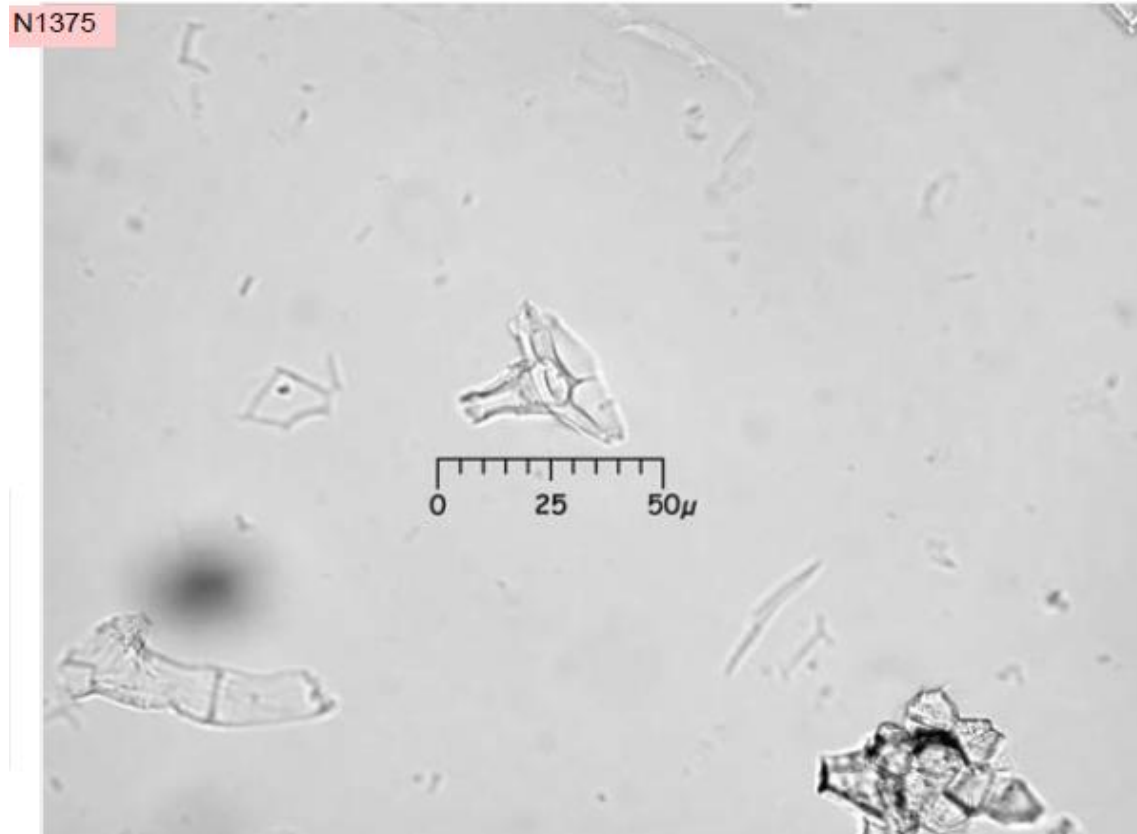


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1397a; Leaf



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Piper aduncum

## Phytolith

Slide 1397a; Leaf  
Picture shows four highly silicified  
central cells

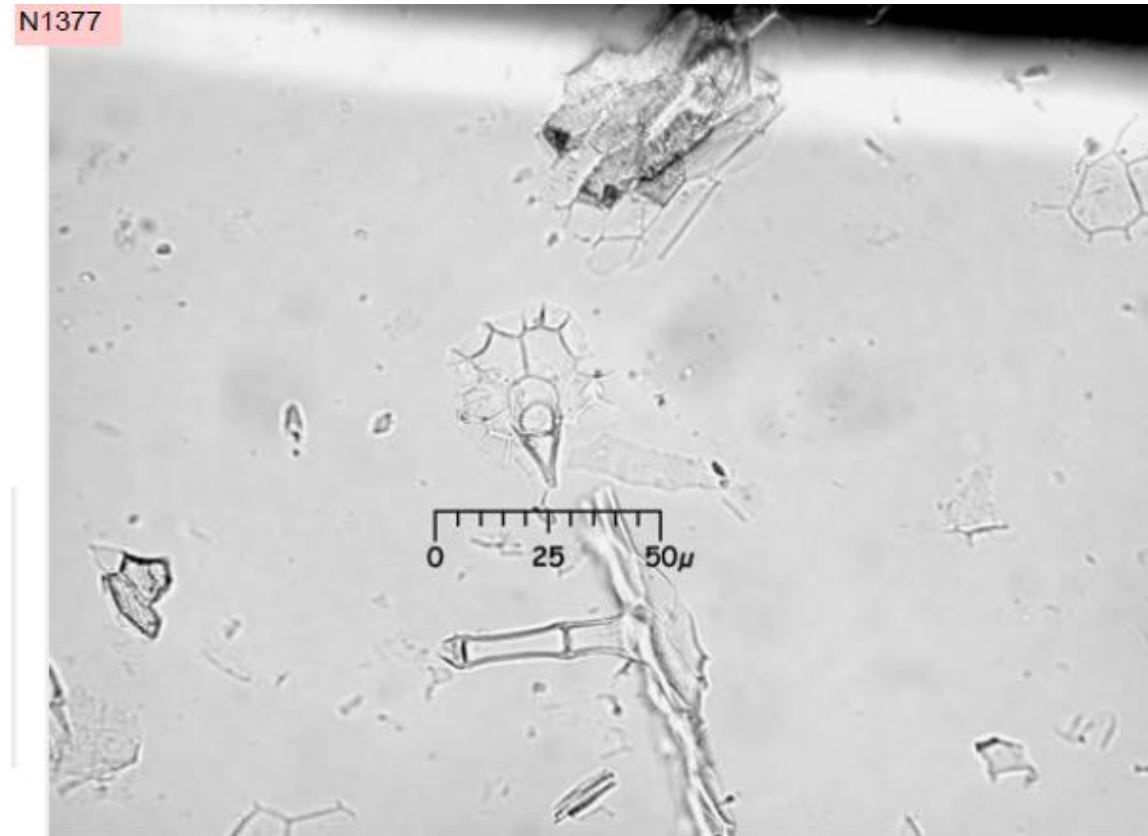


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1397a; Leaf



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1397a; Leaf



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1397a; Leaf



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1397a; Leaf

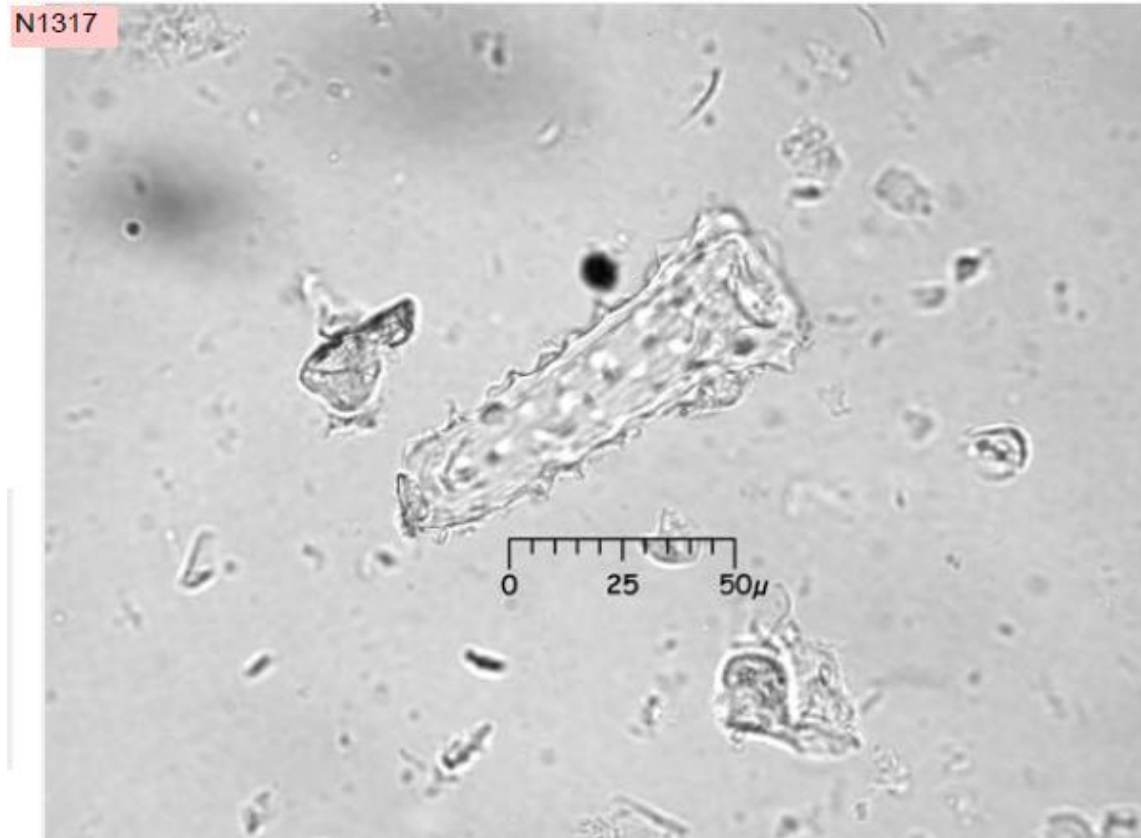


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1398a. Inflorescence. Picture only shows one segment of a hair.



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1398a. Inflorescence

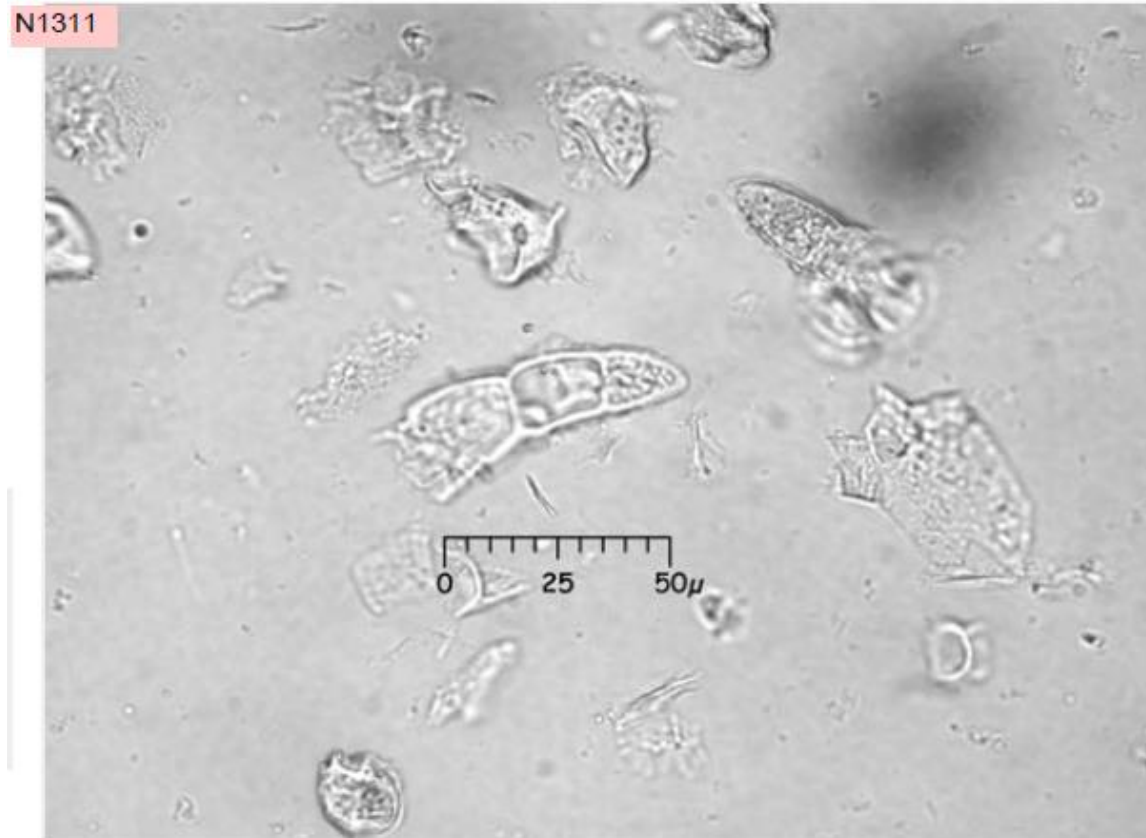


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1398a. Inflorescence  
Segments often occur individually or in  
pairs throughout slide



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Piper aduncum

## Phytolith

Slide 1398a. Inflorescence  
Segments often occur individually or in  
pairs throughout slide



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1398a. Inflorescence

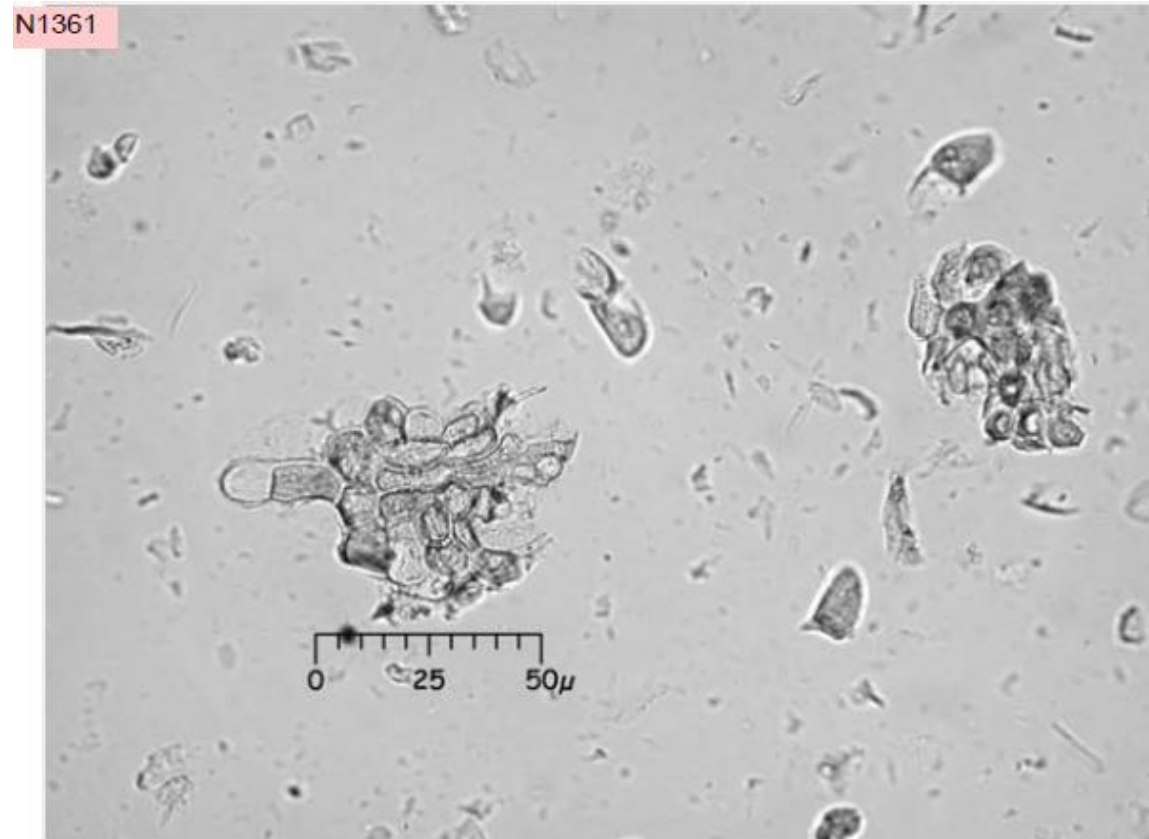


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1398a. Inflorescence.  
Picture shows hair base with hair  
attached and to the far right a hair base  
without hairs attached.

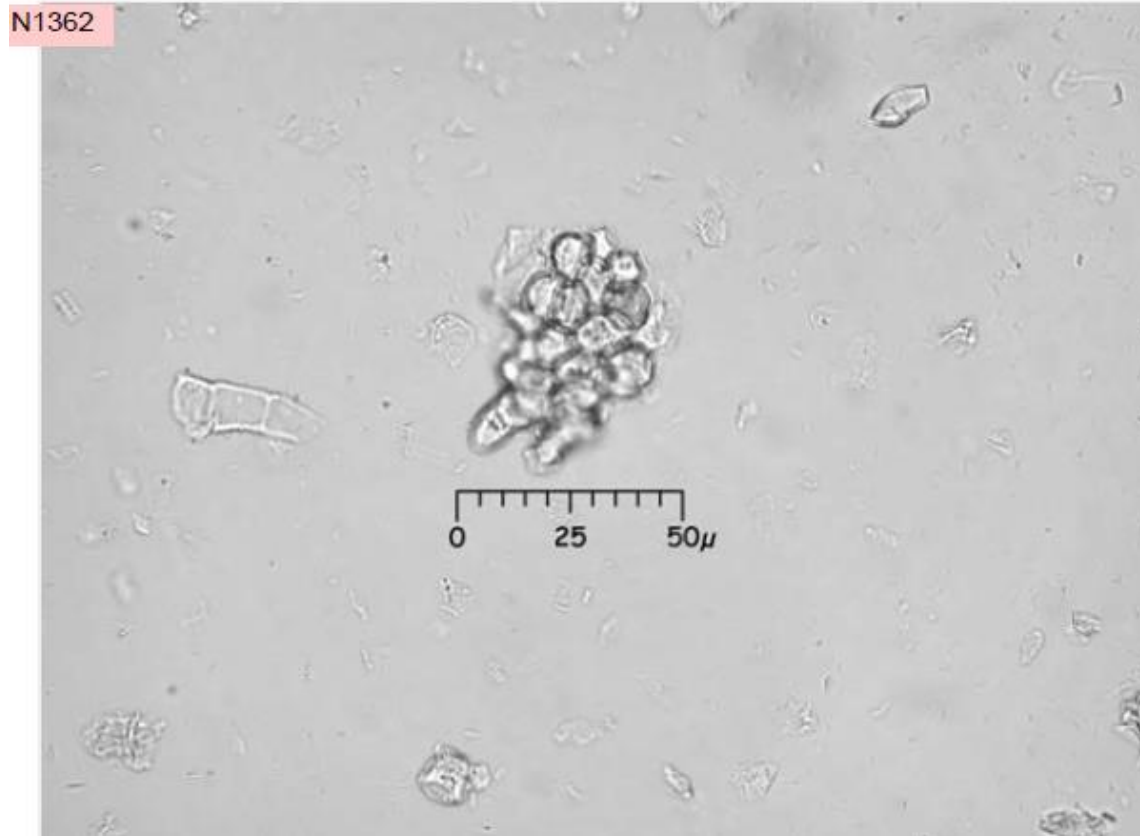


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper aduncum

## Phytolith

Slide 1398a. Inflorescence.



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Piper flagellicuspe

## Phytolith

2. Hair cell phytoliths with two rounded ends from *Piper flagellicuspe* (400 x ).

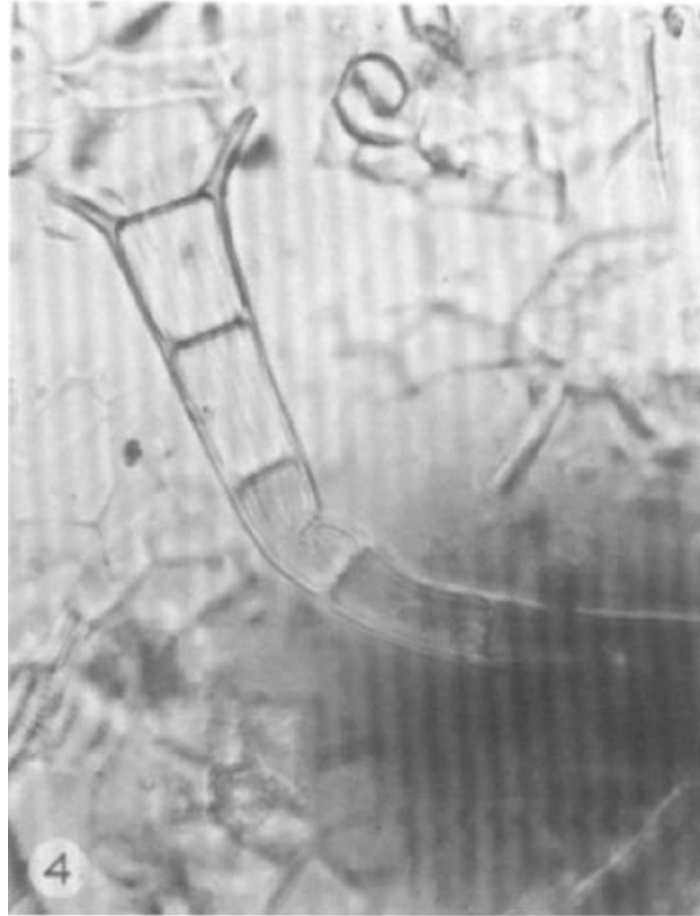


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Piper pseudoasperi

## Phytolith

4. Segmented hair with long distinct striations on the surface from *Piper pseudoasperi* (400×).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

POACEAE

# Panicoideae

## Phytolith



i. Charred silicified sheet fragment of long-cells and bilobate-type short-cells diagnostic of the Poaceae subfamily Panicoideae, and likely derived from leaf material.

Abramiuk, Marc A., Peter S. Dunham, Linda Scott Cummings, Chad Yost, and Todd J. Pesek. 2011. Linking Past and Present: A Preliminary Paleoethnobotanical Study of Maya Nutritional and Medicinal Plant Use and Sustainable Cultivation in the Southern Maya Mountains, Belize. *Ethnobotany Research and Applications* 9:257–73.



# Panicoideae

## Phytolith

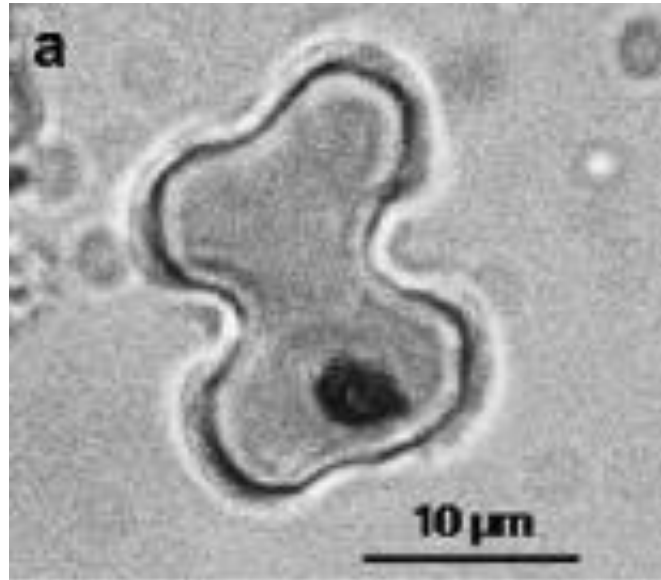


Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. a) Panicoideae cross-shaped phytolith (BD M1, 10-20 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Panicoideae

## Phytolith

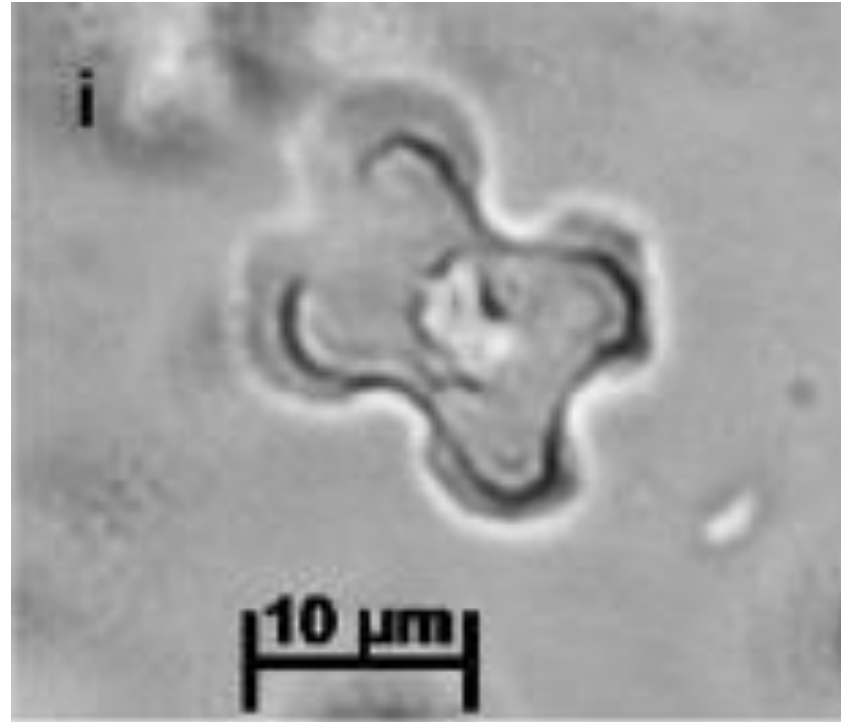


Fig. 5. Selected microbotanical remains. Phytoliths: i) Panicoideae cross-shape (Sed. Sample 2)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Oryzoideae

## Phytolith

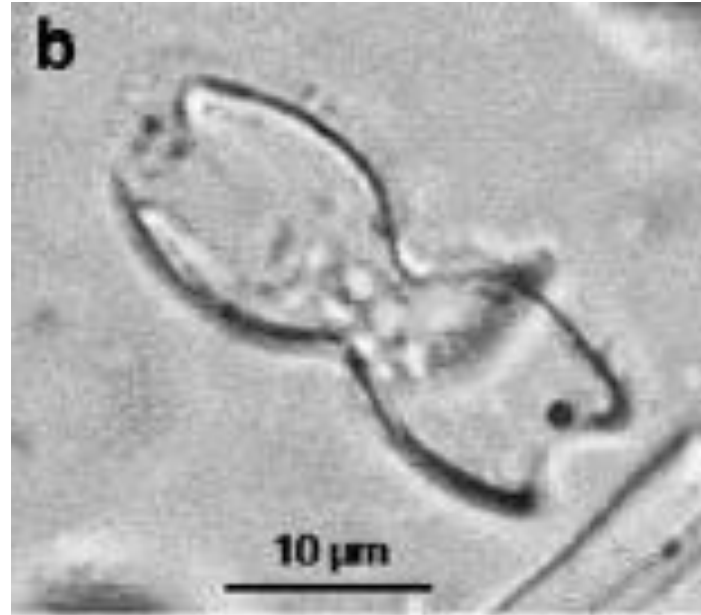


Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. b) Oryzoideae scooped bilobate (P. Ridged Field 2, 0-10 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Pooideae

## Phytolith

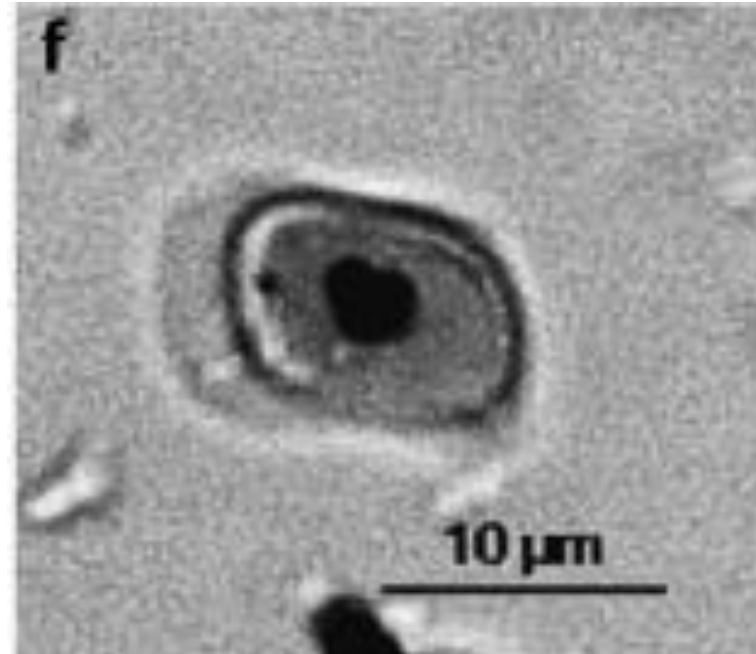


Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. f) Pooideae oblong phytolith (BD M1, 40-50 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Olyreae

## Phytolith

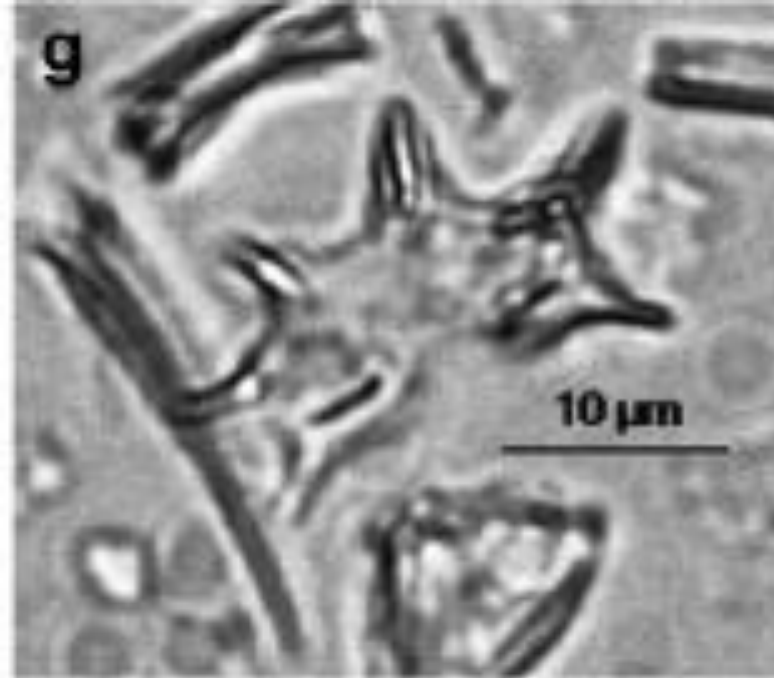


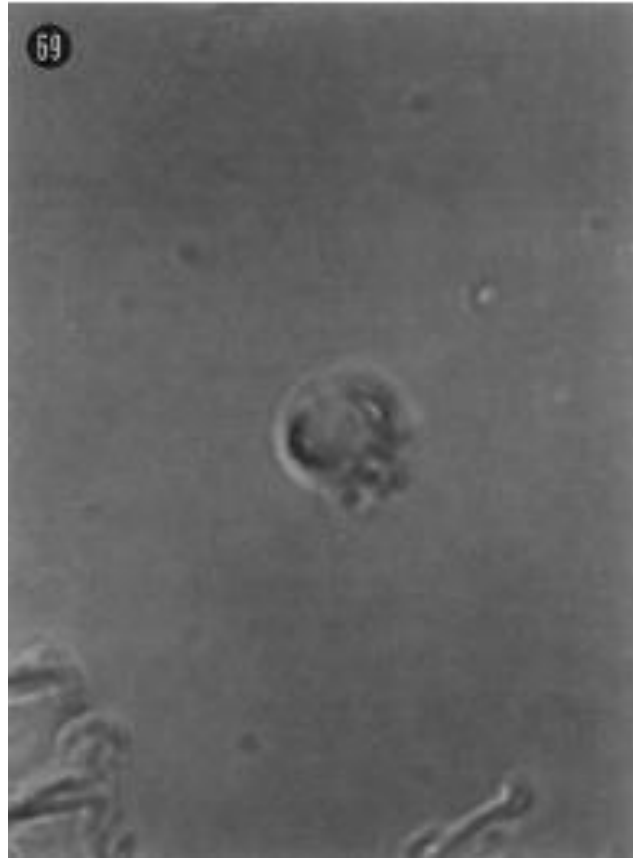
Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. g) Olyreae Phytolith with irregular concavities and pointed edges (K-VIII M 1.1. 0-10 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Actinocladum merticulatum

## Phytolith

FIGURES 69-72.-69, A two-peaked conical siliceous body from *Actinocladum merticulatum* (x400).

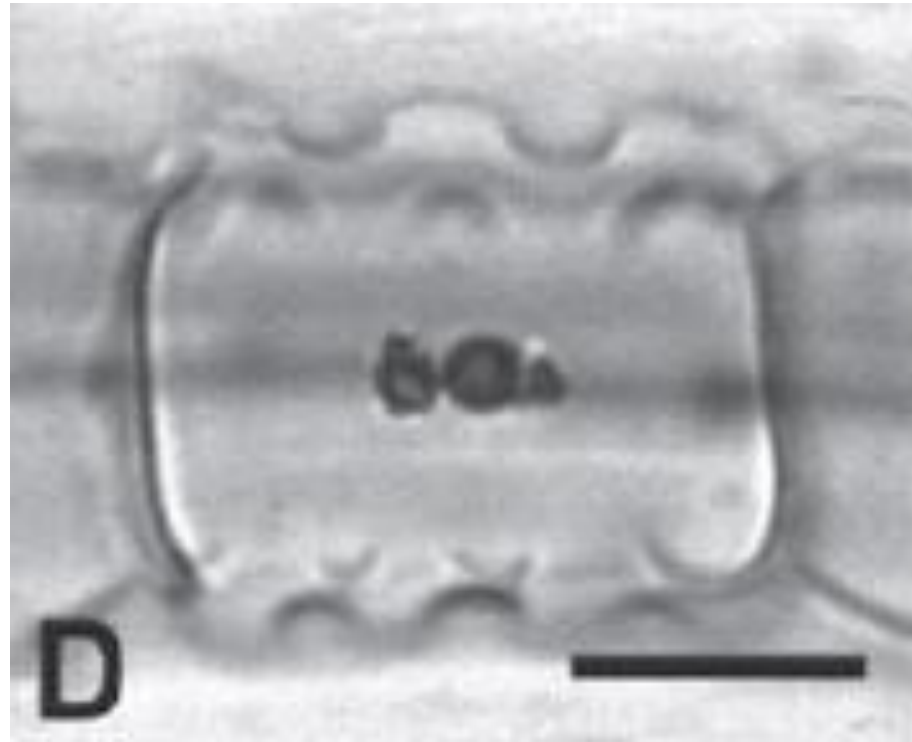


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Aegilops triaristata

## Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. D. *Aegilops triaristata*, a horizontally elongated silica body with sinuous outlines (bar = 10  $\mu\text{m}$ ).

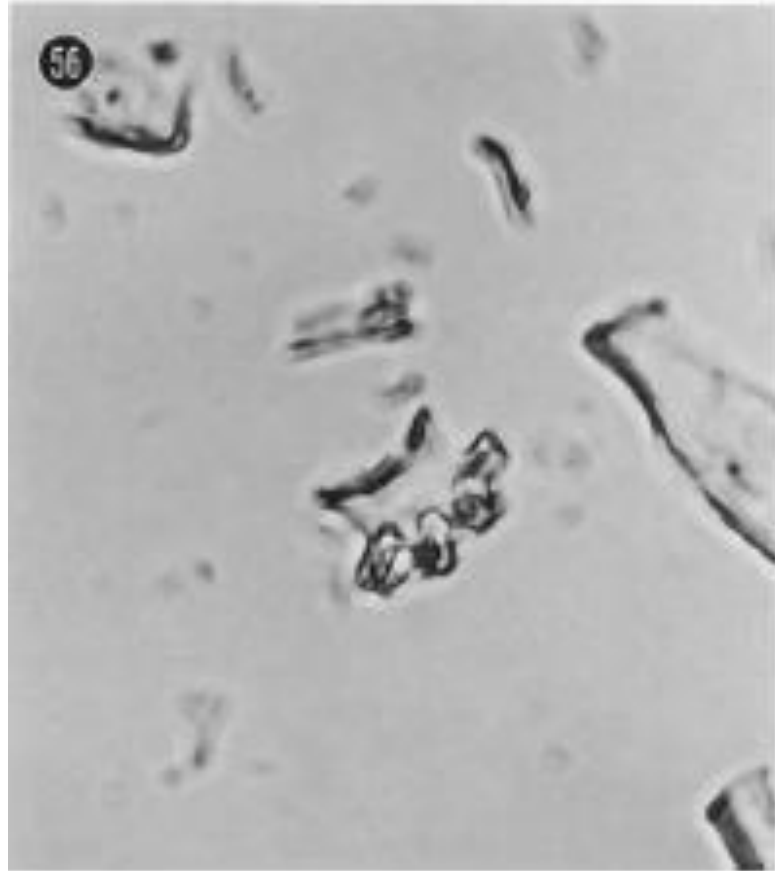


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Aegopogon cenchroides

## Phytolith

FIGURES 53-56.-56, A phytolith from  
Aegopogon cenchroides (x400)



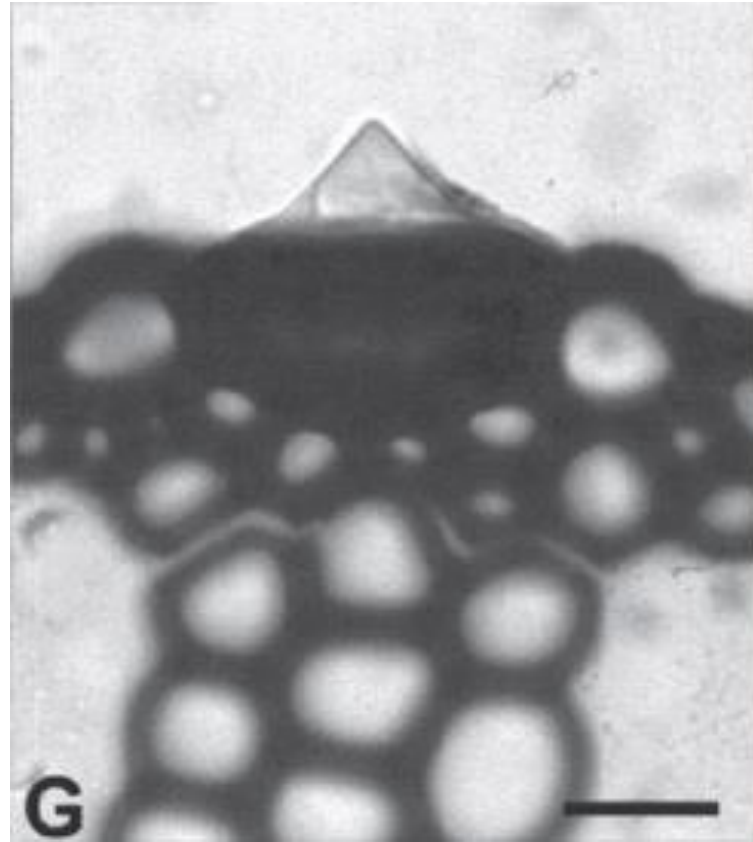
Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.



# Agropyron elongatum

## Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. G. *Agropyron elongatum*, a conical silica body (bar = 20  $\mu\text{m}$ ).

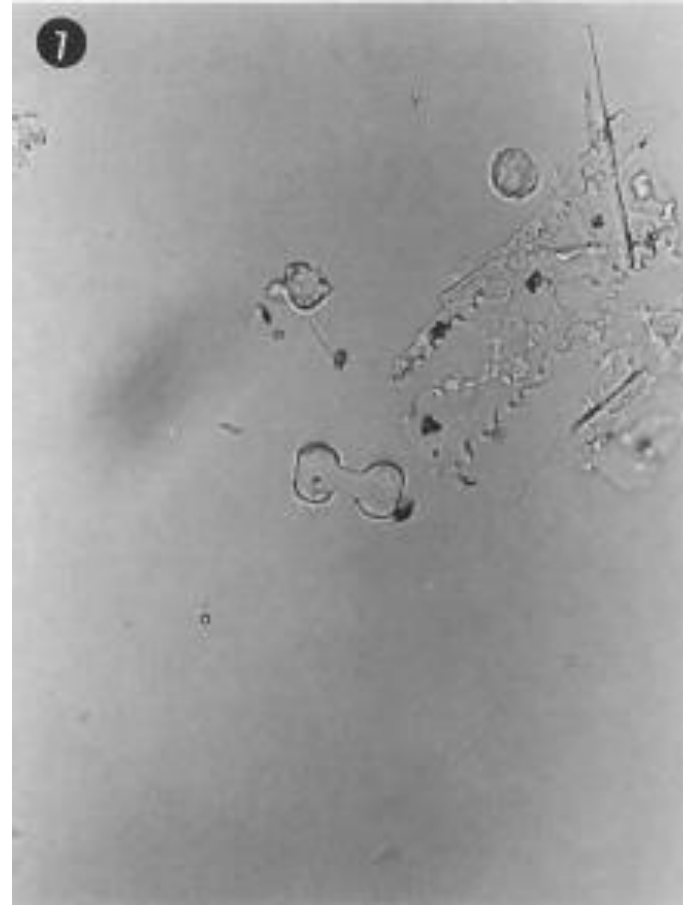


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Andropogon bicornis

## Phytolith

FIGURES 5-8. 7, Center, a bilobate with squared lobes and a distinct, moderately thin shaft from *Andropogon bicornis* (x200)



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Andropogon leucbostacbya

## Phytolith

FIGURES 5-8. 5, Bilobates with semirounded lobes and long, thin shafts from *Andropogon leucbostacbya* (x200).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Anthochloa lepidula

## Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. E. *Anthochloa lepidula*, horizontally elongated bodies with smooth outlines (bar = 20  $\mu\text{m}$ ).

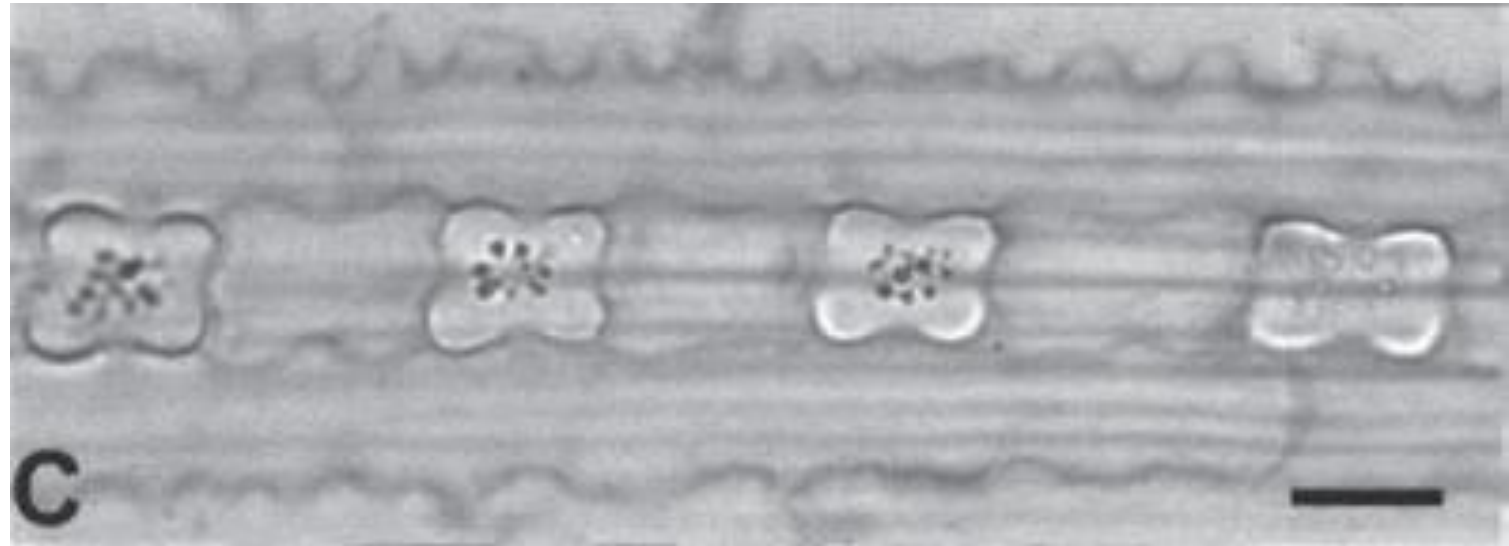


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Apochiton burttii

## Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. C. *Apochiton burttii*, cross-shaped silica bodies (bar = 10  $\mu\text{m}$ ).

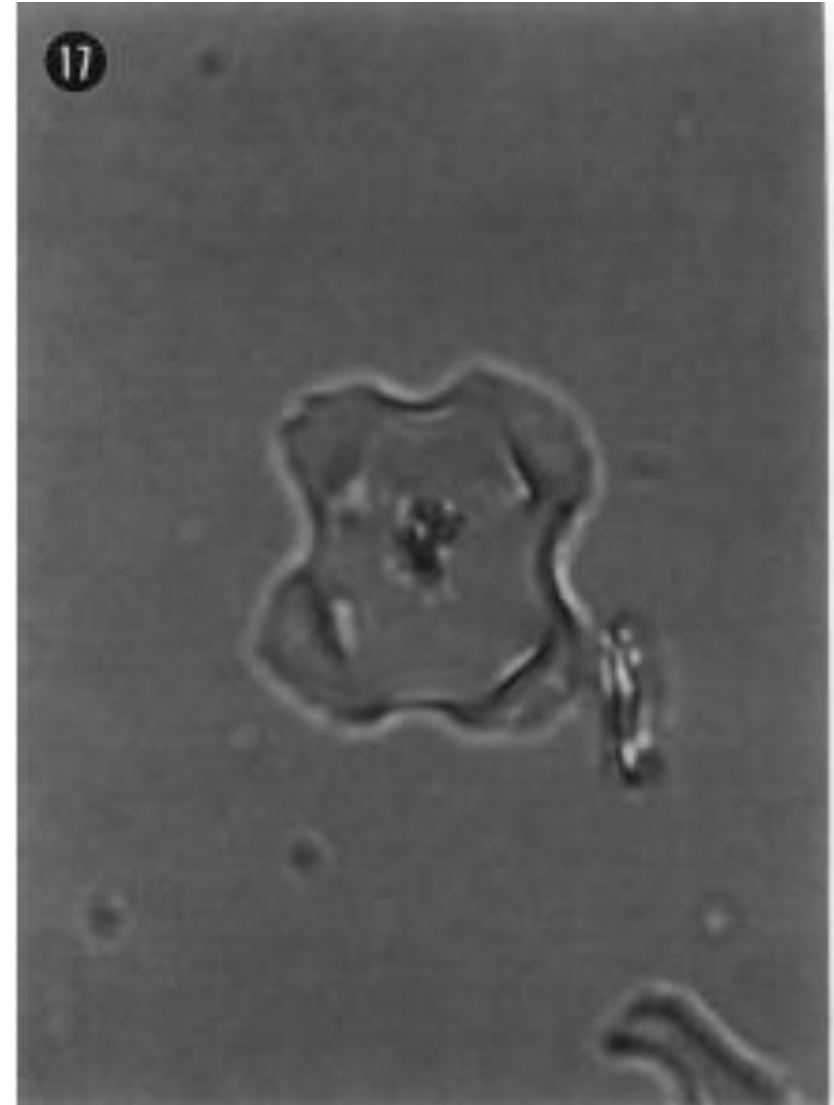


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Arberella dressleri

## Phytolith

FIGURES 17-20. 17, A Variant 3 cross-shaped phytolith from *Arberella dressleri* with conical protrusions on the upper face (x400).

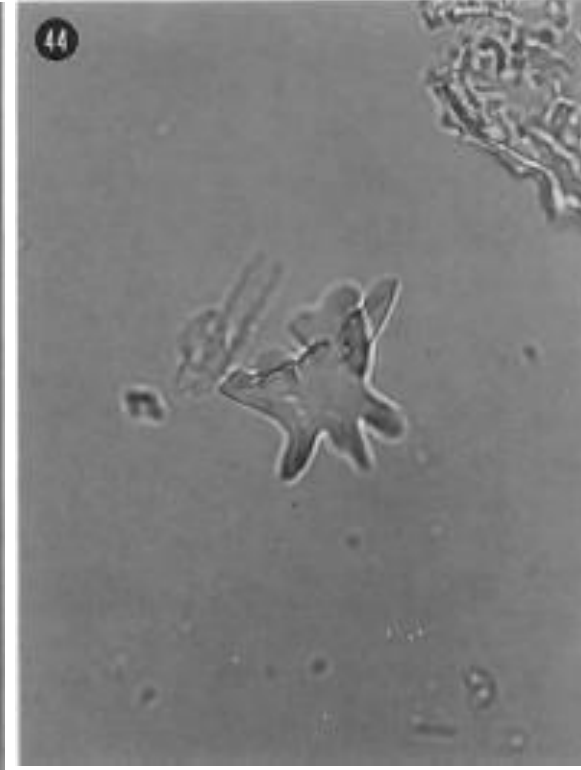
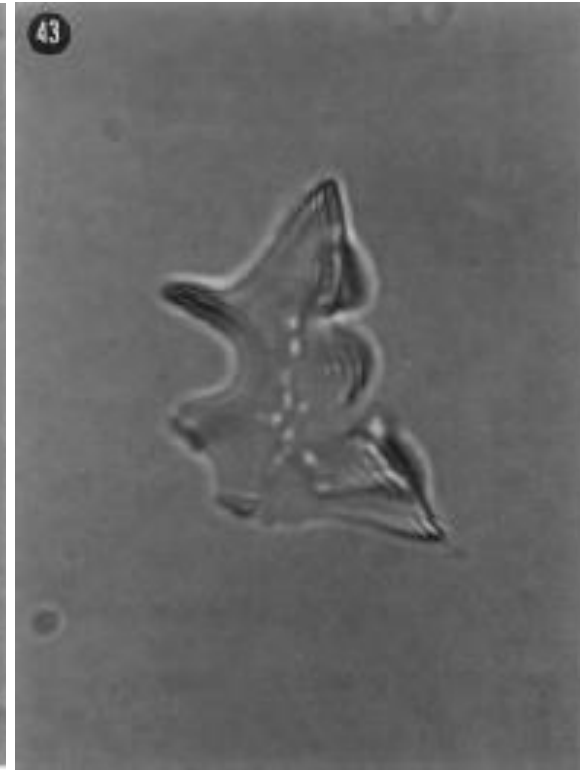
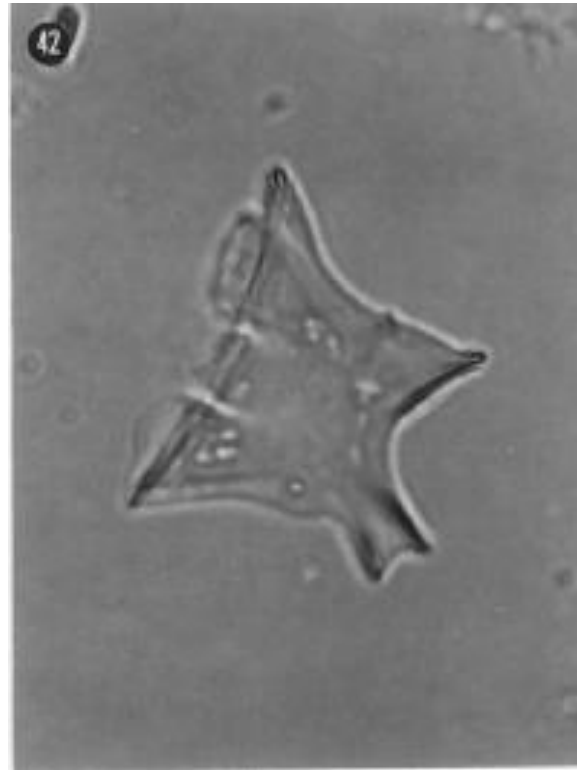


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Arberella dressleri

## Phytolith

FIGURES 41-44. 42, A phytolith From *Arberella dressleri* with one sinuous and one concave, irregularly pointed edge (x400). 43, A phytolith from *Arberella dressleri* with one sinuous and one concave, irregularly pointed edge (x400). 44, A phytolith from *Arberella dressleri* with one sinuous and one irregularly pointed edge (x400)

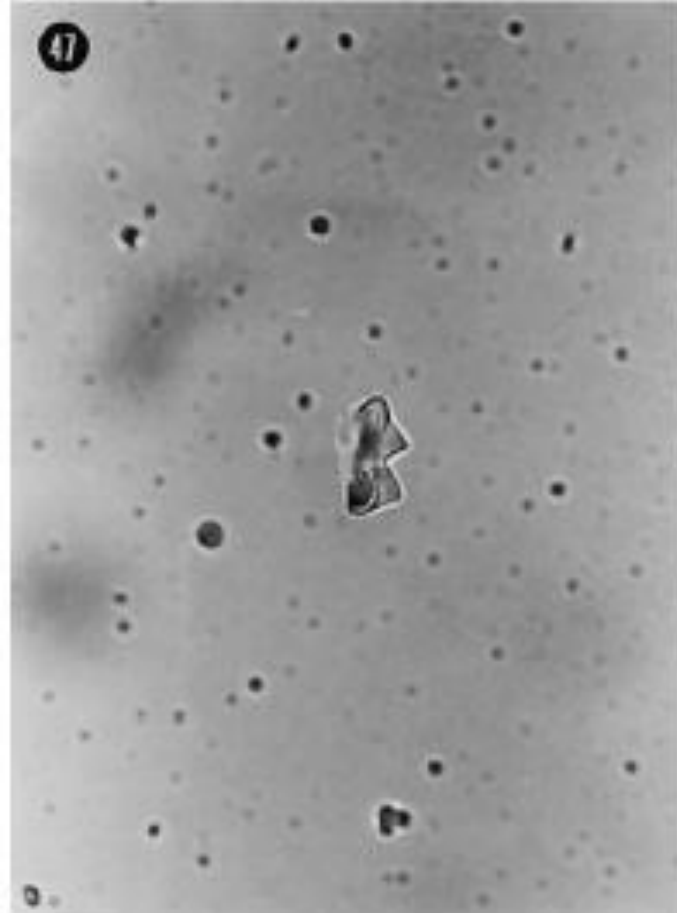


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Arberella dressleri

## Phytolith

FIGURES 45-48.-47, A Variant 3 bilobate phytolith from *Arberella dressleri*. The phytolith is partially turned, revealing aspects of both of its faces (x400)



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.



# Aristida sp.

## Phytolith

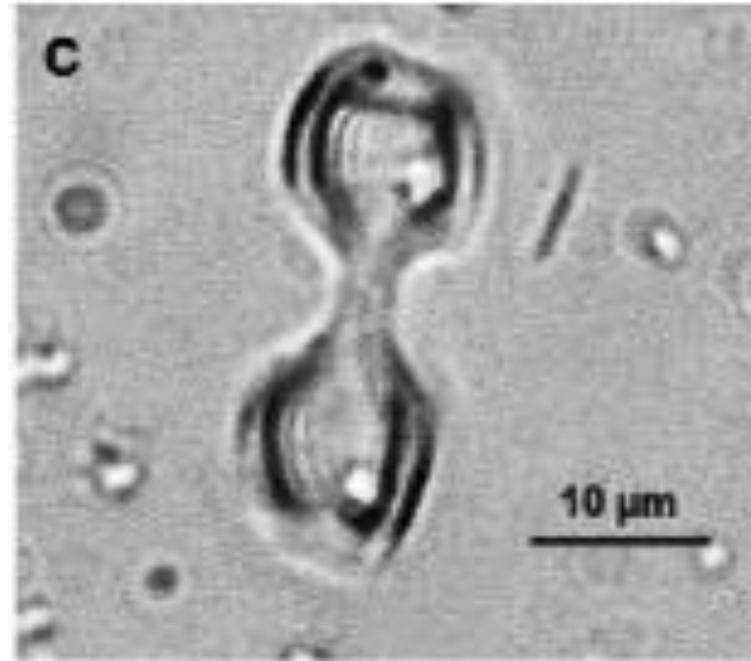


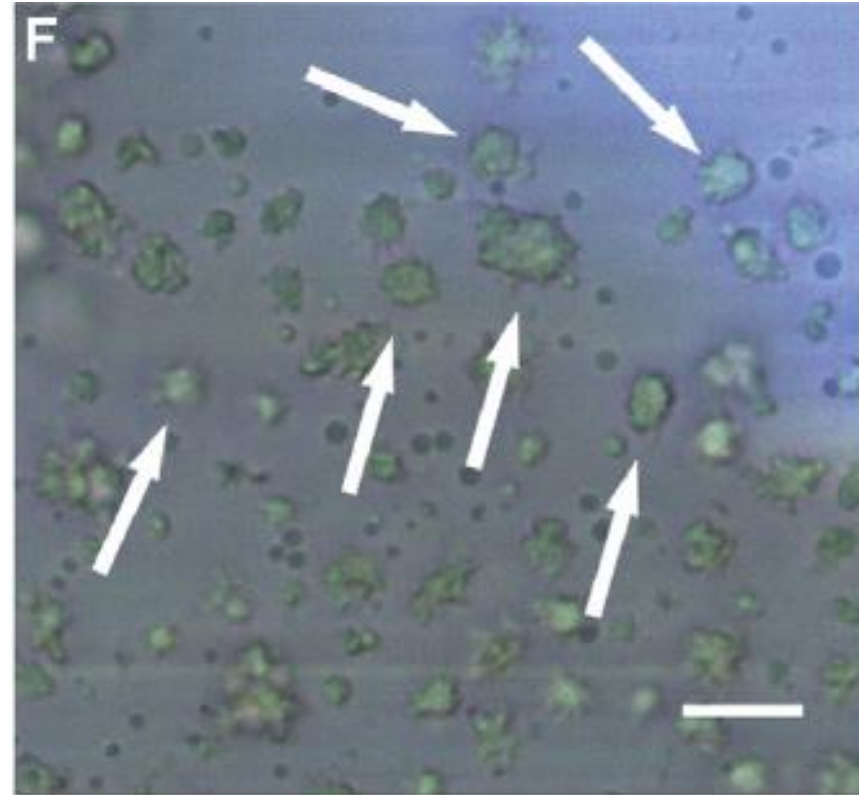
Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. c) *Aristida* sp. bilobate (GM RP, 0-15 cm)

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Aristida mendocina

## Starch

Fig. 3. Pampean native wild grasses from reference collection. F-G: Compound starch grains, supernumerary aggregates of class b. F: *Aristida mendocina*. (Scale bars: 10  $\mu$ m).



Musaubach, María Gabriela, Anabela Plos, and María Del Pilar Babot. 2013. Differentiation of Archaeological Maize (*Zea Mays* L.) from Native Wild Grasses Based on Starch Grain Morphology. Cases from the Central Pampas of Argentina. *Journal of Archaeological Science* 40 (2). Elsevier Ltd:1186–93. <http://dx.doi.org/10.1016/j.jas.2012.09.026>.

# Aristida orizaliensis

## Phytolith

FIGURES 5-8. 8, Bilobates with semirounded lobes and long, thin shafts from *Aristida orizaliensis* (x200)

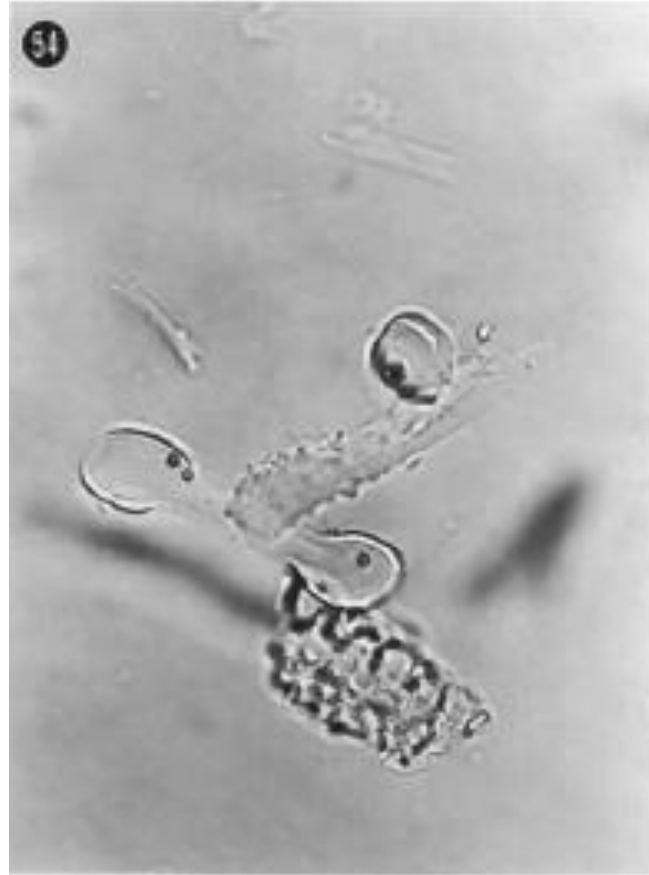


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Aristida orizaliensis

## Phytolith

FIGURES 53-56.-54, Top, a rondeloid/saddleloid phytolith from *Aristida orizaliensis*. Also present is a bilobate (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Aristida orizaliensis

## Phytolith

FIGURES 65-68.-65, An odd silica body with saddle tendencies from the culm of *Aristida orizaliensis* (x400). 66, An unusual silica body from the inflorescence of *Aristida orizaliensis* (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Aristida recurrata

## Phytolith

FIGURES 53-56.-53, A  
rondeloid/saddeloid phytolith from the  
inflorescence of *Aristida recurrafa*. As the  
name implies, it exhibits features  
characteristic both of phytoliths in the  
Pooideae and Chloridoideae (x400).

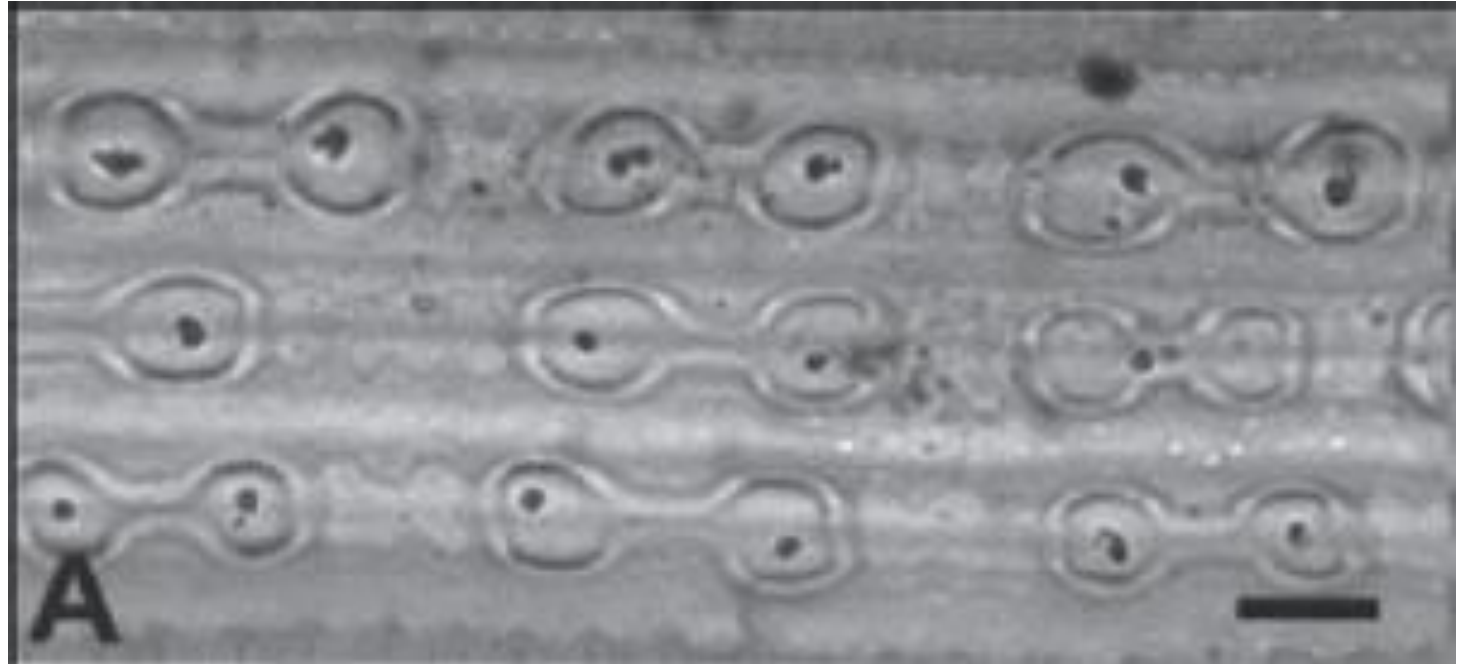


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Aristida setigera

## Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. A. *Aristida setigera*, costal dumbbell-shaped silica bodies (bar = 10  $\mu\text{m}$ ).



Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Aristida ternipes

## Phytolith

FIGURES 61-64.-64, An odd silica body from the culm of *Aristida ternipes* (x400)



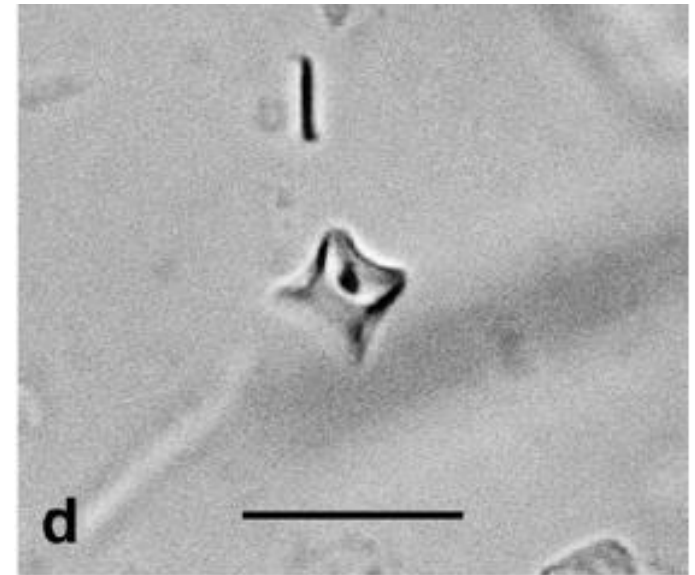
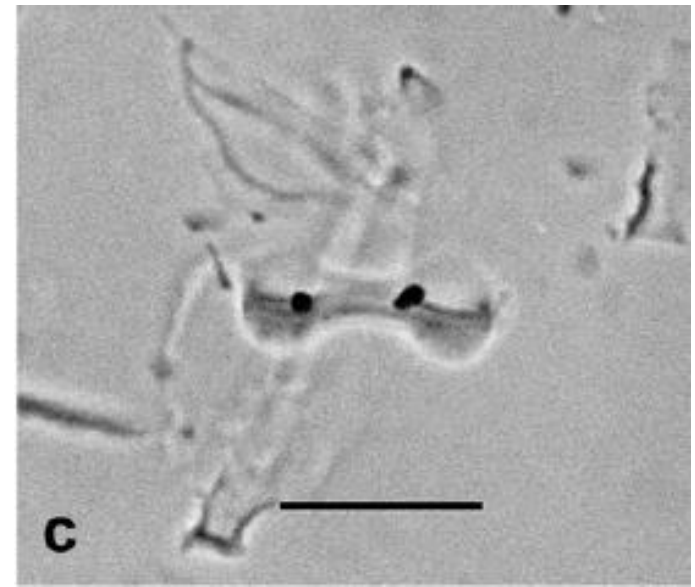
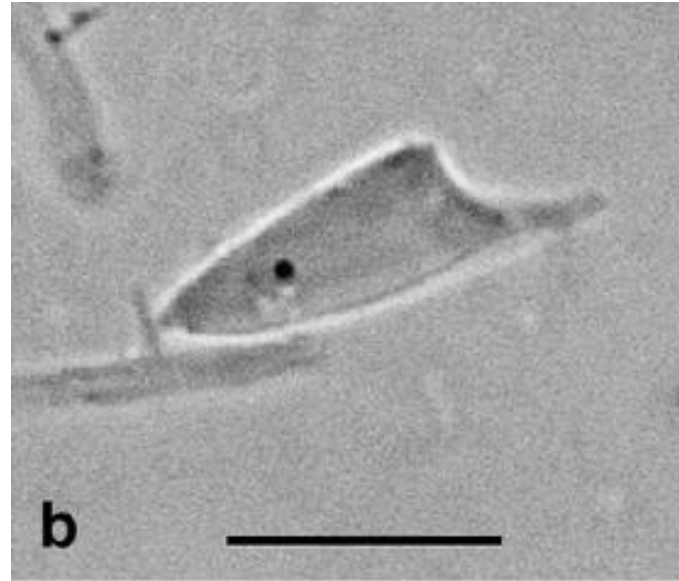
Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.



# Aristida tinctoria

## Phytolith

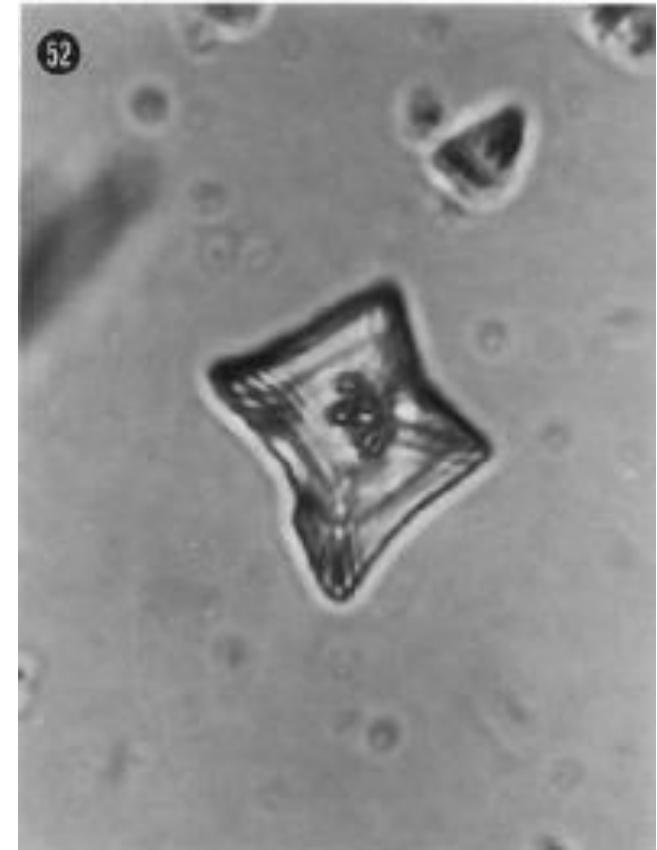
Fig. 4. Phytoliths from Poaceae. b) Prickle-type hair from *Aristida tinctoria*, c) *Aristida*-type bilobate from *Aristida tinctoria* d) Rondeloid/saddleoid phytolith from *A. tinctoria*



# Arundinella confinis

## Phytolith

FIGURES 49-52.-51, A phytolith from *Arundinella confinis* marked by considerable width and the presence of one slightly concave and one somewhat sloping edge (x400). 52, A phytolith from *Arundinella confinis* marked by considerable width and the presence of one somewhat concave and one somewhat sloping edge (x400)

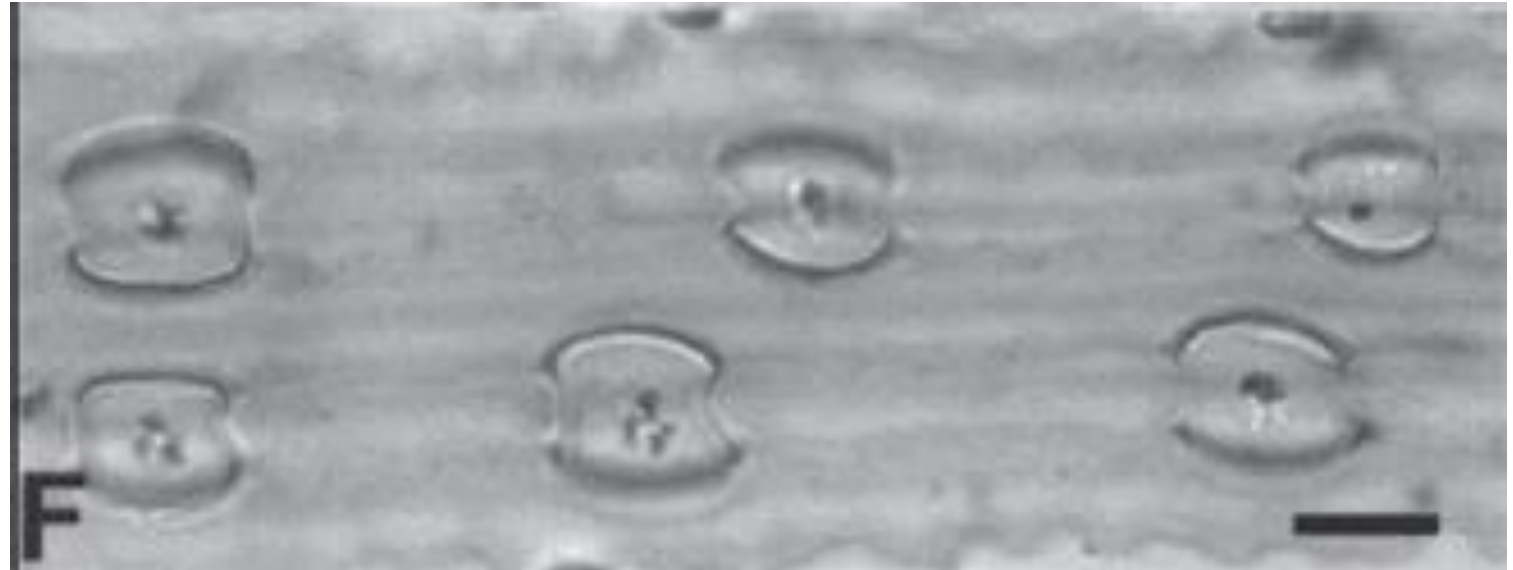


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Astrebla squarrosa

## Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. F. *Astrebla squarrosa*, saddle-shaped silica bodies (bar = 10  $\mu\text{m}$ ).



Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Avena sterilis

## Starch

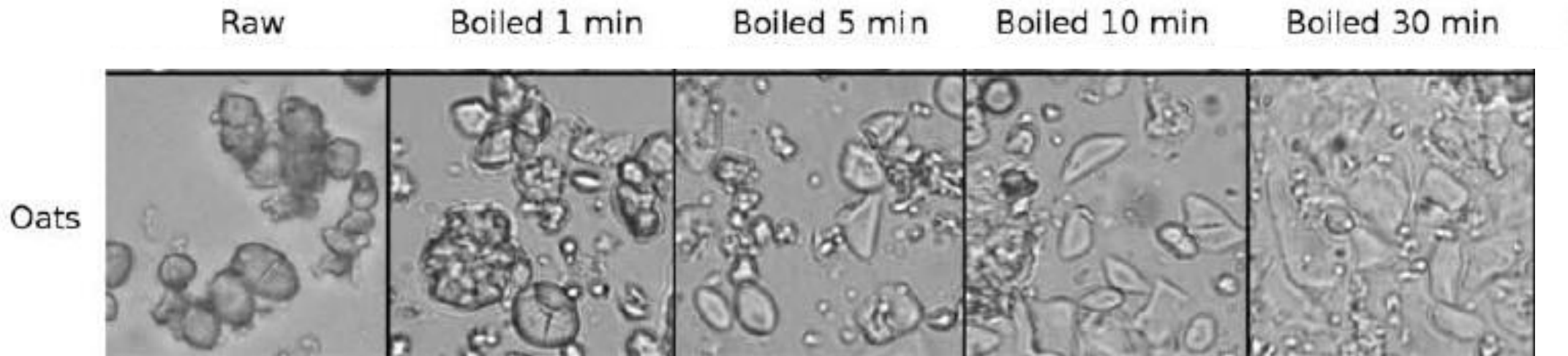


Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Avena sterilis

## Starch

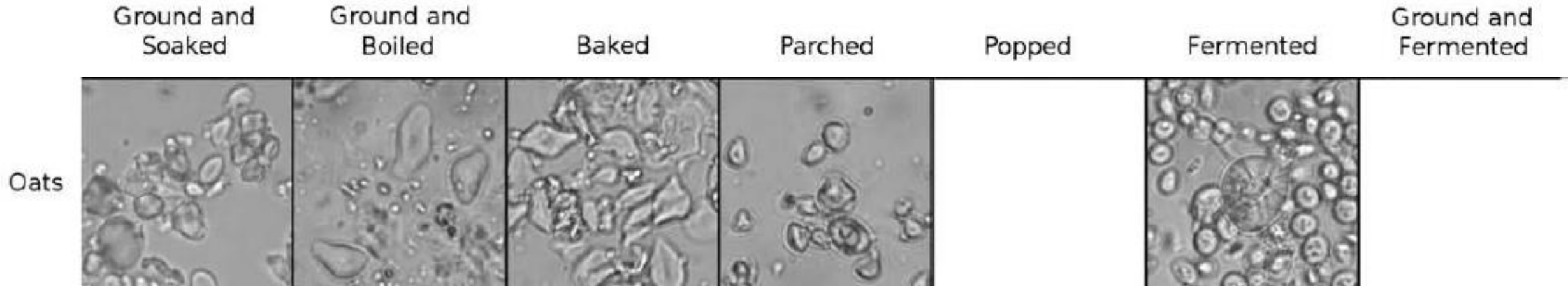


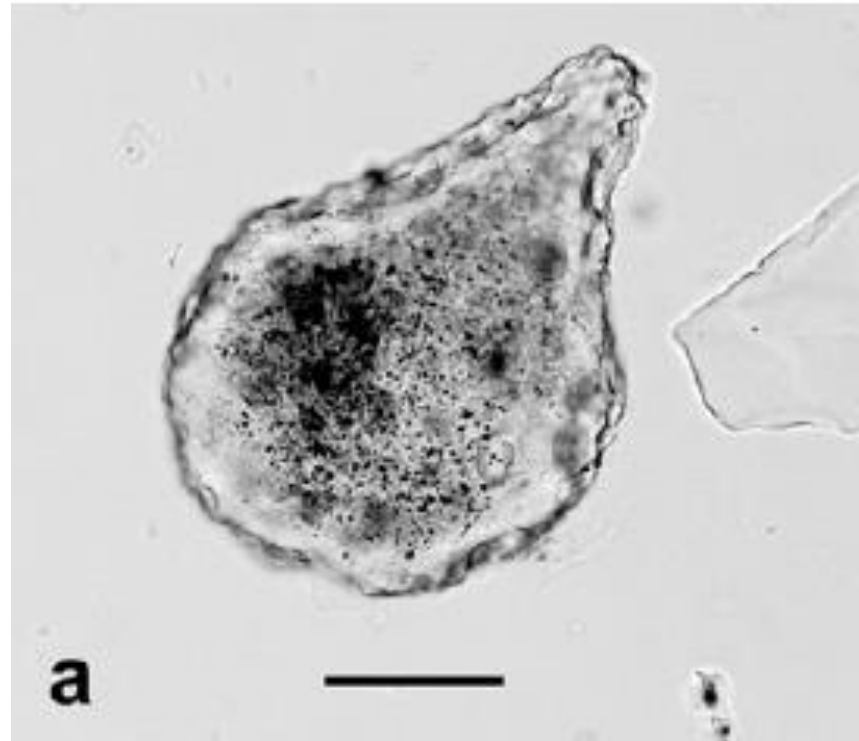
Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Axonopus aureus

## Phytolith

Fig. 4. Phytoliths from Poaceae. a)  
Bulliform cell from *Axonopus aureus*

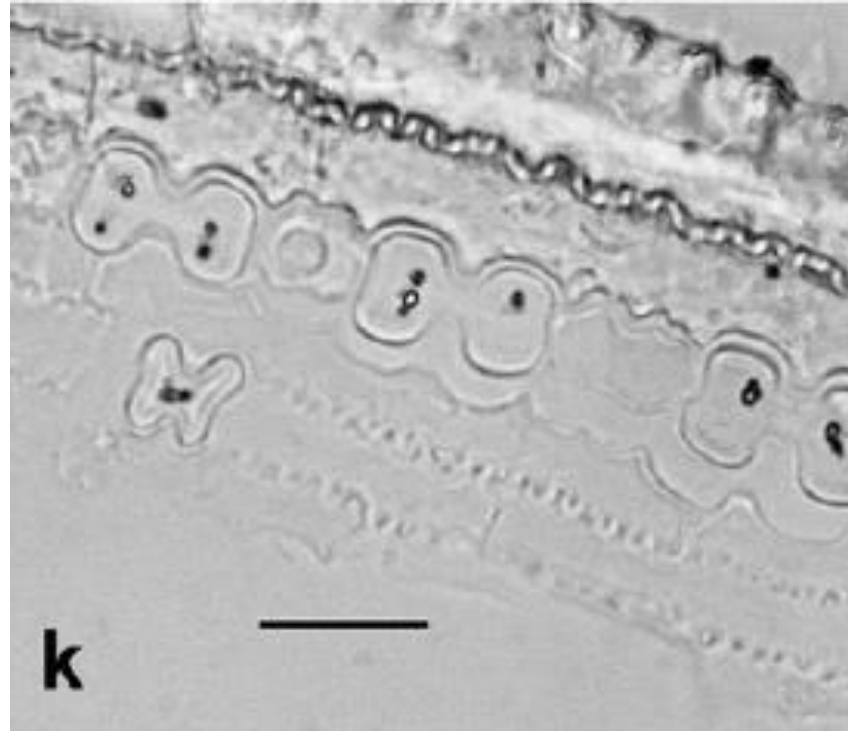


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Axonopus aureus

## Phytolith

Fig. 4. Phytoliths from Poaceae. k)  
Bilobate from *Axonopus aureus*



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Bathriochloa ischaemum

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 7. *Bathriochloa ischaemum*



7

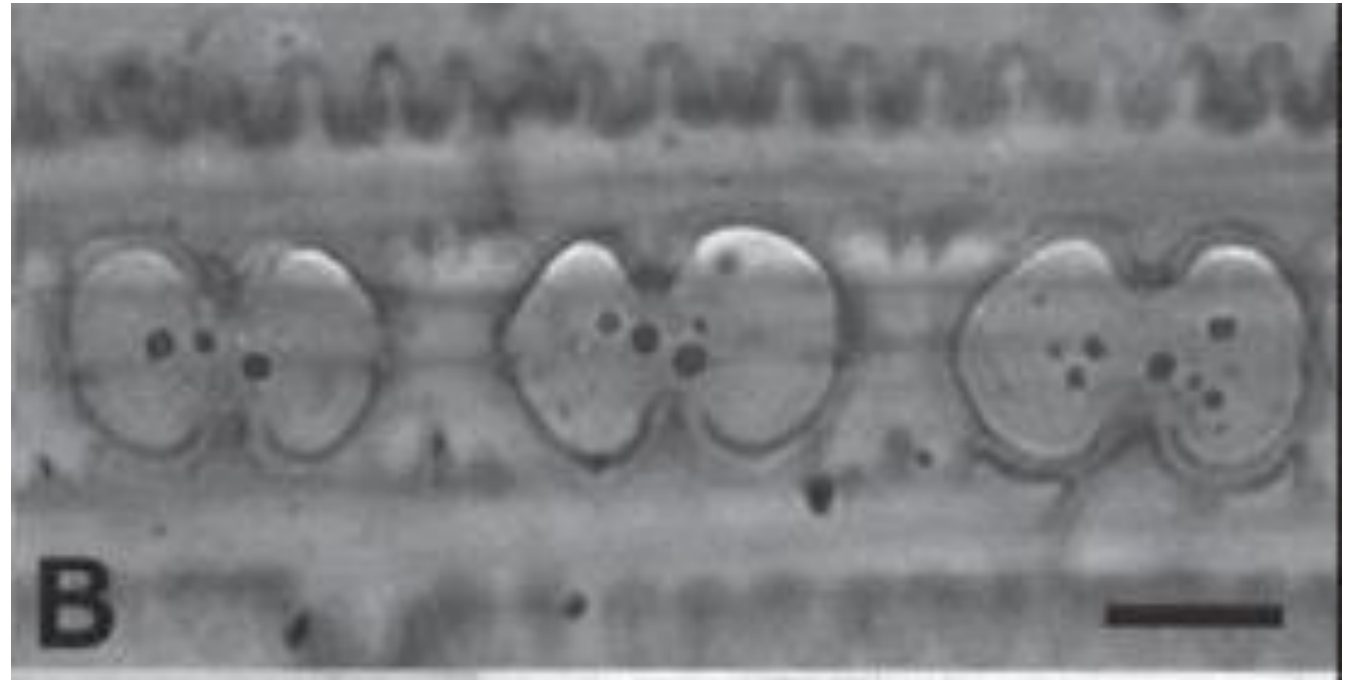
Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.



# Brachiaria jubata

## Phytolith

Fig. 6. Various silica body morphologies found in the epidermal cells of Poaceae. B. *Brachiaria jubata*, a form of silica intermediate between the dumbbell-shaped form and the cross-shaped form (bar = 10  $\mu\text{m}$ ).

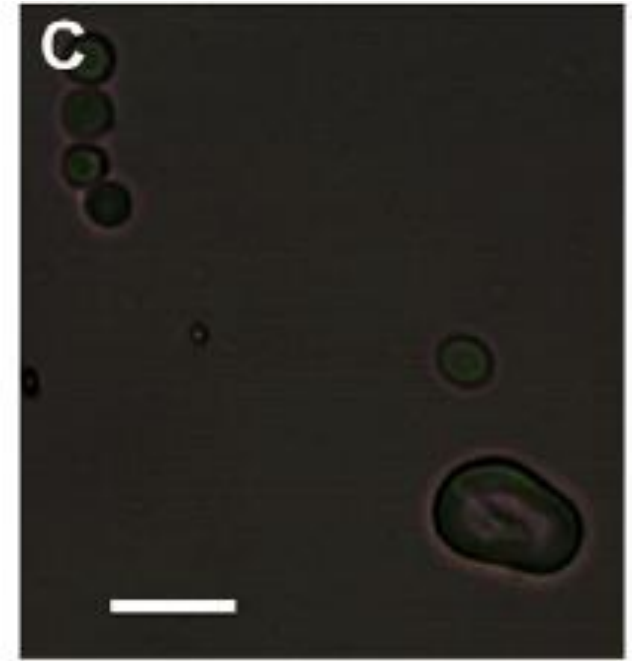
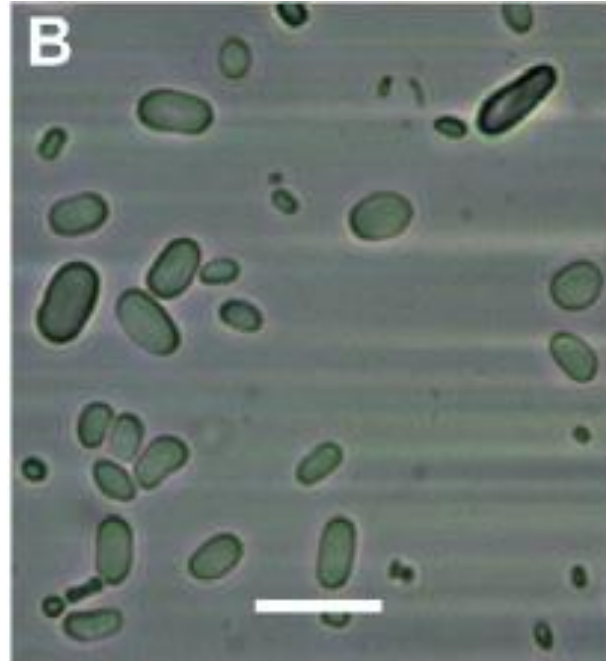


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Bromus auleticus

## Starch

Fig. 3. Pampean native wild grasses from reference collection. A-C: Simple starch grains. B and C: *Bromus auleticus*. (Scale bars: 10  $\mu$ m).

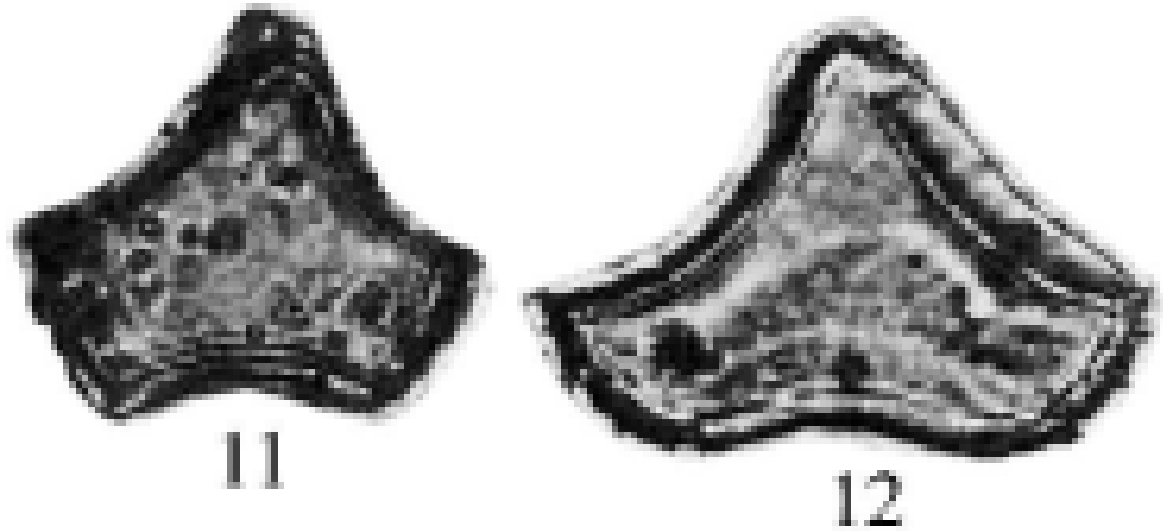


Musaubach, María Gabriela, Anabela Plos, and María Del Pilar Babot. 2013. Differentiation of Archaeological Maize (*Zea Mays* L.) from Native Wild Grasses Based on Starch Grain Morphology. Cases from the Central Pampas of Argentina. *Journal of Archaeological Science* 40 (2). Elsevier Ltd:1186–93. <http://dx.doi.org/10.1016/j.jas.2012.09.026>.

# Buchloe dactyloides

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 11, 12. *Buchloe dactyloides*



Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.

# Cencrus echinatus

## Starch

### APPENDIX:

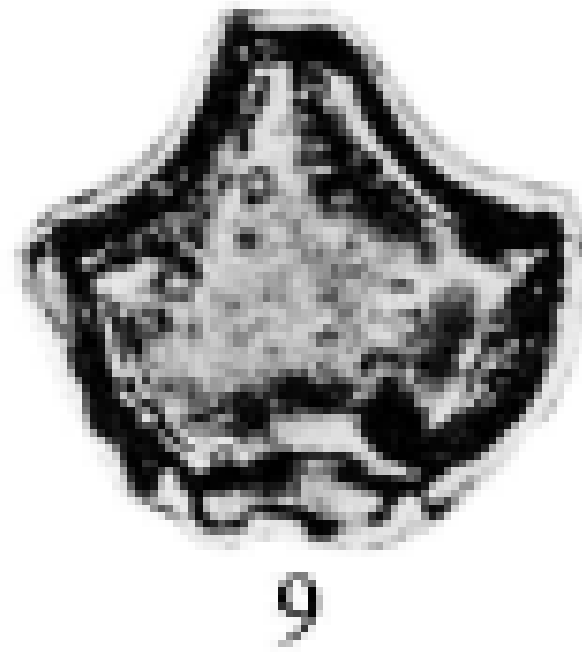
Cencrus echinatus. Compound grains, with many pressure facets. The double border is visible on part of the grain. The hilum is centrally located and the central fissures can be deep and distinct. Indistinct radiating fissures are present. Size: 10–16 microns long.

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Chimonobambusa quagrangularis

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 9. *Chimonobambusa quagrangularis*



Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.

# Chloris eiliata

## Phytolith

FIGURES 17-20. 18, Center, two squat saddles, and top, a tall saddle from *Chloris eiliata* (x400).

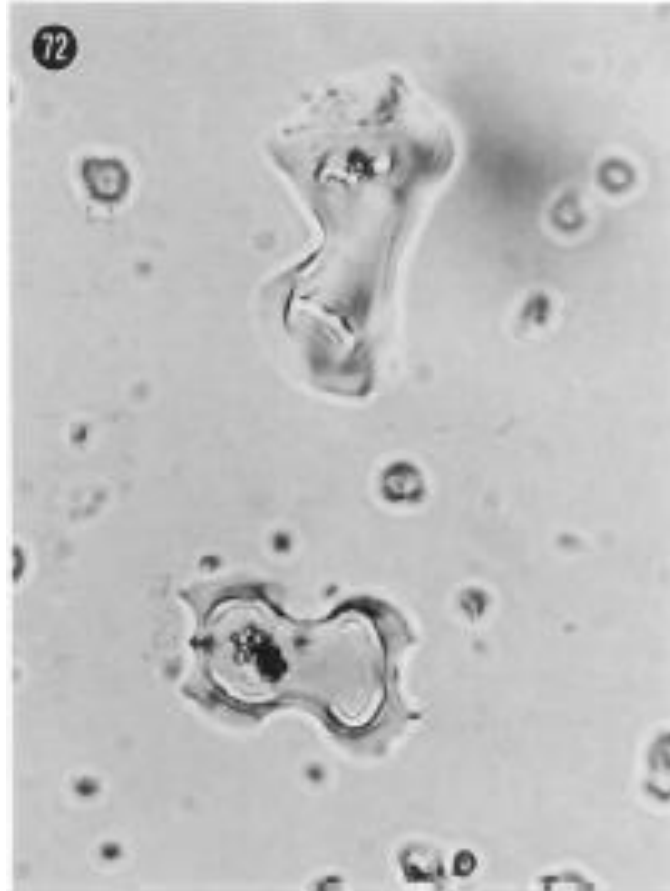


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Chusquea sp.

## Phytolith

FIGURES 69-72.-72, Top, a Chusquea-body phytolith as it would appear in leaf tissue. Below is a Chusquea-type bilobate (x400)

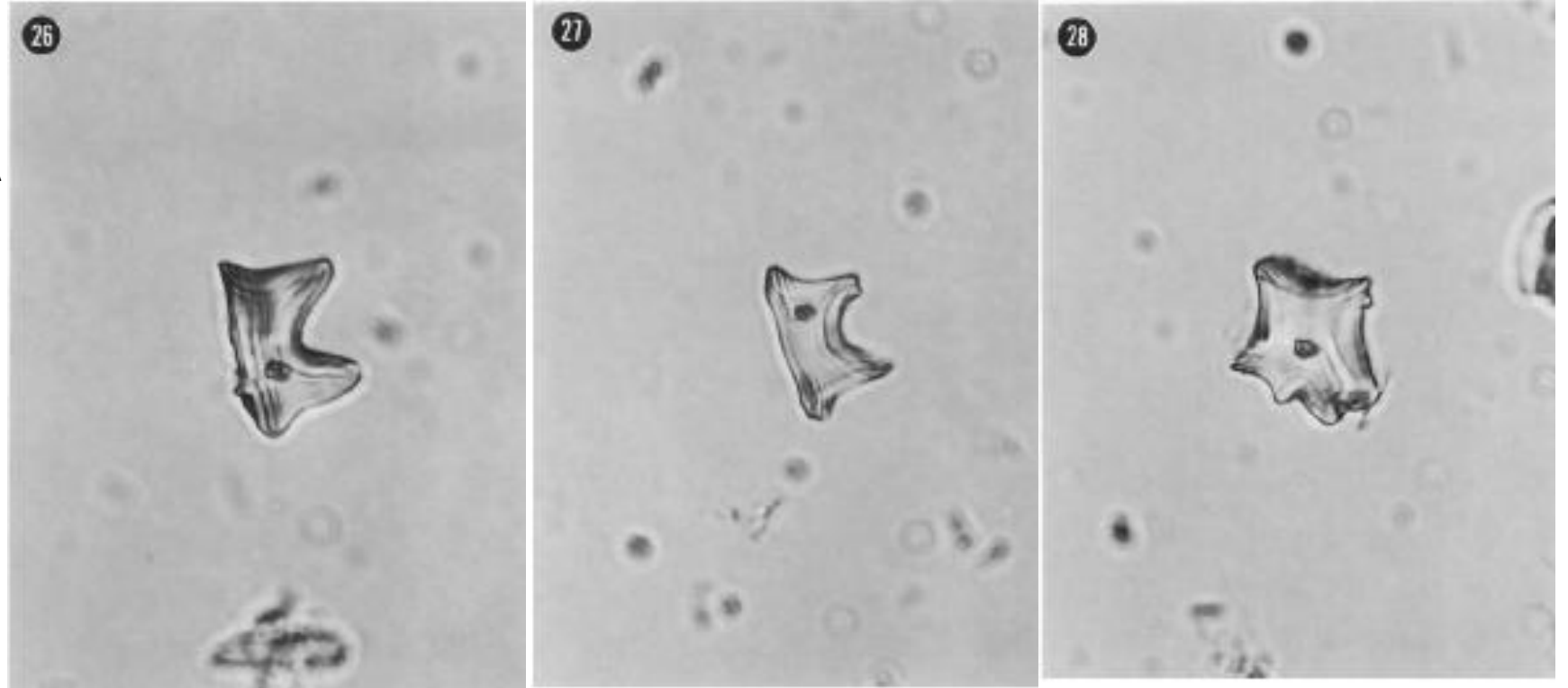


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Chusquea grandiflora

## Phytolith

FIGURES 25-28. 26, A collapsed saddle from *Chusquea grandiflora* (x400). 27, A partially collapsed saddle from *Chusquea grandiflora* (x400). 28, A two-spiked-side phytolith from *Chusquea grandiflora*. Spikes are present on the bottom of the phytolith (x400).



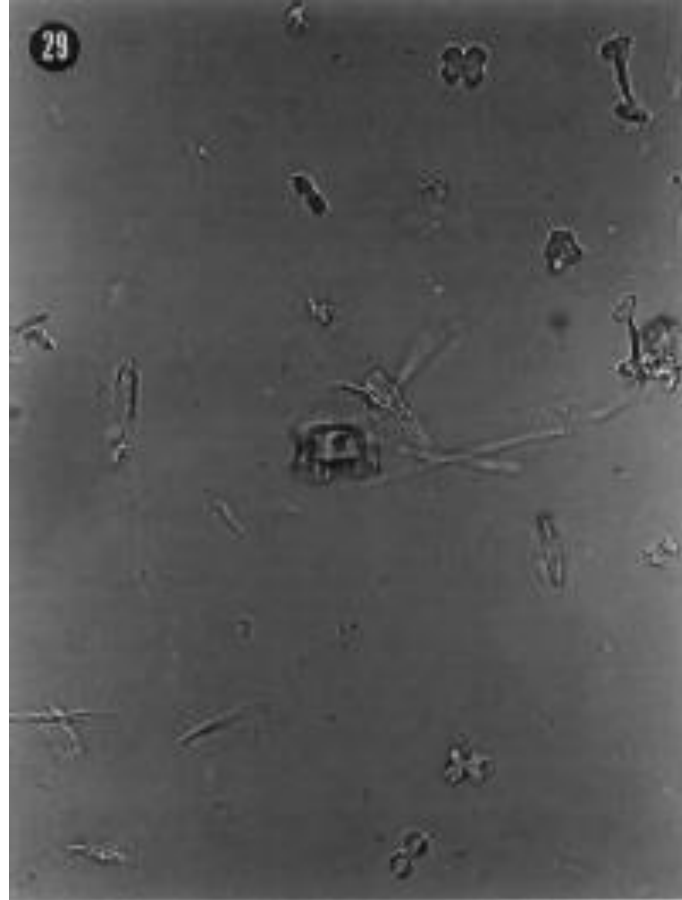
Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.



# Chusquea grandiflora

## Phytolith

FIGURES 29-32.-29, Center, a saddle with a ridged platform from *Chusquea grandiflora* (x400). 31, A saddle bilobate both sides type of phytolith from *Chusquea grandiflora* (x400).

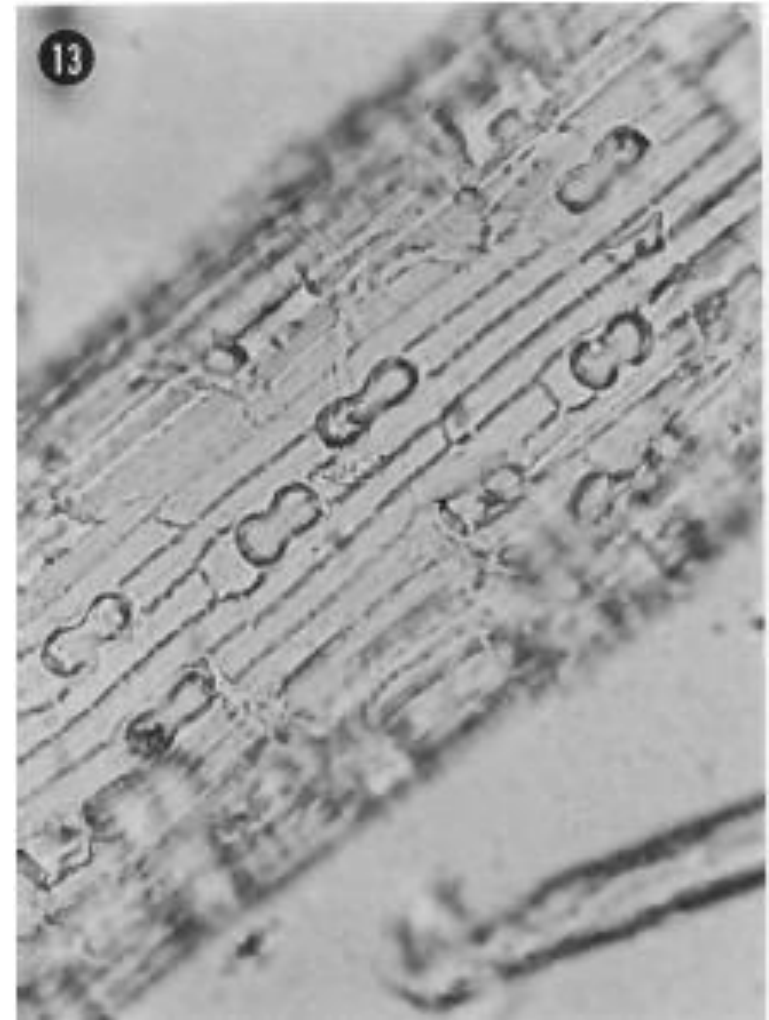


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Chusquea longifolia

## Phytolith

FIGURES 13-16. 13, Bilobates from the culm of Chusquea longifolia (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Chusquea longifolia

## Phytolith

FIGURES 57-60.-59, Center, bilobates from the inflorescence of *Chusquea longifolia*. They are attached to two elongated phytoliths (x200).

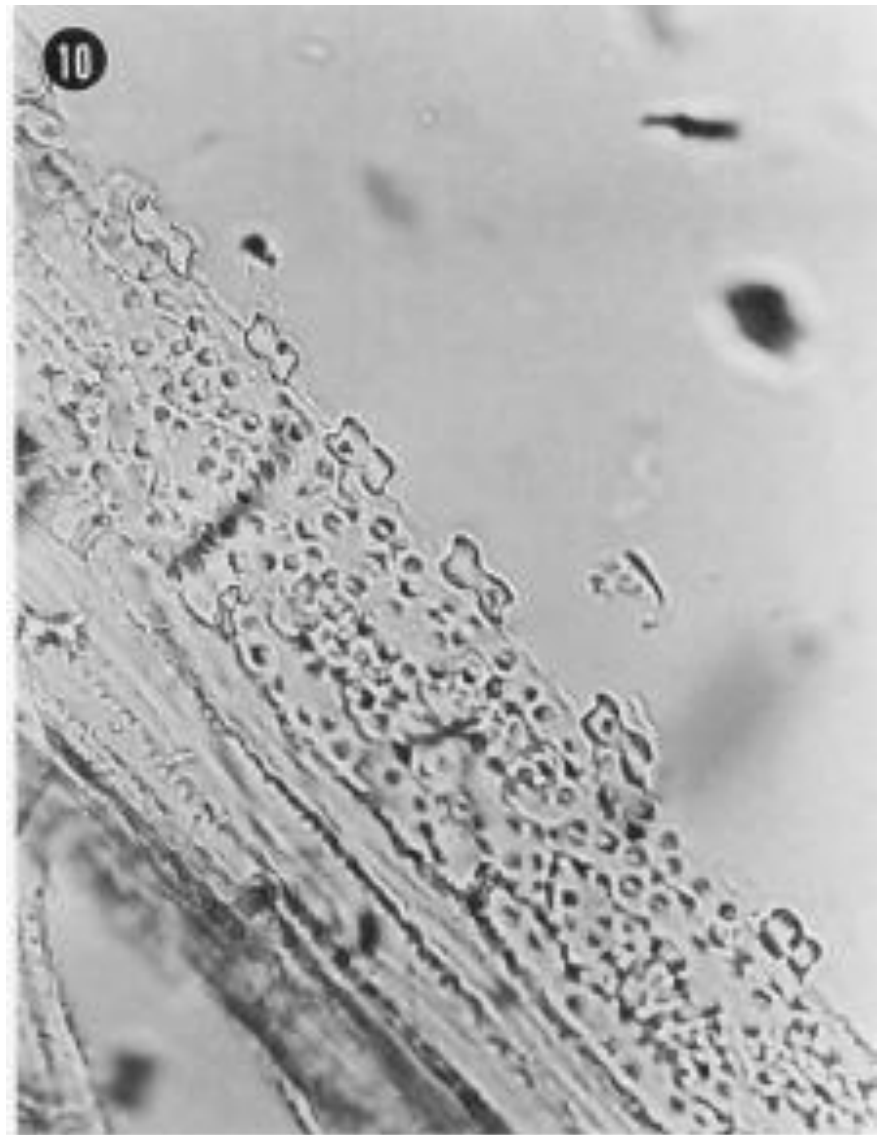


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Chusquea patens

## Phytolith

FIGURES 9-12. 10, A row of bilobates from *Chusquea patens* (x200). Their morphology, although not overlapping the panicoid types, is unusual for bamboos



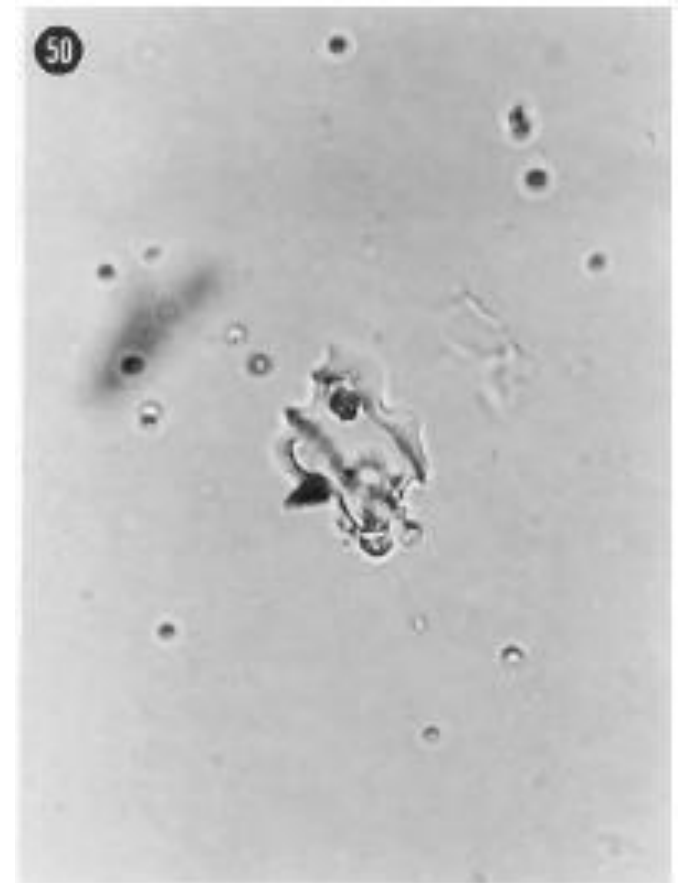
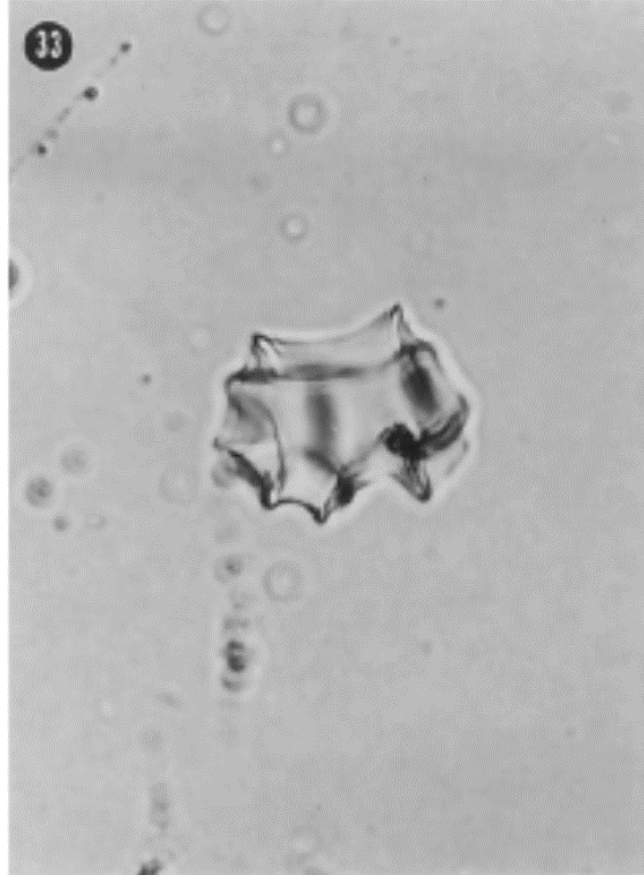
Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Chusquea pittieri

## Phytolith

FIGURES 33-36.-33, A multifaceted Chusquea-body phytolith from *Chusquea pittieri* (x400).

FIGURES 49-52.-50, A cross-shaped phytolith from *Chusquea pittieri* with serrated short axes, three indentations, and a concave face (x400). This phytolith is not as thick as is usual in the genus.

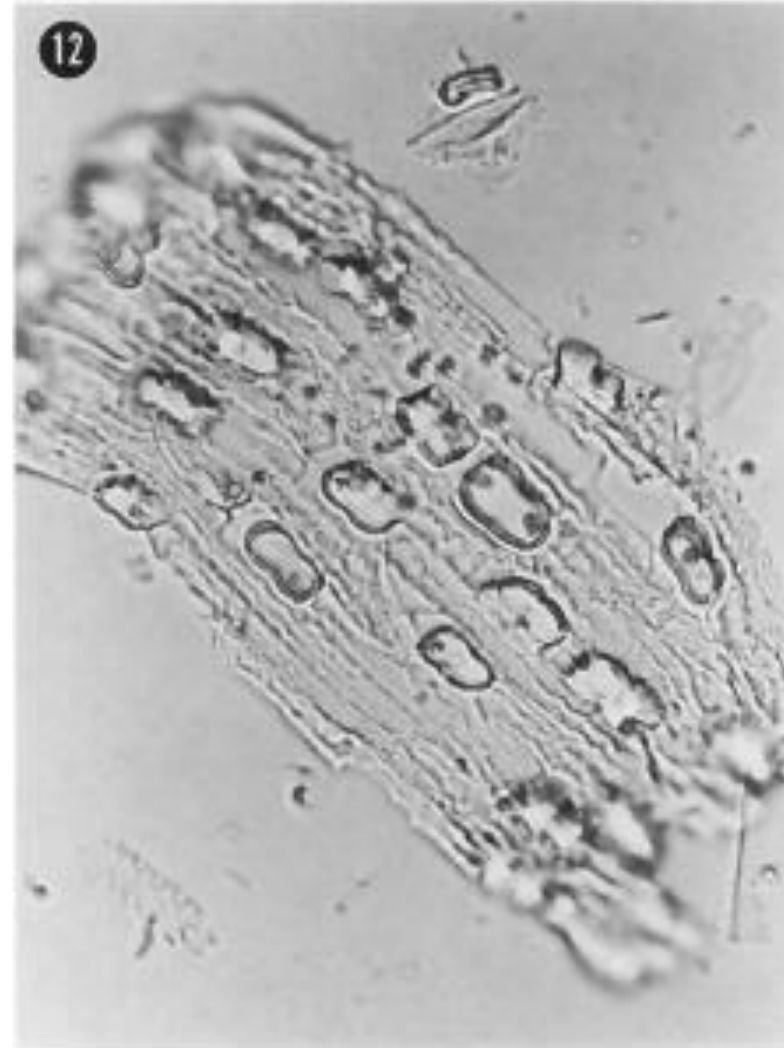


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Chusquea pohlii

## Phytolith

FIGURES 9-12. 12, Bilobates in tissue from *Chusquea pohlii* (x200).

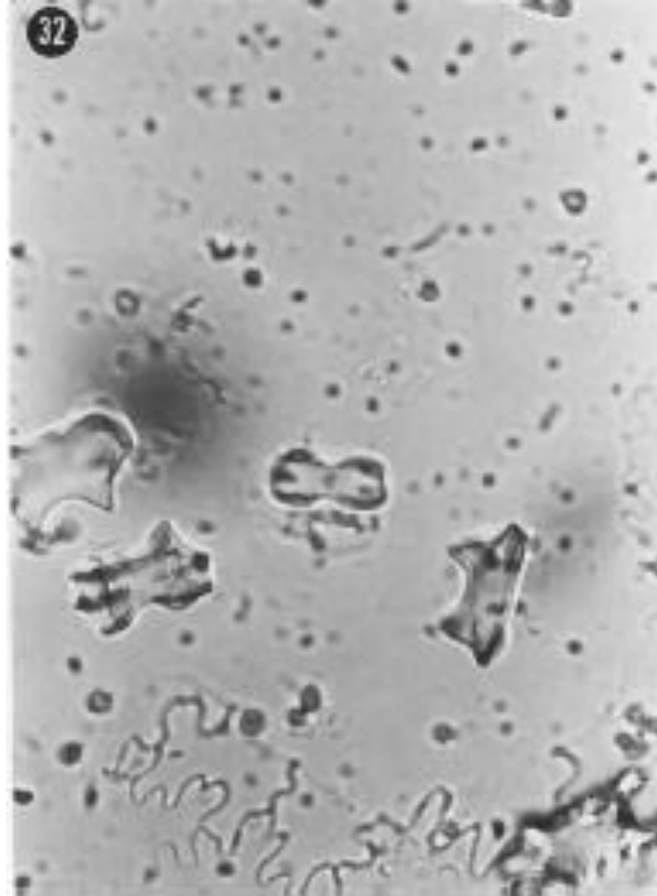


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Chusquea simpliciflora

## Phytolith

FIGURES 29-32.-32, Right and left, Chusquea-body phytoliths diagnostic of this genus from *Chusquea simpliciflora*. The phytolith on the bottom left is still orientated as it would appear in the leaf (x200). The center phytolith is a bilobate



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Coix lacryma-jobi var. ma-yuen

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 8. *Coix lacryma-jobi* var. *ma-yuen*

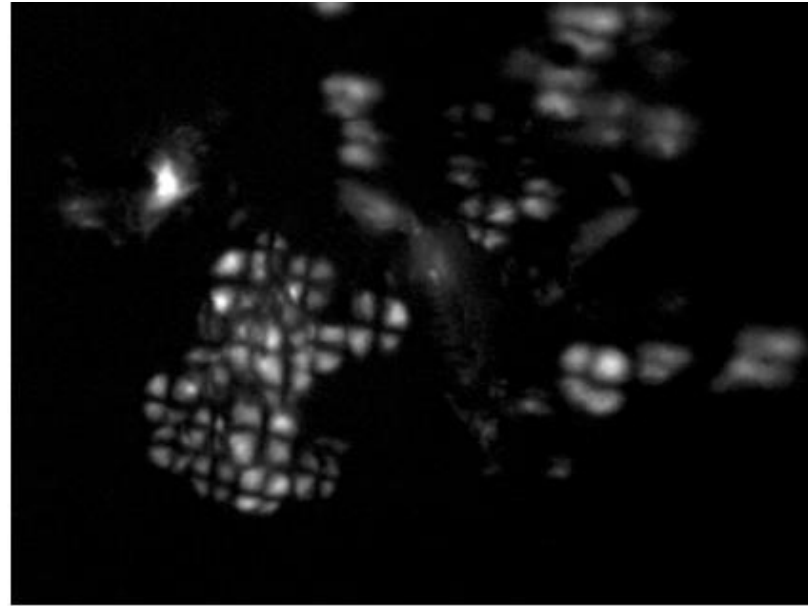
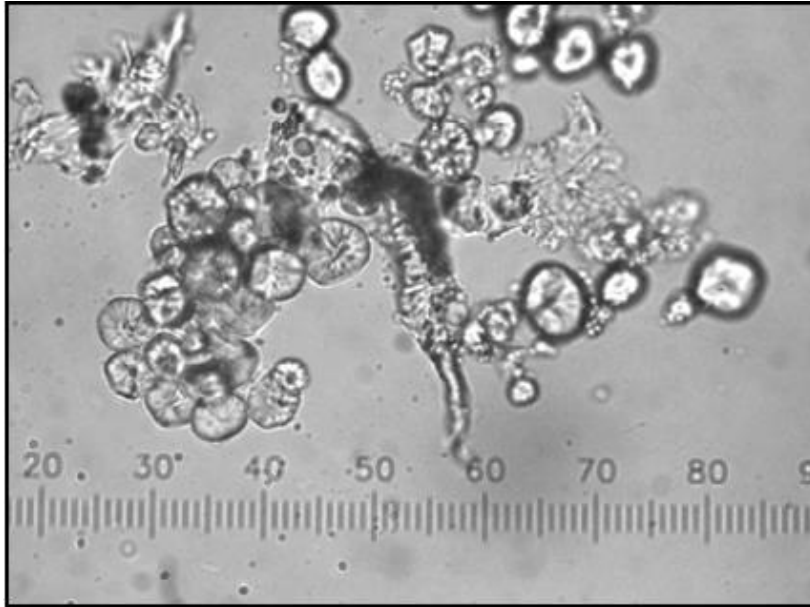


Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.



# Coix lacryma-jobi

Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Cortaderia speciosa

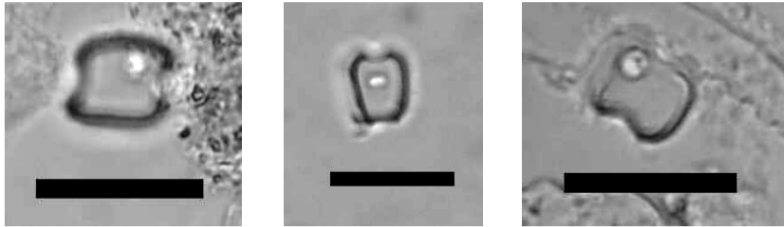
Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

Poaceae *Cortaderia speciosa* "cortadera"

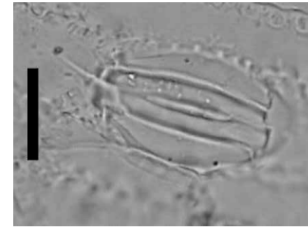
## Phytolith assemblage characterization

Non diagnostic phytoliths:

a) Bilobate (saddle) silica phytolith. Very common.



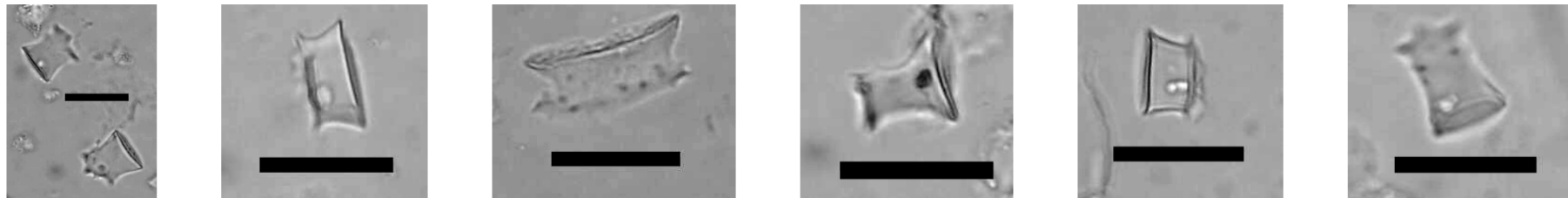
c) Silica stomata. Common.



**References:** Reported in Zucol 1999 for *Cortaderia selloana*.

leaf

b) Round silica phytolith, different lengths. Very common.



Scale bar = 20µm.

# Criciuma asymmetrica

## Phytolith

FIGURES 29-32.-30, A  
Chusqoid body from *Criciuma asymmetrica*. This phytolith, unlike the *Chusquea* body, is fairly widely distributed in bamboos (x400).

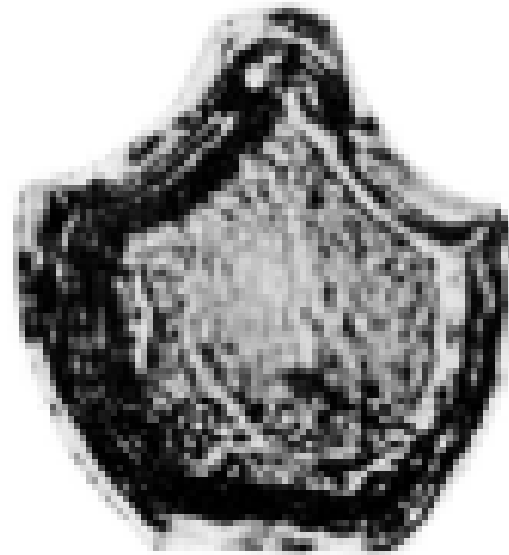


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Cynodon dactylon

## Phytolith

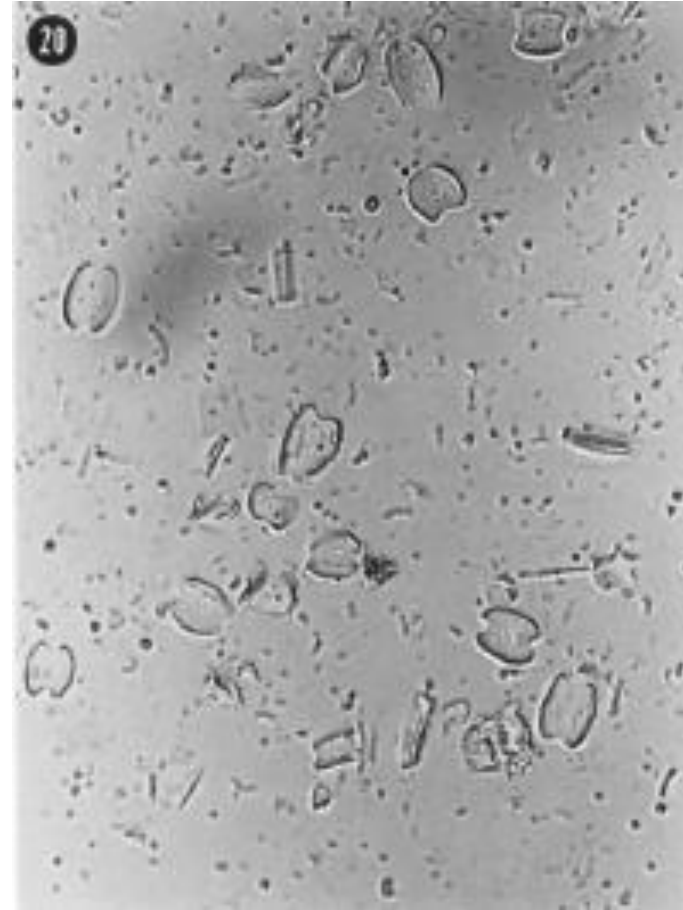
Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 5, 10. *Cynodon dactylon*



# Dactyloctenium aegyptium

## Phytolith

FIGURES 17-20. 20, Saddle-shaped phytoliths from *Dactyloctenium aegyptium*. Many of them are squat (x200).

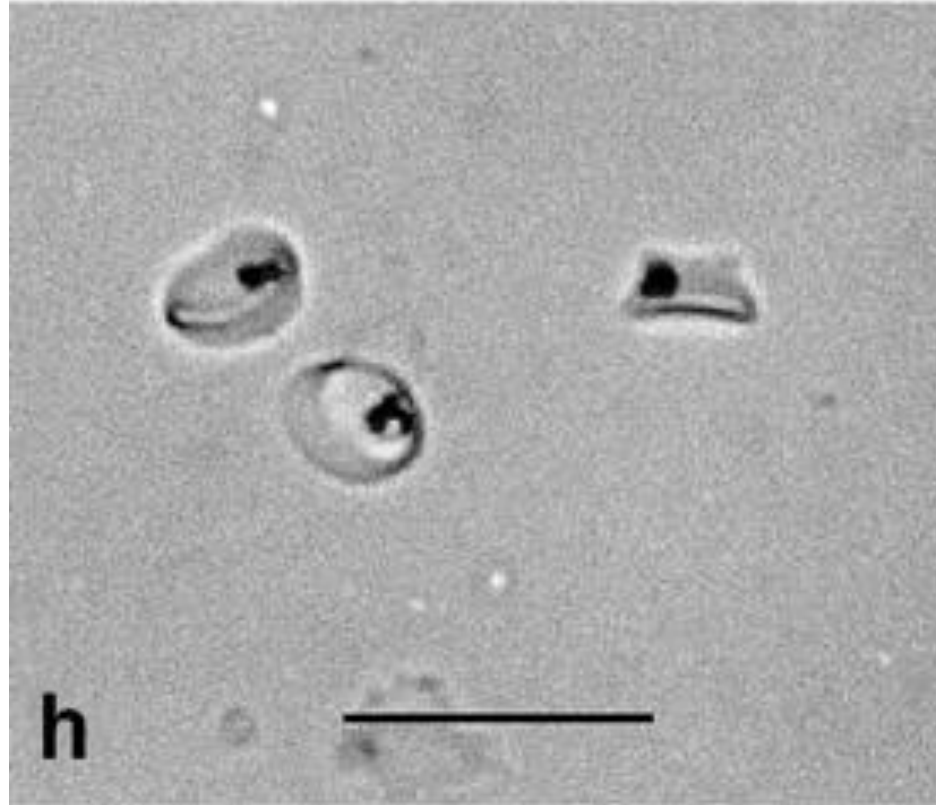


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Distichlis spicata

## Phytolith

Fig. 4. Phytoliths from Poaceae. h)  
Spooled/horned towers from  
*Distichlis spicata*

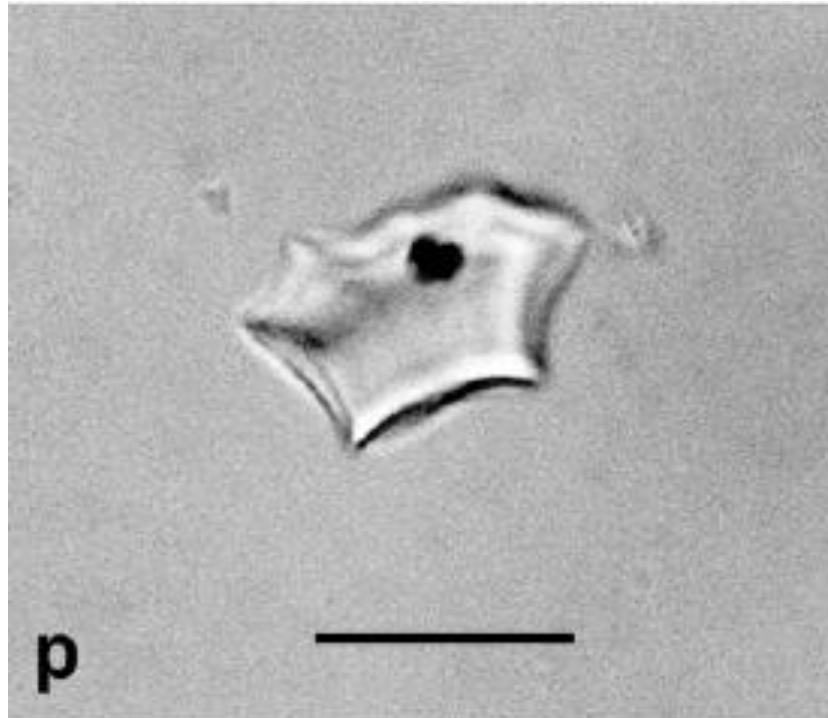


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Echinolaena inflexa

## Phytolith

Fig. 4. Phytoliths from Poaceae. p)  
Fan-shaped rondel from *Echinolaena*  
*inflexa*

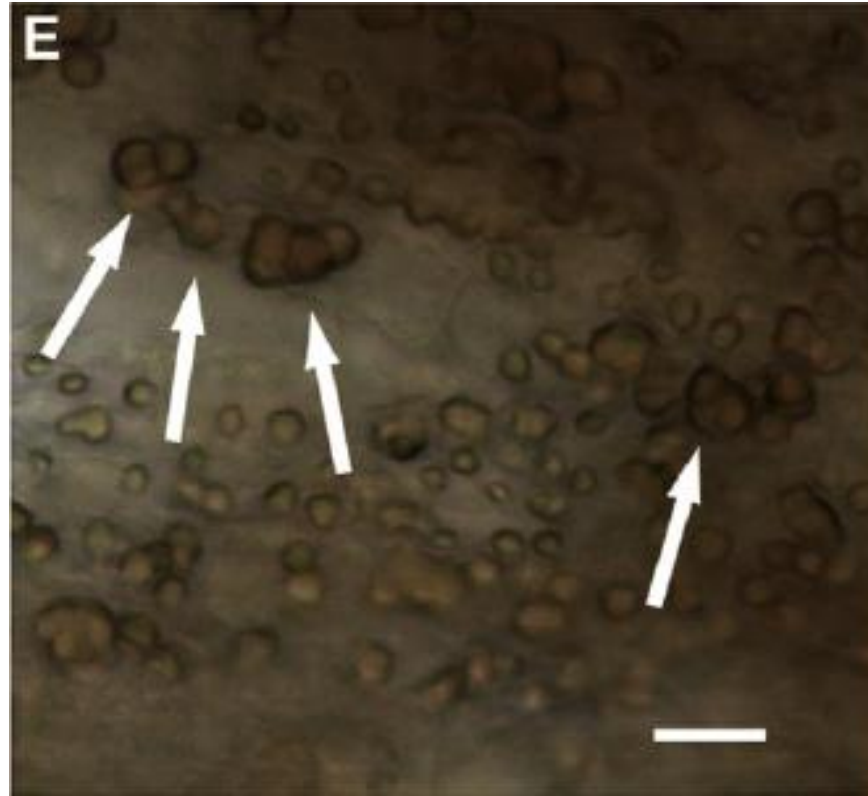


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Elionorus muticus

## Starch

Fig. 3. Pampean native wild grasses from reference collection. D-E: Compound starch grains as discrete aggregates of class a. E: *Elionorus muticus*. (Scale bars: 10 mm).



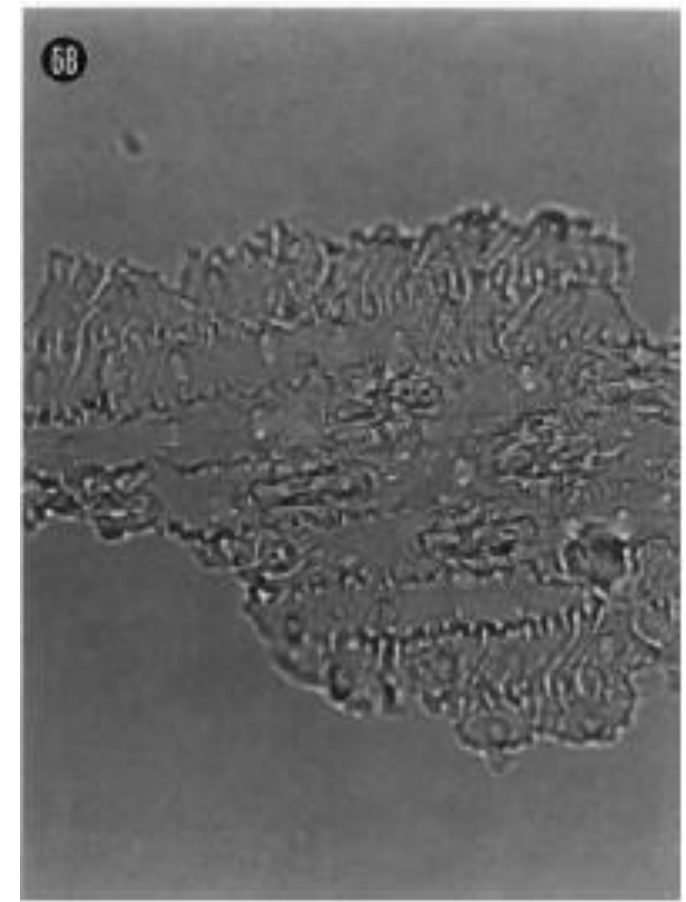
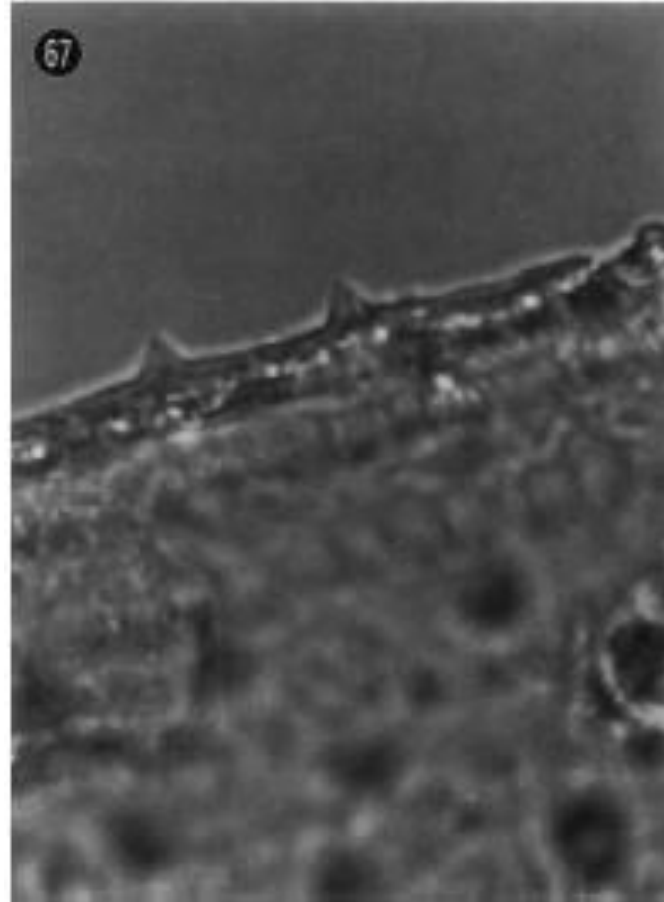
Musaubach, María Gabriela, Anabela Plos, and María Del Pilar Babot. 2013. Differentiation of Archaeological Maize (*Zea Mays* L.) from Native Wild Grasses Based on Starch Grain Morphology. Cases from the Central Pampas of Argentina. *Journal of Archaeological Science* 40 (2). Elsevier Ltd:1186–93. <http://dx.doi.org/10.1016/j.jas.2012.09.026>.



# Elytrostachys clanisera

## Phytolith

FIGURES 65-68.-67, Top, conical siliceous bodies emerging from the leaf epidermis of *Elytrostachys clanisera* (x400). 68, Two-peaked conical siliceous bodies in epidermis from *Elytrostachys clanisera* (x200).

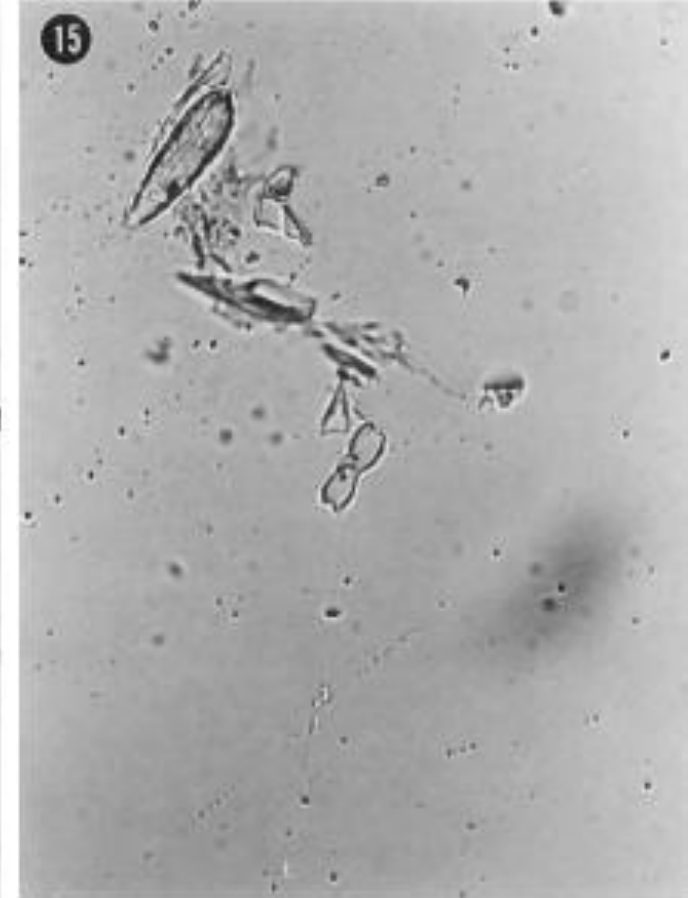
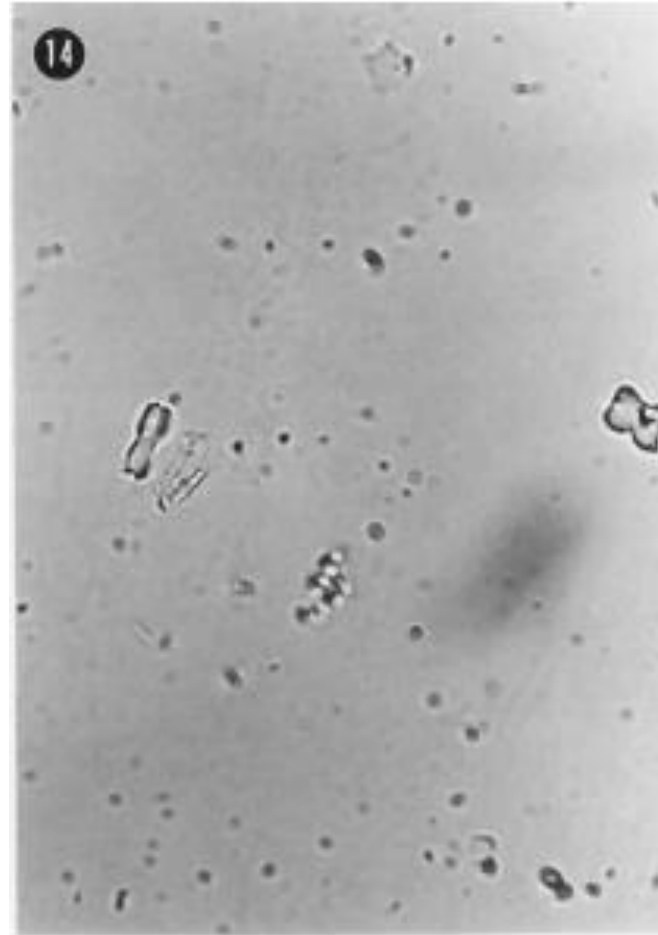


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Eragrostis mexicana

## Phytolith

FIGURES 13-16. 14, A bilobate (left) and a cross-shaped phytolith (right) from *Eragrostis mexicana* (x200). The bilobate has four indentations and both phytoliths have the flared edges typical of the Chloridoideae. 15, Center, a complex bilobate from *Eragrostis mexicana* with multiple indentations (x200).

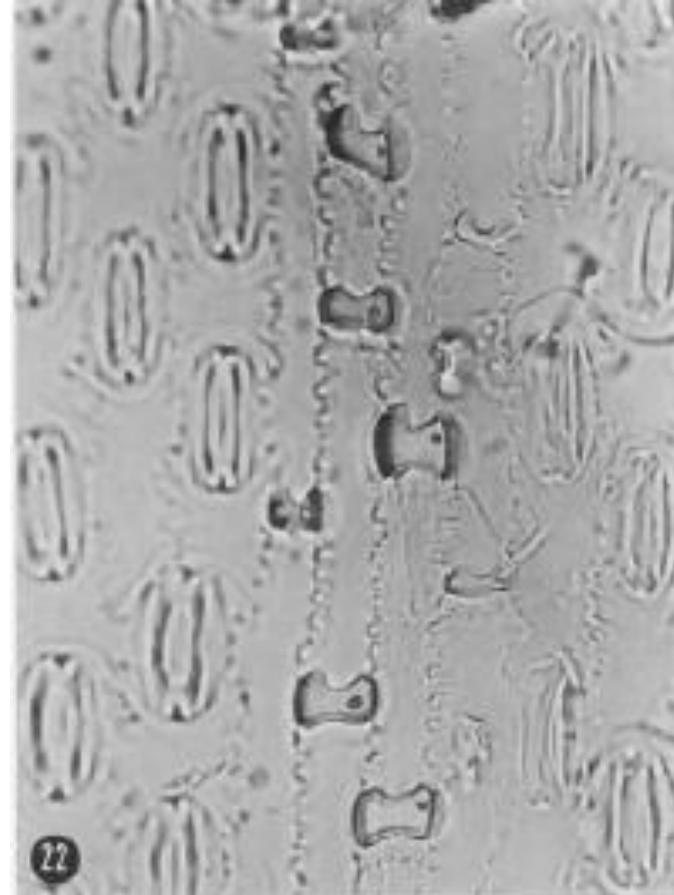


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Guadua amplexifolia

## Phytolith

FIGURES 21-24.-21, Saddle-shaped phytoliths from *Guadua amplexifolia*. All but one are tall (x200). 22, Saddle-shaped and narrow-elliptical phytoliths from *Guadua amplexifolia*. All of the saddles are very tall (x200)

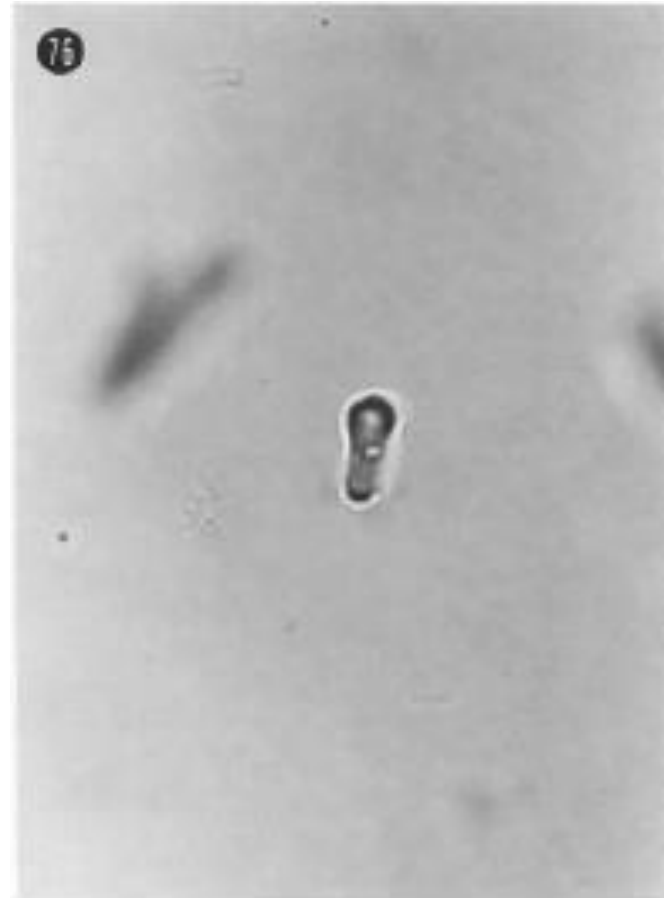


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Guadua amplexifolia

## Phytolith

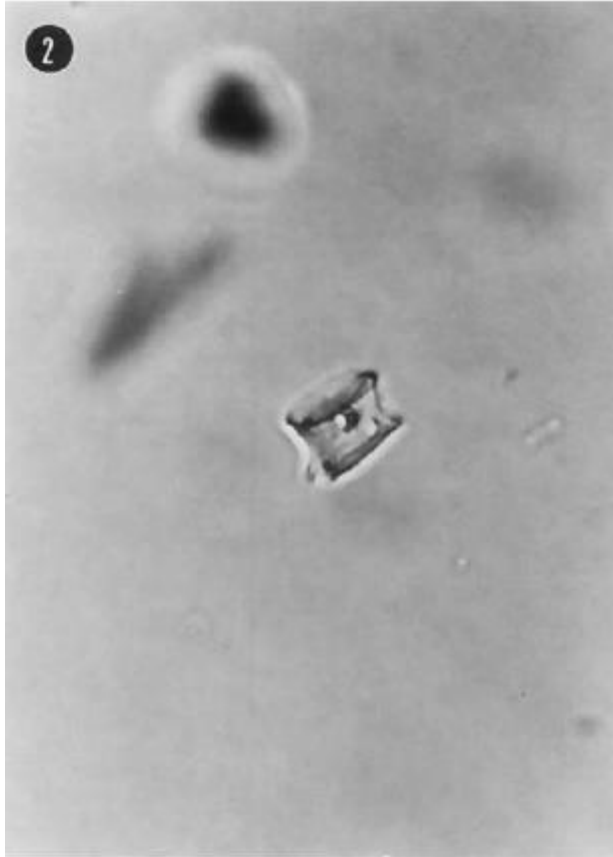
FIGURES 73-76.-75, Right, a thick, collapsed saddle from *Guadua amplexifolia* (x400). 76, A phytolith with both saddle and bilobate characteristics from *Guadua amplexifolia* (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Guadua angustifolia

## Phytolith



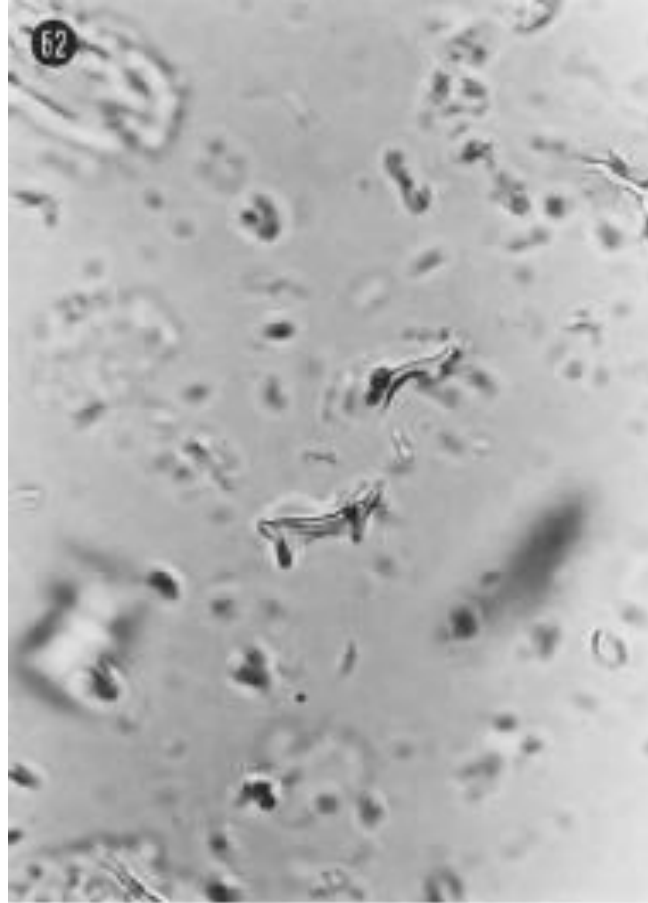
A rondel from the culm  
of *Guadua angustifolia*  
(400x)

Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Guadua angustifolia

## Phytolith

FIGURES 61-64.-62, Narrow elliptate phytoliths from *Guadua angustifolia* removed from tissue (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Guadua latifolia

## Phytolith



Center, 3 rondels from the inflorescence of *Guadua latifolia*. The phytolith at the top is a bilobate (400x)

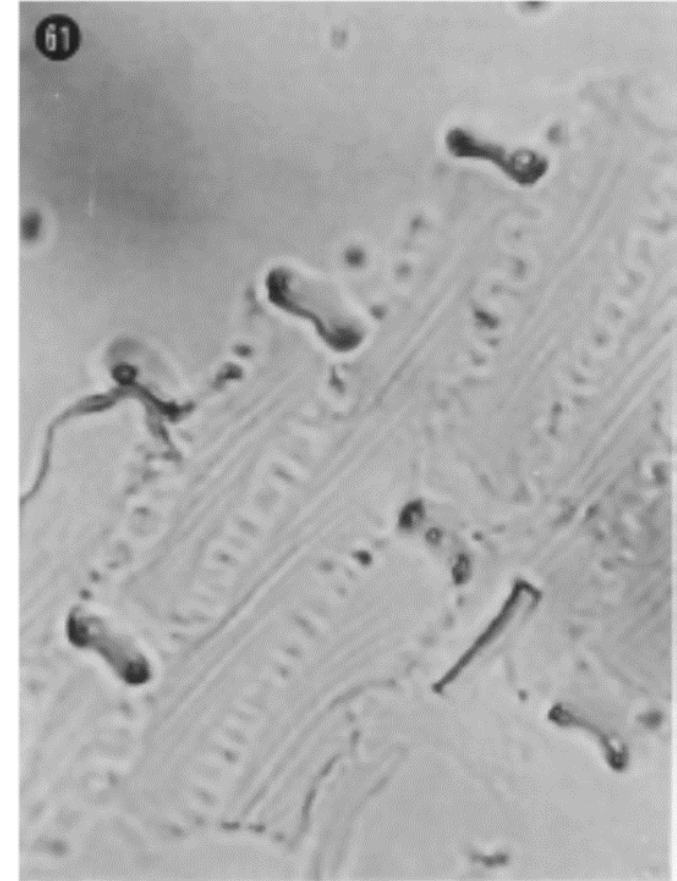
Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Guadua latifolia

## Phytolith

FIGURES 57-60.-58, Center, a bilobate from the inflorescence of *Guadua latifolia* (x400).

FIGURES 61-64.-61, Narrow elliptate phytoliths from *Guadua latifolia* still enclosed in tissue (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.



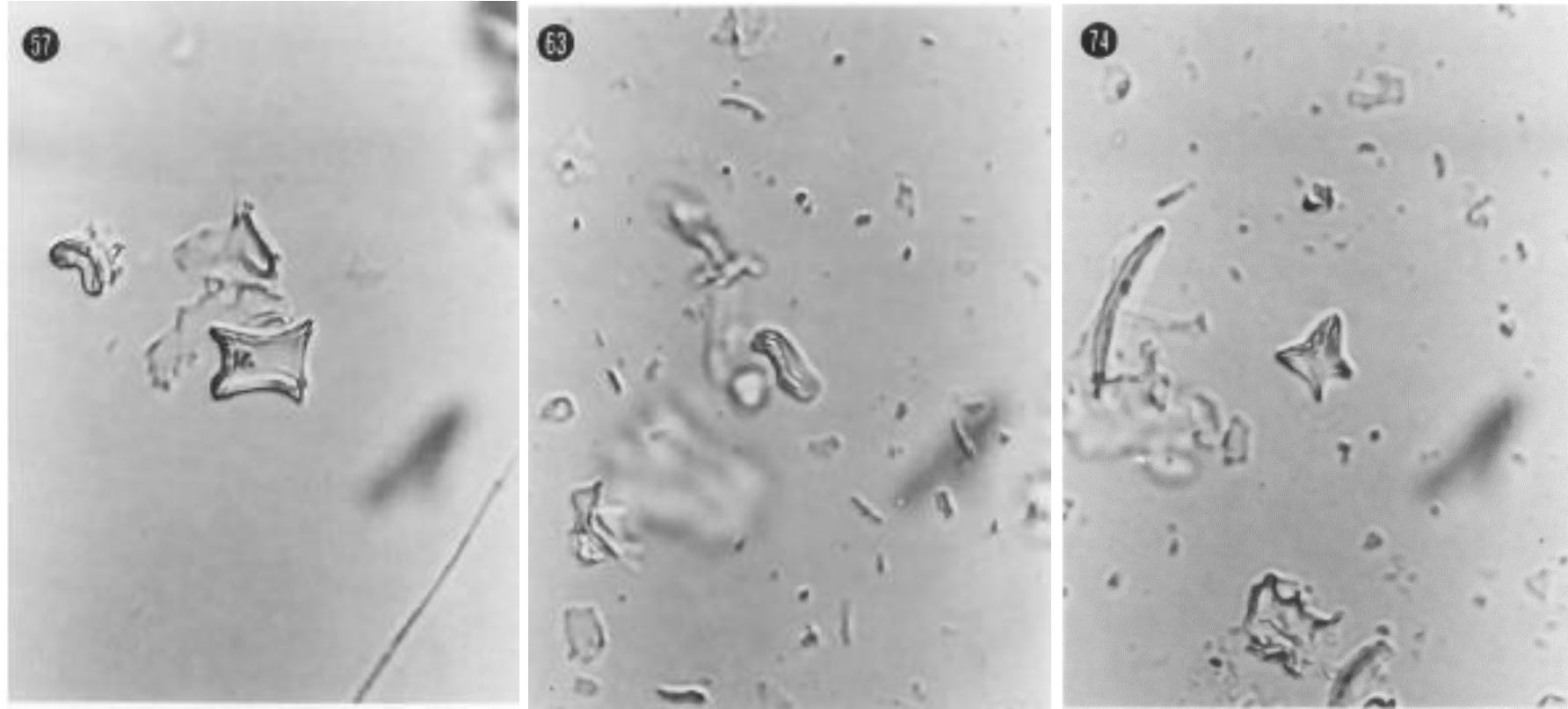
# Gynerium sagittatum

## Phytolith

FIGURES 57-60.-57, A phytolith typically produced in the leaves of *Gynerium sagittatum* (x400).

FIGURES 61-64.-63, A narrow elliptate phytolith from *Gynerium sagittatum* (x400).

FIGURES 73-76.-74, A typical phytolith from *Gynerium sagittatum* (x400).

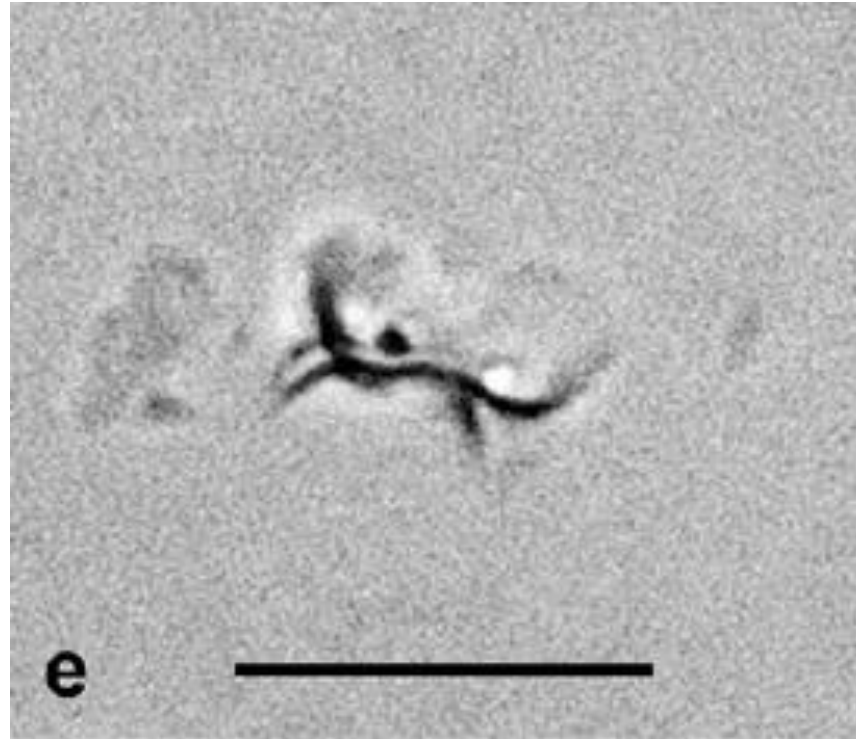


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Gynerium sagittatum

## Phytolith

Fig. 4. Phytoliths from Poaceae. e)  
Elliptoid/biloboid phytolith from  
*Gynerium sagittatum*



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Hordeum sp.

## Phytolith

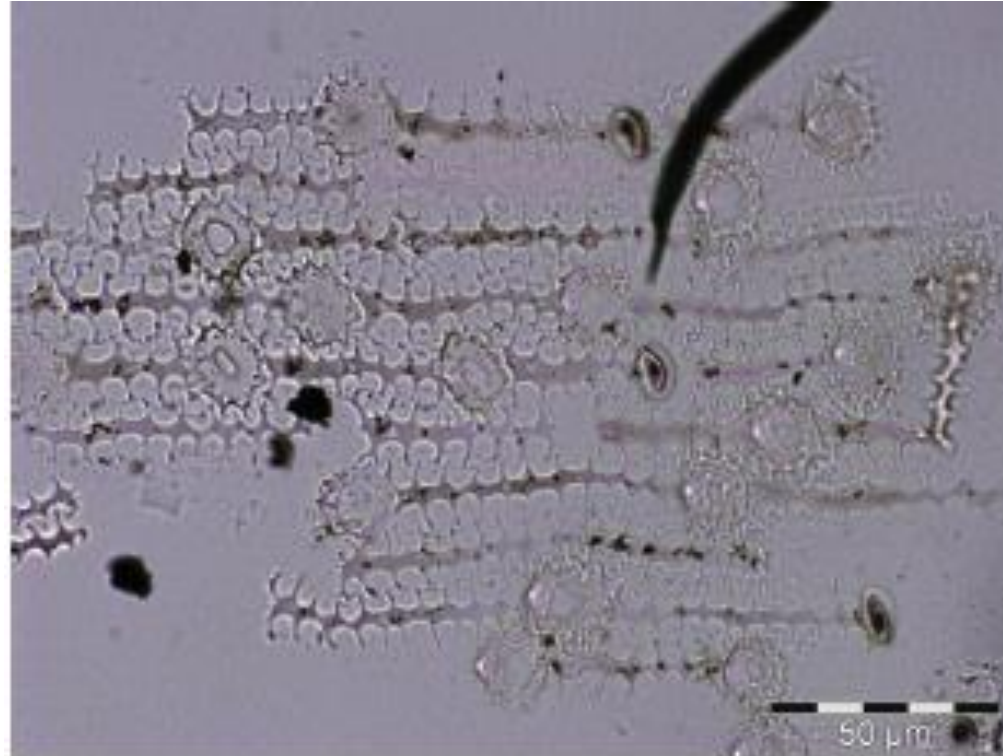


Fig. 10. An articulated aggregation of inflorescence bract phytoliths from *Hordeum vulgare* showing the long cell wave patterns and papillae characteristic of *Hordeum* sp. Photo by Arlene M. Rosen from modern plant phytolith reference collection at ICREA, University of Barcelona, courtesy of Rosa M. Albert

Ball, T. B., K. Chandler-Ezell, R. Dickau, N. Duncan, T. C. Hart, J. Iriarte, C. Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <https://doi.org/10.1016/j.jas.2015.08.010>.

# Hordeum vulgare

## Starch

Raw

Boiled 1 min

Boiled 5 min

Boiled 10 min

Boiled 30 min

Boiled 60 min

Barley

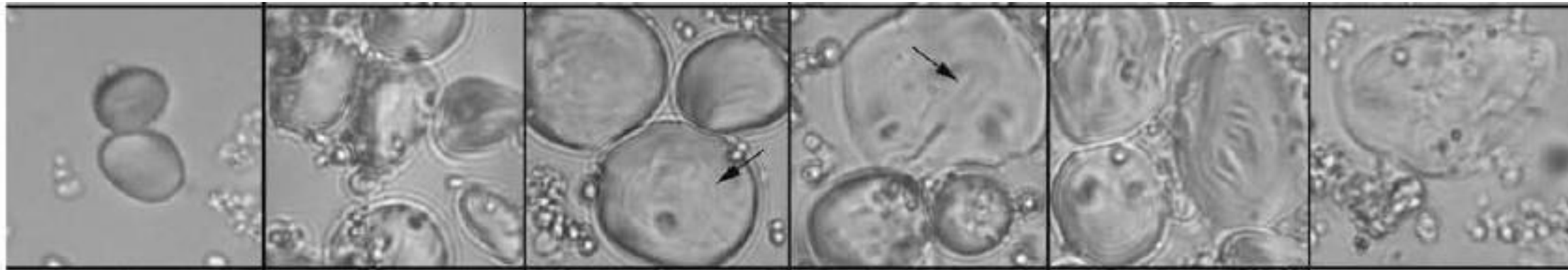


Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Hordeum vulgare

## Starch

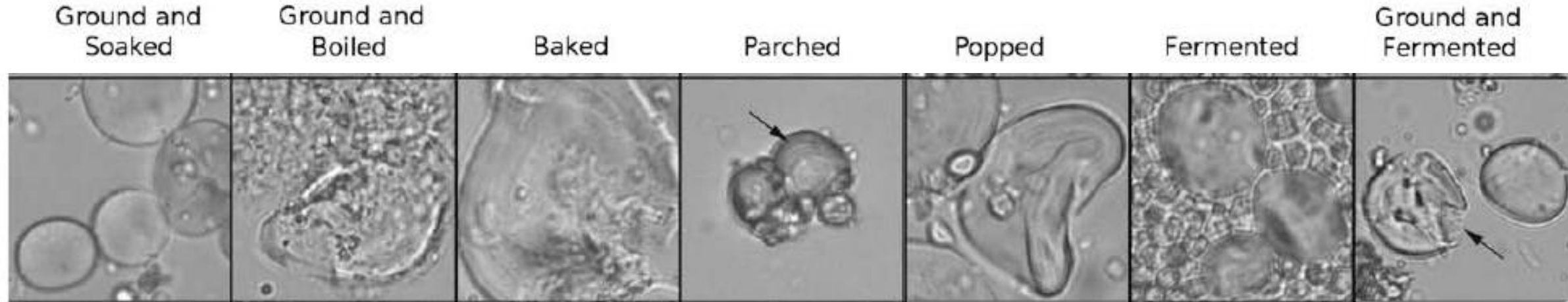


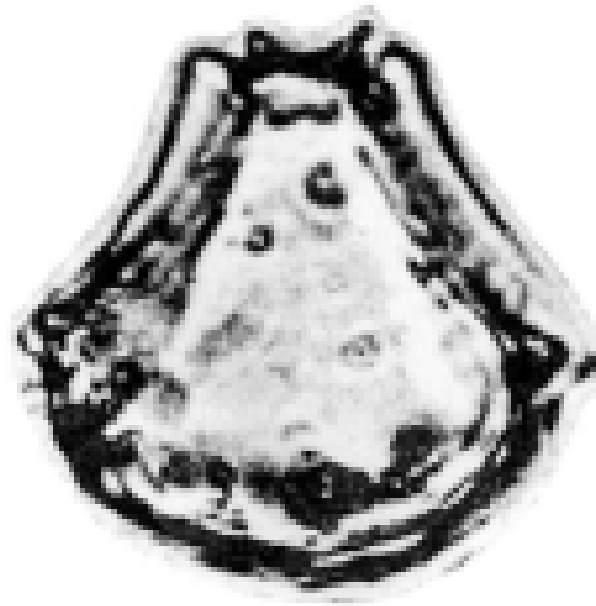
Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Indocalamus tessellates

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 13. *Indocalamus tessellates*



13

Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.

# Isachne arundinaceae

## Phytolith

FIGURES 73-76.-73, A tall saddle from  
Isachne arundinaceae (x400). 74,)

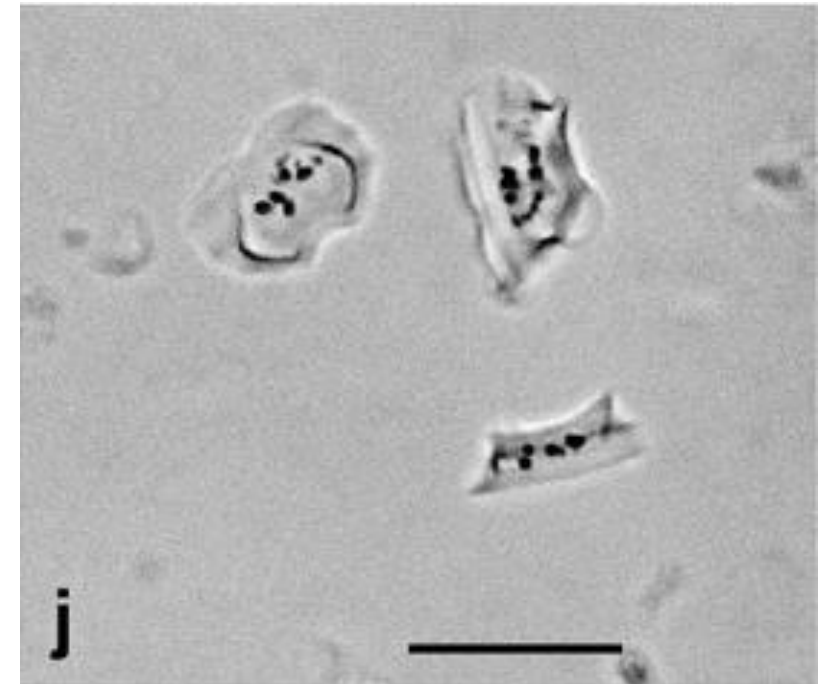
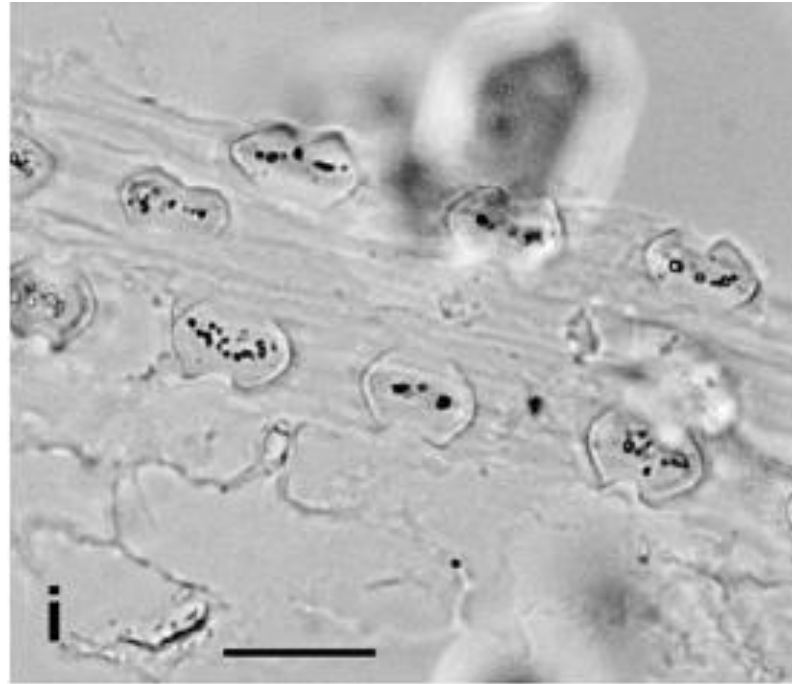


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Isachne polygonoides

## Phytolith

Fig. 4. Phytoliths from Poaceae. i) Tall saddles from *Isachne polygonoides*, j) Saddleoid/biloboid phytoliths from *Isachne polygonoides*



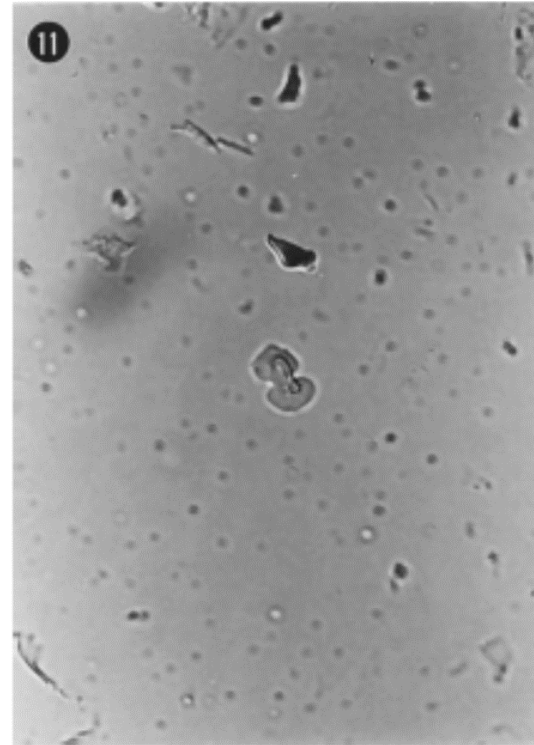


# Maclurolyra tecta

## Phytolith

FIGURES 9-12. 11, A bilobate from *Maclurolyra tecta* (x200).

FIGURES 37-40.-39, An irregular, complex short-cell phytolith from *Maclurolyra tecta* orientated as it would be in leaf tissue (x400). Compare with Figure 40. 40, An irregular, complex short-cell phytolith from *Maclurolyra tecta* exhibiting extreme width and one sinuous and one sloping edge (x400).

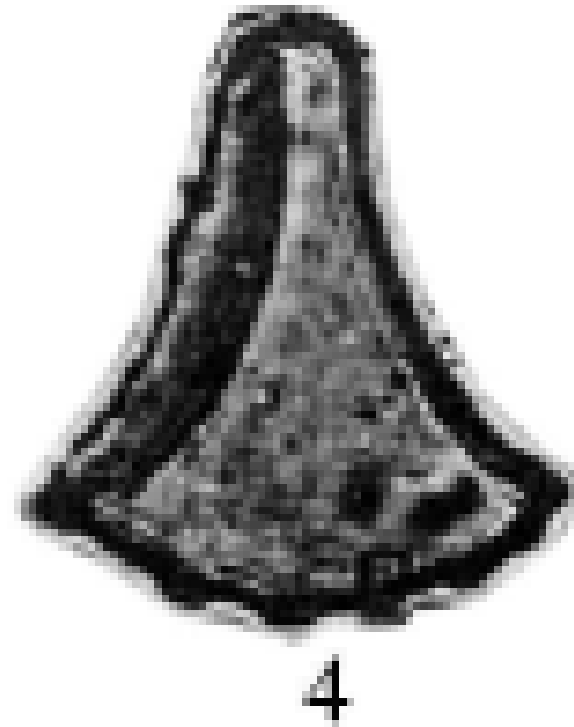


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Miscanthus floridulus

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 4. *Miscanthus floridulus*



# Msicanthus sinensis

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 14. *Msicanthus sinensis*

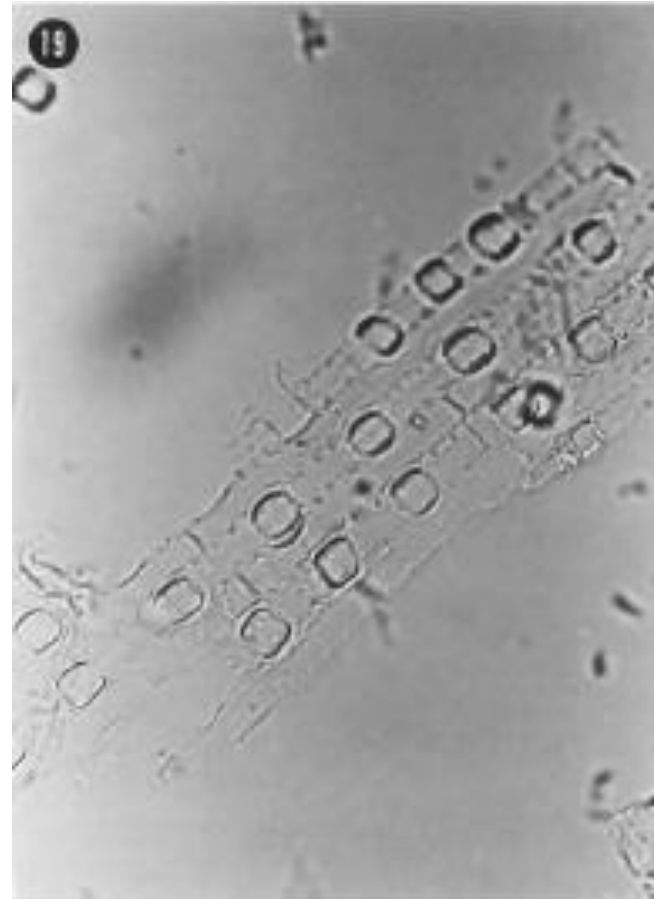


14

# Muhlenbergii emersleyi

## Phytolith

FIGURES 17-20. 19, Saddle-shaped phytoliths from *Muhlenbergii emersleyi*. Many of them are squat saddles (x200).

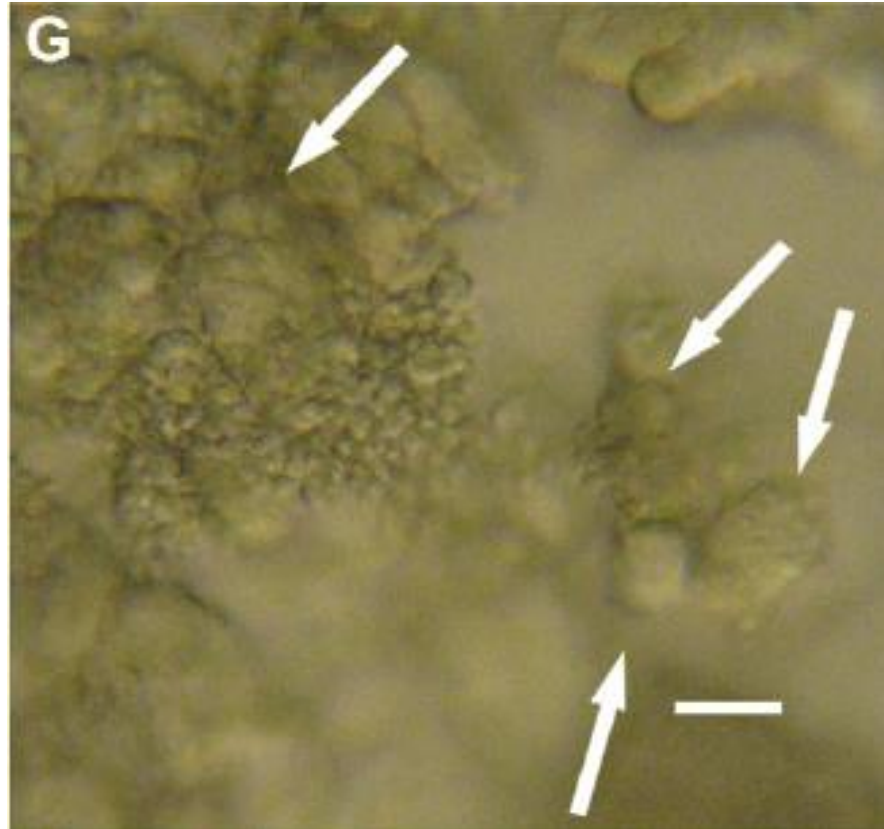


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Nasella clarasii

## Starch

Fig. 3. Pampean native wild grasses from reference collection. F-G: Compound starch grains, supernumerary aggregates of class b. G: *Nasella clarasii*. (Scale bars: 10  $\mu$ m).



Musaubach, María Gabriela, Anabela Plos, and María Del Pilar Babot. 2013. Differentiation of Archaeological Maize (*Zea Mays* L.) from Native Wild Grasses Based on Starch Grain Morphology. Cases from the Central Pampas of Argentina. *Journal of Archaeological Science* 40 (2). Elsevier Ltd:1186–93. <http://dx.doi.org/10.1016/j.jas.2012.09.026>.

# Neurolepis pittiera

## Phytolith

FIGURES 33-36.-35, A small, wide, tent-shaped body from *Neurolepis pittiera* (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Olyra latifolia

## Starch

### APPENDIX:

Olyra latifolia. Compound grains, with pressure facets. A double border is visible and a cavity is usually found at the hilum. Size: 4–8 microns.

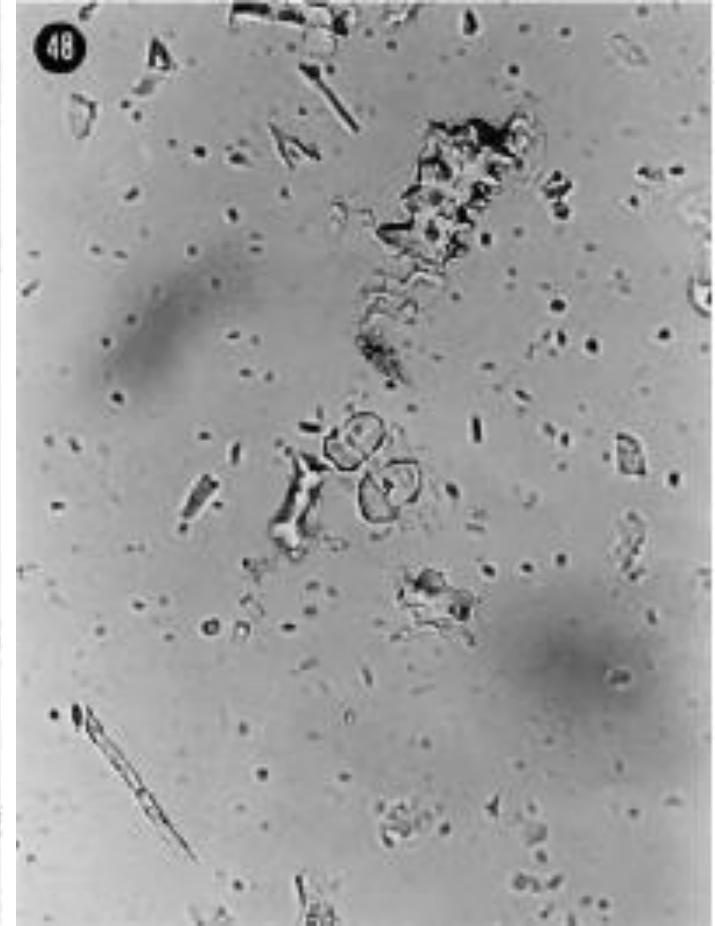
Panicum

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Olyra latifolia

## Phytolith

FIGURES 45-48.-45, Top and bottom, irregular, complex short-cell phytoliths from *Olyra latifolia*. These phytoliths are characteristic of the tribe Olyreae. The phytolith in the center is a bilobate (x200). 48, Center, two Variant 8 bilobates from *Olyra latifolia* (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.



# Oplismenus compositus

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 16. *Oplismenus compositus*.



Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.

# Oplismenus undulatifolius

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 15. *Oplismenus undulatifolius*



Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.

# Oryzeae tribe

## Phytolith

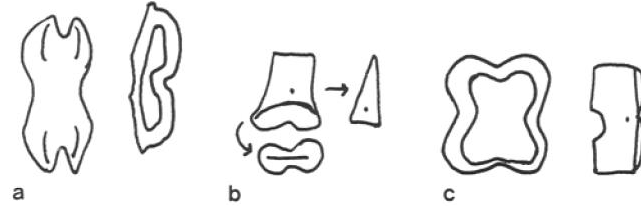
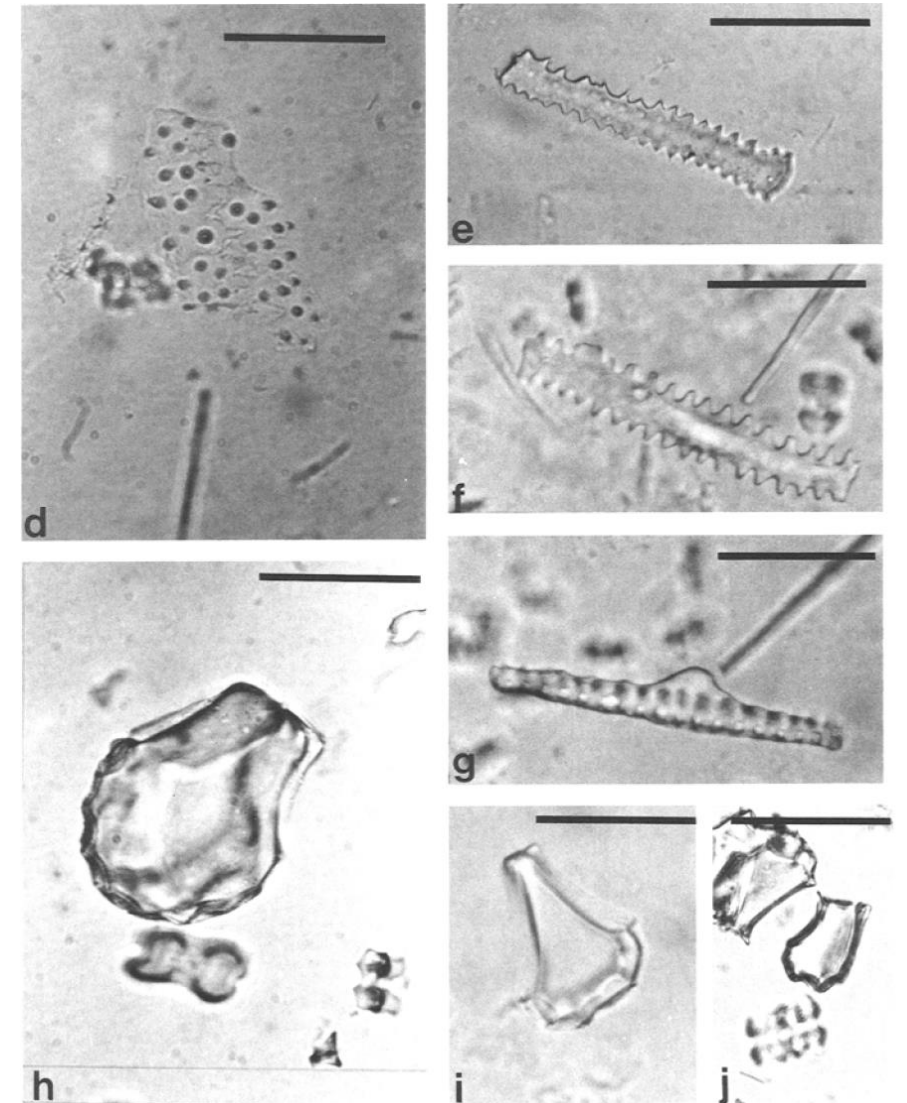


Fig. 2. Phytolith types distinguishing the Oryzeae tribe, a: Type 1 dumbbell with scooped ends, curved and lobed in side view (fight), thick. The most common short cell in many taxa in the tribe. Grades into a scooped cross-like form; b: Type 8a short cell with a dumbbell on one tier (bottom view, lower), and a thin plate extending perpendicular to the dumbbell-type tier (side view, right); c: Type 5 thick cross, lobed in side view (fight), with raised corners. Common in two genera (a--c short cells not drawn to scale. Size 15-25 micrometers); d: 10IIef epidermal long cell, weakly silicified, with regular, well-silicified, rounded projections (example from *Oryza sativa*); e: 1 IIIICa. 1 IIIICa--Cc are blocky epidermal cells with numerous projections of variable size, and sometimes with one prominent projection (example from *Oryza manilensis*); f: 1 IIIICc, top view (example from *Oryza sativa*); g: same as f, side view; h: 50IIIAc. 50III Aa, b, and c are keystone bulliform types, sometimes thick and with multiple ridges (example from *Oryza meyeriana*); i: 50IIIAb (example from *Oryza minuta*); j: 50III Aa (example from *Oryza manilensis*). Scale bar = 20 micrometers.

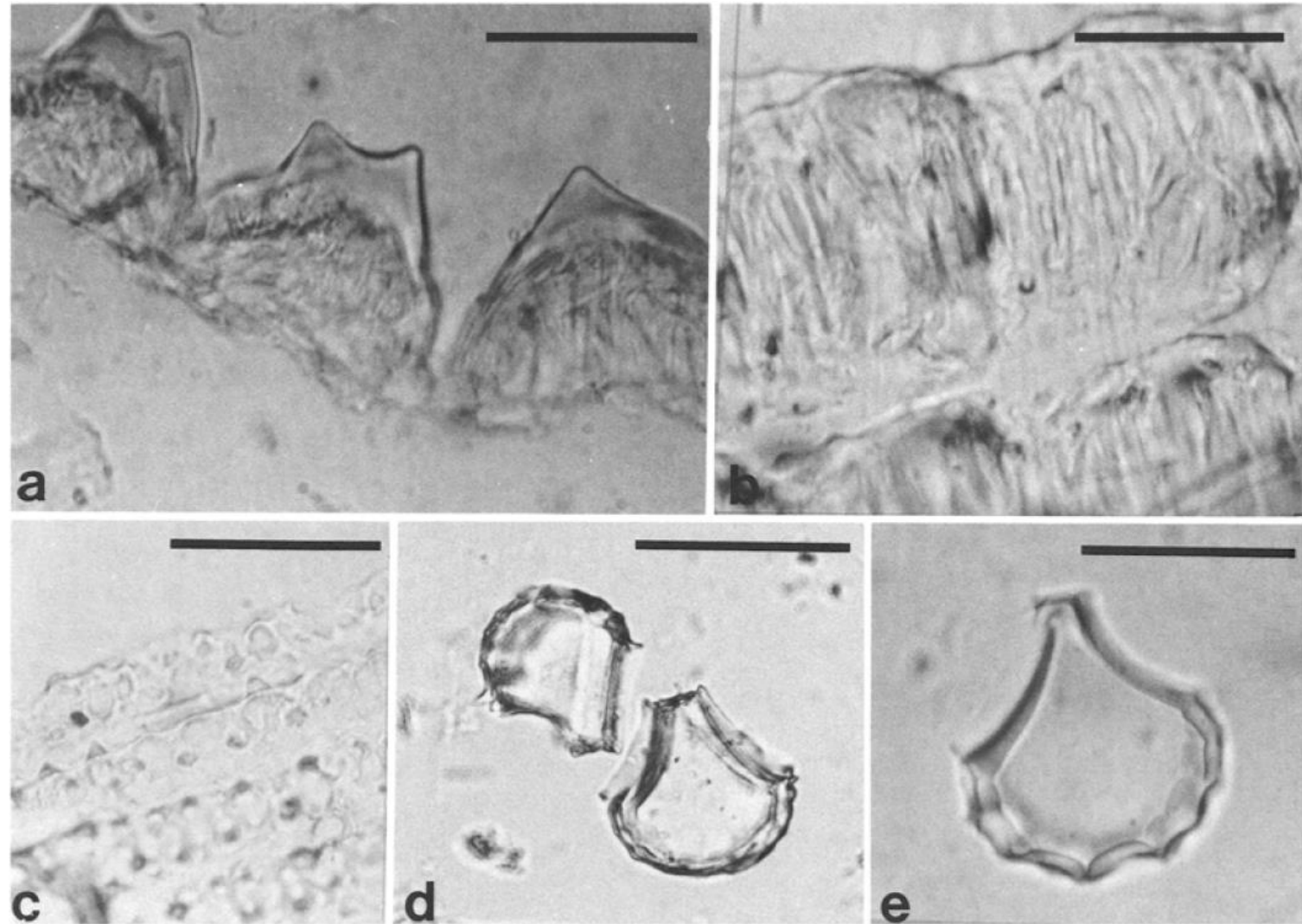


Pearsall, Deborah Marie, Dolores R. Piperno, Elizabeth H. Dinan, Marcelle Umlauf, Zhijun Zhao, and Robert A. Benfer. 1995. Distinguishing Rice (*Oryza Sativa* Poaceae) from Wild *Oryza* Species through Phytolith Analysis: Results of Preliminary Research. *Economic Botany* 49 (2):183–96.

# Oryza sp.

## Phytolith

Fig. 3. Epidermal and bulliform types distinguishing the genus *Oryza*. a: 22IIIAa and 22IIIAb. Seed epidermis with large conical hairs (22IIIAa: 1 peak, 22IIIAb: two peaks) arising from very deeply serrated cells. Large hairs may be flanked by smaller projections (example from *Oryza sativa*); b: 22IVA. Seed epidermis, very deeply serrated, with pointed serrations (example from *Oryza sativa*); c: 22IVB. Seed epidermis, very deeply serrated, with sinuous-edged serrations (example from *Oryza sativa*); d: 50IIIAc1 and 50IIIAc2. Very widely flared keystone bulliform cells, a number of forms, varying by the extent of flaring and width of top. Bases symmetrical (example from *Oryza sativa*); e: 50IIIAb301. Small, moderately flared keystone bulliform cells (example from *Oryza minuta*). Scale bar = 20 micrometers.

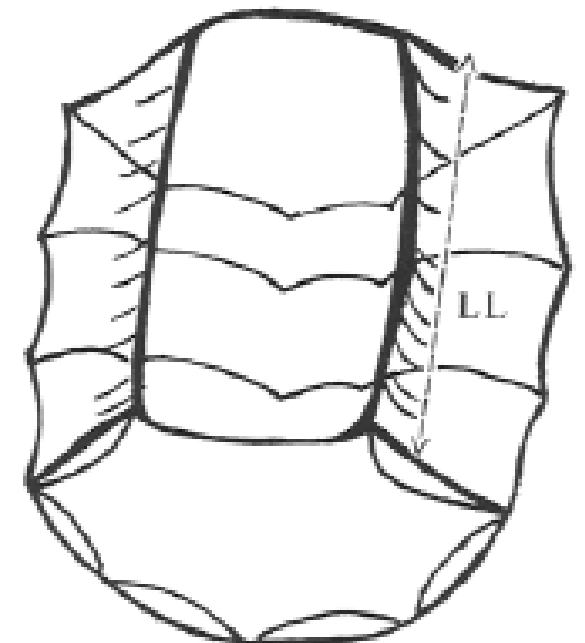
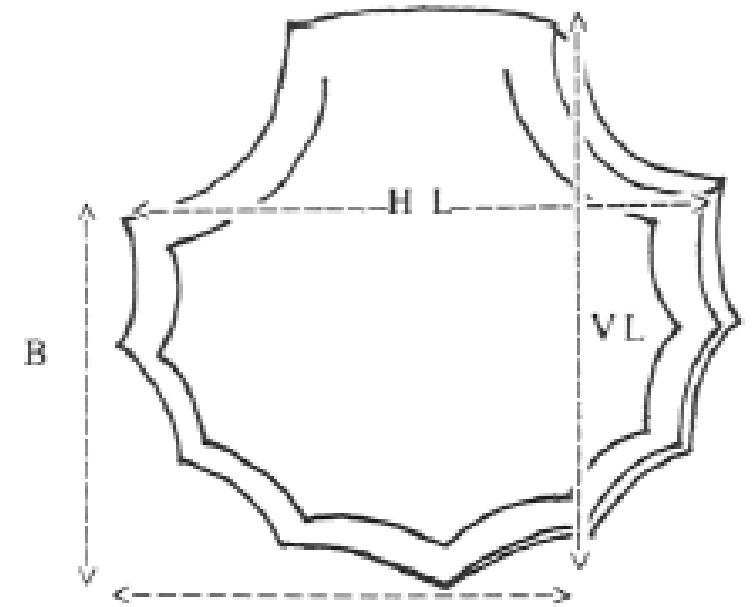


Pearsall, Deborah Marie, Dolores R. Piperno, Elizabeth H. Dinan, Marcelle Umlauf, Zhijun Zhao, and Robert A. Benfer. 1995. Distinguishing Rice (*Oryza Sativa* Poaceae) from Wild *Oryza* Species through Phytolith Analysis: Results of Preliminary Research. *Economic Botany* 49 (2):183–96.

# Oryza sp.

## Phytolith

Fig. 4. Measurements of keystone bulliforms, shown from side view (upper) and top view (lower). HL: horizontal length (length of base); LL: lateral length (width of side); VL: vertical length; B: length of base portion.

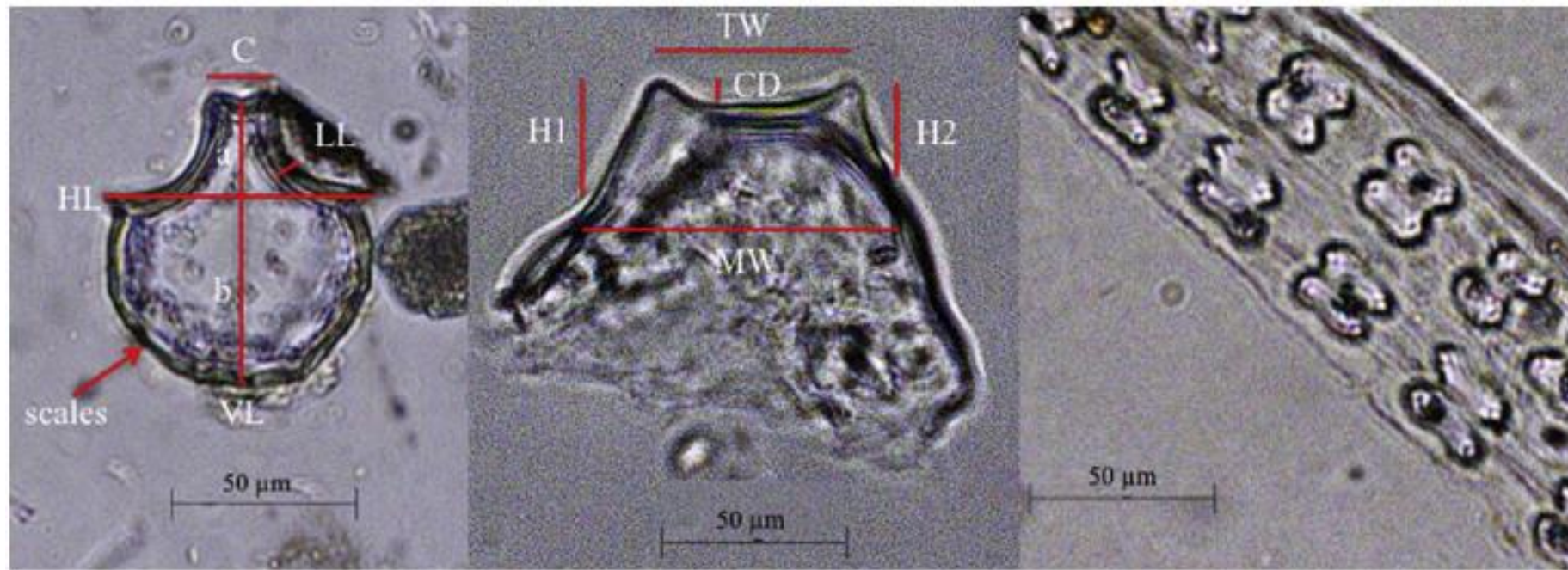


Pearsall, Deborah Marie, Dolores R. Piperno, Elizabeth H. Dinan, Marcelle Umlauf, Zhijun Zhao, and Robert A. Benfer. 1995. Distinguishing Rice (*Oryza Sativa* Poaceae) from Wild *Oryza* Species through Phytolith Analysis: Results of Preliminary Research. *Economic Botany* 49 (2):183–96.

# Oryza sp.

## Phytolith

Fig. 2. Phytolith types from rice and morphological parameters: bulliform (left); double-peaked (center); bilobate (right). Abbreviations in bulliform: HL (horizontal length); VL (vertical length); LL (lateral length); a (vertical length of the non-base portion); b (vertical length of the base portion). Abbreviations in double-peaked: TW (top width); MW (middle width); H1, H2 (height 1, height 2); CD (curve depth).

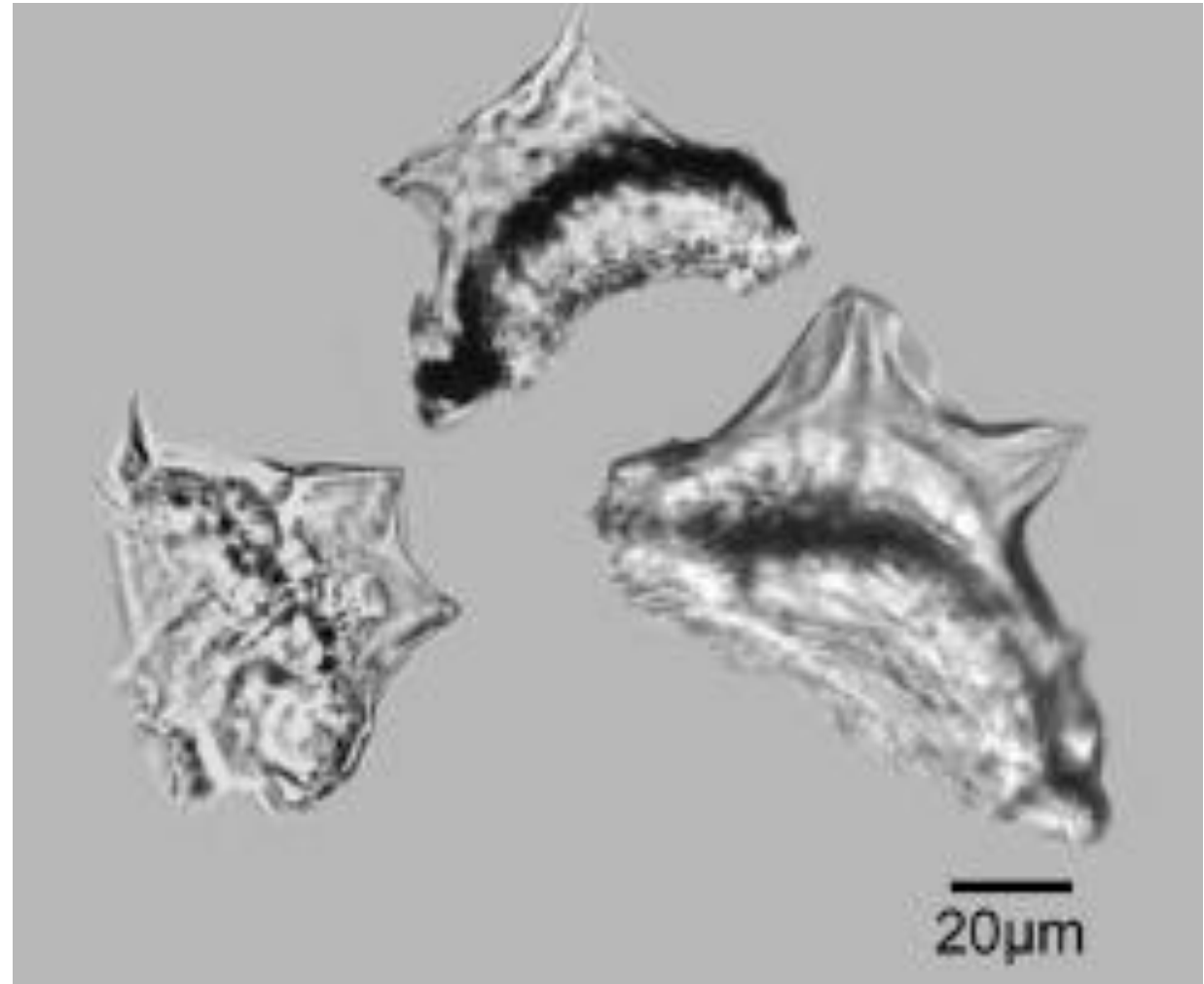


Pasqua, Alessandro, Liovando Marciano da Costa, and Ervan Garrison. 2017. Phytolith Evidence of Historical Rice Cultivation at Wormsloe Historic Site, Georgia, USA. *Journal of Archaeological Science: Reports* 14 (June). Elsevier:557–74. <http://linkinghub.elsevier.com/retrieve/pii/S2352409X17300159>.

# Oryza sp.

## Phytolith

Fig. 13. Double-peaked glume cell phytoliths from *Oryza*. From Piperno, 2006. Originally re-printed from Zhao et al., 1998

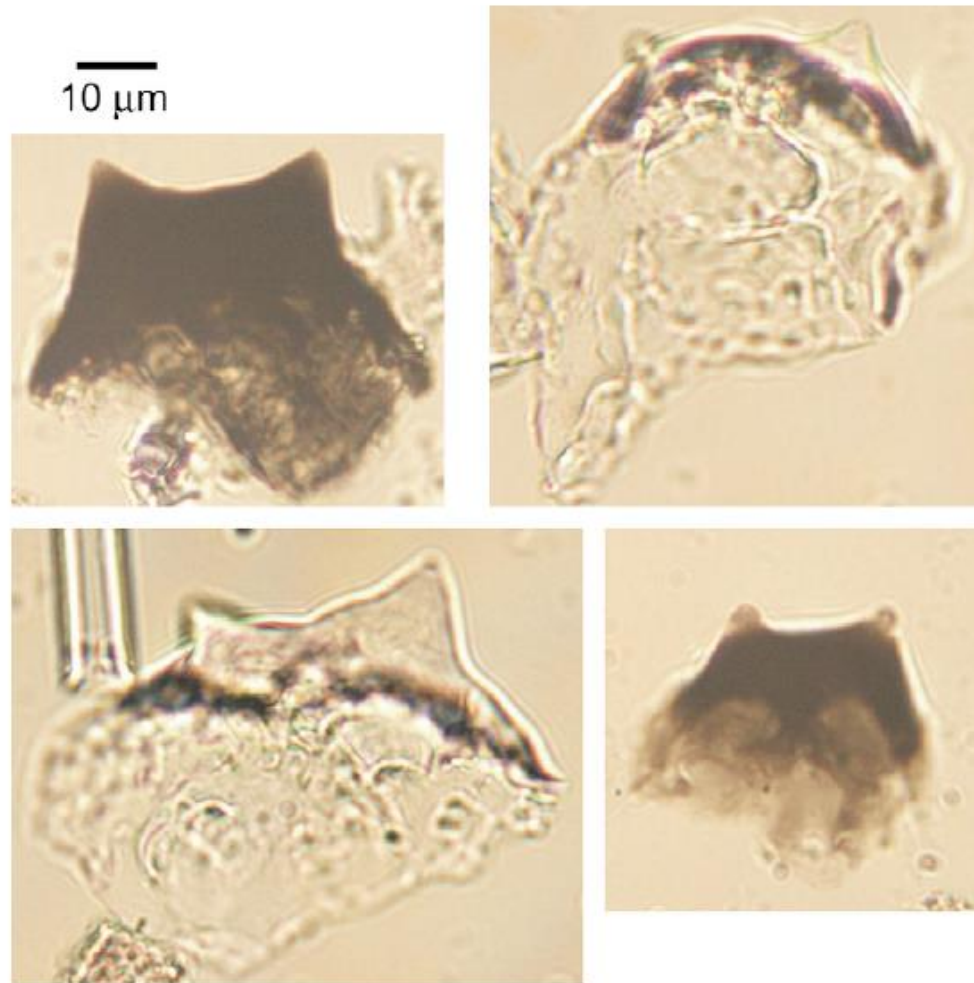


Ball, Terry B., Karol Chandler-Ezell, Ruth Dickau, Neil Duncan, Thomas C. Hart, José Iriarte, Carol Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <http://dx.doi.org/10.1016/j.jas.2015.08.010>.

# Oryza sp.

## Phytolith

Fig. 2. *Oryza* double-peaked husk cells from Qingpu. (A) and (D) 68e70 cm, 1870 BP, darker colour suggests likely burnt; (B) 82 cm, ca. 1940 BP; (C) 98 cm, ca. 2010 BP.



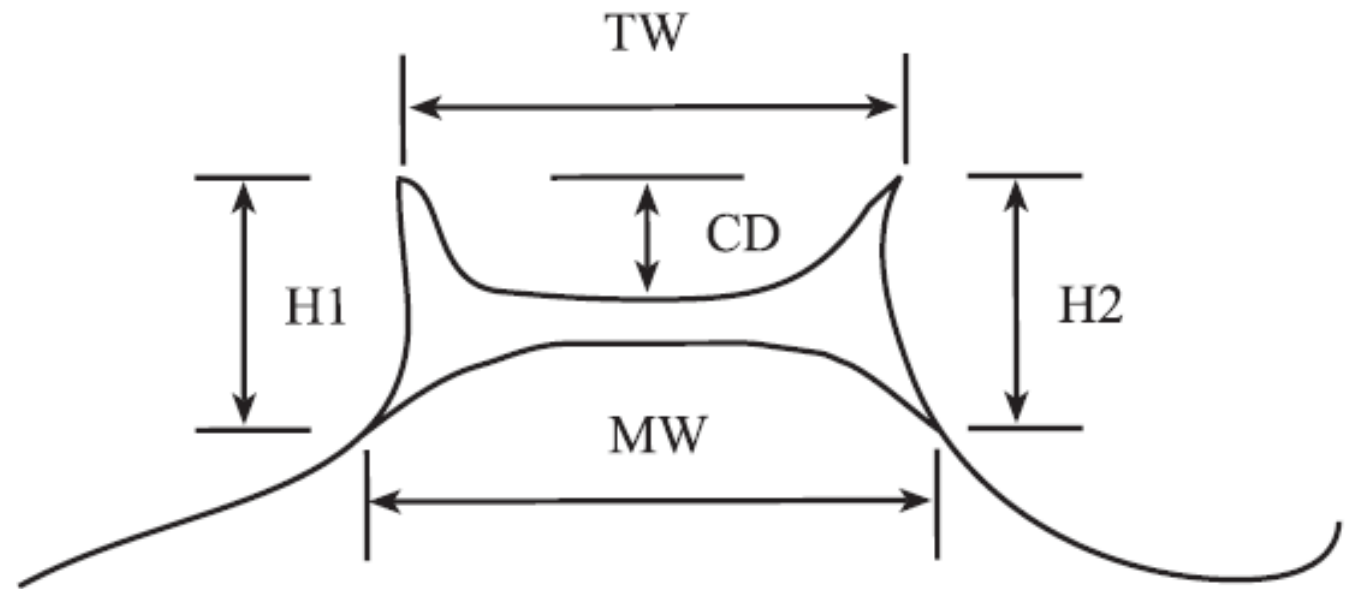
Itzstein-Davey, Freea, David Taylor, John Dodson, Pia Atahan, and Hongbo Zheng. 2007. Wild and Domesticated Forms of Rice (*Oryza* Sp.) in Early Agriculture at Qingpu, Lower Yangtze, China: Evidence from Phytoliths. *Journal of Archaeological Science* 34 (12):2101–8.



# Oryza sp.

## Phytolith

Fig. 3. Measurements of double-peaked rice *Oryza* husks required to distinguish between wild, domesticated or indeterminate varieties based on discriminant function formulas developed by Zhao et al. (1998). TW, distance between the two peaks; MW, width at the point where the hair attaches to the base; H1, height of largest peak, measured from the tip to the base of the hair; H2, height of smallest peak, measured from the tip to the base of the hair; CD, depth of the curve (adapted from Zhao et al., 1998).

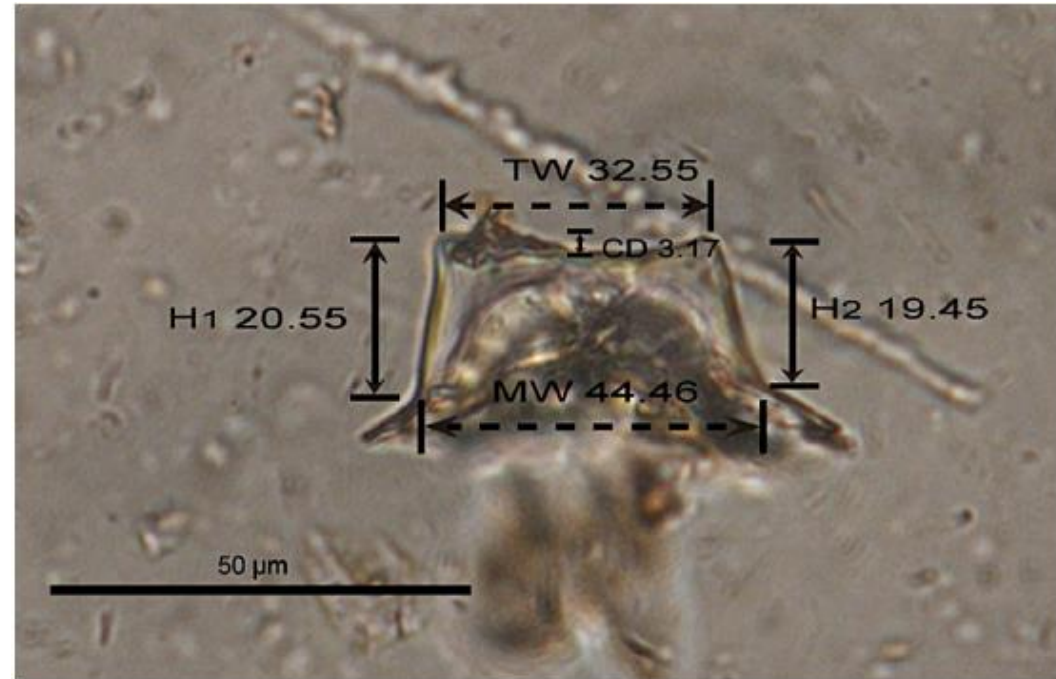


Itzstein-Davey, Freea, David Taylor, John Dodson, Pia Atahan, and Hongbo Zheng. 2007. Wild and Domesticated Forms of Rice (*Oryza* Sp.) in Early Agriculture at Qingpu, Lower Yangtze, China: Evidence from Phytoliths. *Journal of Archaeological Science* 34 (12):2101–8.

# Oryza sp.

## Phytolith

Fig. 2. 3-D scattered plots for morphological parameters of double-peaked glume cells from Shangshan Period (TW) Top width. (MW) Width of the middle. (H) Mean height of two peaks. (CD) The depth of the curve Scale bars  $\frac{1}{4}$  20  $\mu\text{m}$



Wu, Yan, Leping Jiang, Yunfei Zheng, Changsui Wang, and Zhijun Zhao. 2014. Morphological Trend Analysis of Rice Phytolith during the Early Neolithic in the Lower Yangtze. *Journal of Archaeological Science* 49 (1). Elsevier Ltd:326–31. <http://dx.doi.org/10.1016/j.jas.2014.06.001>.

# Oryza sp.

## Phytolith

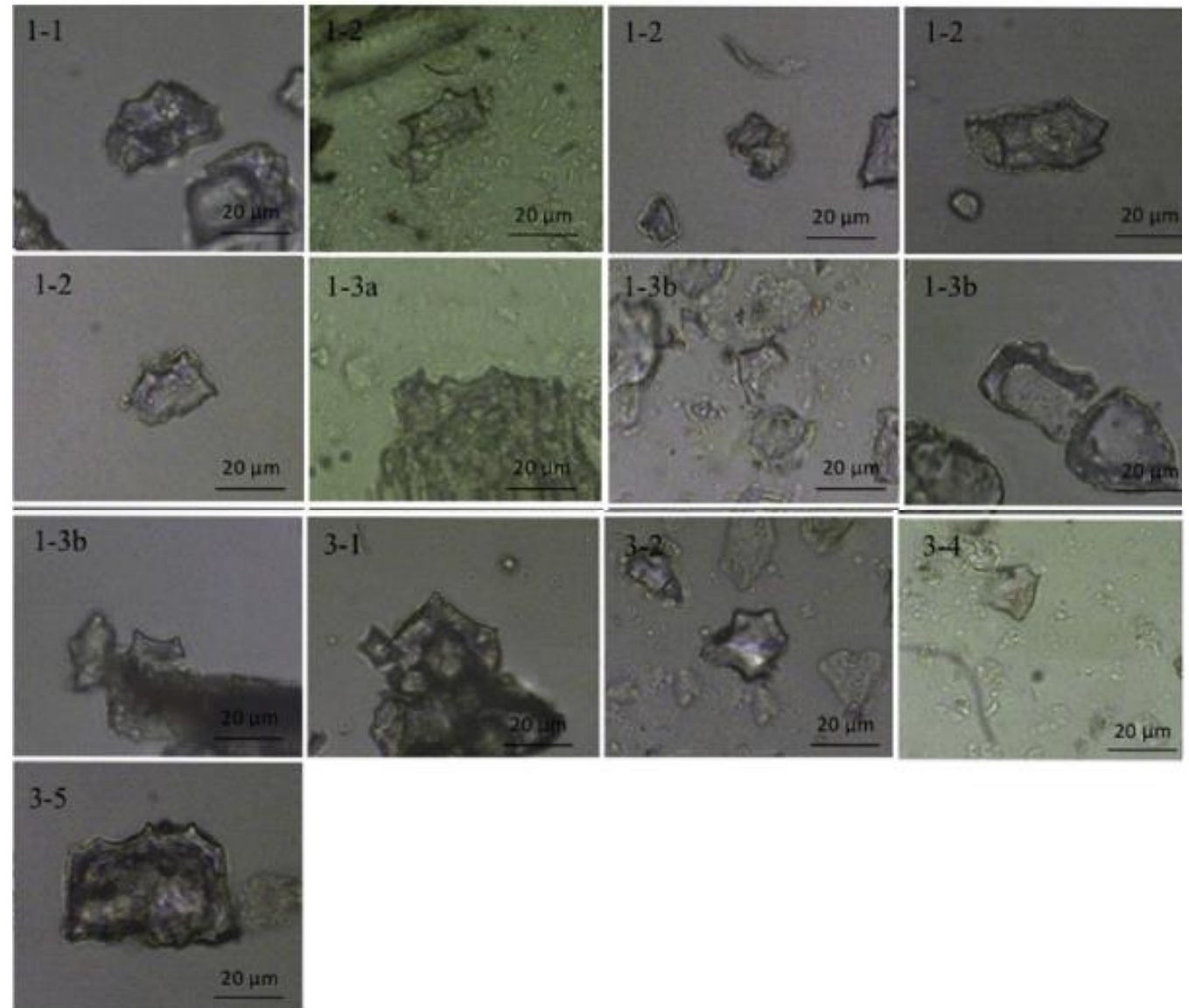


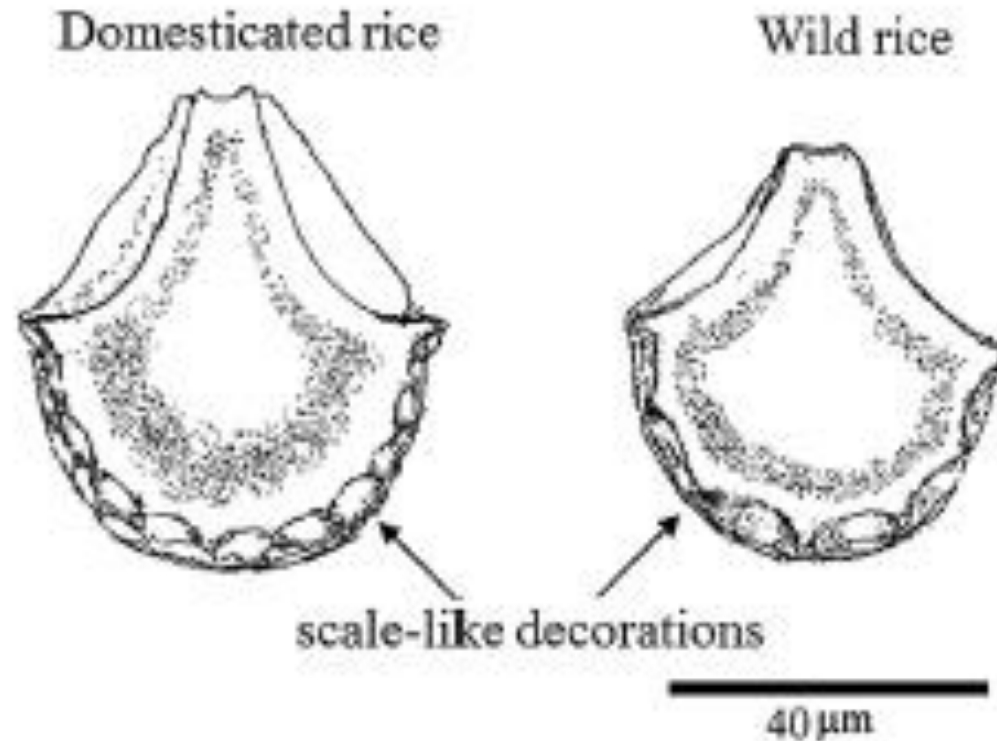
Fig. 6. Domesticated double-peaked phytoliths from Wormsloe.

Pasqua, Alessandro, Liovando Marciano da Costa, and Ervan Garrison. 2017. Phytolith Evidence of Historical Rice Cultivation at Wormsloe Historic Site, Georgia, USA. *Journal of Archaeological Science: Reports* 14 (June). Elsevier:557–74. <http://linkinghub.elsevier.com/retrieve/pii/S2352409X17300159>.

# Oryza sp.

## Phytolith

Fig. 14. Comparison of the scale-like decorations on bulliform phytoliths in domesticated and wild rice. Modified from Fujiwara (1976)



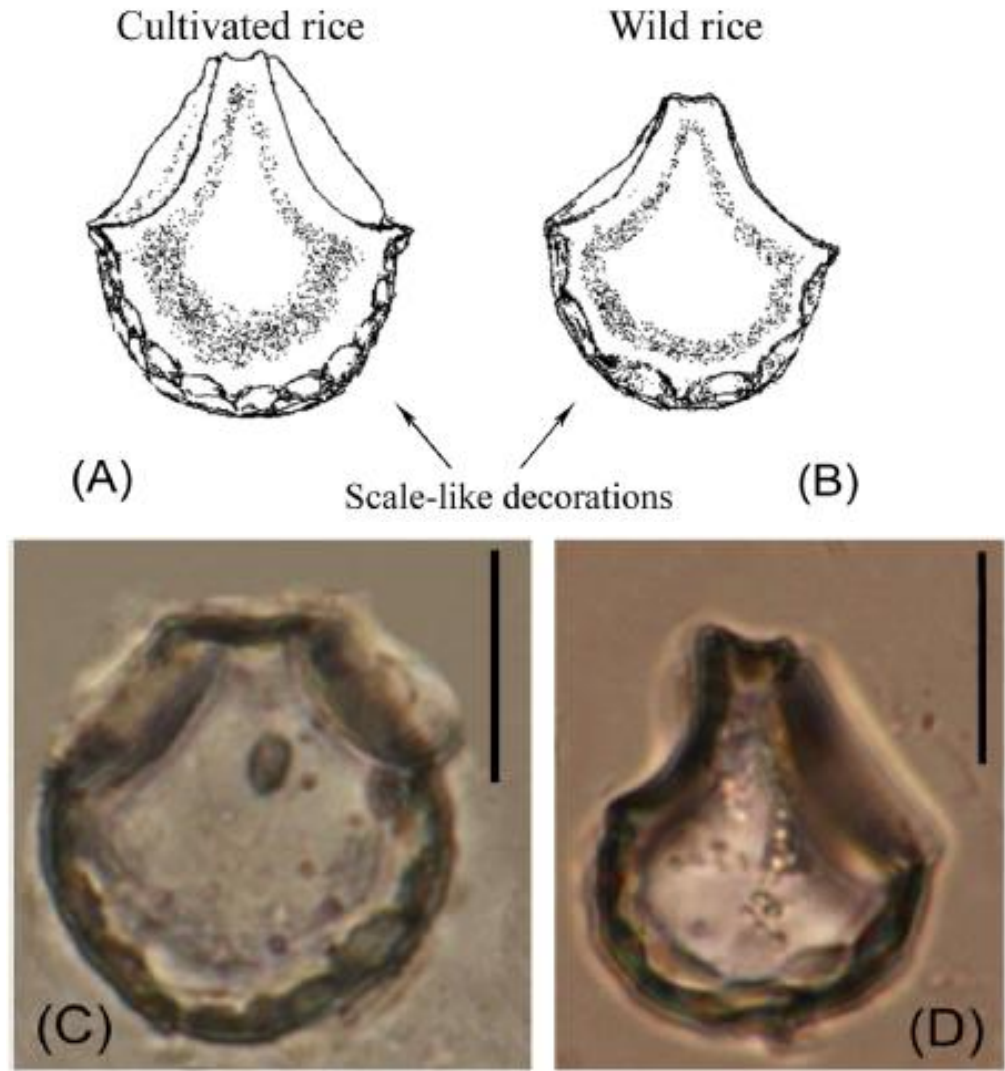
Ball, Terry B., Karol Chandler-Ezell, Ruth Dickau, Neil Duncan, Thomas C. Hart, José Iriarte, Carol Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <http://dx.doi.org/10.1016/j.jas.2015.08.010>.

Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Chang: Phytolith Evidence from East China. *Boreas* 31:378–85.

# Oryza sp.

## Phytolith

Fig. 5. Scale-like decorations on cuneiform bulliform cells phytoliths. A,B modified from Lu et al. (17)A. domestic rice with 11 scale-like decorations; B. Wild rice with 6 scale-like decorations. C, D. cuneiform bulliform cells phytoliths extracted from the Shangshan Period (around c. 11,000e9000 cal. BP). C. shows 11 scale-like decorations; D. shows 6 scale-like decorations. Scale bars  $\frac{1}{4}$  20  $\mu\text{m}$

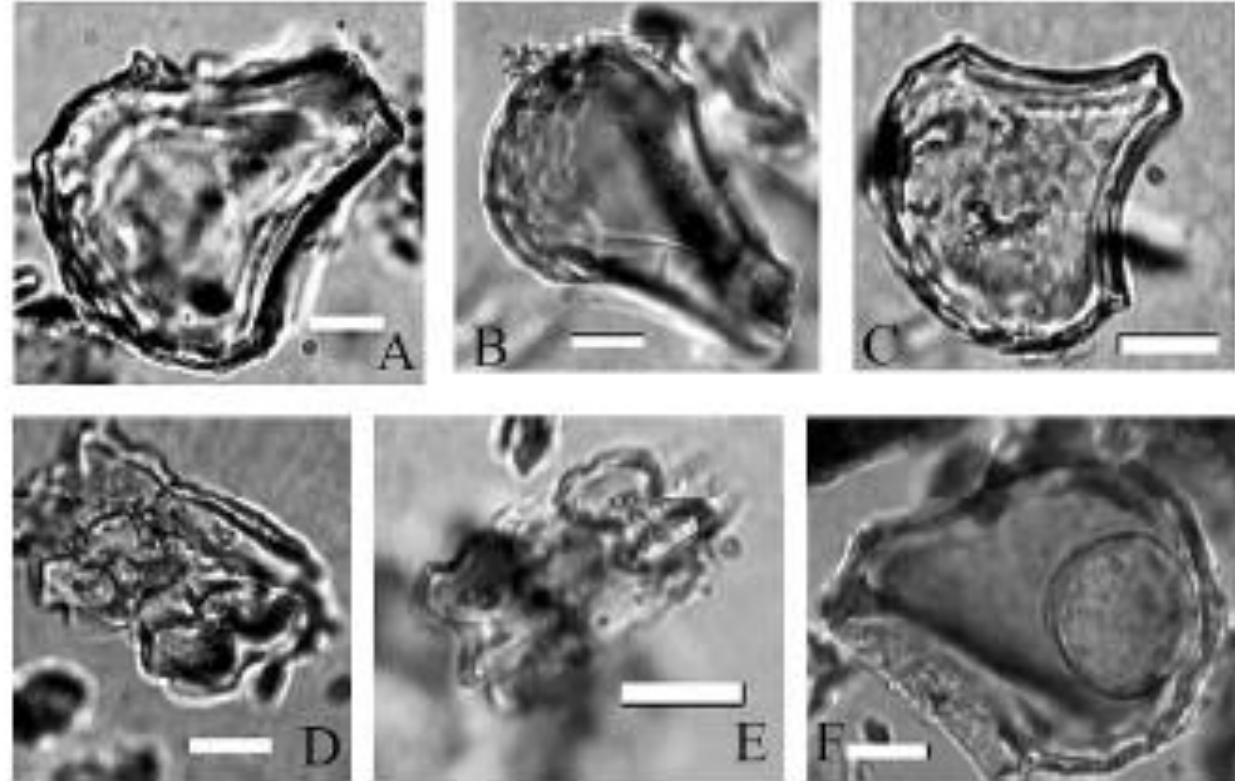


Wu, Yan, Leping Jiang, Yunfei Zheng, Changsui Wang, and Zhijun Zhao. 2014. Morphological Trend Analysis of Rice Phytolith during the Early Neolithic in the Lower Yangtze. *Journal of Archaeological Science* 49 (1). Elsevier Ltd:326–31. <http://dx.doi.org/10.1016/j.jas.2014.06.001>.

# Oryza sp.

## Phytolith

Fig. 4. Optical micrographs of fossil rice phytoliths from the DG9603 core. A, B, C, F. Bulliform phytolith (fan-shaped) with more than nine small shallow scale-like decorations on the half round side. D, E. Dumbbell-shaped with scooped ends, paralleled arrangement. Scale bar = 10  $\mu\text{m}$ .

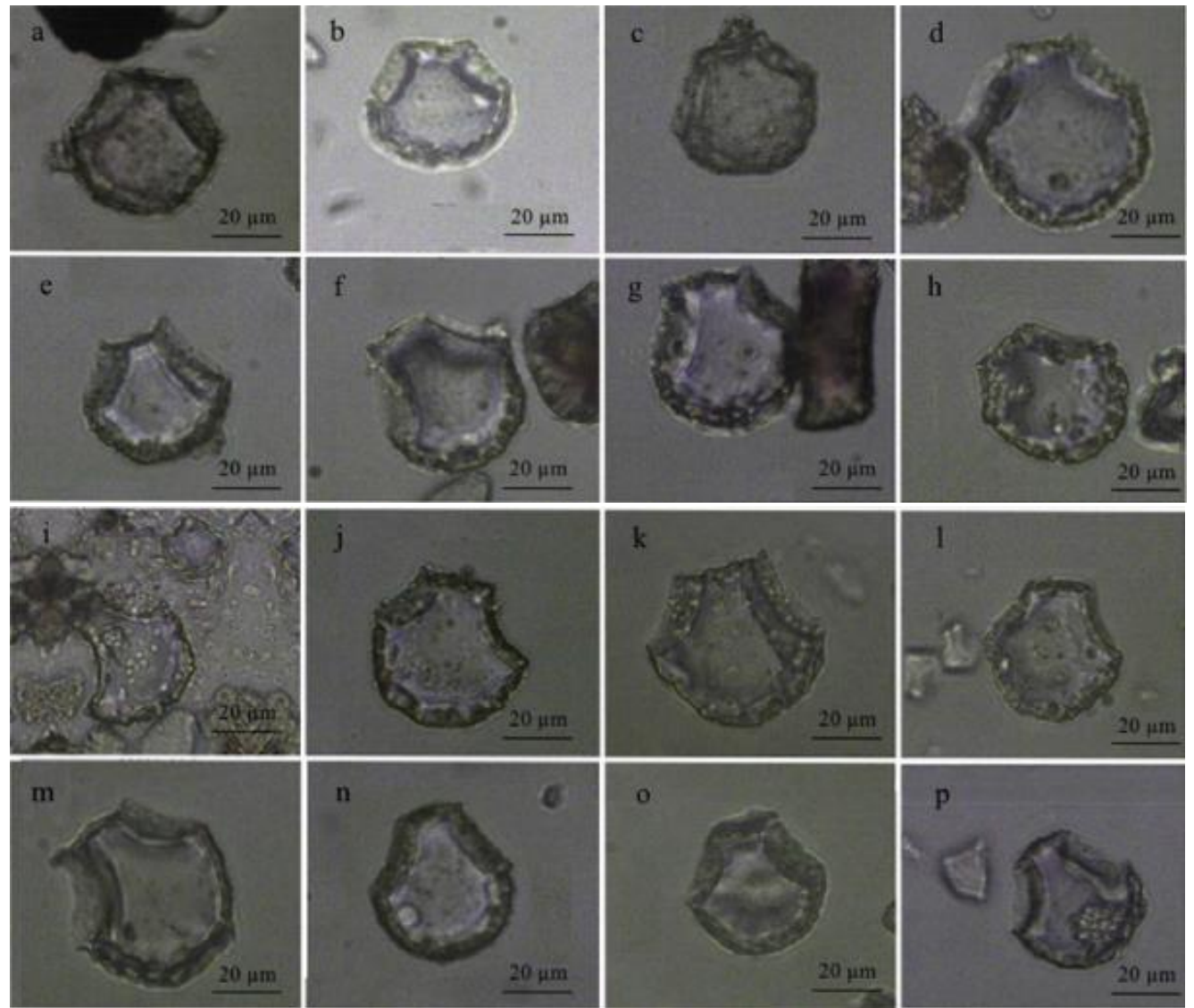


Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Chang: Phytolith Evidence from East China. *Boreas* 31:378–85.

# Oryza sp.

## Phytolith

Fig. 4. Domesticated bulliform phytoliths from Wormsloe.

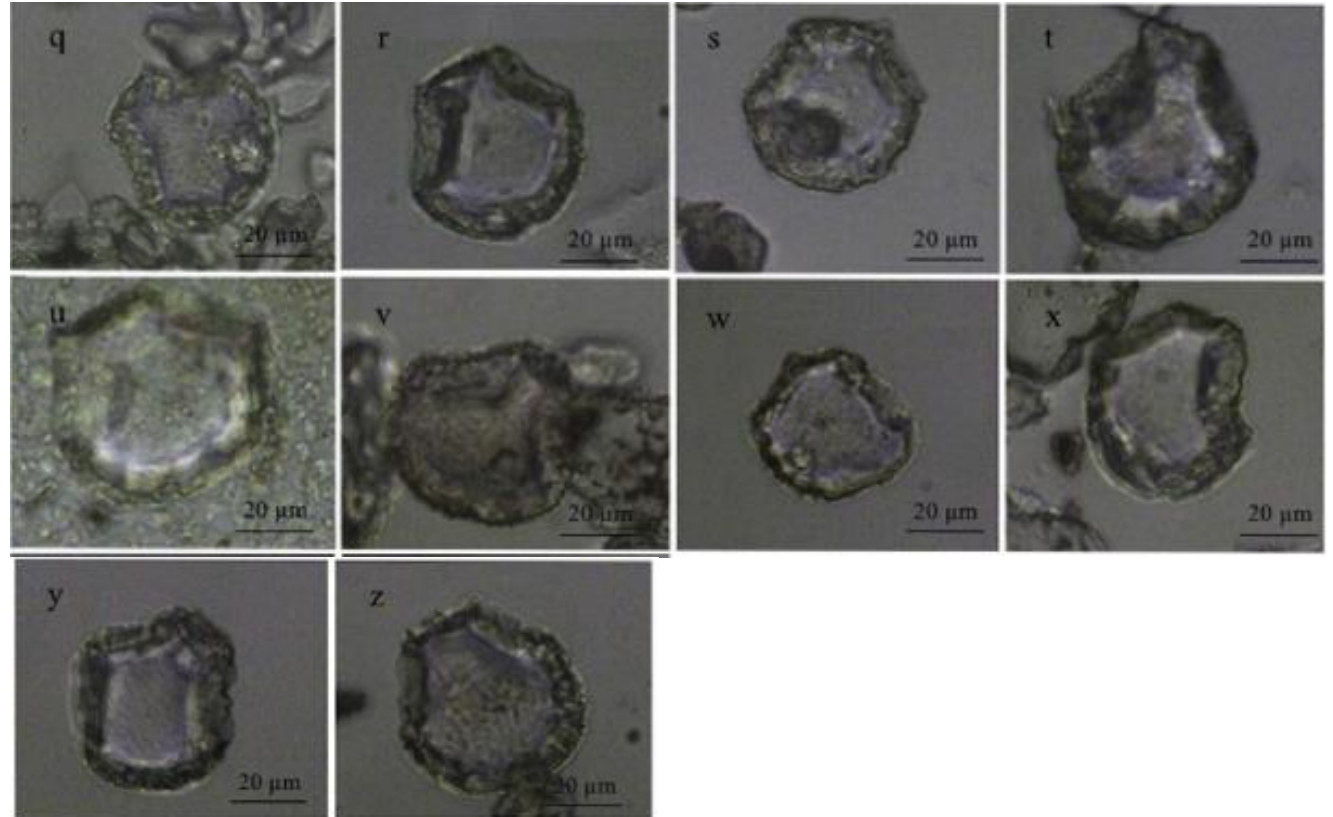


Pasqua, Alessandro, Liovando Marciano da Costa, and Ervan Garrison. 2017. Phytolith Evidence of Historical Rice Cultivation at Wormsloe Historic Site, Georgia, USA. *Journal of Archaeological Science: Reports* 14 (June). Elsevier:557–74. <http://linkinghub.elsevier.com/retrieve/pii/S2352409X17300159>.

# Oryza sp.

## Phytolith

Fig. 4. Domesticated bulliform phytoliths from Wormsloe.



Pasqua, Alessandro, Liovando Marciano da Costa, and Ervan Garrison. 2017. Phytolith Evidence of Historical Rice Cultivation at Wormsloe Historic Site, Georgia, USA. *Journal of Archaeological Science: Reports* 14 (June). Elsevier:557–74. <http://linkinghub.elsevier.com/retrieve/pii/S2352409X17300159>.



# Oryza sp.

## Phytolith

Brazilian rice bulliforms. Scale bar is 50  $\mu\text{m}$

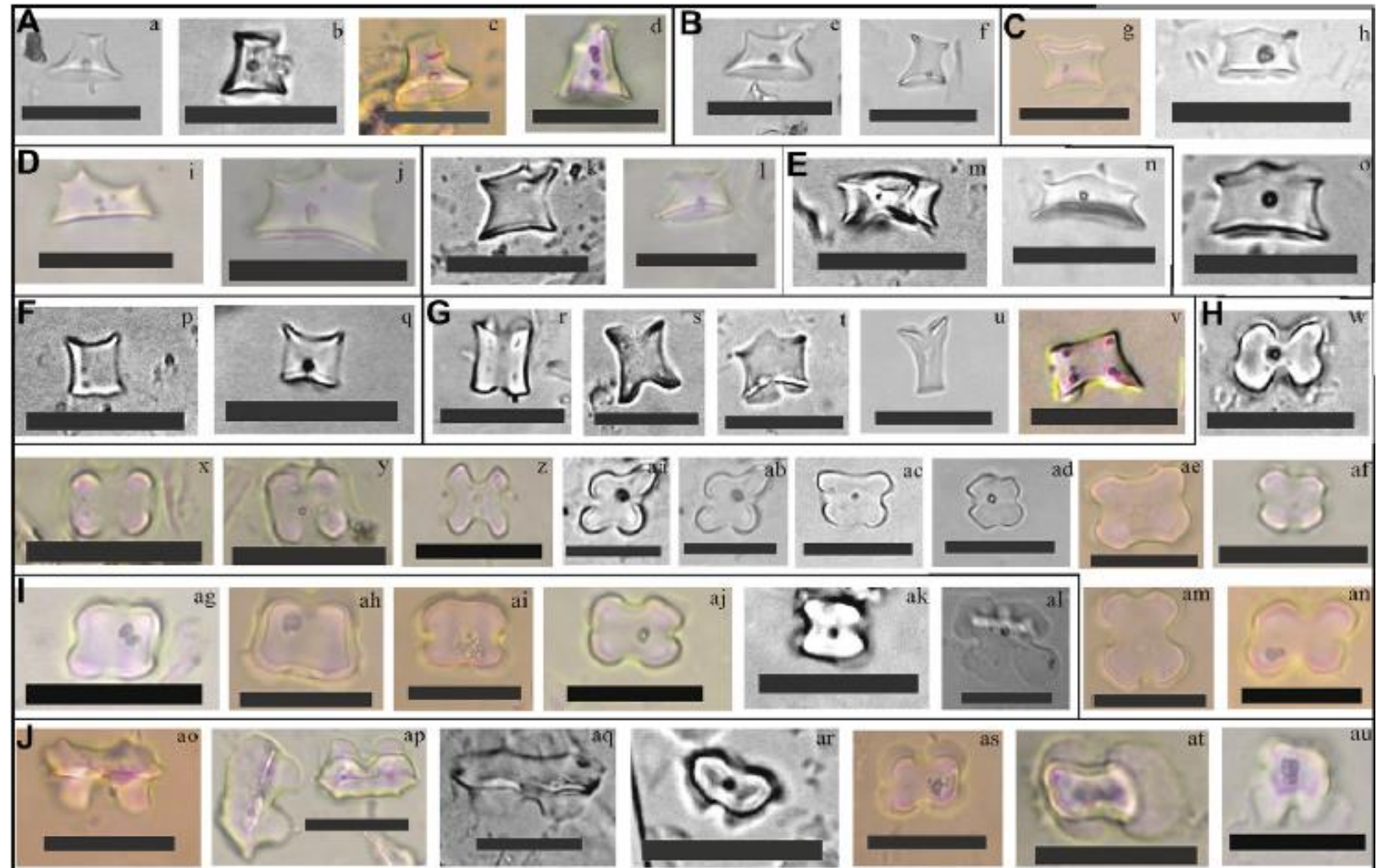
Pasqua, Alessandro, Liovando Marciano da Costa, and Ervan Garrison. 2017. Phytolith Evidence of Historical Rice Cultivation at Wormsloe Historic Site, Georgia, USA. *Journal of Archaeological Science: Reports* 14 (June). Elsevier:557–74. <http://linkinghub.elsevier.com/retrieve/pii/S2352409X17300159>.



# Oryza sp.

## Phytolith

Fig. 1. Rondels, crosses, and complex saddles in the domesticated and wild rice species. (A) mirror-image rondels (flat cone, less than 15 mm). (B) Two-spiked rondels (the solid, less than 15 mm). (C) Wavy-top rondels (less than 20 mm). (D) Three-spiked rondels (less than 20 mm). (E) Rondeloid/saddloid types (less than 20 mm). (F) Two-spiked rondels (the hollow, less than 10 mm). (G) Complex rondels (the hollow, less than 20 mm). (H) Variant 1 crosses (less than 20 mm). (I) Irregular trapezoidal crosses (less than 20 mm). (J) Complex saddles (less than 25 mm). a, e, h, i, l, n, at, au: *O. longiglumis*, inflorescence; b, o, q, ab, ad, ar: *O. sativa*, inflorescence; c, ao-ap, as: *O. granulata*, leaf; d, j, aj: *O. ridleyi*, inflorescence; f: *O. minuta*, inflorescence; g: *O. meyeriana*, inflorescence; k, m, p, reu, w-aa, ac, ak, aq: *O. sativa*, leaf; v, ag: *O. ridleyi*, leaf; x-y: *O. longiglumis*, leaf; z: *O. rufipogon*, leaf; ae, af, ah, al: *O. meyeriana*, leaf; ai: *O. minuta*, leaf. Scale bar  $\frac{1}{4}$  20 mm.

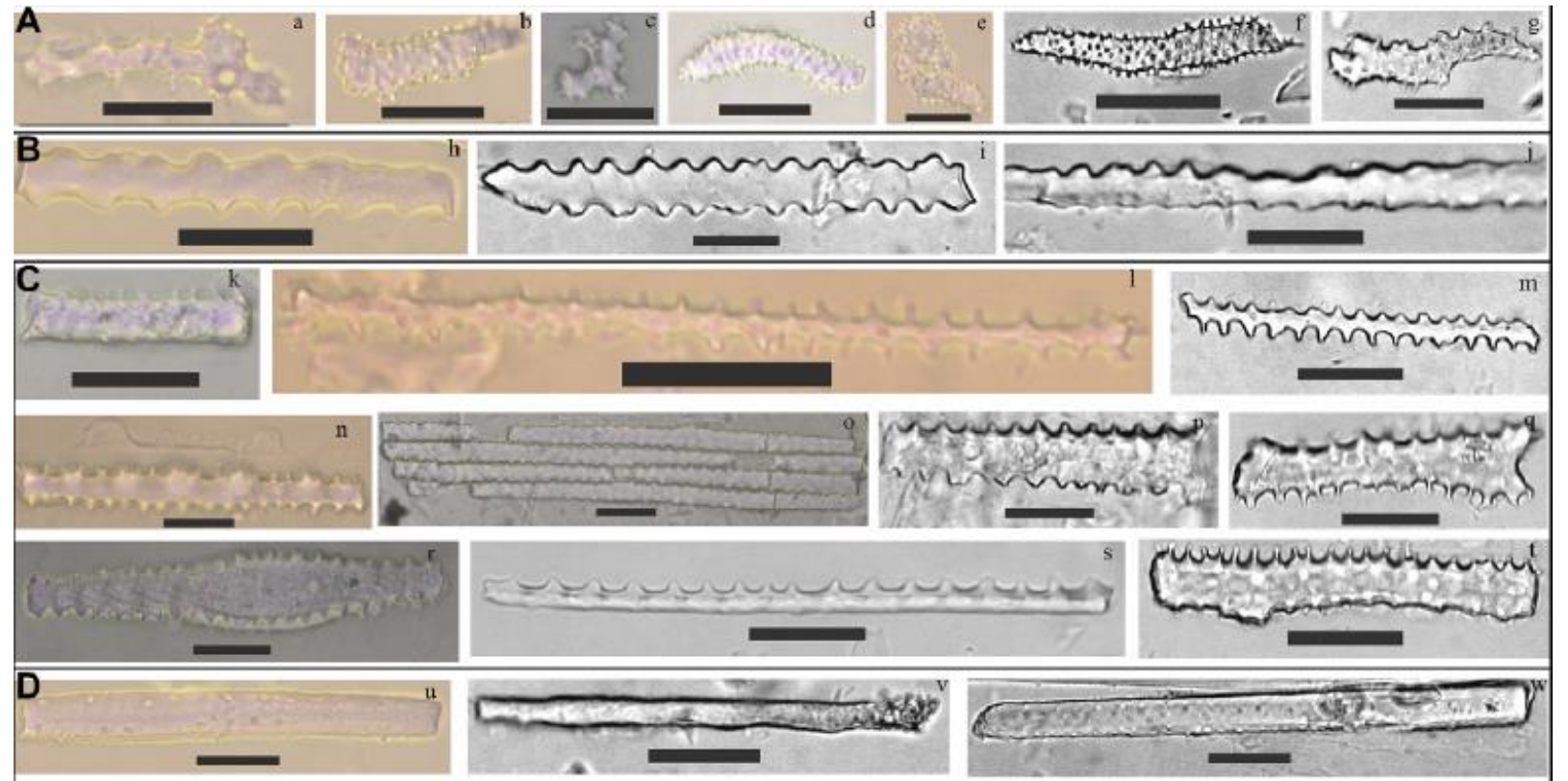


Gu, Yansheng, Zhijun Zhao, and Deborah Marie Pearsall. 2013. Phytolith Morphology Research on Wild and Domesticated Rice Species in East Asia. *Quaternary International* 287. Elsevier Ltd and INQUA:141–48.  
<http://dx.doi.org/10.1016/j.quaint.2012.02.013>.

# Oryza sp.

## Phytolith

Fig. 2. Long cells in domesticated and wild rice species. (A) Irregular elongate with short protrusions. (B) Elongate sinuate. (C) Elongate echinate. (D) Elongate smooth. a: *O. minuta*, inflorescence; b: *O. granulata*, inflorescence; c, h: *O. rufipogon*, inflorescence; d, k: *O. longiglumis*, inflorescence; e, l: *O. meyeriana*, inflorescence; f-g, i-j, m: *O. sativa*, inflorescence; n, u: *O. minuta*, leaf; o: *O. longiglumis*, leaf; p-q, r-t, v, w: *O. sativa*, leaf. Scale bar  $\frac{1}{4}$  20 mm



Gu, Yansheng, Zhijun Zhao, and Deborah Marie Pearsall. 2013. Phytolith Morphology Research on Wild and Domesticated Rice Species in East Asia. *Quaternary International* 287. Elsevier Ltd and INQUA:141–48. <http://dx.doi.org/10.1016/j.quaint.2012.02.013>.

# Oryza sp.

## Phytolith

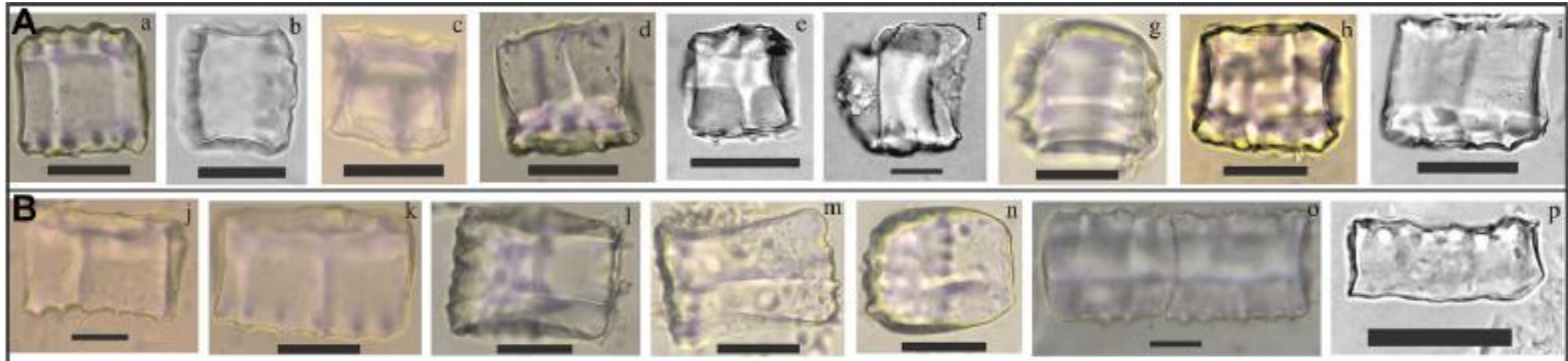


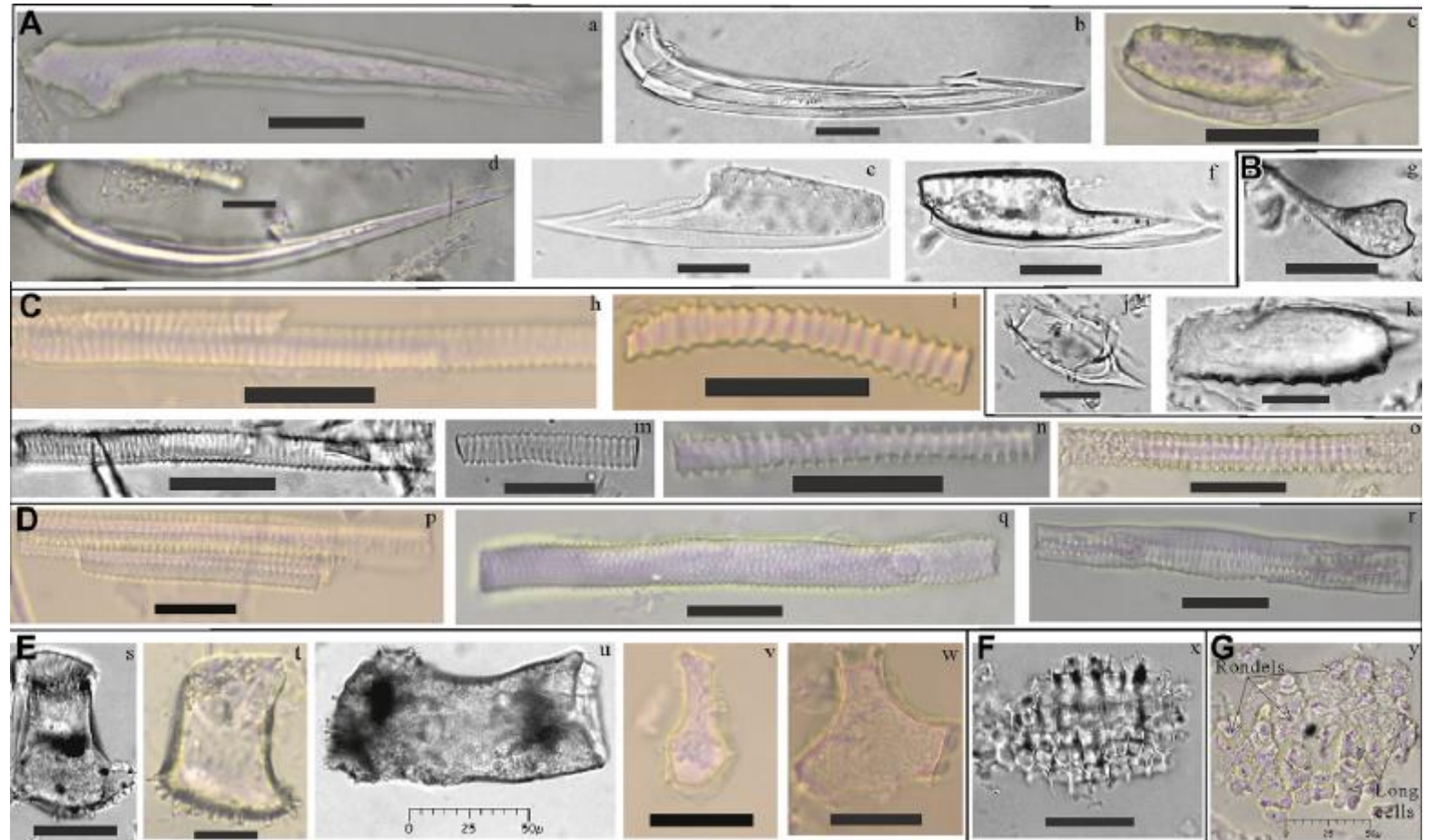
Fig. 3. Parallepipetal bulliform cells from the leaves of eight rice species in East Asia. (A) Parallepipetal bulliform cells. (B) Parallepipetal bulliform cells. a, c: *O. minuta*; b, d, f, i, p: *O. sativa*; g-h: *O. ridleyi*; j: *O. granulata*; k: *O. meyeriana*; l: *O. Officinalis*; m-n: *O. rufipogon*; o: *O. longiglumis*. Scale bar  $\frac{1}{4}$  20 mm.

Gu, Yansheng, Zhijun Zhao, and Deborah Marie Pearsall. 2013. Phytolith Morphology Research on Wild and Domesticated Rice Species in East Asia. *Quaternary International* 287. Elsevier Ltd and INQUA:141–48.  
<http://dx.doi.org/10.1016/j.quaint.2012.02.013>.

# Oryza sp.

## Phytolith

Fig. 4. Hair cells, papillae cells, tracheid and vascular tissue and other phytoliths in domesticated and wild rice species. (A) Hair cells. (B) Papillae cells. (C) Cylindric sulcate tracheids. (D) Vascular tissues. (E) Irregular epidermal phytoliths. (F) Mesophyll tissue, *O. sativa*, leaf. (G) Silicified epidermal tissue with rondels and irregular long cells, *O. ridleyi*, inflorescence. a, n: *O. ridleyi*, inflorescence; b, g, l, s, u: *O. sativa*, inflorescence; c, o: *O. granulate*, leaf; d-f, j-k, m, r, x: *O. sativa*, leaf; h, i: *O. minuta*, inflorescence; p, v, w: *O. meyeriana*, inflorescence; q, t, y: *O. rufipogon*, inflorescence. Scale bar  $\frac{1}{4}$  20 mm

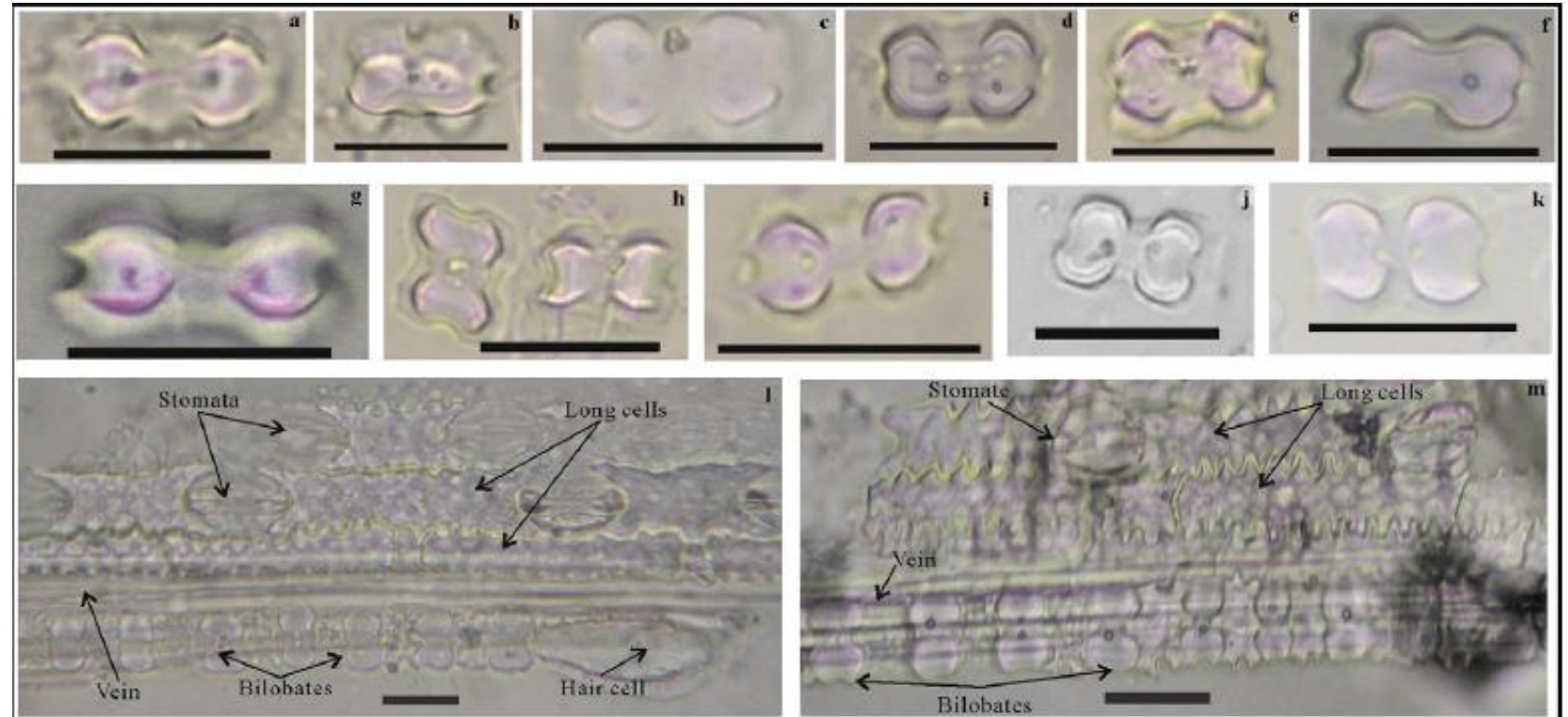


Gu, Yansheng, Zhijun Zhao, and Deborah Marie Pearsall. 2013. Phytolith Morphology Research on Wild and Domesticated Rice Species in East Asia. *Quaternary International* 287. Elsevier Ltd and INQUA:141–48. <http://dx.doi.org/10.1016/j.quaint.2012.02.013>.

# Oryza sp.

## Phytolith

Fig. 5. Bilobates from the leaves of *O. sativa* and wild rice species in East Asia. a, b: *O. granulata*; c: *O. longiglumis*; d *O. meyeriana*; e, g: *O. officinalis*; f: *O. ridleyi*; h: *O. rufipogon*; i: *O. minuta*; j-k: *O. sativa*; l: Paralleled arrangement for bilobates in the silicified issue from the leaf of *O. longiglumis*; m: Paralleled arrangement for bilobates in the silicified issue from the leaf of *O. sativa* paralleled bilobates. Scale bar  $\frac{1}{4}$  20 mm.

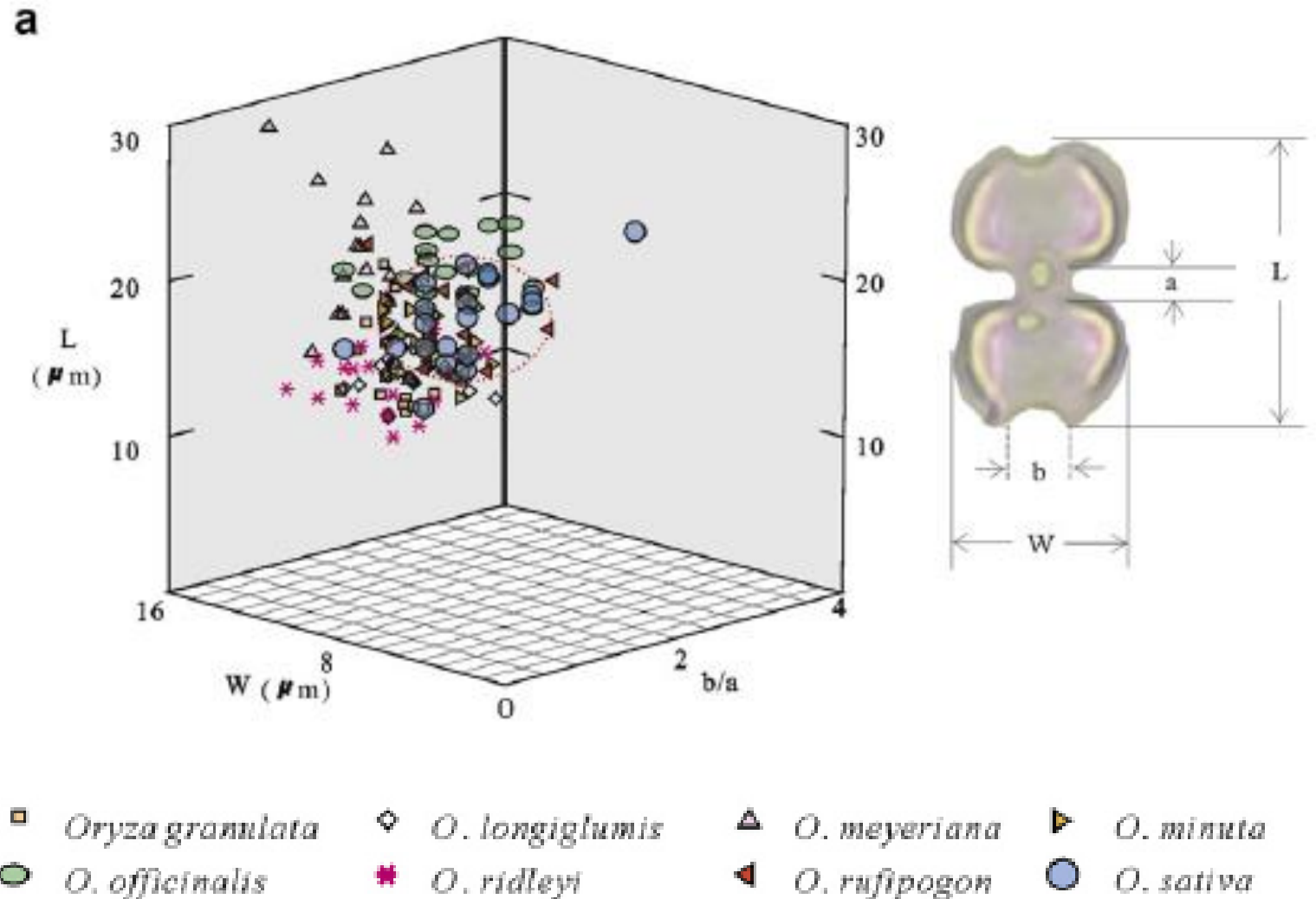


Gu, Yansheng, Zhijun Zhao, and Deborah Marie Pearsall. 2013. Phytolith Morphology Research on Wild and Domesticated Rice Species in East Asia. *Quaternary International* 287. Elsevier Ltd and INQUA:141–48. <http://dx.doi.org/10.1016/j.quaint.2012.02.013>.

# Oryza sp.

## Phytolith

Fig. 6. 3-D scattered plots for morphological parameters of bilobates (a), cuneiform bulliform cells (b) and double-peaked glume cells (c) in *Oryza* species. (L) Vertical length. (W) Width of the lobe. (a) Width of the shank. (b) Width of the scooped end at the top of the lobe. (HL) Horizontal length. (LL) Lateral length. (VL) Vertical length. (B) Length of base portion. (A) Length of non-base portion. (TW) Top width. (MW) Width of the middle. (H) Mean height of two peaks. (CD) The depth of the curve.

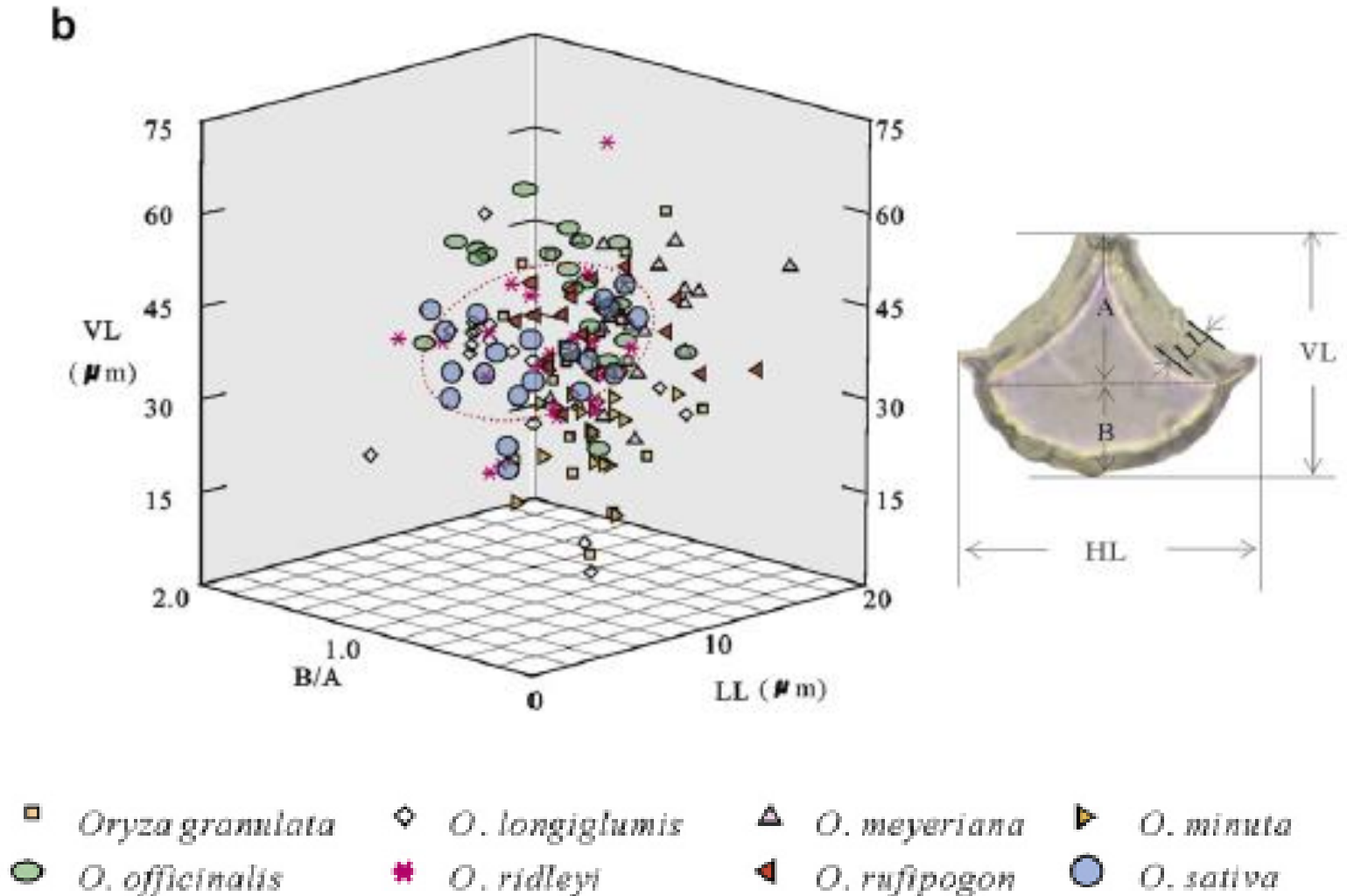


Gu, Yansheng, Zhijun Zhao, and Deborah Marie Pearsall. 2013. Phytolith Morphology Research on Wild and Domesticated Rice Species in East Asia. *Quaternary International* 287. Elsevier Ltd and INQUA:141–48. <http://dx.doi.org/10.1016/j.quaint.2012.02.013>.

# Oryza sp.

## Phytolith

Fig. 6. 3-D scattered plots for morphological parameters of bilobates (a), cuneiform bulliform cells (b) and double-peaked glume cells (c) in *Oryza* species. (L) Vertical length. (W) Width of the lobe. (a) Width of the shank. (b) Width of the scooped end at the top of the lobe. (HL) Horizontal length. (LL) Lateral length. (VL) Vertical length. (B) Length of base portion. (A) Length of non-base portion. (TW) Top width. (MW) Width of the middle. (H) Mean height of two peaks. (CD) The depth of the curve.



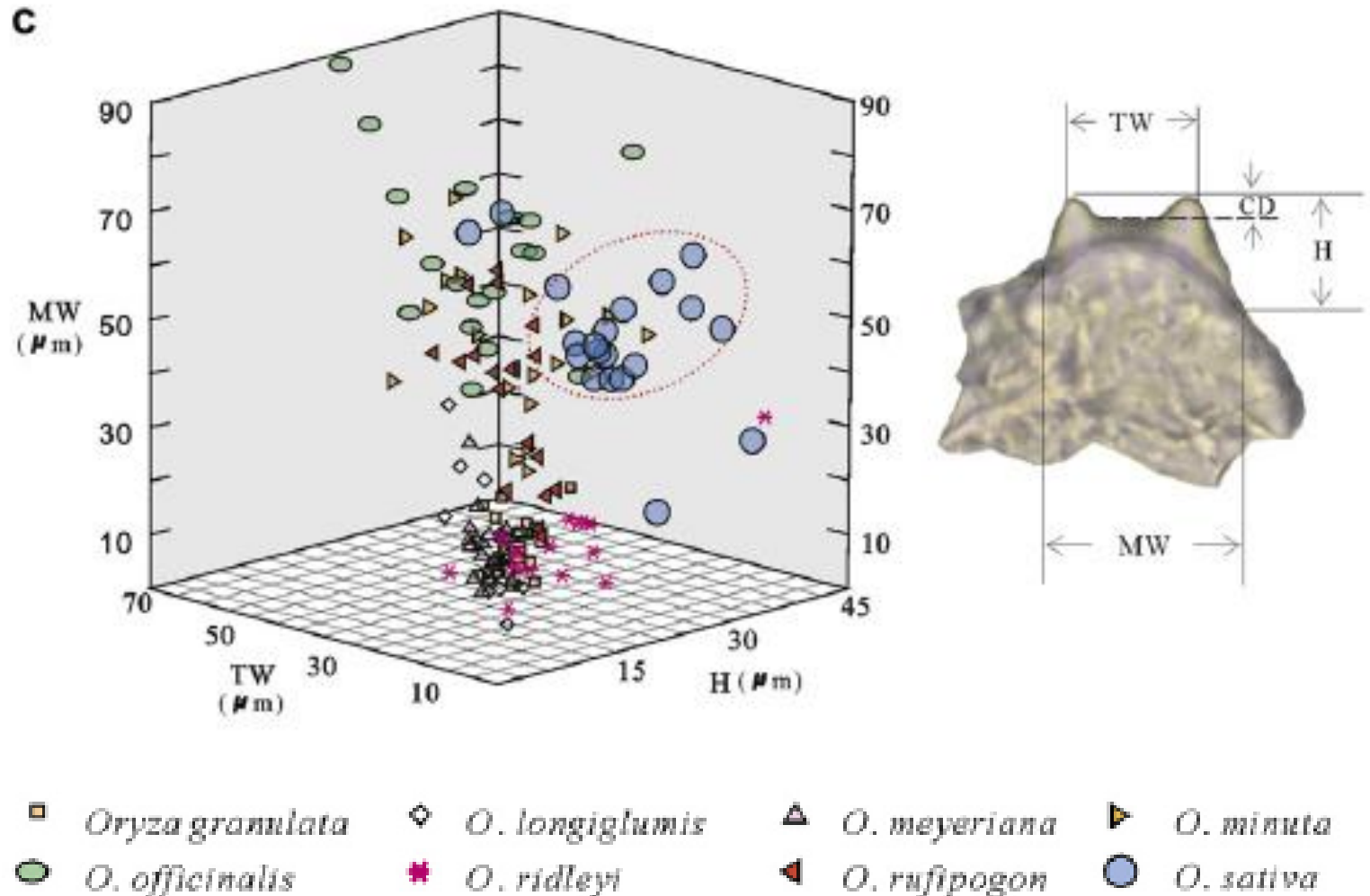
Gu, Yansheng, Zhijun Zhao, and Deborah Marie Pearsall. 2013. Phytolith Morphology Research on Wild and Domesticated Rice Species in East Asia. *Quaternary International* 287. Elsevier Ltd and INQUA:141–48. <http://dx.doi.org/10.1016/j.quaint.2012.02.013>.



# Oryza sp.

## Phytolith

Fig. 6. 3-D scattered plots for morphological parameters of bilobates (a), cuneiform bulliform cells (b) and double-peaked glume cells (c) in *Oryza* species. (L) Vertical length. (W) Width of the lobe. (a) Width of the shank. (b) Width of the scooped end at the top of the lobe. (HL) Horizontal length. (LL) Lateral length. (VL) Vertical length. (B) Length of base portion. (A) Length of non-base portion. (TW) Top width. (MW) Width of the middle. (H) Mean height of two peaks. (CD) The depth of the curve.

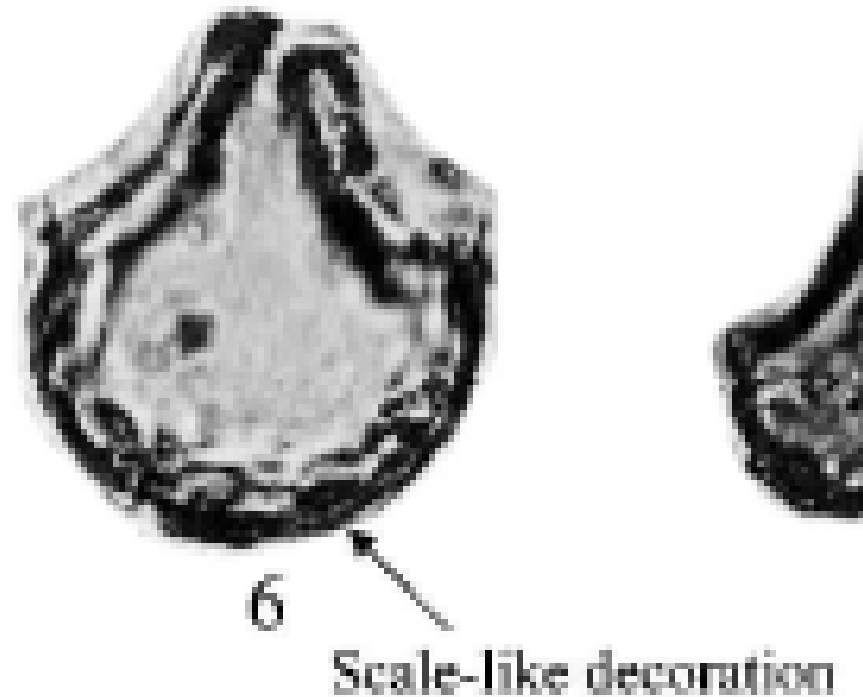


Gu, Yansheng, Zhijun Zhao, and Deborah Marie Pearsall. 2013. Phytolith Morphology Research on Wild and Domesticated Rice Species in East Asia. *Quaternary International* 287. Elsevier Ltd and INQUA:141–48. <http://dx.doi.org/10.1016/j.quaint.2012.02.013>.

# Oryza sativa

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 6. *Oryza sativa*



Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.

# Oryza sativa

## Starch

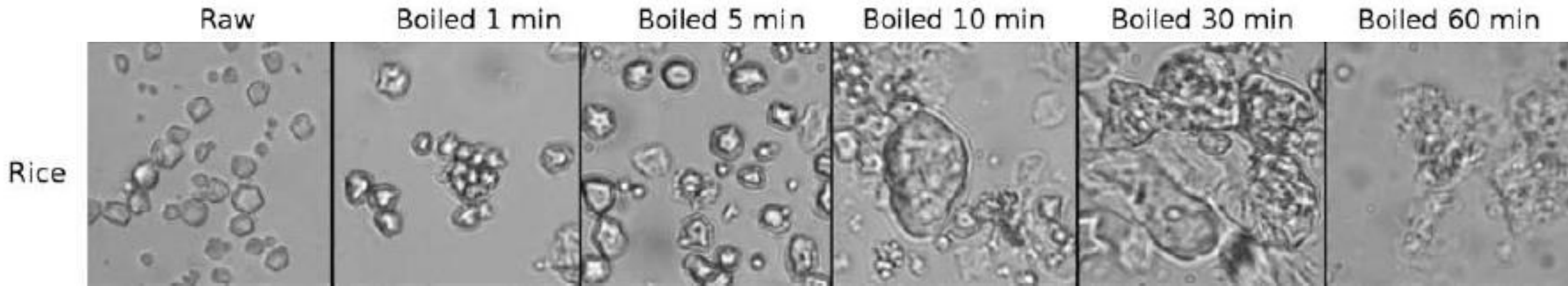


Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Oryza sativa

## Starch

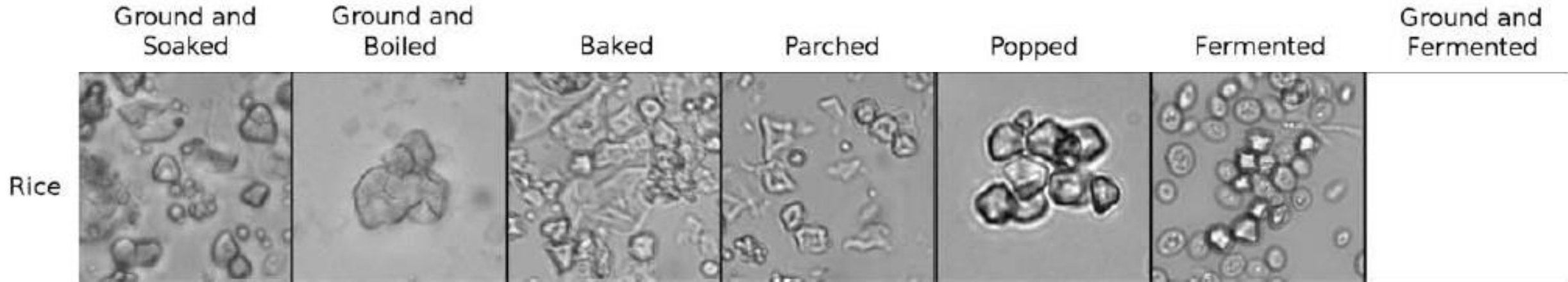


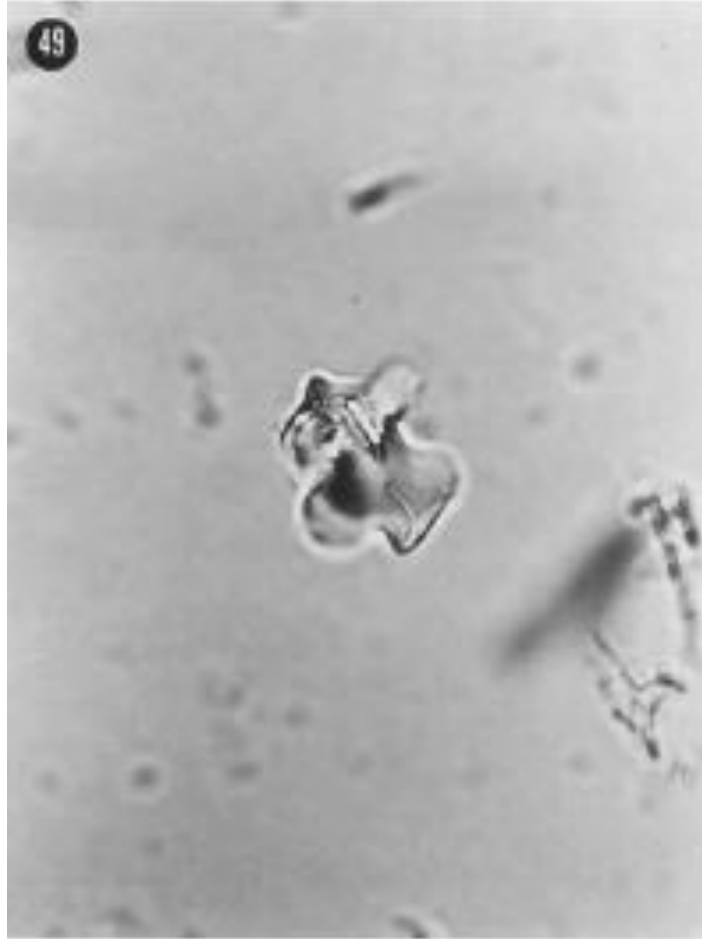
Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Otatea fimbriata

## Phytolith

FIGURES 49-52.-49, A thick, cross-shaped phytolith with a concave face from *Otatea fimbriata* (x400). Most cross-shaped phytoliths from this species have only three indentations.



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Panicum cyanescens

## Phytolith

Fig. 4. Phytoliths from Poaceae. l)  
Squat bilobate from *Panicum  
cyanescens*

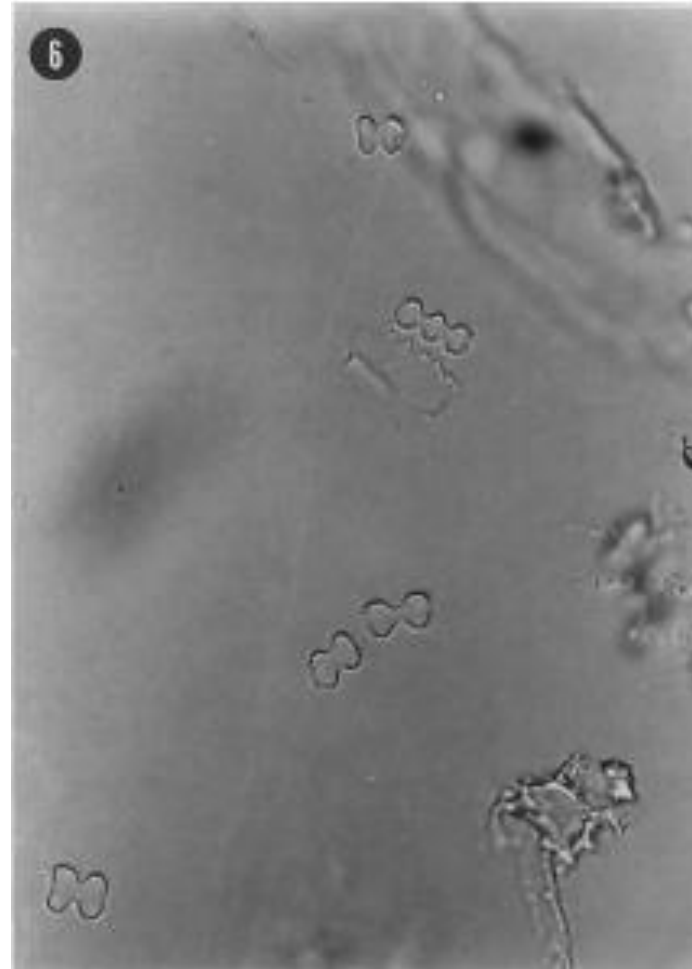


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Panicum fasciculatum

## Phytolith

FIGURES 5-8. 6, Bilobates and a complex bilobate from *Panicum fasciculatum* (x200).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Panicum mertensii

## Starch

### APPENDIX:

*Panicum mertensii*. Simple and compound grains, spherical, very often with an ornamented border. Indistinct radiating fissures are present and a double border may be prominent. Size: 4–10 microns.

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.



# Panicum miliaceum

## Starch

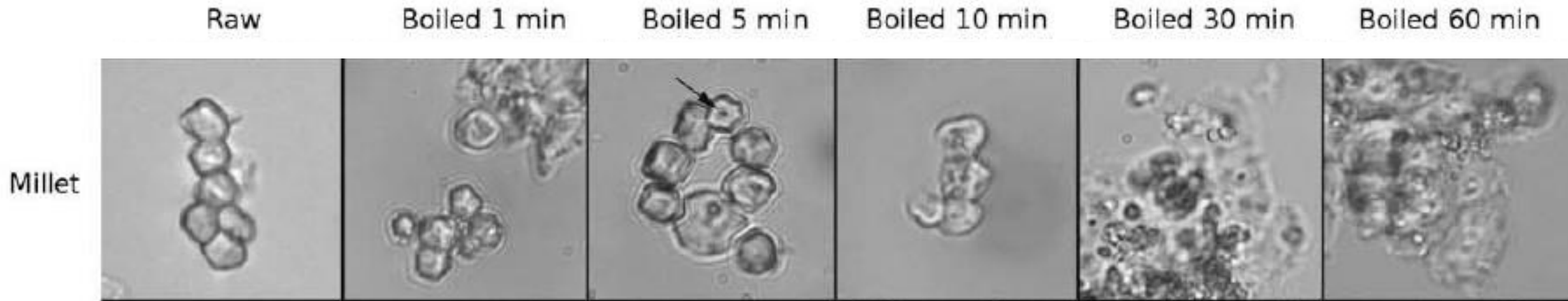


Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Panicum miliaceum

## Starch

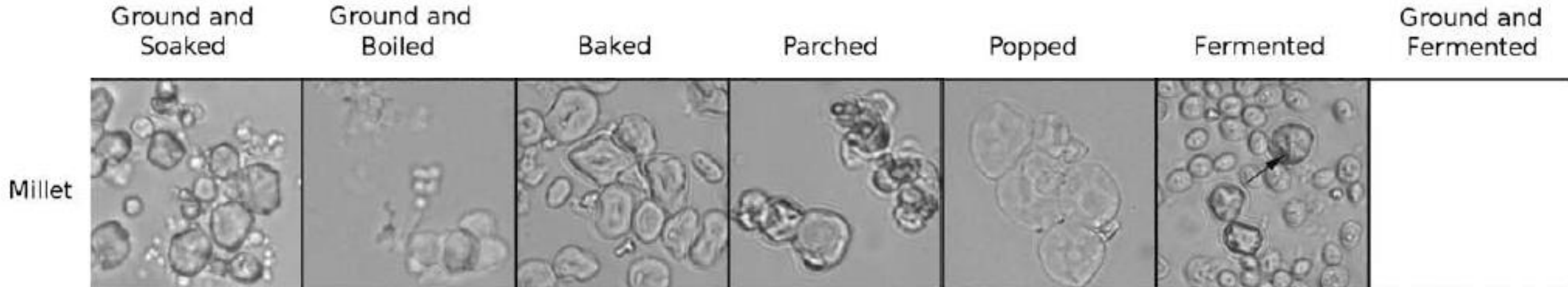


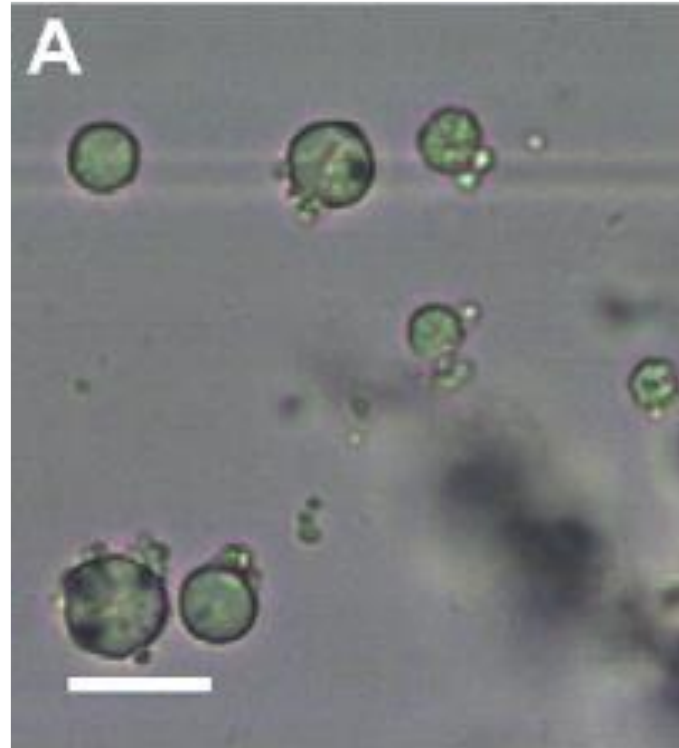
Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Panicum urvilleanum

## Starch

Fig. 3. Pampean native wild grasses from reference collection. A-C: Simple starch grains. A: *Panicum urvilleanum*. (Scale bars: 10  $\mu$ m).

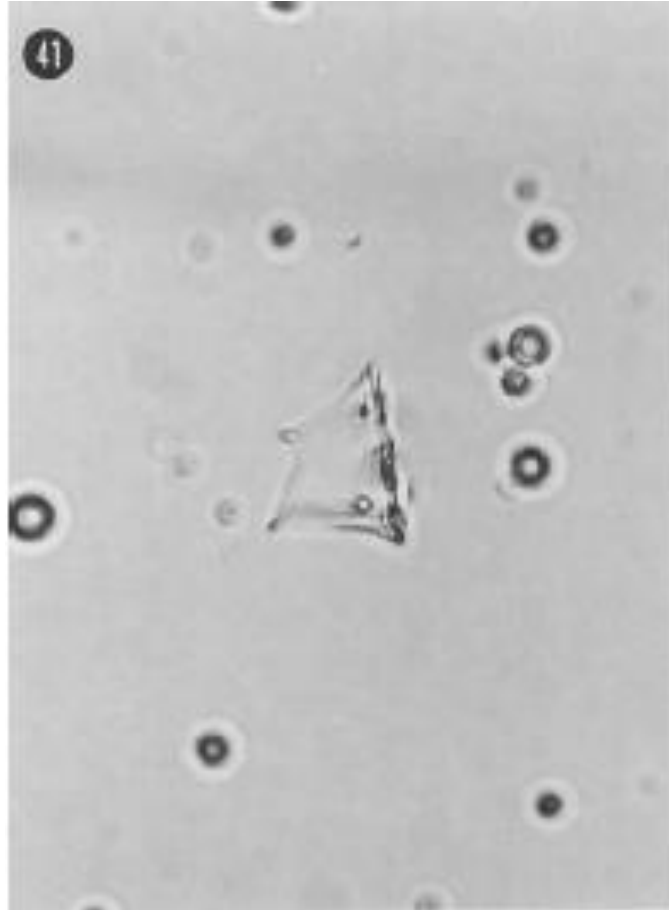


Musaubach, María Gabriela, Anabela Plos, and María Del Pilar Babot. 2013. Differentiation of Archaeological Maize (*Zea Mays* L.) from Native Wild Grasses Based on Starch Grain Morphology. Cases from the Central Pampas of Argentina. *Journal of Archaeological Science* 40 (2). Elsevier Ltd:1186–93. <http://dx.doi.org/10.1016/j.jas.2012.09.026>.

# Pariana campestris

## Phytolith

FIGURES 41-44.-41, A phytolith from *Pariana campestris* with one sinuous and one sloping edge. It is neither as tall nor as wide as that from *Maclurolyra tecta* (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Pariana campestris

## Phytolith

FIGURES 45-48.-46, An irregular, complex short-cell phytolith from *Pariana campestris* (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Parodiolyra luetzelbergii

## Phytolith

Fig. 4. Phytoliths from Poaceae. f) Irregular/complex phytoliths (1) from *Parodiolyra luetzelbergii*. Bilobate (2) to the right is variant 3/8

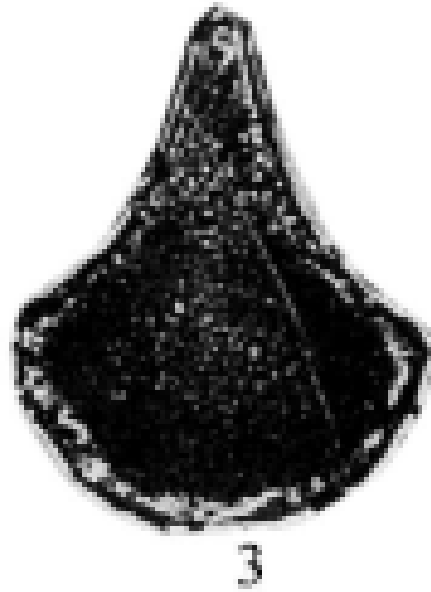


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Paspalum sp.

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 3. *Paspalum* sp.



Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.

# Paspalum lividum

## Phytolith

### Tubular body

These bodies are very similar to the narrow rectangular IRP, but are tubules, not flattened pieces. These occur mostly in non-Zea grasses and rarely in Zea spp. Diagnostic level: wild Poaceae



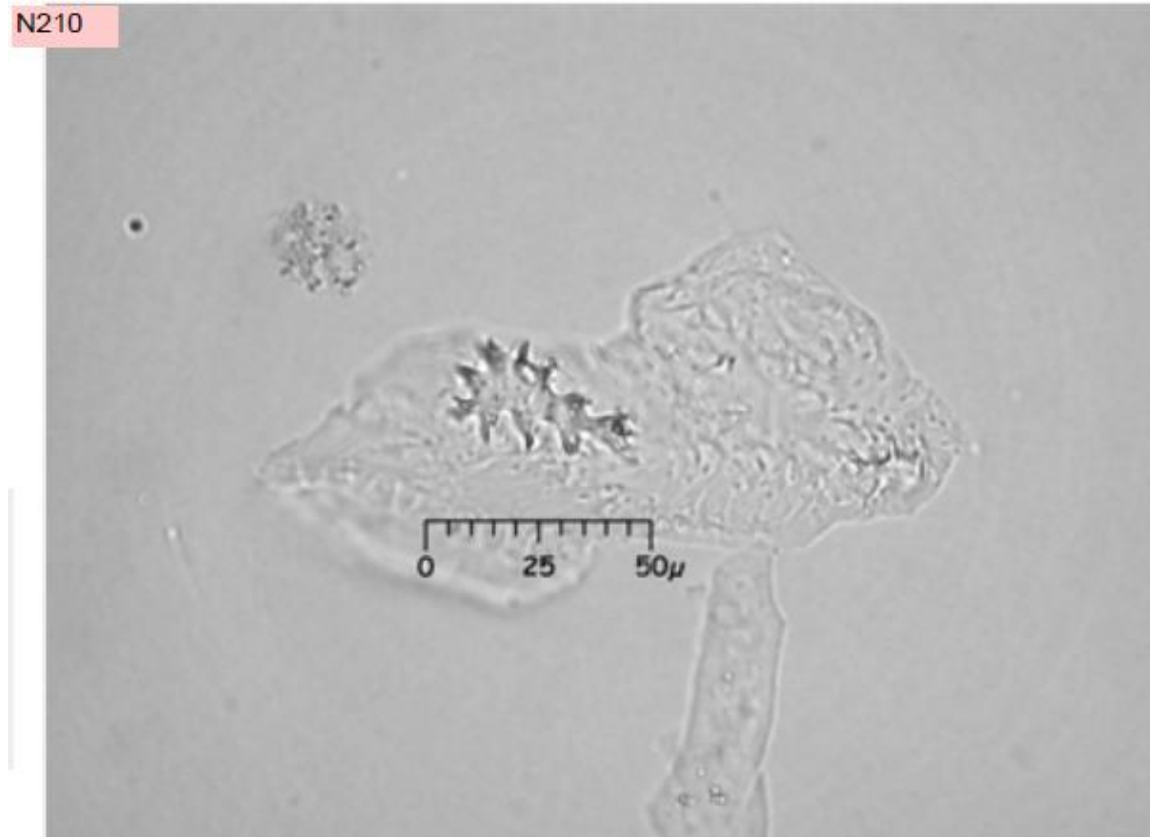
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Paspalum lividum

## Phytolith

Burr-like spheres and elongate bodies with needle projections.  
Occur mainly in *Digitaria* spp. and in *Arundinella hispida*, but not in *Zea* spp.  
Diagnostic level: wild Poaceae

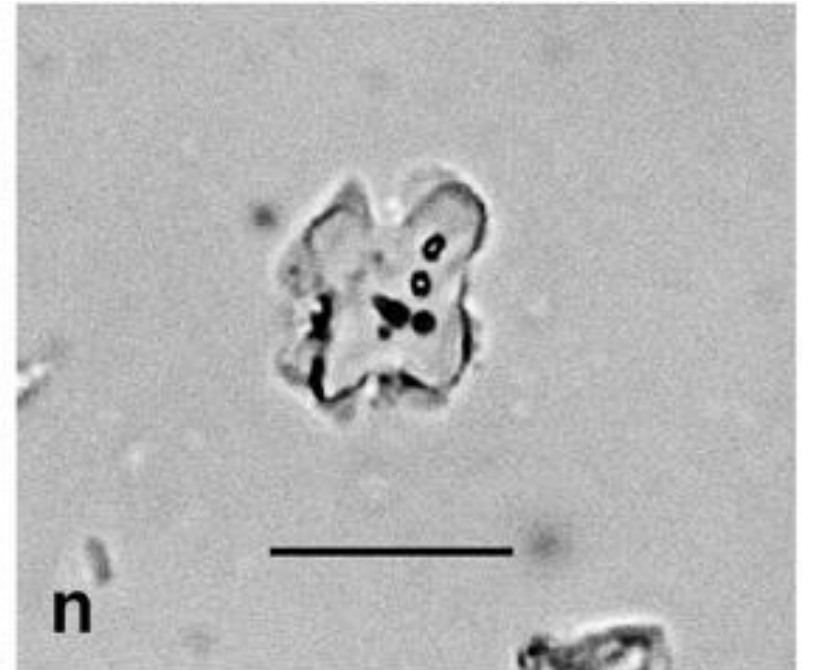
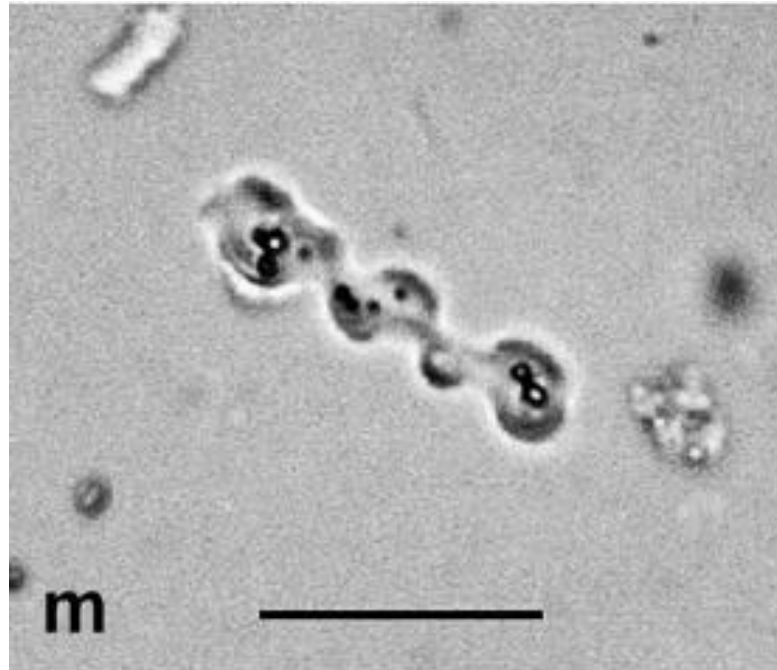


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Paspalum parviflorum

## Phytolith

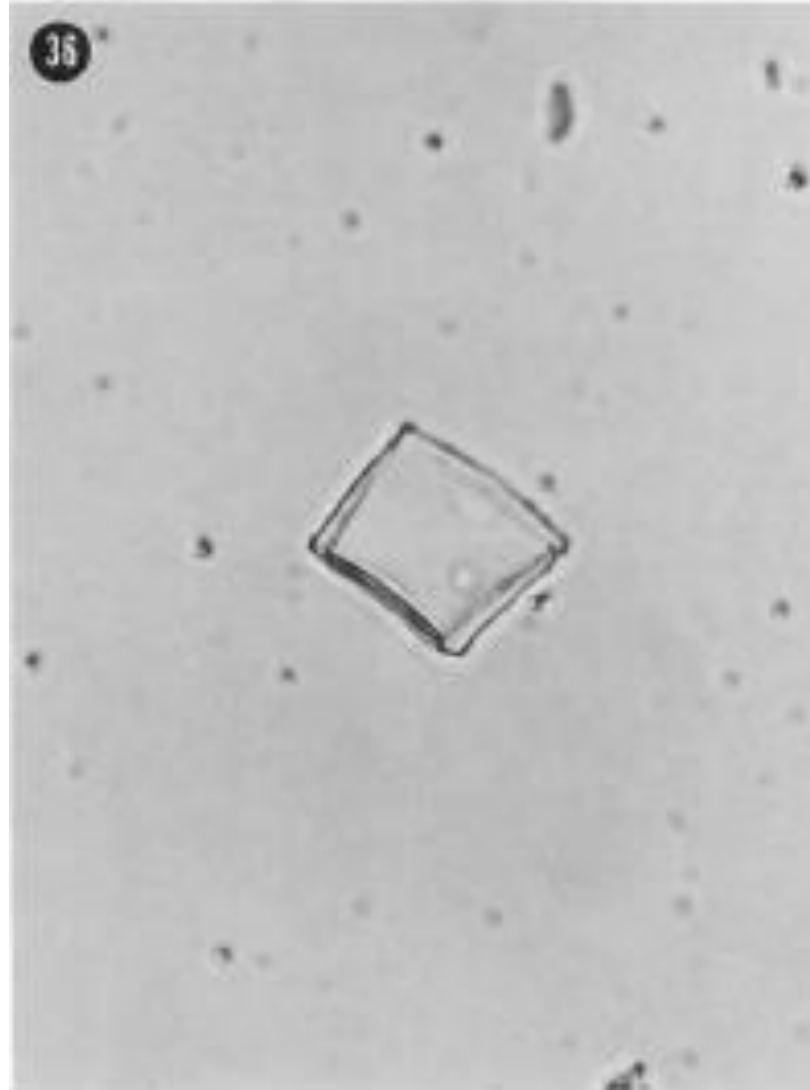
Fig. 4. Phytoliths from Poaceae. m) Polybate from Paspalum parviflorum, n) Cross from P. parviflorum



# Pharus sp.

## Phytolith

FIGURES 33-36.-36, A Pharus body characterized by its flatness, considerable width, and presence of (bottom left) dumbboid and (upper right) rectanguloid lateral edges (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Phragmites sp.

## Phytolith

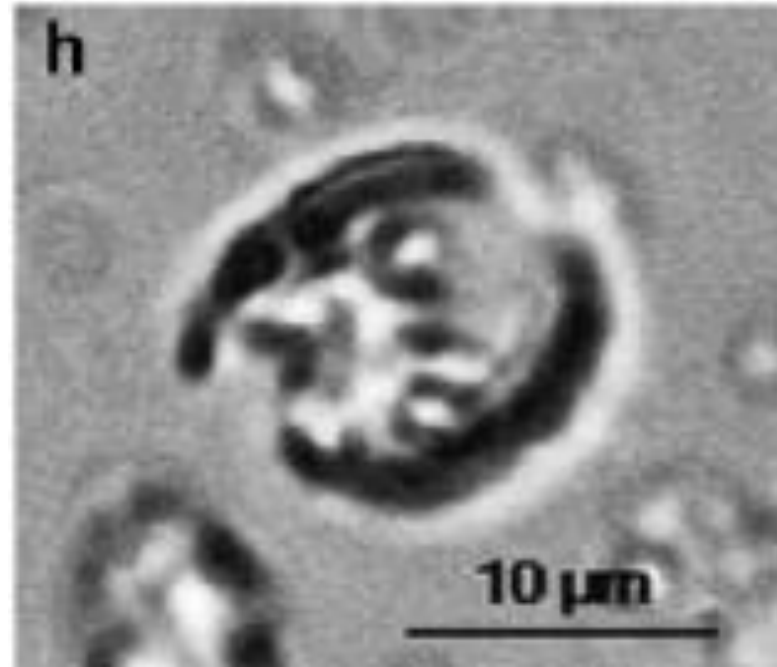


Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. h) Phragmites large ridged saddle (P Ridged Field 2, 10-20 cm).

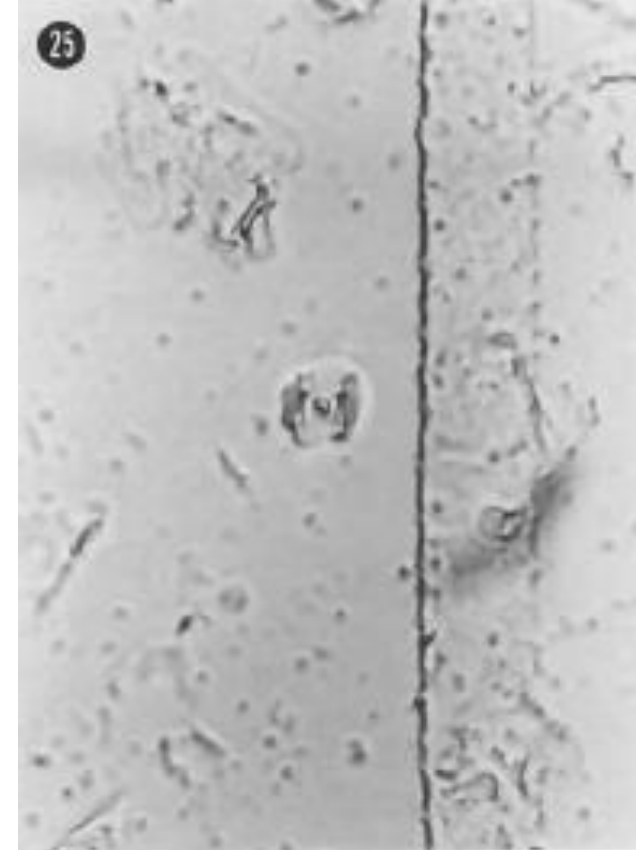
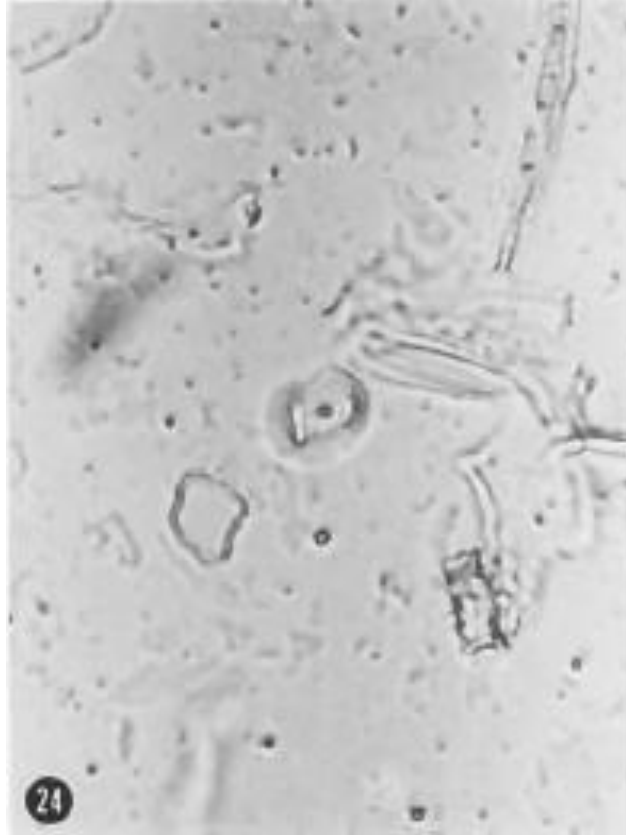
Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannas. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Phragmites australis

## Phytolith

FIGURES 21-24.- 24, Center, a  
plateaued saddle from  
Phragmites australis (x400)

FIGURES 25-28.-25, A  
plateaued saddle from  
Phragmites australis (x400)

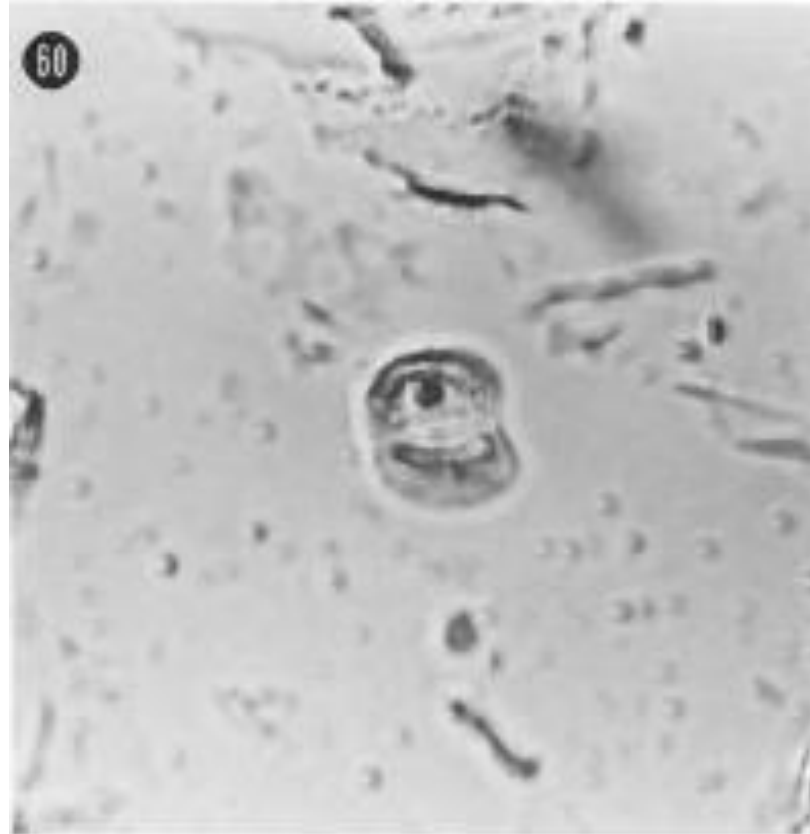


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Phragmites australis

## Phytolith

FIGURES 57-60.-60, A tall saddle  
from *Phragmites australis* (x400)

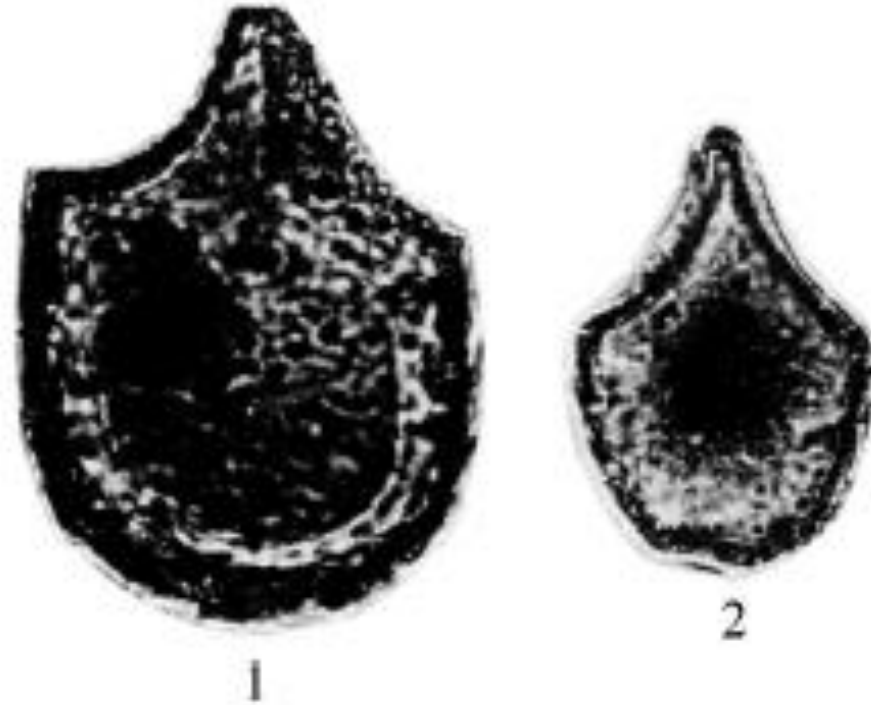


Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Phragmites australis

## Phytolith

Fig. 2. Characteristics of bulliform phytoliths from 16 grasses showing rice phytoliths with scale-like decoration. 1, 2. *Phragmites australis*



Lu, Houyuan, Zhenxia Liu, Naiqin Wu, Serge Berné, Yoshiki Saito, Baozhu Liu, and Luo Wang. 2002. Rice Domestication and Climatic Change: Phytolith Evidence from East China. *Boreas* 31:378–85.

# Polypogon elongatus

## Phytolith

FIGURES 53-56.-55, A unique type of cross-shaped phytolith, from *Polypogon elongatus*, in which one side of the phytolith has a saddle- or bilobate-like structure that extends only about two-thirds the length of the longer, cross-shaped side. It is also very wide. The phytolith is slightly turned, thus both faces may be seen (x400). Bilobates from this grass also carry the same features.



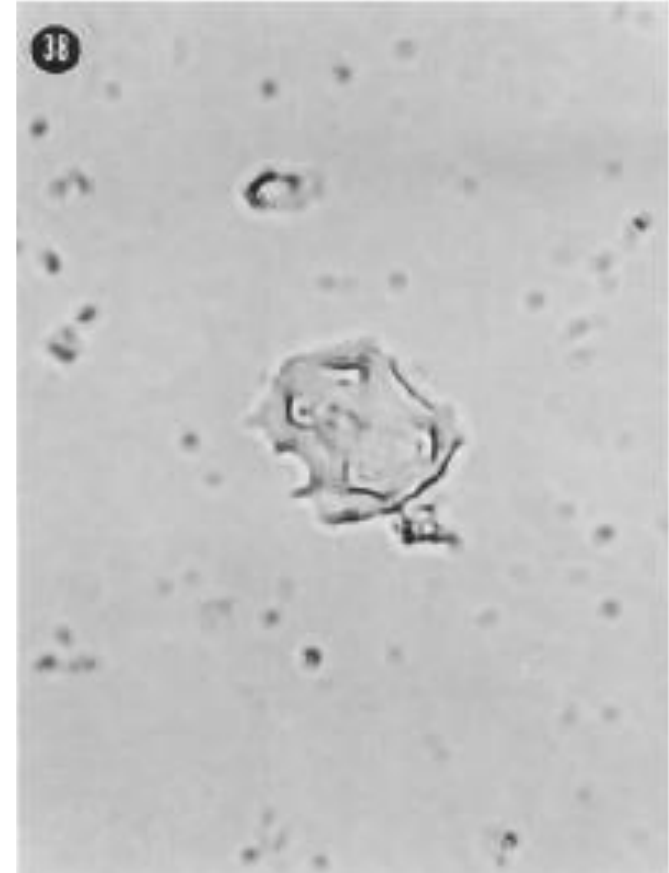
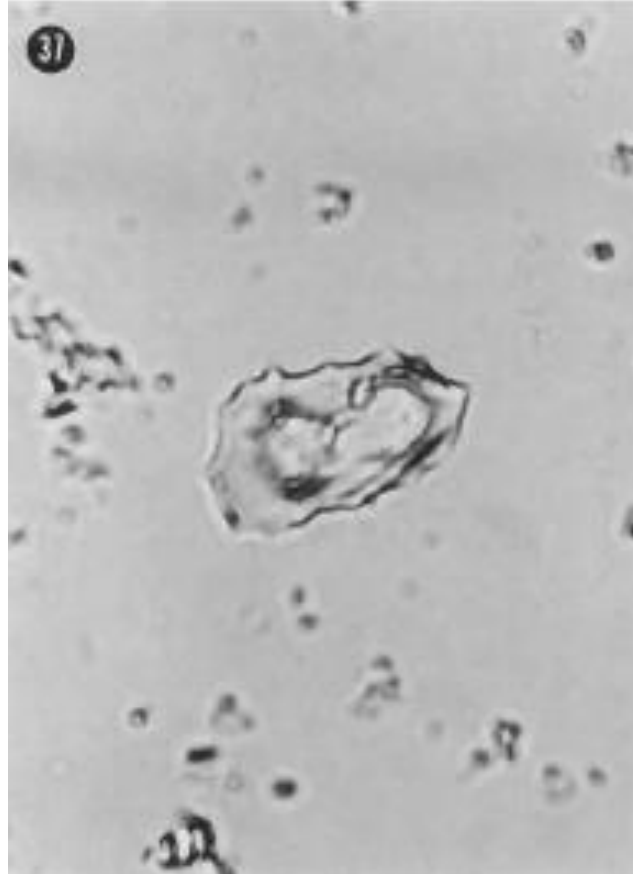
Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.



# Raddiella nana

## Phytolith

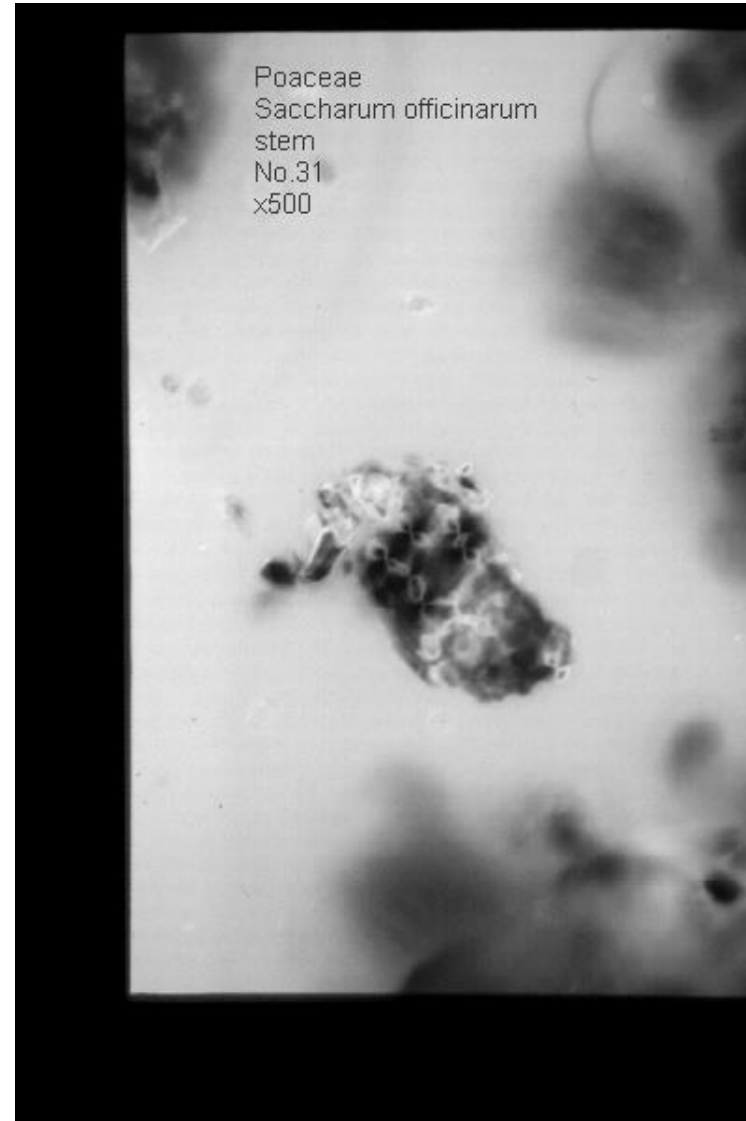
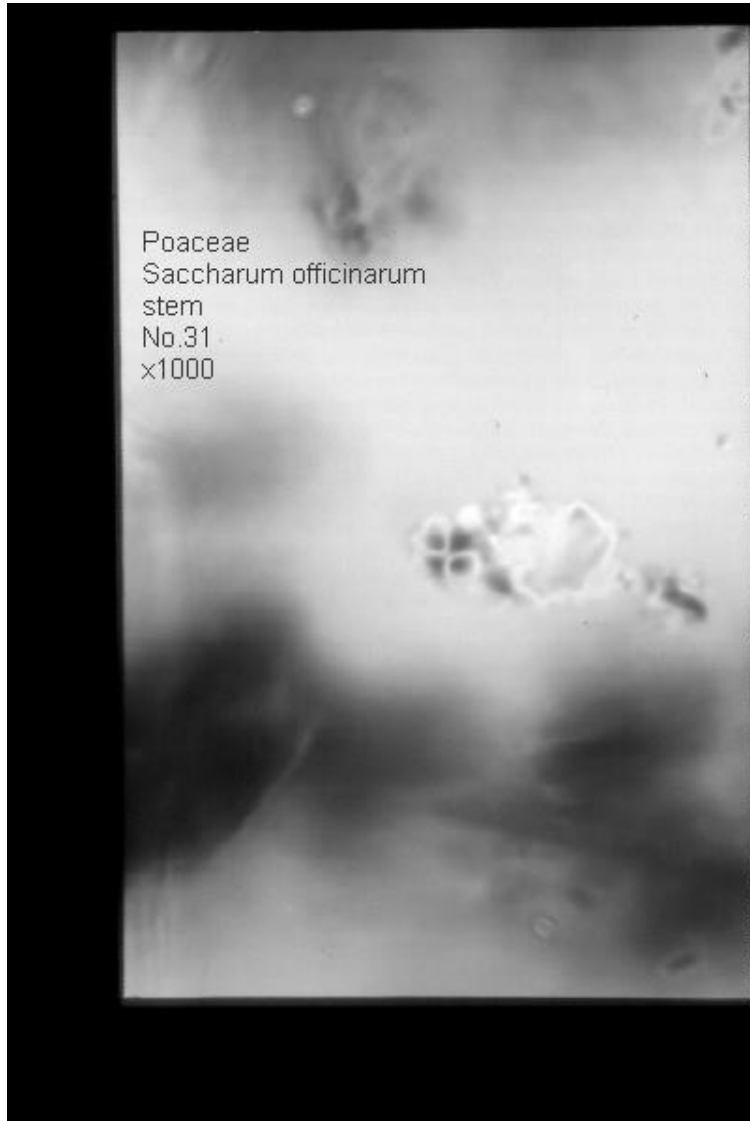
FIGURES 37-40.-37. A biloboid from Raddiella nana enclosed in a siliceous plate (x400). 38, A cross-shaped-like phytolith from Raddiella nana enclosed in a siliceous plate (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Saccharum officinarum

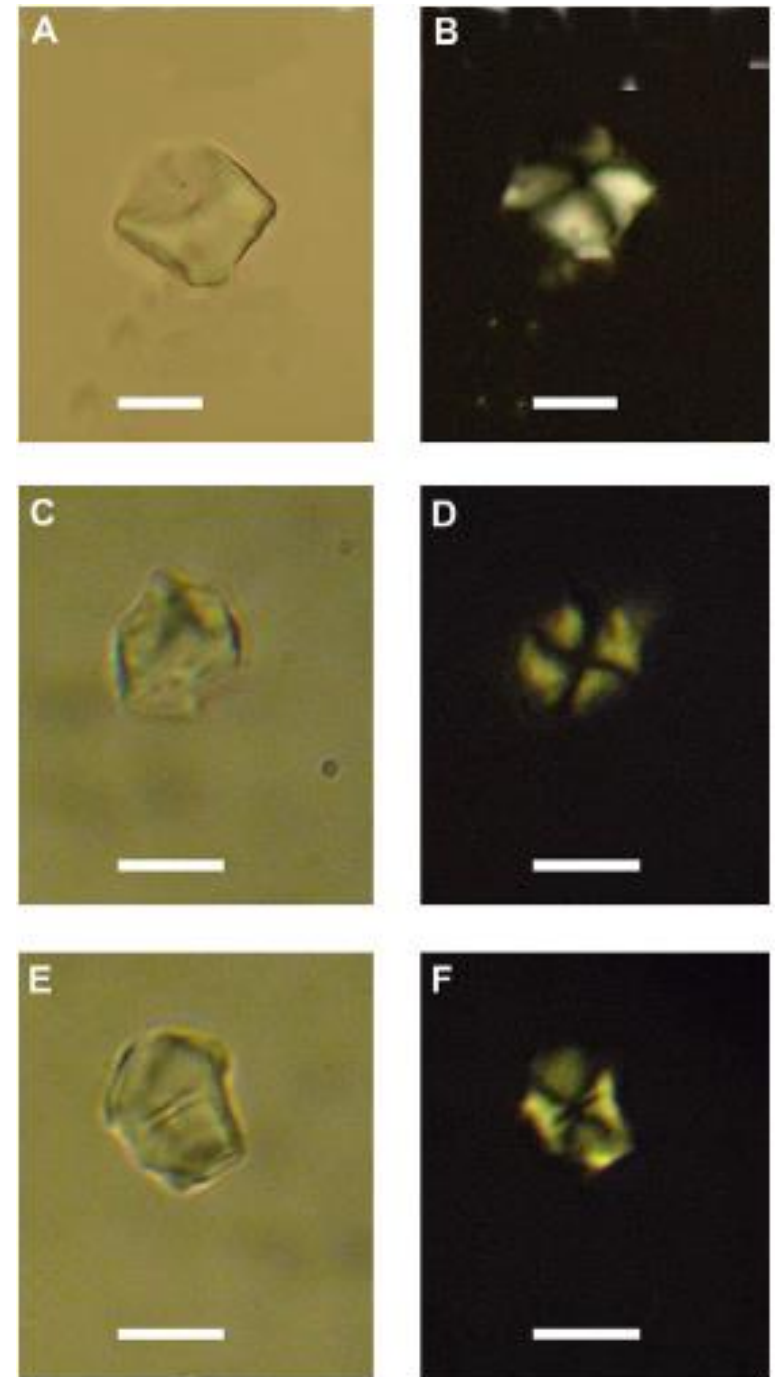
Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Sorghastrum pellitum

## Starch

Fig. 4. Classic Panicoid starch grain morphotype of *Sorghastrum pellitum*. A: Example of centric hilum as a deep depression. B: Same starch grain with polarized light. C: Example of faceted shapes with angular edges. D: Same starch grain with polarized light. E: Example of simple starch grains with transverse fissures. F: Same starch grain with polarized light (Scale bars: 10 mm)



Musaubach, María Gabriela, Anabela Plos, and María Del Pilar Babot. 2013. Differentiation of Archaeological Maize (*Zea Mays* L.) from Native Wild Grasses Based on Starch Grain Morphology. Cases from the Central Pampas of Argentina. *Journal of Archaeological Science* 40 (2). Elsevier Ltd:1186–93. <http://dx.doi.org/10.1016/j.jas.2012.09.026>.

# Sorghum bicolor

## Starch

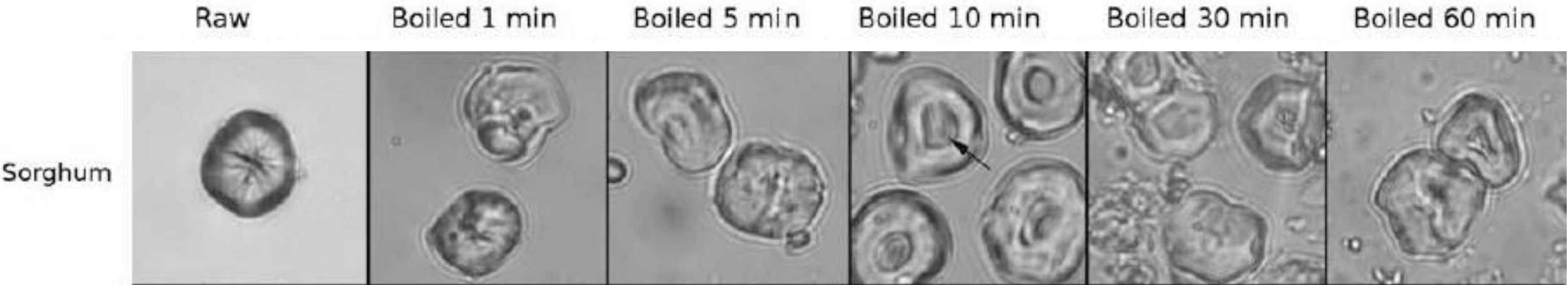


Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Sorghum bicolor

## Starch

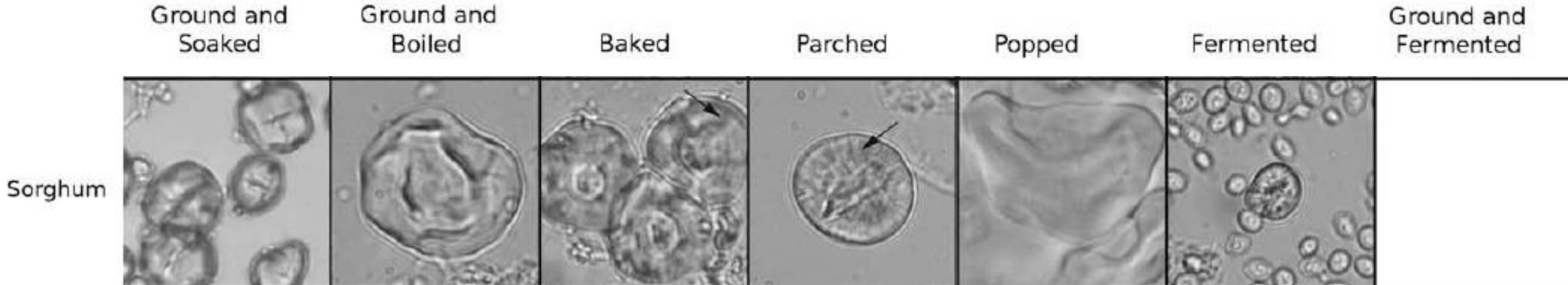


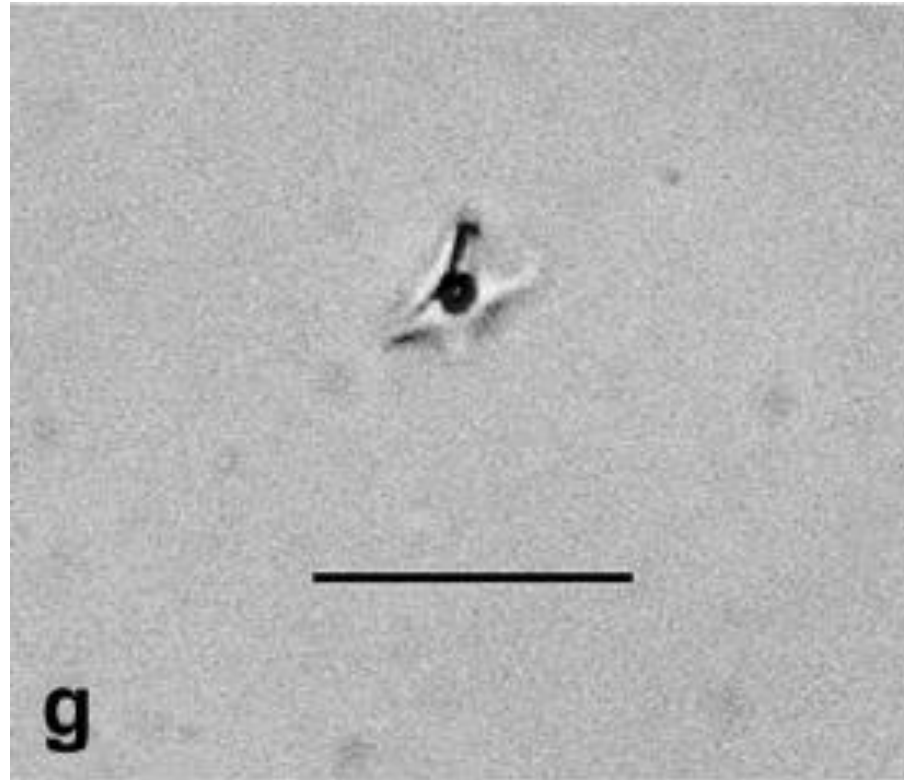
Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Spartina alterniflora

## Phytolith

Fig. 4. Phytoliths from Poaceae. g)  
Rondeloid/saddleoid phytolith from  
*Spartina alterniflora*

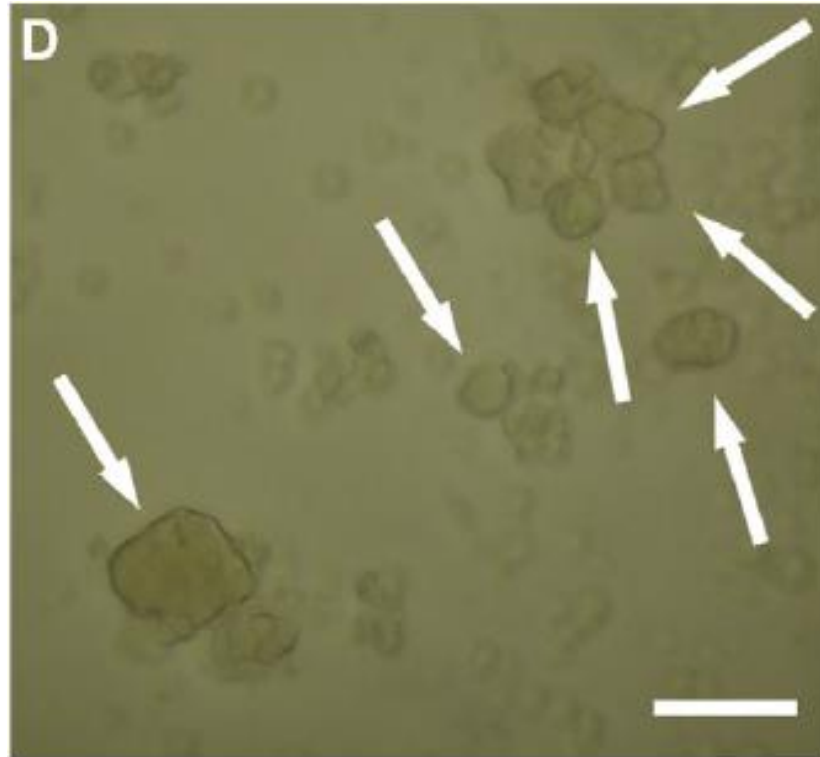


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Sporobolus rigens

## Starch

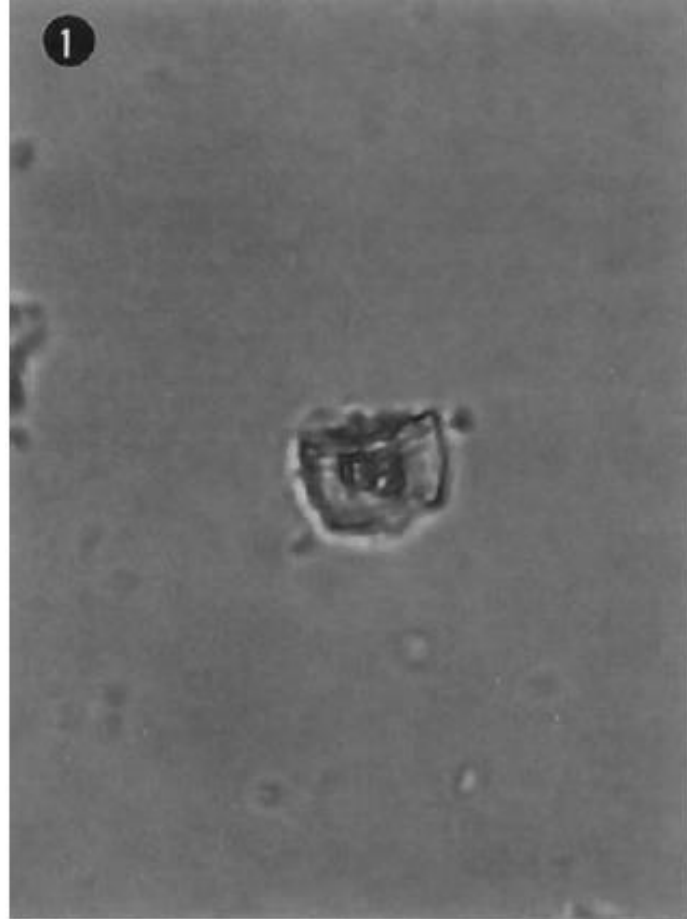
Fig. 3. Pampean native wild grasses from reference collection. D-E: Compound starch grains as discrete aggregates of class a. D: *Sporobolus rigens*. (Scale bars: 10 mm).



Musaubach, María Gabriela, Anabela Plos, and María Del Pilar Babot. 2013. Differentiation of Archaeological Maize (*Zea Mays* L.) from Native Wild Grasses Based on Starch Grain Morphology. Cases from the Central Pampas of Argentina. *Journal of Archaeological Science* 40 (2). Elsevier Ltd:1186–93. <http://dx.doi.org/10.1016/j.jas.2012.09.026>.

# Stipa ichu

## Phytolith



A rondel from *Stipa ichu* (400x)

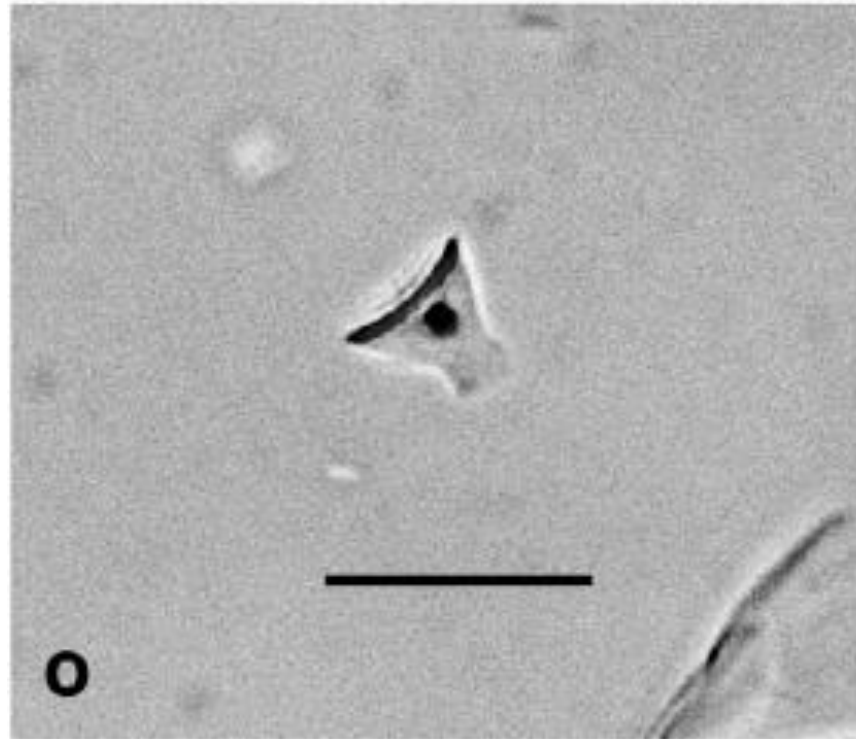
Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.



# Trachypogon spicatus

## Phytolith

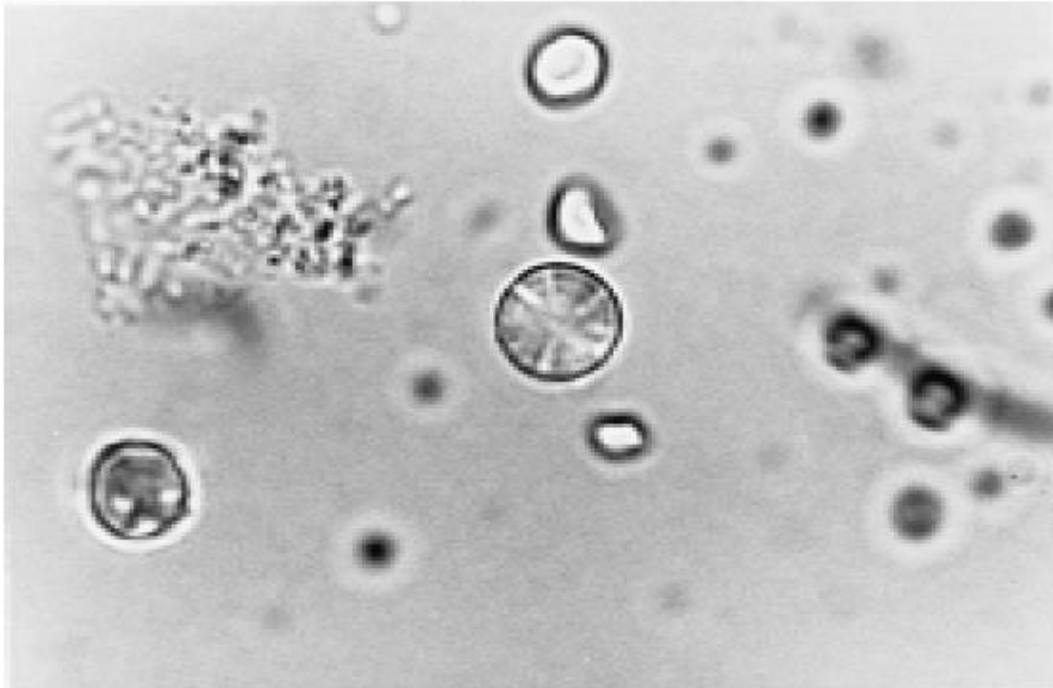
Fig. 4. Phytoliths from Poaceae. o)  
Spooled/horned towers from  
Trachypogon spicatus



Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Tripsacum dactyloides

## Starch



Starch grains from seeds of modern *Tripsacum dactyloides*. They have prominent radiating fissure 400x

### APPENDIX:

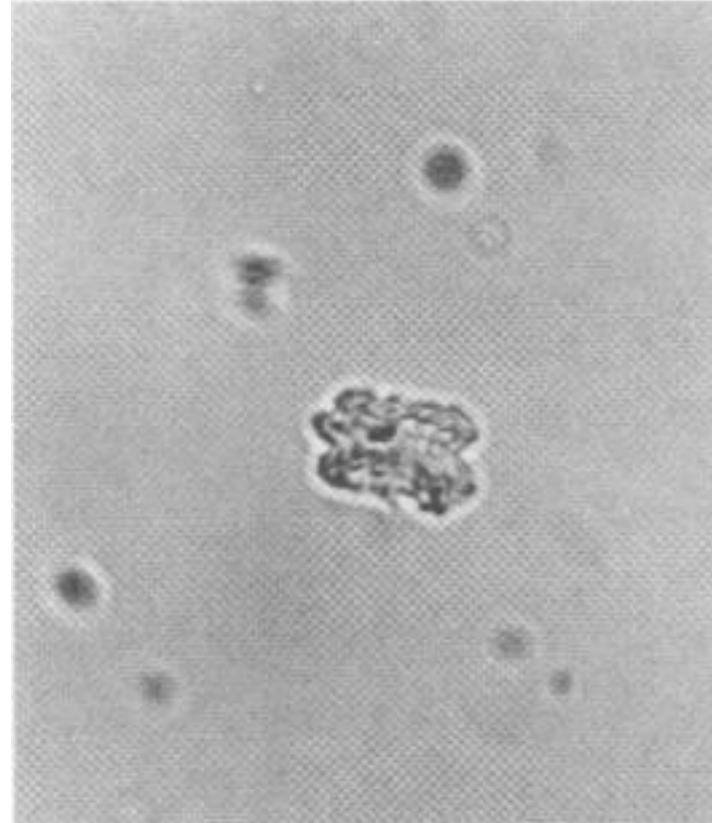
*Tripsacum dactyloides* (Figure 8). Simple and compound grains, spherical, with one or more slight depressions. The hilum is large in relation to the size of the grain. The radiating fissures are very prominent. The double border is not conspicuous and often not continuous. Size 2–10 microns long.

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Tripsacum lanceolatum

## Phytolith

Fig. 7. A *Tripsacum*-specific fruitcase phytolith from *T. lanceolatum*. It has markedly serrated edges and possesses ridges on the top.



Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449. <http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Tripsacum lanceolatum

## Phytolith

FIGURES 69-72.-70, A genus-specific epidermal-cell phytolith from the fruitcase of *Tripsacum lanceolatum* (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Tripsacum sp.

## Phytolith

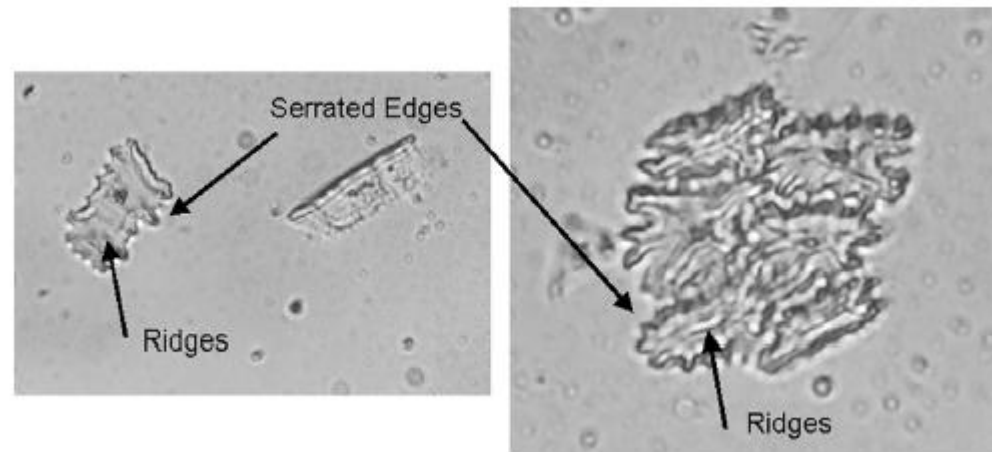


Fig. 4. Tripsacum fruitcase phytoliths. Unlike those of teosinte or maize, they have serrated edges and ridges across the top. Piperno 2006

Ball, T. B., K. Chandler-Ezell, R. Dickau, N. Duncan, T. C. Hart, J. Iriarte, C. Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <https://doi.org/10.1016/j.jas.2015.08.010>.

Piperno, Dolores R. 2006. *Phytoliths: A Comprehensive Guide for Archaeologists and Paleoecologists*. Oxford: Alta Mira Press.

# Triticum sp.

## Phytolith

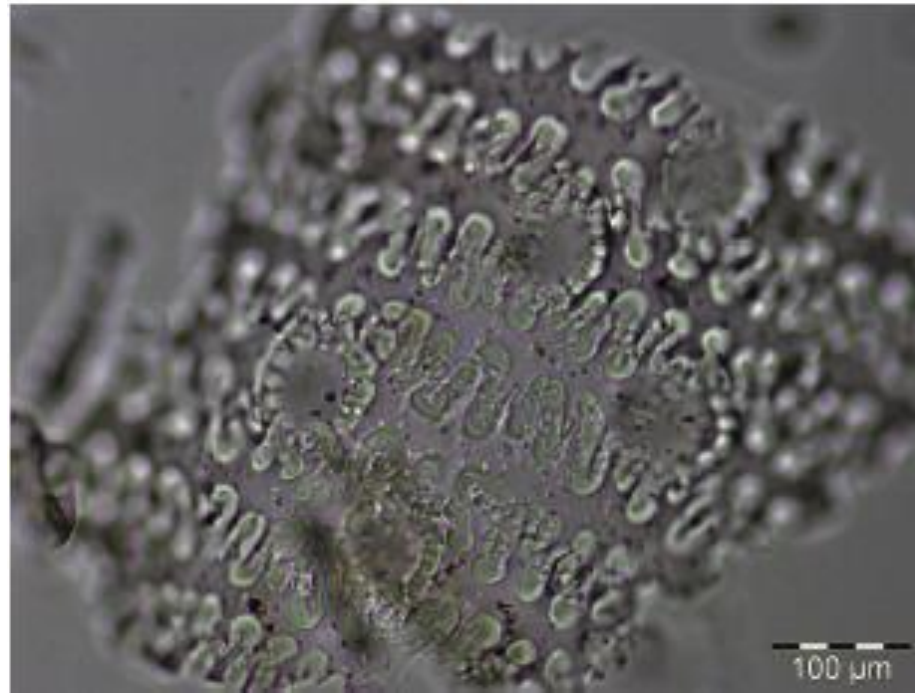


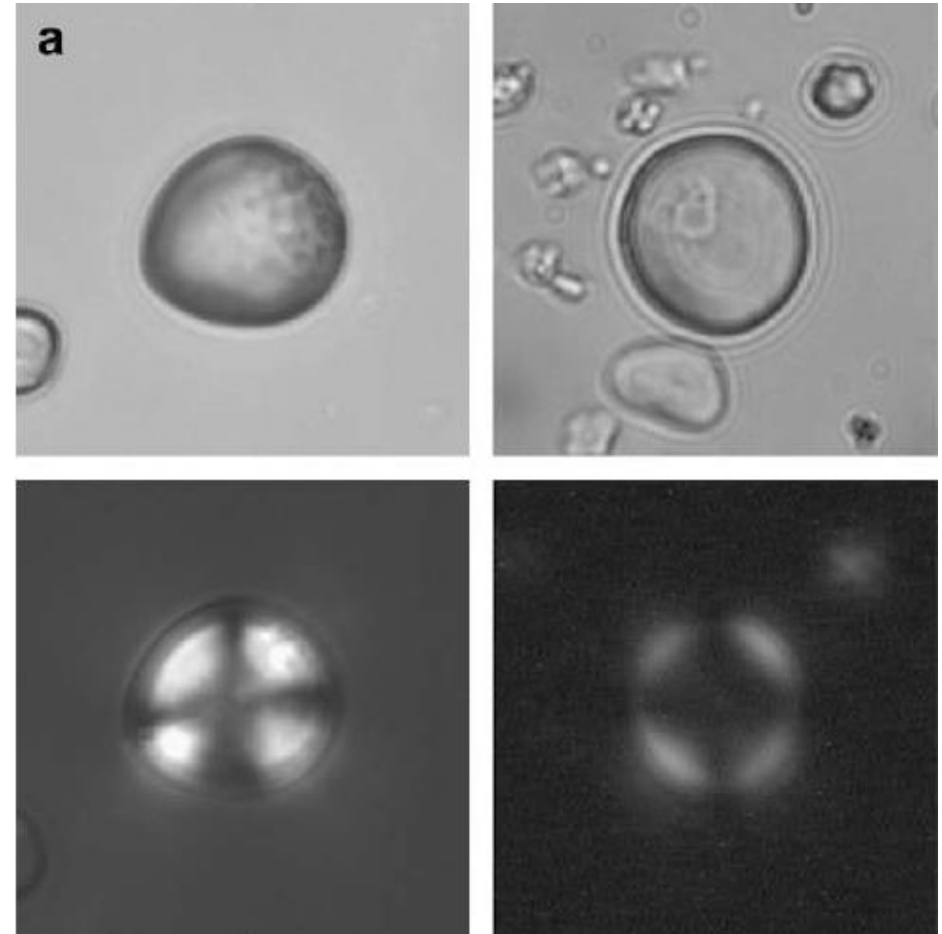
Fig. 9. An articulated aggregation of inflorescence bract phytoliths from *Triticum aestivum* showing the long cell wave patterns and papillae characteristic of *Triticum* sp. Photo by Arlene M. Rosen from modern plant phytolith reference collection at ICREA, University of Barcelona, courtesy of Rosa M. Albert

Ball, T. B., K. Chandler-Ezell, R. Dickau, N. Duncan, T. C. Hart, J. Iriarte, C. Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <https://doi.org/10.1016/j.jas.2015.08.010>.

# Triticum aestivum

## Starch

Fig. 1. Comparisons of raw and boiled starch grains showing damage to extinction crosses. (a) Wheat starch grains. Left side, raw wheat starch grain; right side, wheat starch grain boiled for 10 min. Notice there is very little change to the grain under regular light, but the extinction cross is much faded and with a very wide center. Each image is 50 mm wide.



Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Triticum aestivum

## Starch

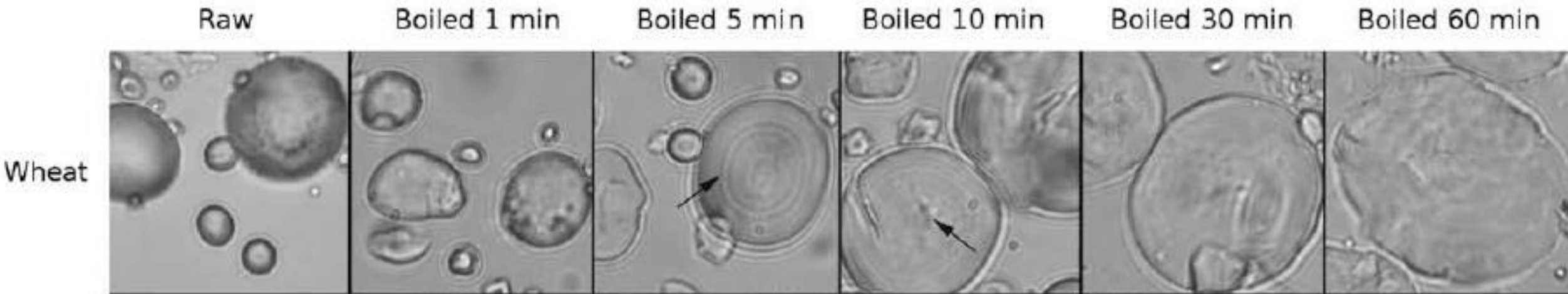


Fig. 2. Ten starch grain types shown raw, and from whole caryopses/pulses cooked for 1, 5, 10, 30 and 60 min. There were no visibly recognizable starch grains in whole oats boiled for 60 min, therefore there were no images included. Each individual image is 50 mm wide. See text for details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.



# Triticum aestivum

## Starch

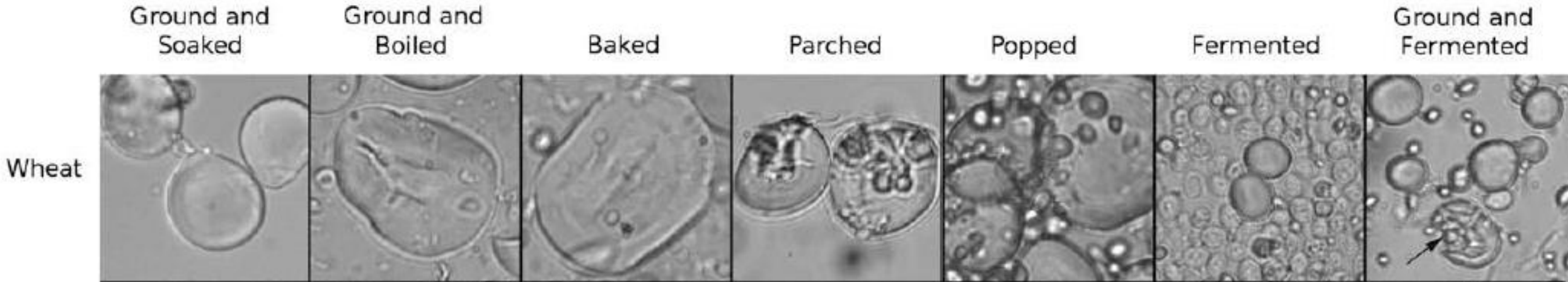


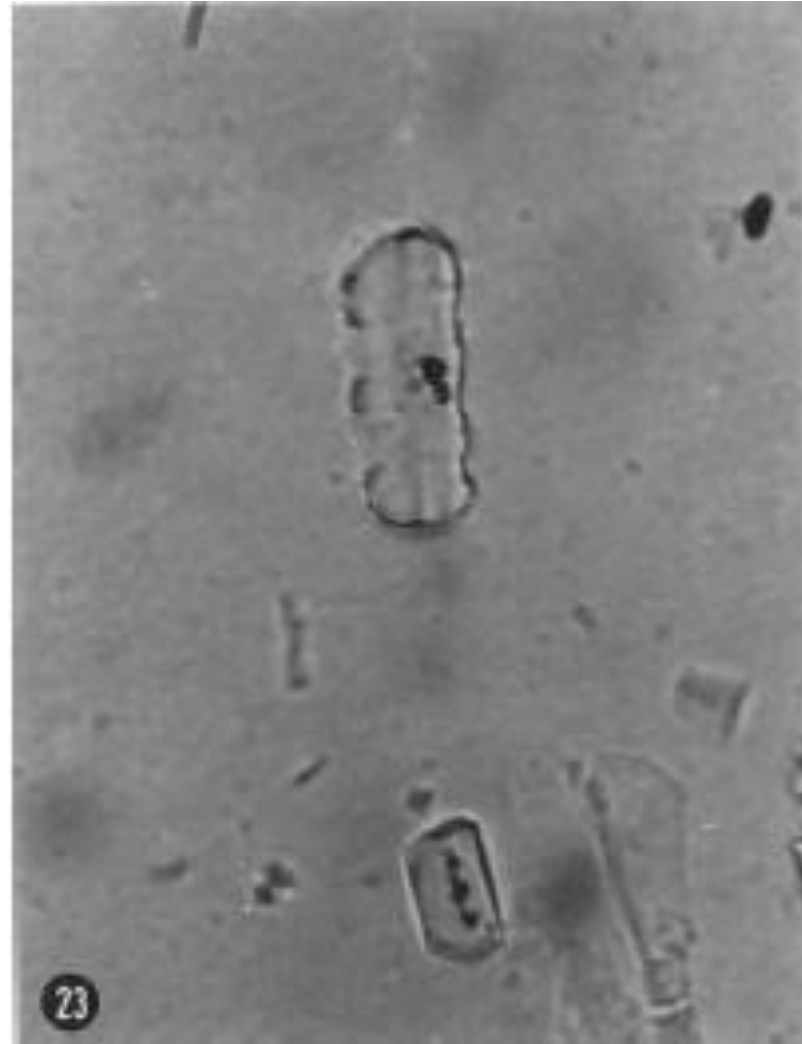
Fig. 3. Ten starch grain types shown ground and soaked, ground and boiled until gelatinized, baked, parched, popped, fermented and ground and fermented. The boiled ground images show the shortest time at which the starch grains have lost their defining characteristics, which varies from plant to plant. Wheat is shown at 10 min, barley at 5 min, oats at 1 min, millet at 1 min, sorghum at 1 min, rice at 10 min, lentils at 1 min, green peas at 1 min, chick peas at 10 min, mung beans at 1 min. None of the legumes were popped. The oats were steel-cut before purchase and were therefore unsuitable for popping. Only wheat, barley and chick peas were ground and fermented. Each individual image is 50 mm wide. See text for more details.

Henry, Amanda G., Holly F. Hudson, and Dolores R. Piperno. 2009. Changes in Starch Grain Morphologies from Cooking. *Journal of Archaeological Science* 36 (3). Elsevier Ltd:915–22. <http://dx.doi.org/10.1016/j.jas.2008.11.008>.

# Triticum aestivum

## Phytolith

FIGURES 21-24.- 23, Top, a long, wavy trapezoid from *Triticum aestivum* (x400).



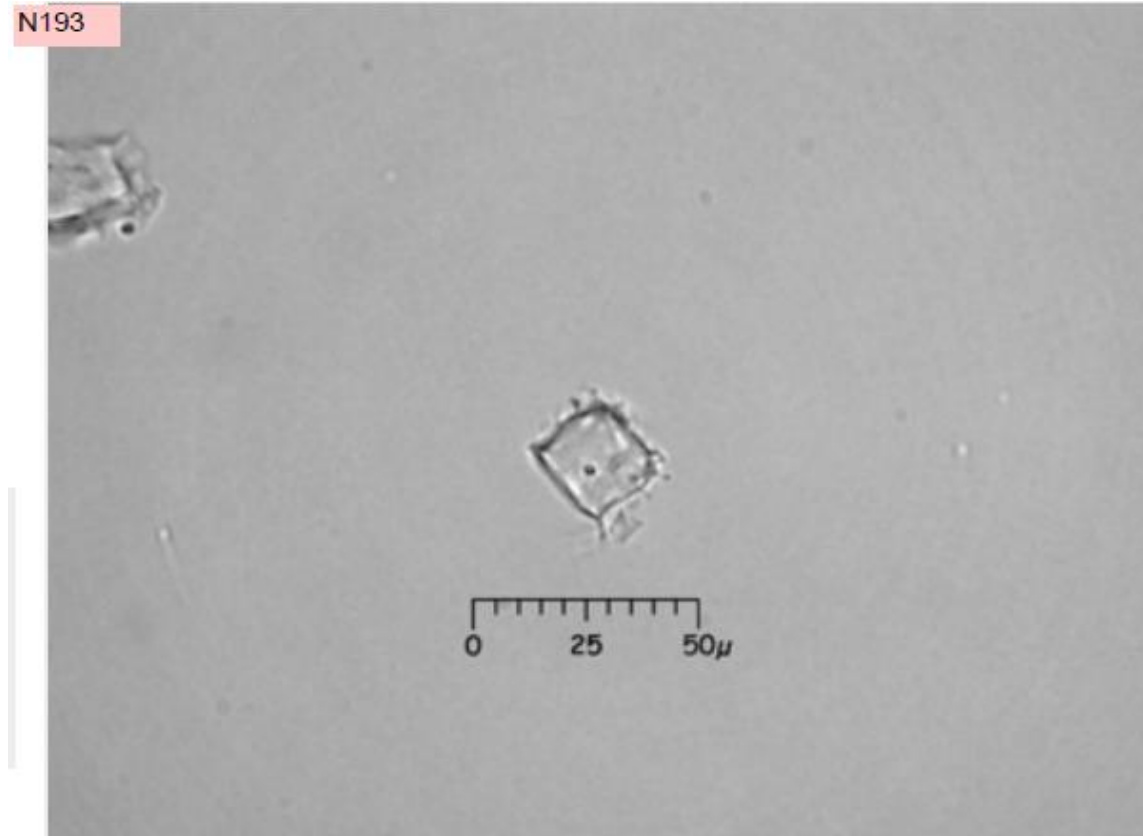
Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Zea luxuriens

## Phytolith

Diagnostic level: genus

Half-decorated rondel. Found in high numbers in teosinte fruit cases, and in very low numbers in some types of maize. A good Zea indicator, and is especially characteristic of teosinte and primitive maize. The body illustrated shows very long speculate projections. See other illustration for range of variation.



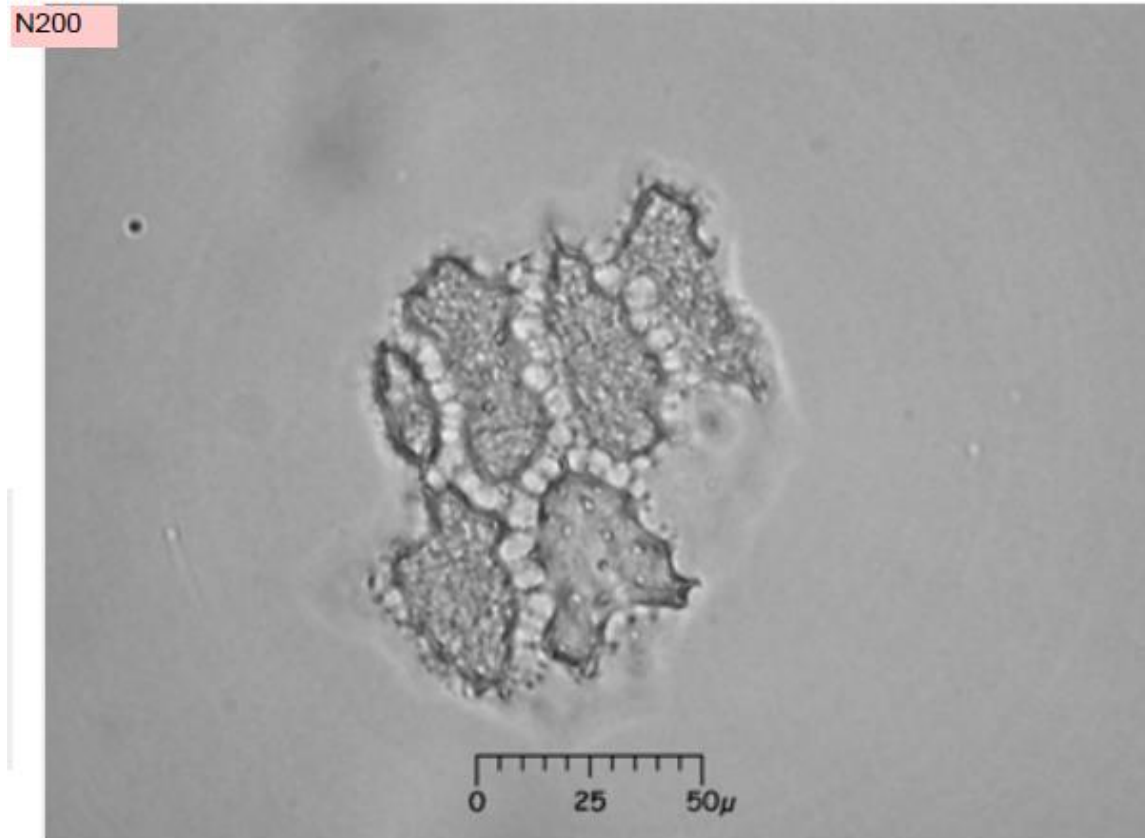
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea luxuriens

## Phytolith

Sheet of robust globular bodies. Robust globular bodies occur in maize and teosinte only, and are good *Zea* spp. indicators.

Diagnostic level: genus

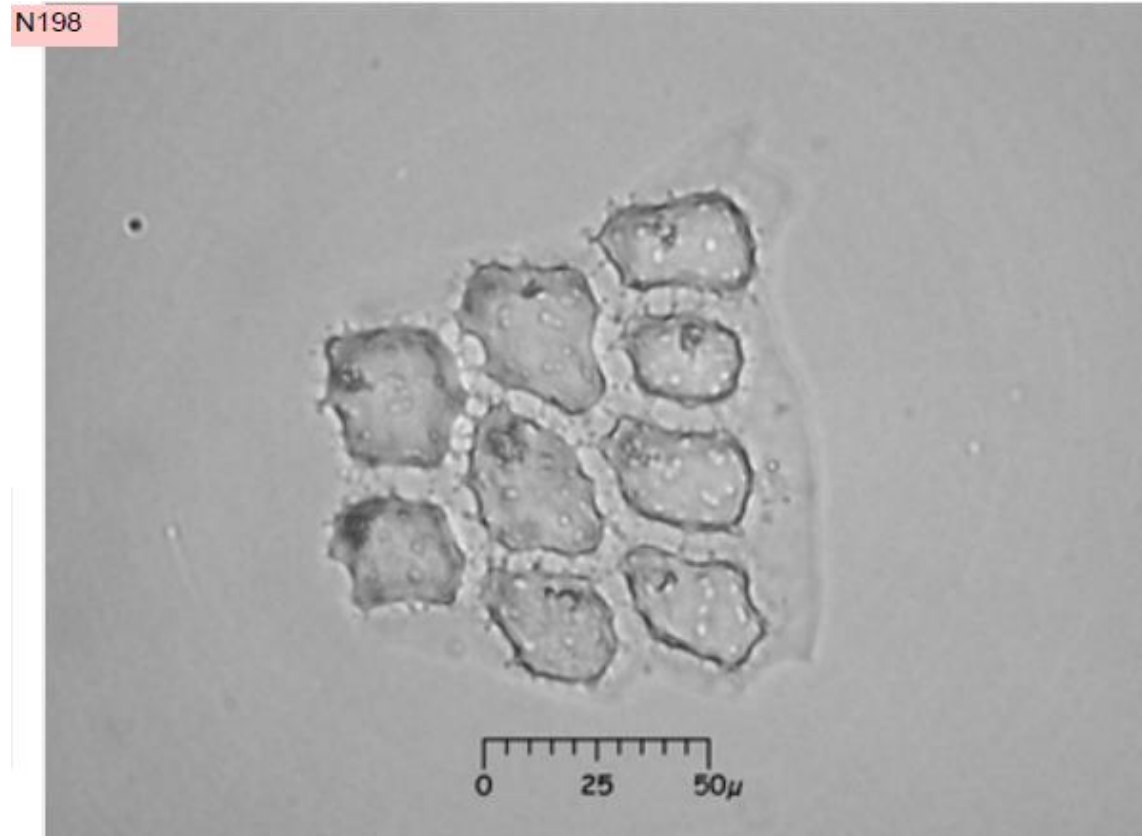


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea luxuriens

## Phytolith

Diagnostic level: genus  
Robust globular body.  
Long sides are roughly parallel. Body may be two-dimensional and flattened, or more three-dimensional (i.e. thickness may vary considerably). Sides may be undulating, but may not be crenate.  
Projections may be distributed regularly or irregularly, as long as they are along

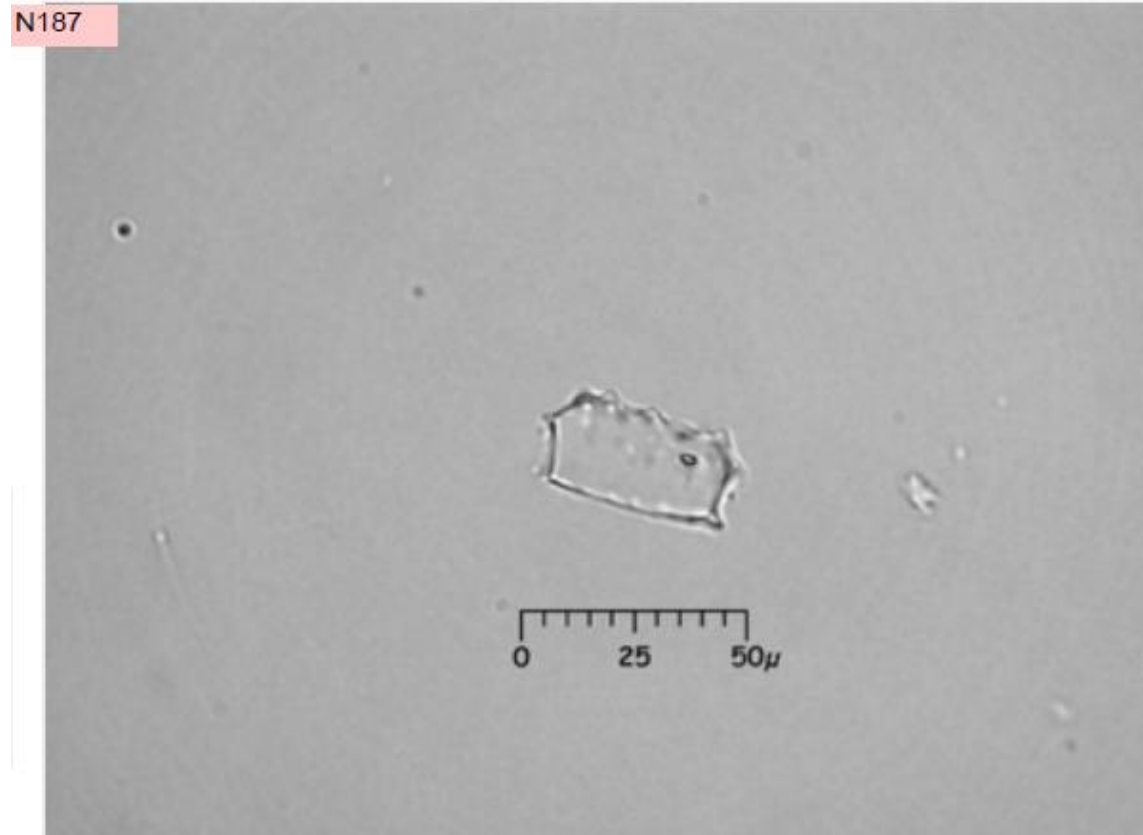


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea luxuriens

## Phytolith

Half-decorated oblong body Differs from the 1/2 decorated rondel only in that their bases are blocky, square or rectangular, not a rondel. Often occur in dense sheets in teosinte.  
Diagnostic level: genus

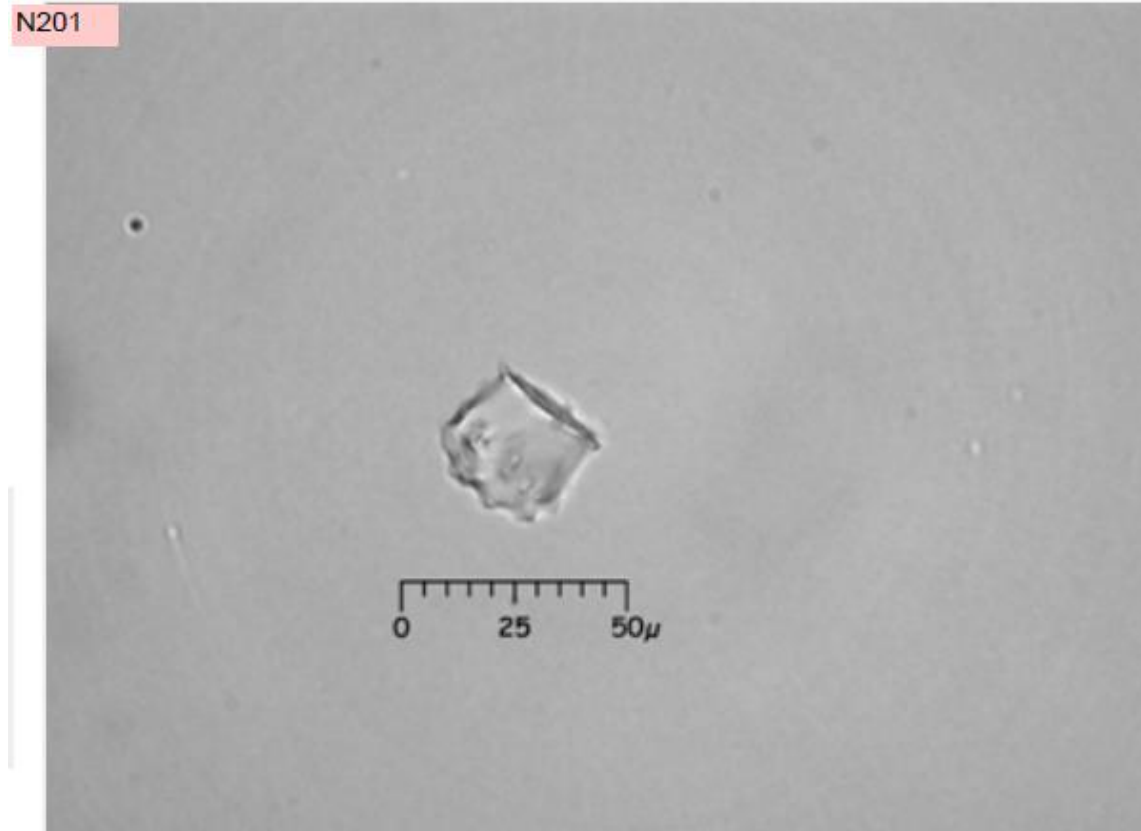


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea luxuriens

## Phytolith

Diagnostic level: genus Half-decorated rondel  
Found in high numbers in teosinte fruit cases, and in very low numbers in some types of maize.  
This is a good Zea indicator, and is especially characteristic of teosinte and primitive maize.  
The body illustrated here shows the beadlike projections. See other



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

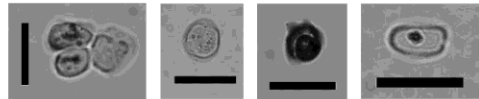
# Zea mays

Poaceae *Zea mays* var. *criollo* "maiz"

## Phytolith assemblage characterization

Diagnostic phytoliths:

a) Oval to round silica short cell. Very common.



Plane view.

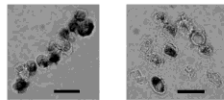


Lateral view.

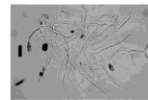
**References:**

Reported in: Piperno & Pearsall 1993, Pearsall 2002.

a) Oval to round silica short cell. Very common.

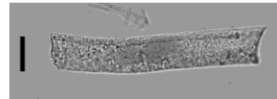


b) Bulbous translucent silica hairs. Common.

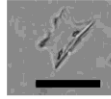


**References:** Reported in: Piperno & Pearsall 1993.

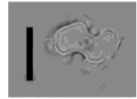
a) Rectangular granulate silica long cell. Very common.



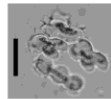
b) Tetra-lobate (crosses) silica short cells. Common.



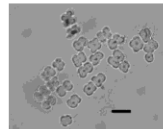
c) Tri-lobate silica short cells. Common.



d) Tetra and poli-lobate silica short cells. Very common.



Assemblage.

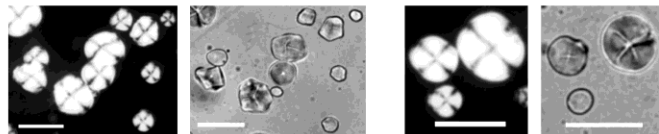


**References:** Reported in: Piperno & Pearsall 1993.

## Starch assemblage characterization

**Kernel.**

a) Mostly single grains, polyhedral, usually four- to five-sided, with a rough, grooved surface -in horny endosperm-; spherical and irregular-elongated, with smooth surface -in floury endosperm-; variable in size from 2µm to 35µm; distinct centric hilum v-shaped, as a dot or line; some indistinct lamella; sometimes irregular depressions, pressure facets, distinct and continuous double border, and/or radiating fissures; distinct centric cross, with four arms visible, although elongated grains generally are non birefringent. May occur in bunch aggregates.



b) Rarely compound grains, only in immature kernels.

**References:** Partially based on Buttrose 1960, Fitt and Maywald Snyder 1984, Piperno and Holst 1998, Piperno et al. 2000, Shannon and Garwood 1984, Watson 1984, Winton and Winton 1932.

Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection



# Zea mays

## Starch

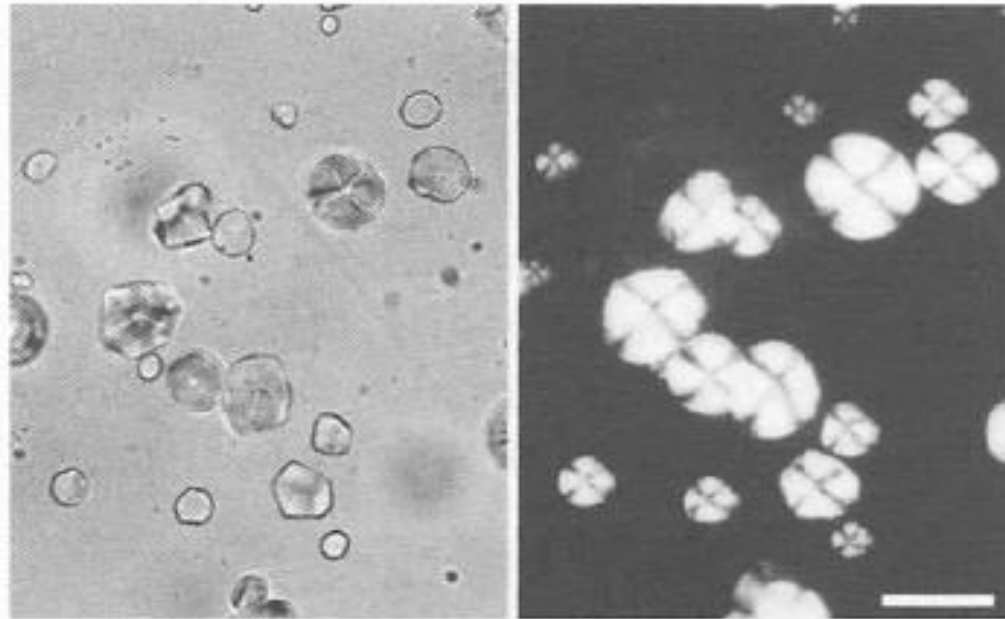


Figure 1. Maize non-processed starch grains. Views with normal (left) and polarised light (right). Scale bar = 20 $\mu$ m.

Babot, María del Pilar. 2003. Starch Grain Damage as an Indicator of Food Processing. In *Phytolith and Starch Research in the Australian-Pacific-Asian Regions: The State of the Art*.

# Zea mays

## Starch

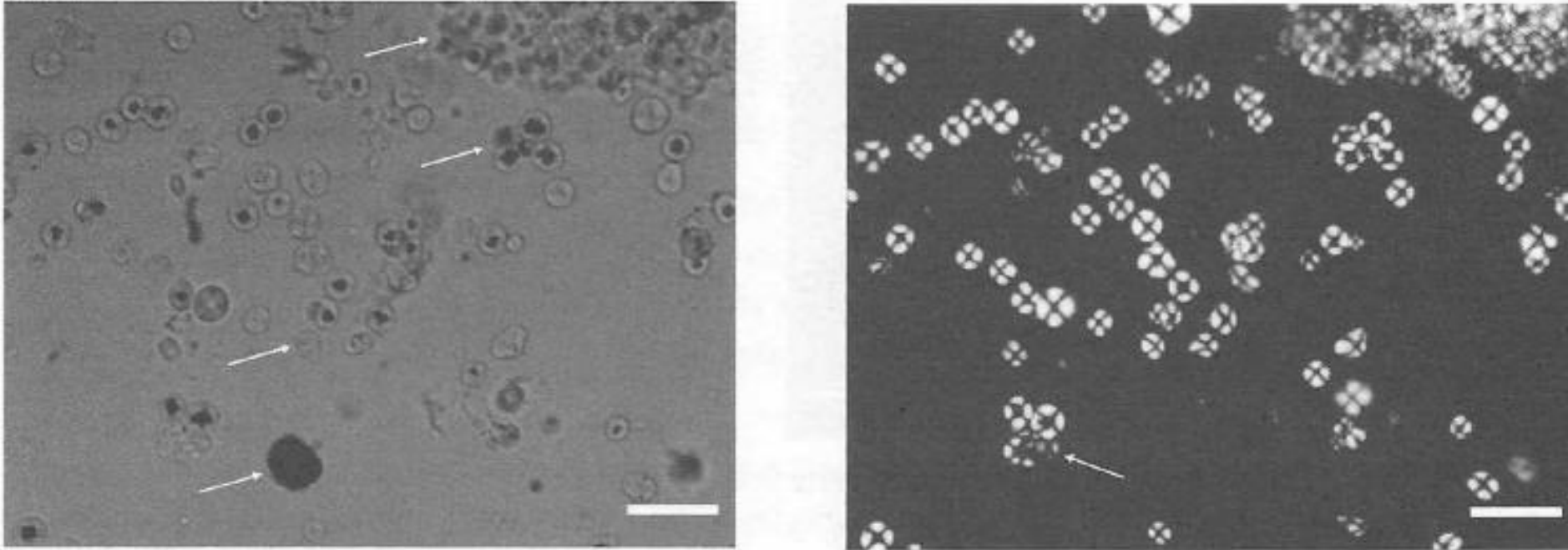


Figure 6. Starch of maize *tostado* showing roasting effects. (a) A charcoal particle, a very flat relief grain, clumps of gelatinised granules and grains with pronounced projections at the hilum are marked with arrows. View with normal light (left). (b) A starch grain with weak birefringence is marked with an arrow. View with polarised light (right). Scale bar = 40 $\mu$ m.

Babot, María del Pilar. 2003. Starch Grain Damage as an Indicator of Food Processing. In *Phytolith and Starch Research in the Australian-Pacific-Asian Regions: The State of the Art*.

# Zea mays

## Starch

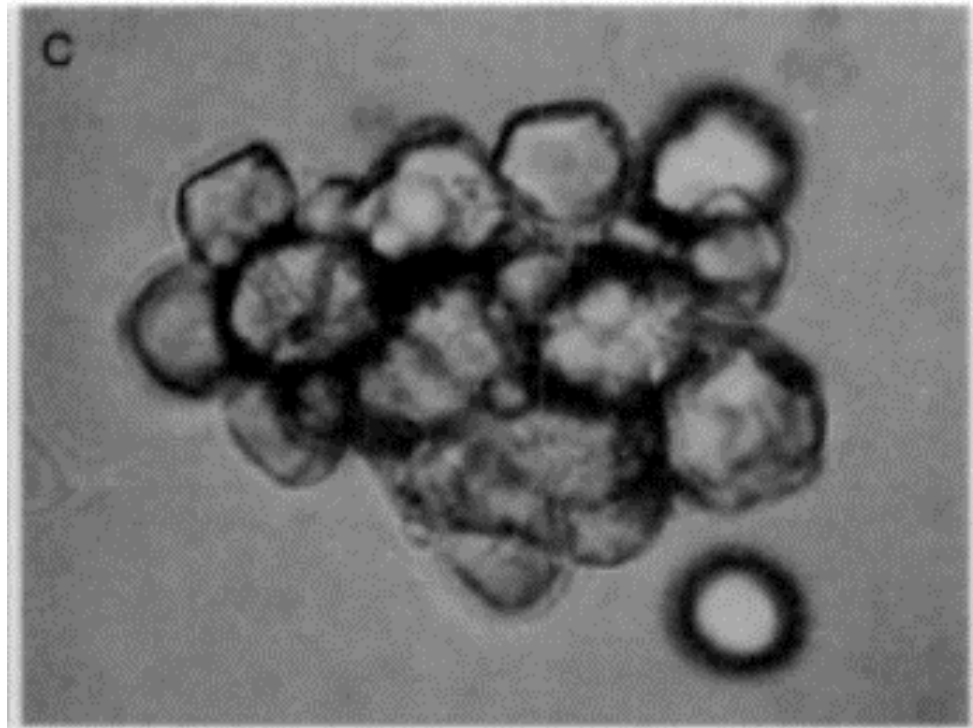


Figure 3. Light micrographs of archaeological starch granules representative of the recovered assemblage. c: Starch granule cluster of *Zea mays* recovered from flake 3

Perry, Linda. 2002. Starch Analyses Reveal Multiple Functions of quartz “manioc” Grater Flakes from the Orinoco Basin, Venezuela. *Interciencia* 27 (11):635–39.

# Zea mays

## Starch

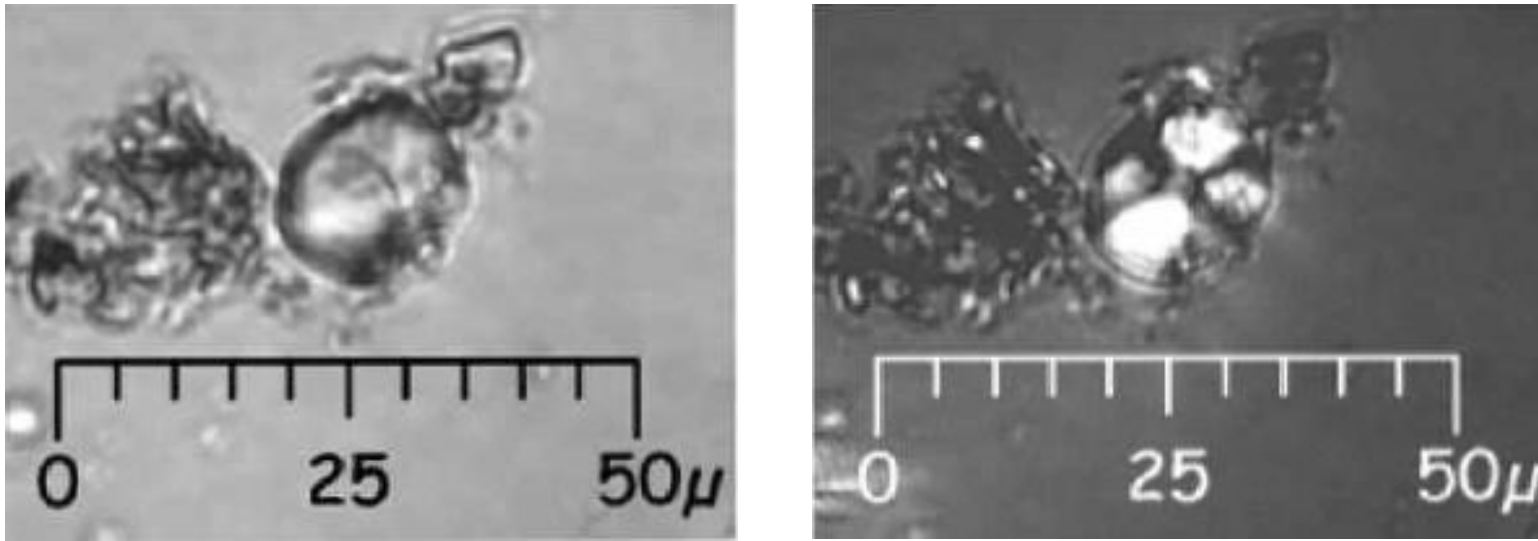
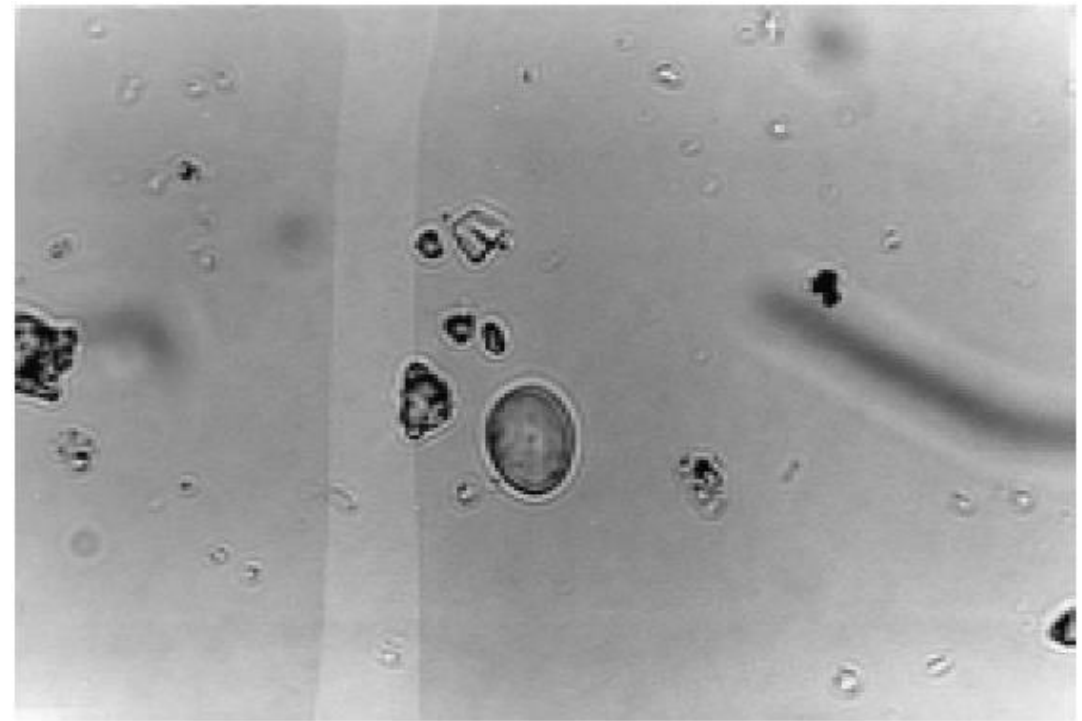
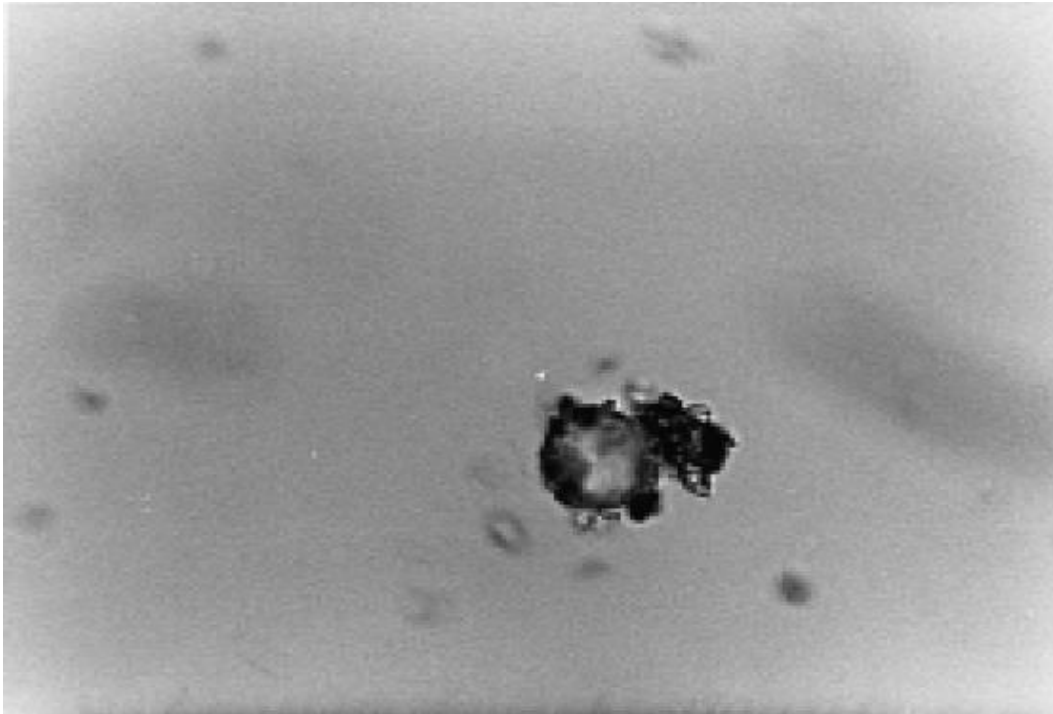


Figure 5. Example of maize starch grain on mano from Chiripa Quispe (Locus 3132), in transmitted (left) and polarized (right) light.

Logan, Amanda L., Christine A. Hastorf, and Deborah Marie Pearsall. 2012. "Let's Drink Together": Early Ceremonial Use of Maize in the Titicaca Basin. *Latin American Antiquity* 23 (3):235–58.

# Zea mays

## Starch



A maize starch grain from La Mula. 160x. The grain measures 12 microns by 10 microns.

A maize starch grain from the Aguadulce shelter. 160x. The grain measures 14 microns by 14 microns.

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Zea mays

## Starch

### APPENDIX:

Zea mays (maize) (Figures 9 and 10). Simple and compound grains, spherical, or with irregular depressions and pressure facets. The grains often have a distinct and continuous double border and radiating fissures. Deep, central fissures may be present. Size: 6–14 microns long (Race Pepetilla), 4–18 microns long (Argentine popcorn), 4–14 microns long (modern cobs from Panama).

Zea mays ssp. parviglumis (teosinte). Simple and compound grains, spherical to bell-shaped, with slight depressions or pressure facets. Double border is indistinct and discontinuous, and radiating fissures are not as defined as in other grasses. The hilum is central and the central fissures are deep and distinct. Size: 4–14 microns long

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Zea mays

## Starch



Fig. 5. Selected microbotanical remains. Starch grains: a) *Zea mays* (SAL 06-10-1642)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Zea mays

## Starch

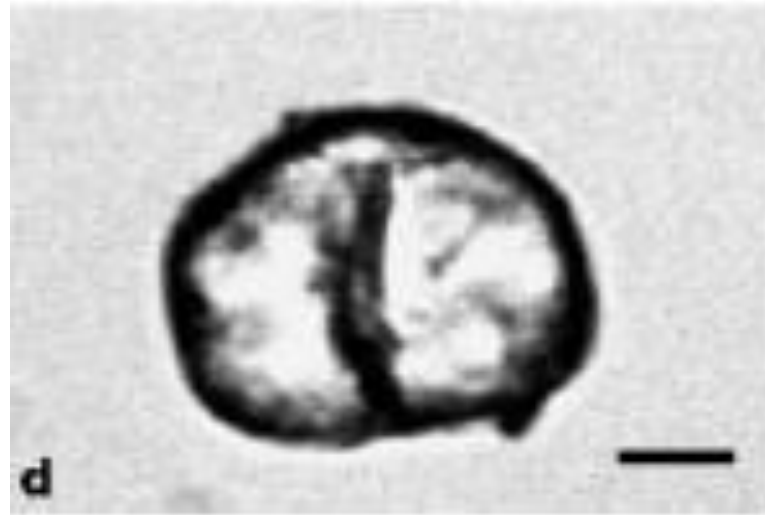


Figure 1. Various starch grains. d, A starch grain from maize from milling stone 42. This type is unique to maize and is found in Race Jala from Mexico. Scale 5  $\mu\text{m}$ .

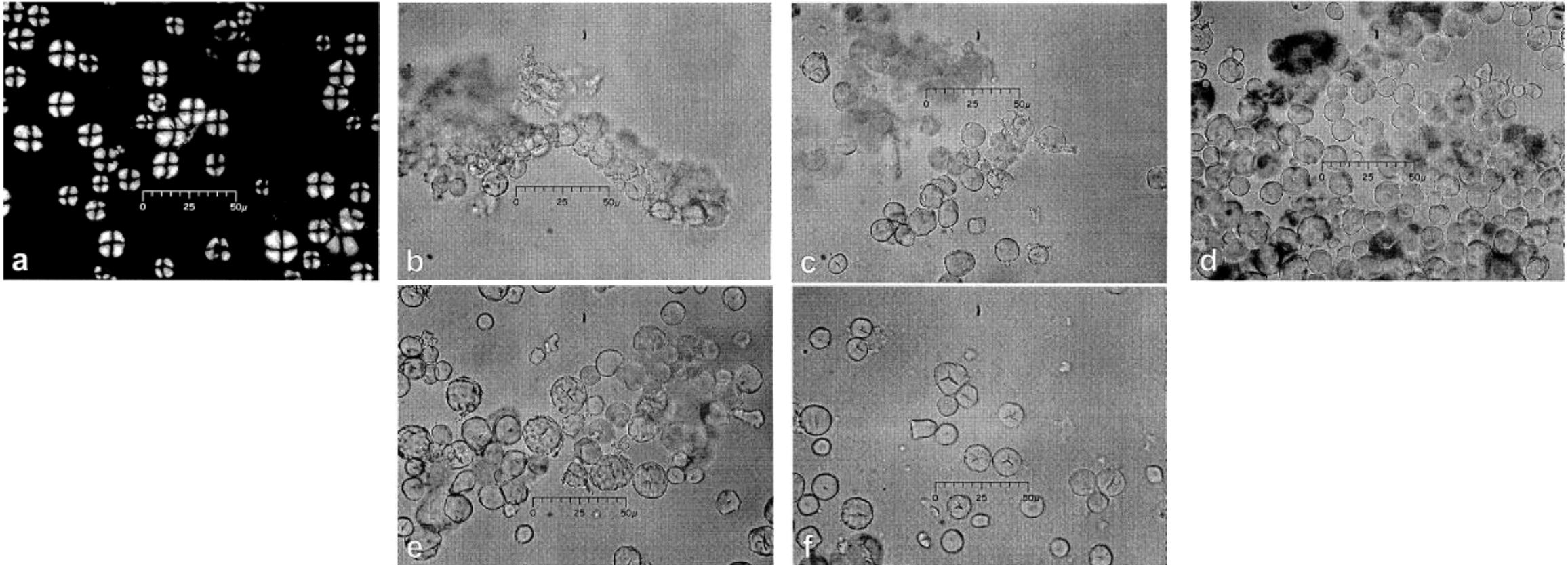
Piperno, Dolores R., Anthony J. Ranere, Irene Holst, and Patricia Hansell. 2000. Starch Grains Reveal Early Root Crop Horticulture in the Panamanian Tropical Forest. *Nature* 407:894–97.



# Zea mays

## Starch

Fig. 5. Comparative maize starch, a: polarized light view of Peruvian sweet corn; b: Reventador popcorn; c: Chapalote flint corn; d: Guatemalan red flour corn; e: Cuzco flour corn; f: Peruvian sweet corn.

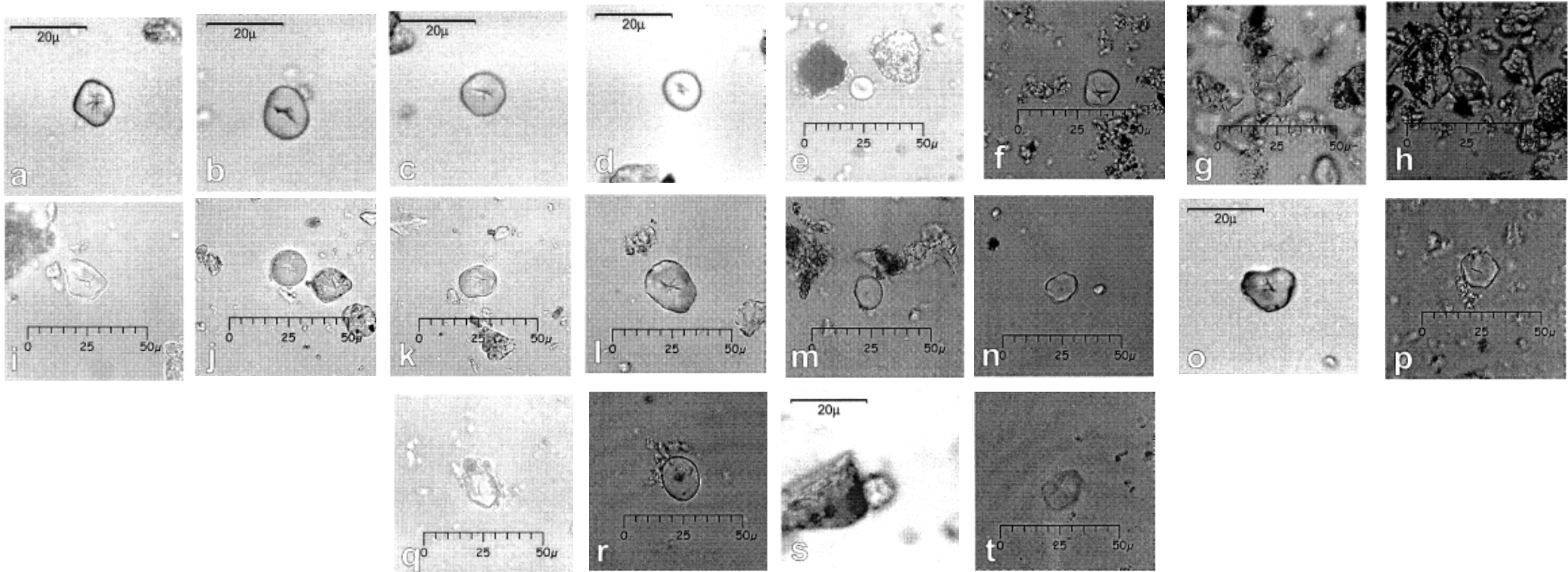


Pearsall, Deborah Marie, Karol Chandler-Ezell, and James A. Zeidler. 2004. Maize in Ancient Ecuador: Results of Residue Analysis of Stone Tools from the Real Alto Site. *Journal of Archaeological Science* 31:423–42.

# Zea mays

## Starch

Fig. 7. Archaeological maize starch, a, b, c, d, from 3290-A; e: 3290-B; f: 3293-A, g: 3293-B, h: 3294-A; i, j, k: 3294-B; l, m, n: 3331-A; o: 3383-A, p: 3383-B, q: 3386; r: 3415-A, s: 3415-B, t: 3417-A.

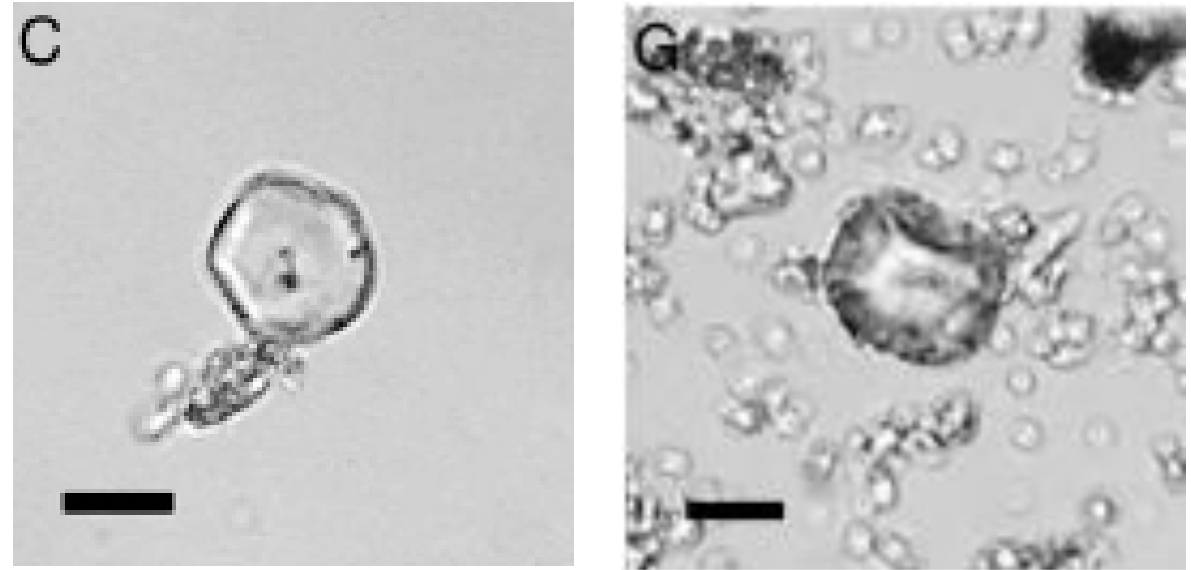


Pearsall, Deborah Marie, Karol Chandler-Ezell, and James A. Zeidler. 2004. Maize in Ancient Ecuador: Results of Residue Analysis of Stone Tools from the Real Alto Site. *Journal of Archaeological Science* 31:423–42.

# Zea mays

## Starch

Fig. 2. Selected archaeological starch grains. (C) Maize (*Z. mays*) starch from Hornito, wedge 77-1, ?7000 cal BP. (G) Maize starch from Ladrones, triangular grinding stone CL-82b, ?7800 cal BP. Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8.



Dickau, Ruth, Anthony J. Ranere, and Richard G. Cooke. 2007. Starch Grain Evidence for the Preceramic Dispersals of Maize and Root Crops into Tropical Dry and Humid Forests of Panama. *Proceedings of the National Academy of Sciences of the United States of America* 104 (9):3651–56.

# Zea mays

## Starch

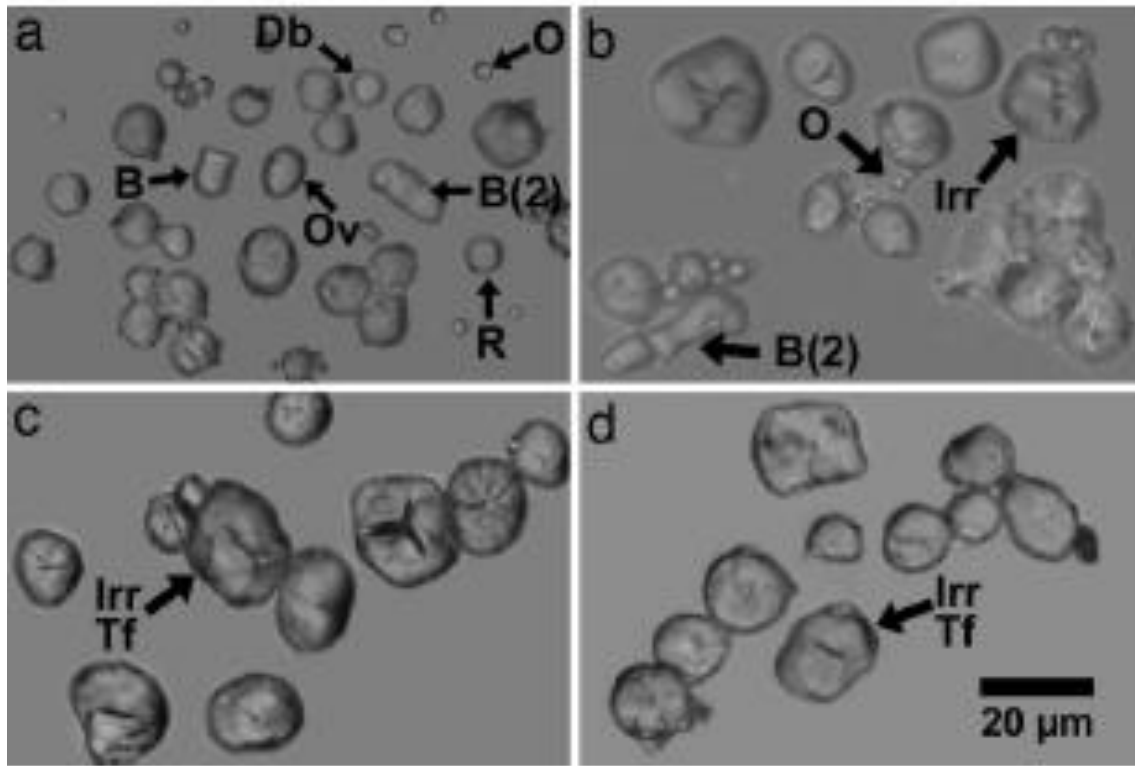


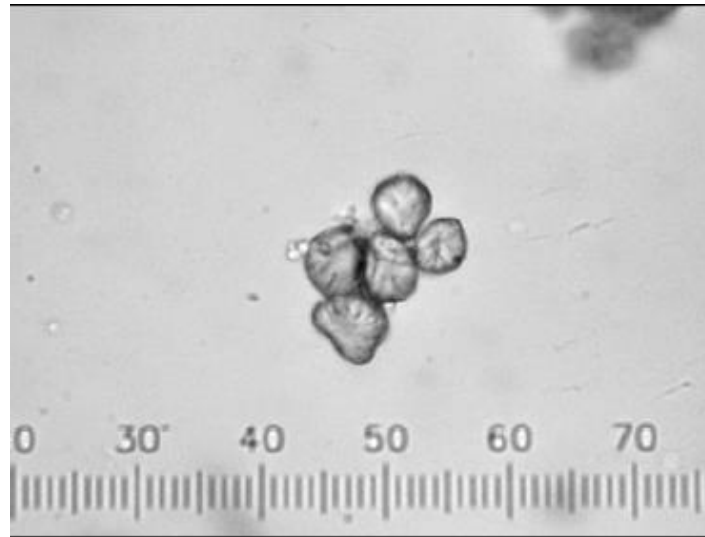
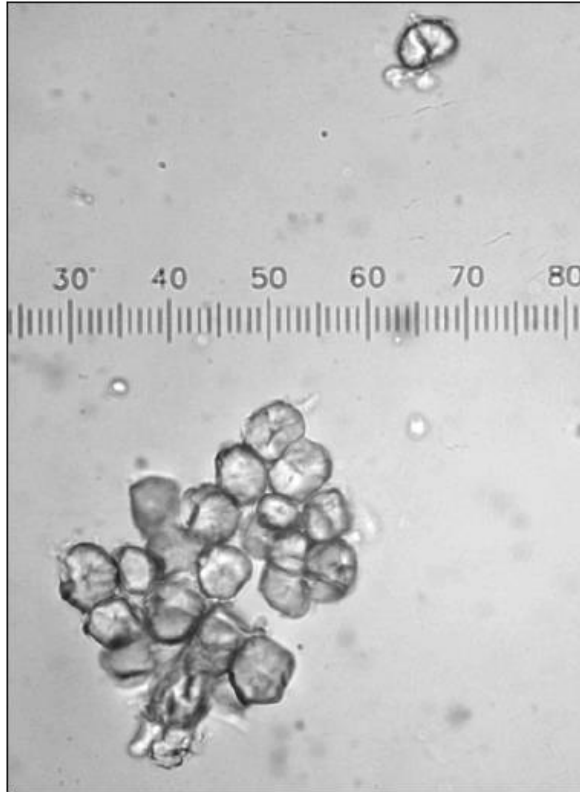
Fig. 1. Starch grains from teosinte and maize. (a) Starch grains from *Zea mays* ssp. *parviglumis*. It can be seen that in contrast to maize (c and d) the majority of grains are oval to round, not irregular, and bell-shaped grains are present. The tiny spheres are oil droplets. Letters next to grains indicate the following: B, bell-shaped; Db, with a double border on the edge; Ov, oval in shape; B (2), two bell-shaped grains joined together as they were formed in the amyloplast; R, round in shape; o, oil droplet. Most of the oil droplets that occurred with the starch grains were not included in the figure. (b) Starch grains from *Zea mays* ssp. *mexicana* (Chalco teosinte). This race of teosinte has a greater proportion of grains that are more like those in maize, but differences are still apparent in morphology when compared with maize. Irr, irregular in shape. Most of the oil droplets that occurred with the starch grains were not included in the figure. (c) Starch grains from the maize race Reventador. As is typical of maize, many grains are irregular, and oval, round, and bell-shaped grains are absent or nearly so. In this race, many grains also have transverse fissures. Irr, irregular in shape; Tf, transverse fissure. (d) Starch grains from the maize race Bolita

Holst, Irene, J Enrique Moreno, and Dolores R. Piperno. 2007. Identification of Teosinte, Maize, and Tripsacum in Mesoamerica by Using Pollen, Starch Grains, and Phytoliths. *Proceedings of the National Academy of Sciences of the United States of America* 104 (45):17608–13.

<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2077075&tool=pmcentrez&rendertype=abstract>.

# Zea mays

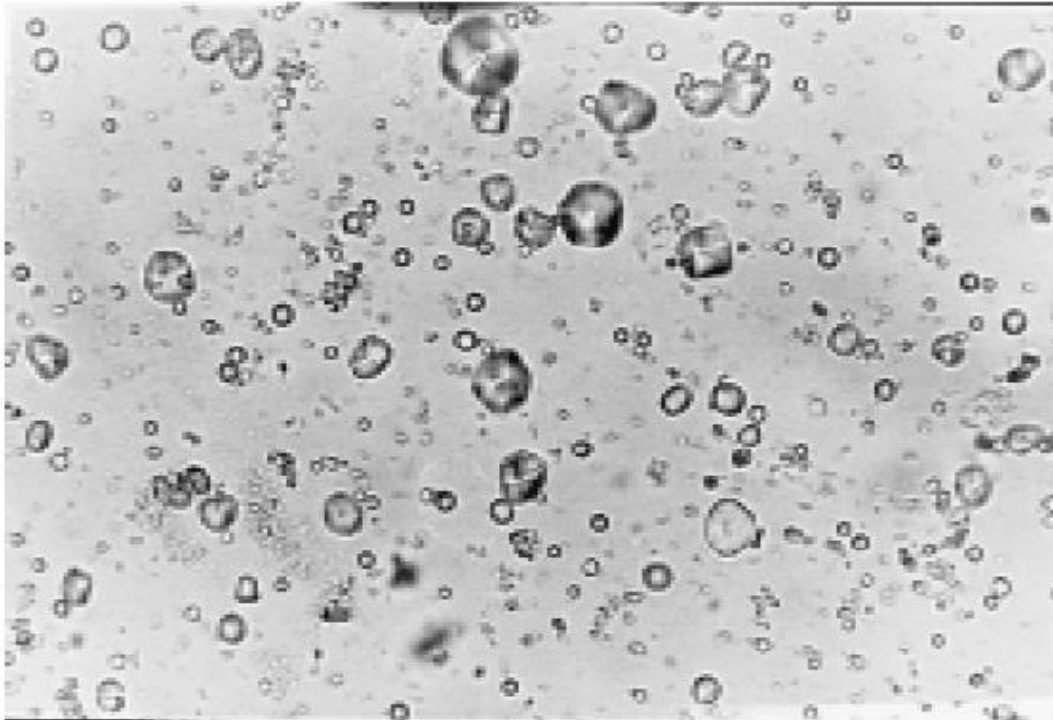
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Zea mays, Race Argentine popcorn

## Starch

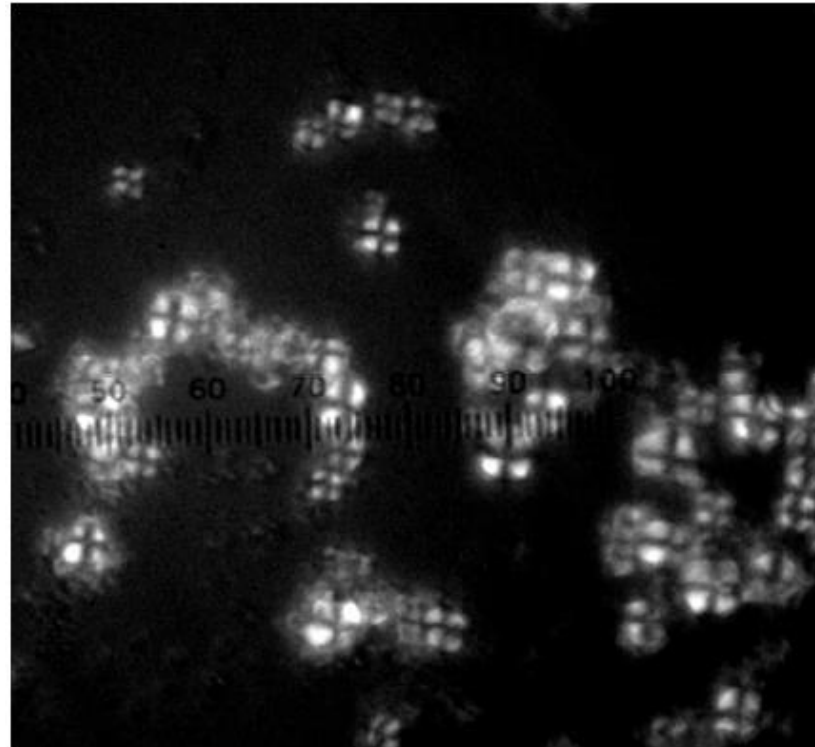
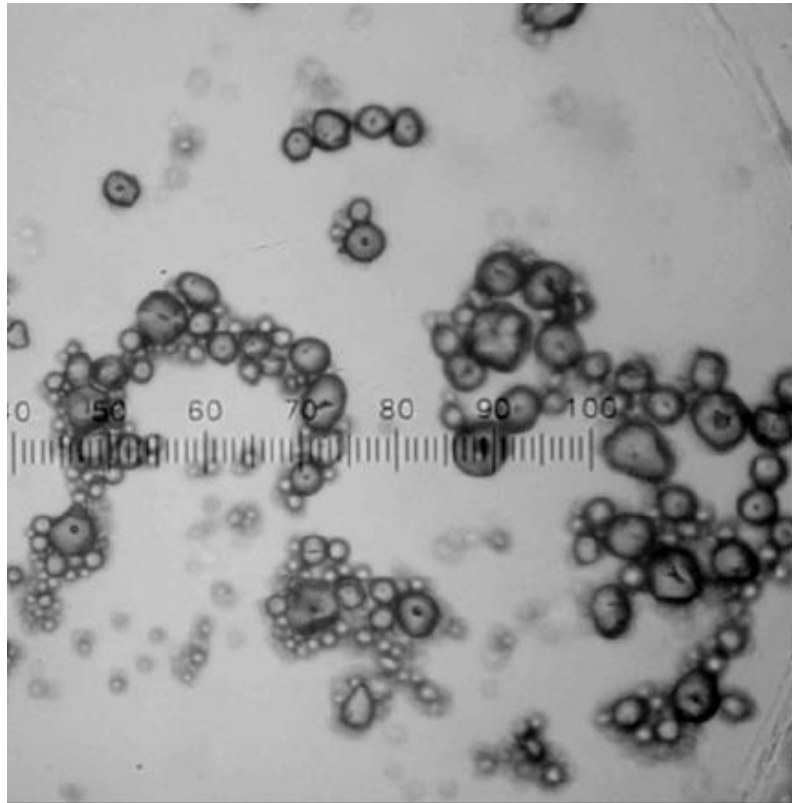


Starch grains from maize kernels, Race Argentine popcorn. 80x

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# *Zea mays*, raza Cateto cristalino

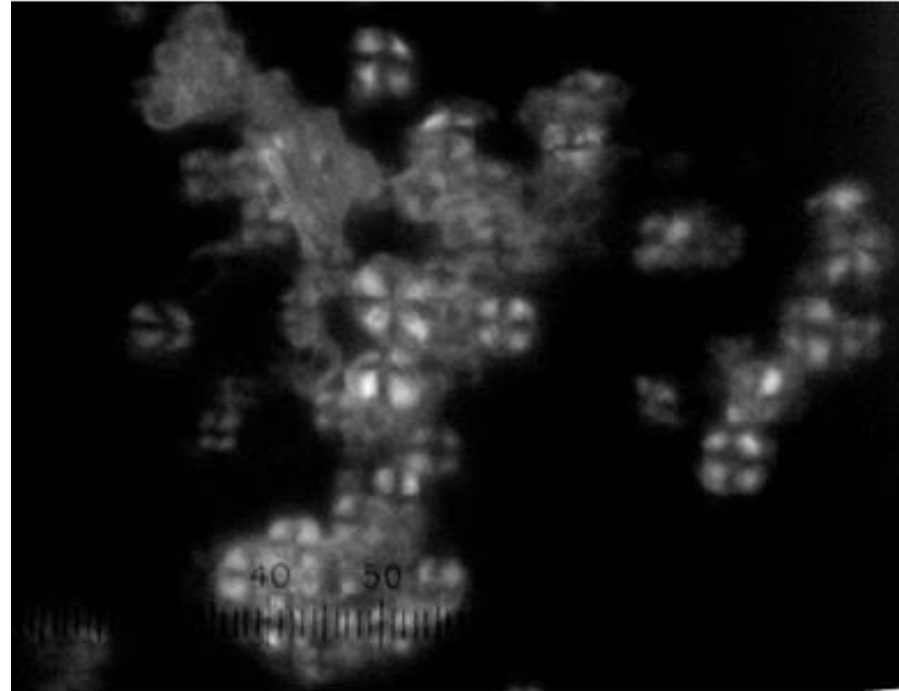
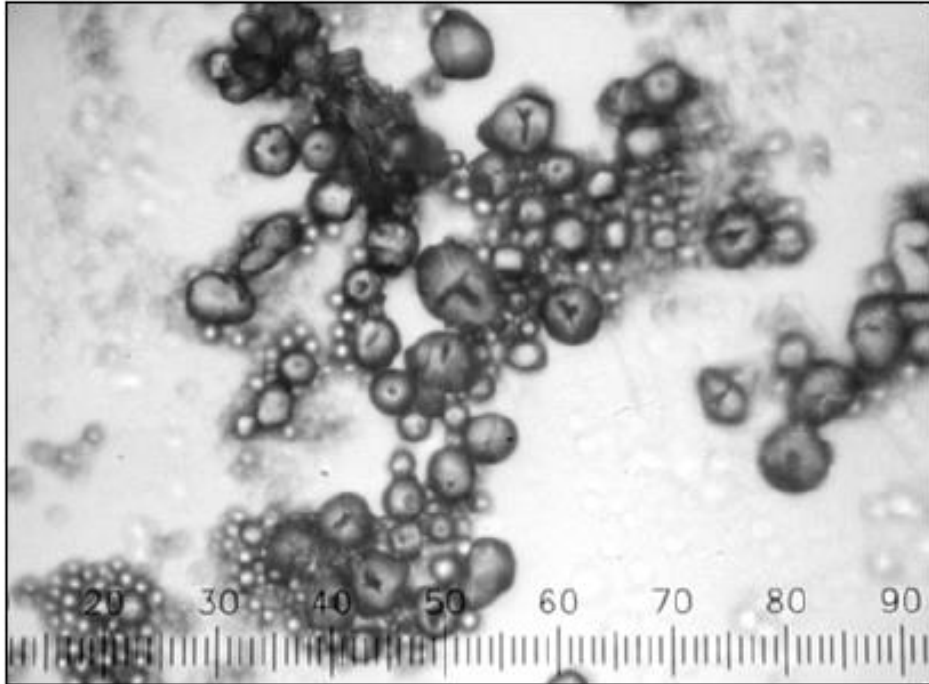
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# *Zea mays*, raza Caribe temprano (Early Caribbean)

## Starch

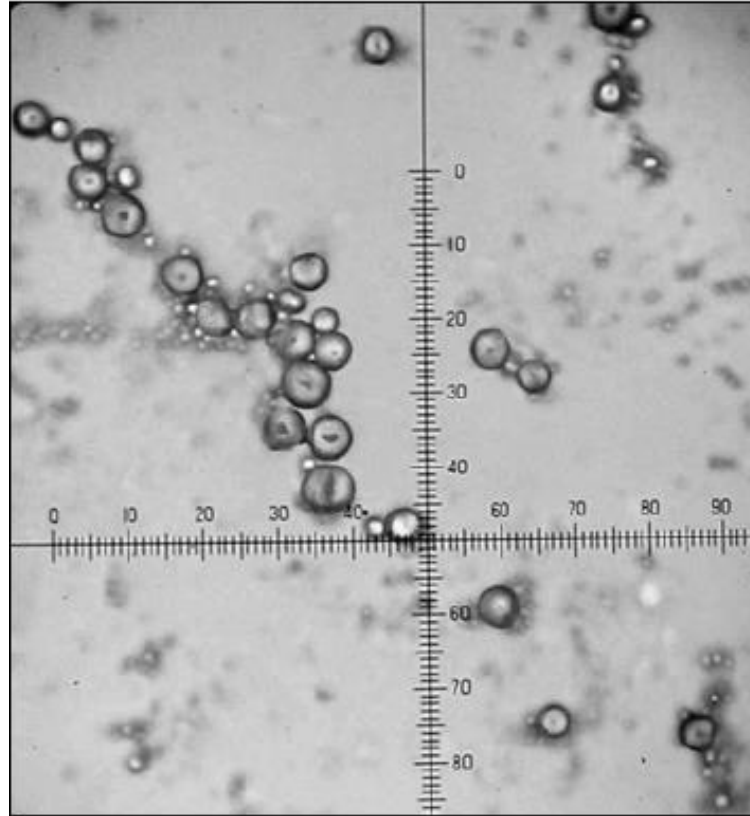


Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.



# *Zea mays*, raza Chandelle (Canilla en Cuba y Venezuela)

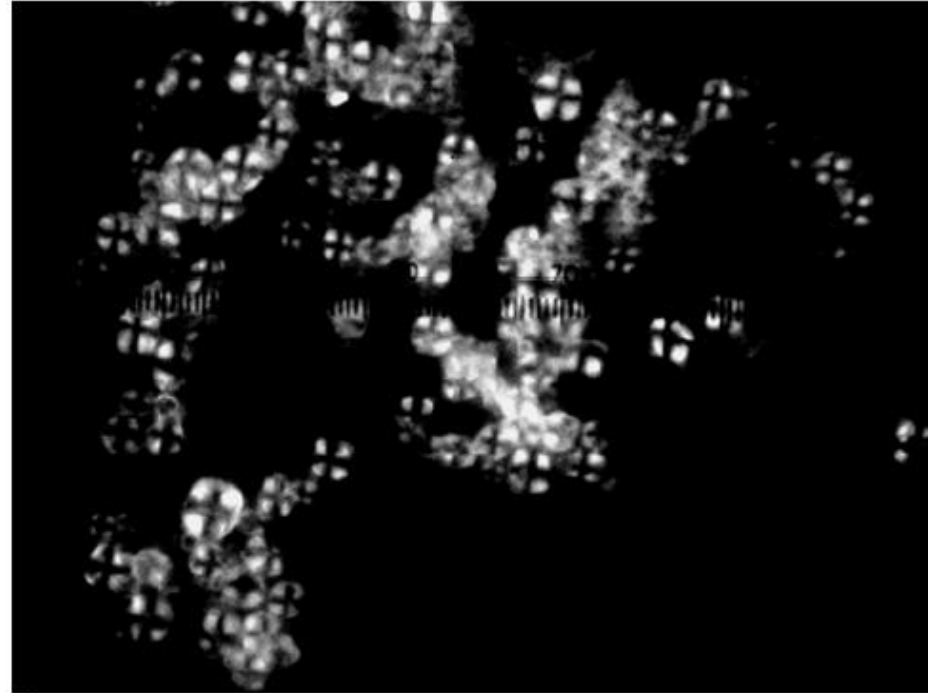
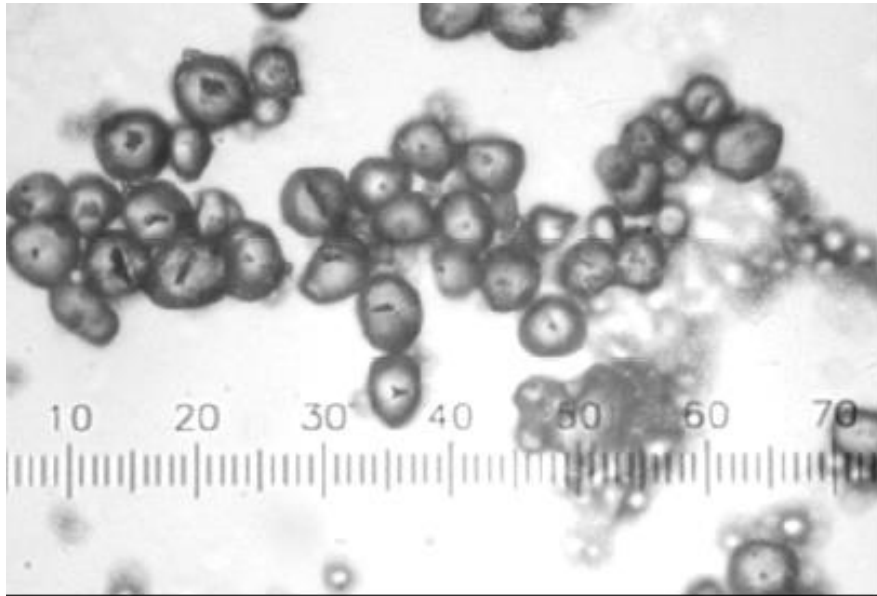
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# *Zea mays*, raza Negrito de Colombia

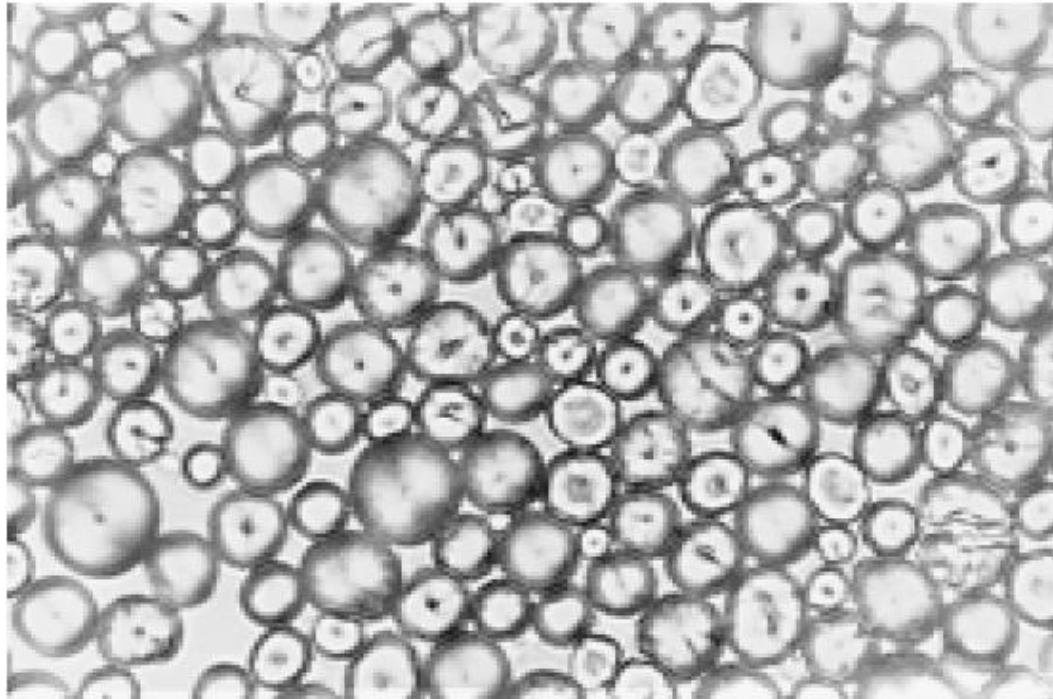
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Zea mays, Race Pepetilla

## Starch

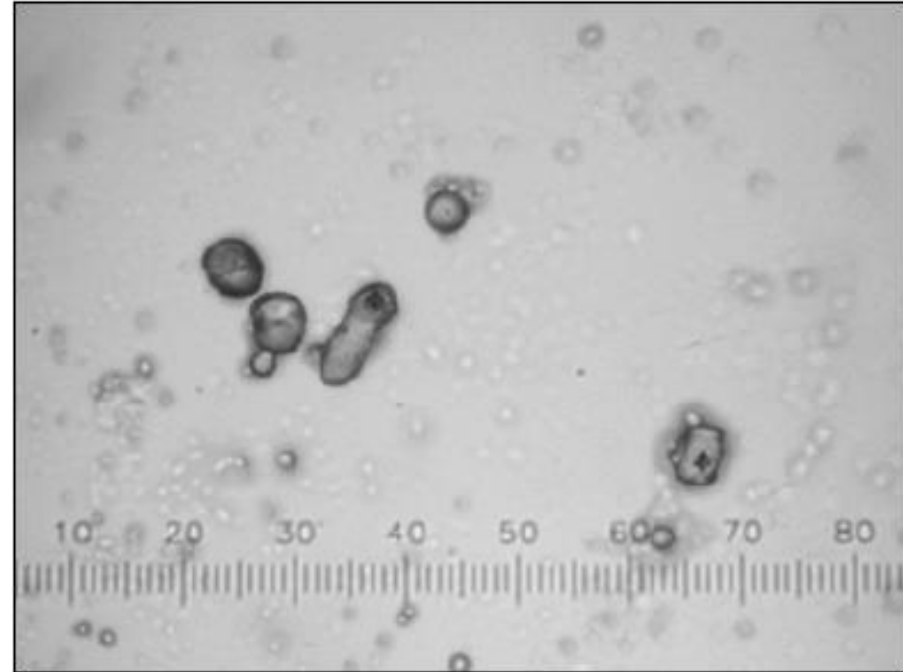
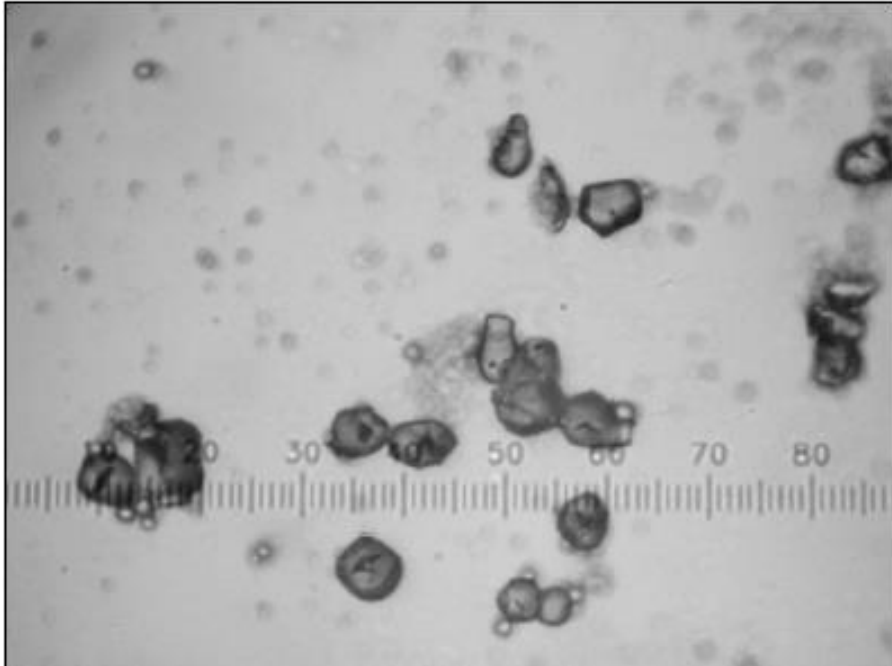


Starch grains from maize kernels, Race Pepetilla.  
160x

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# *Zea mays*, raza Pollo

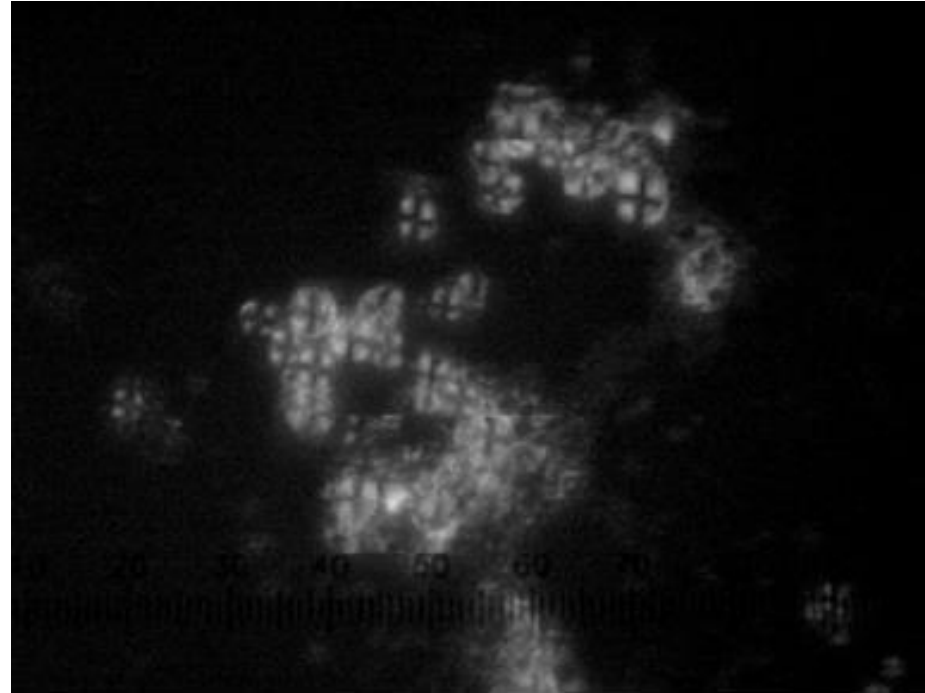
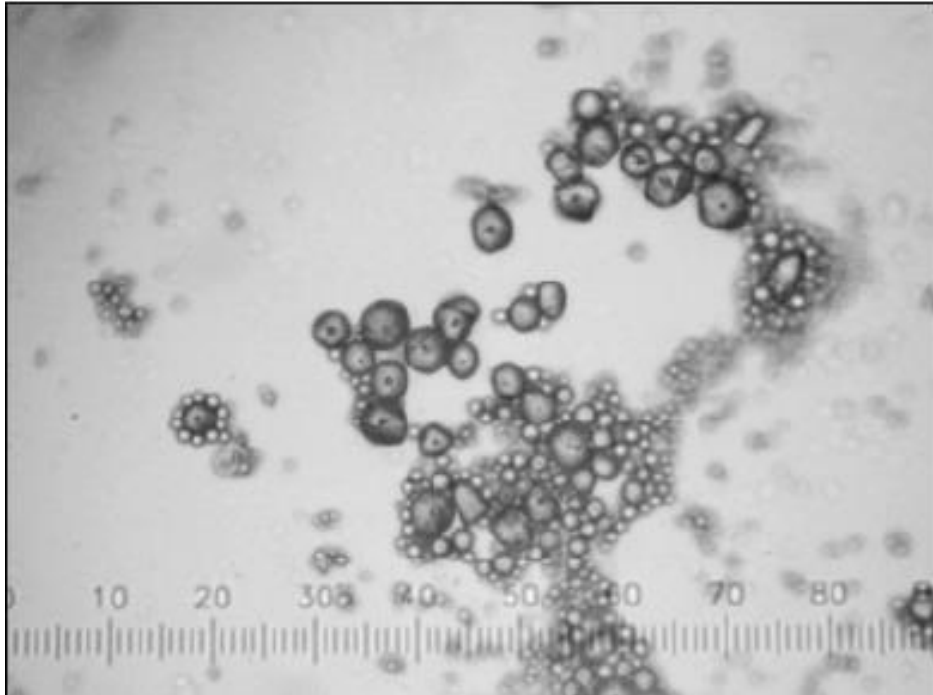
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# *Zea mays*, raza Tusón (Tuñón)

## Starch

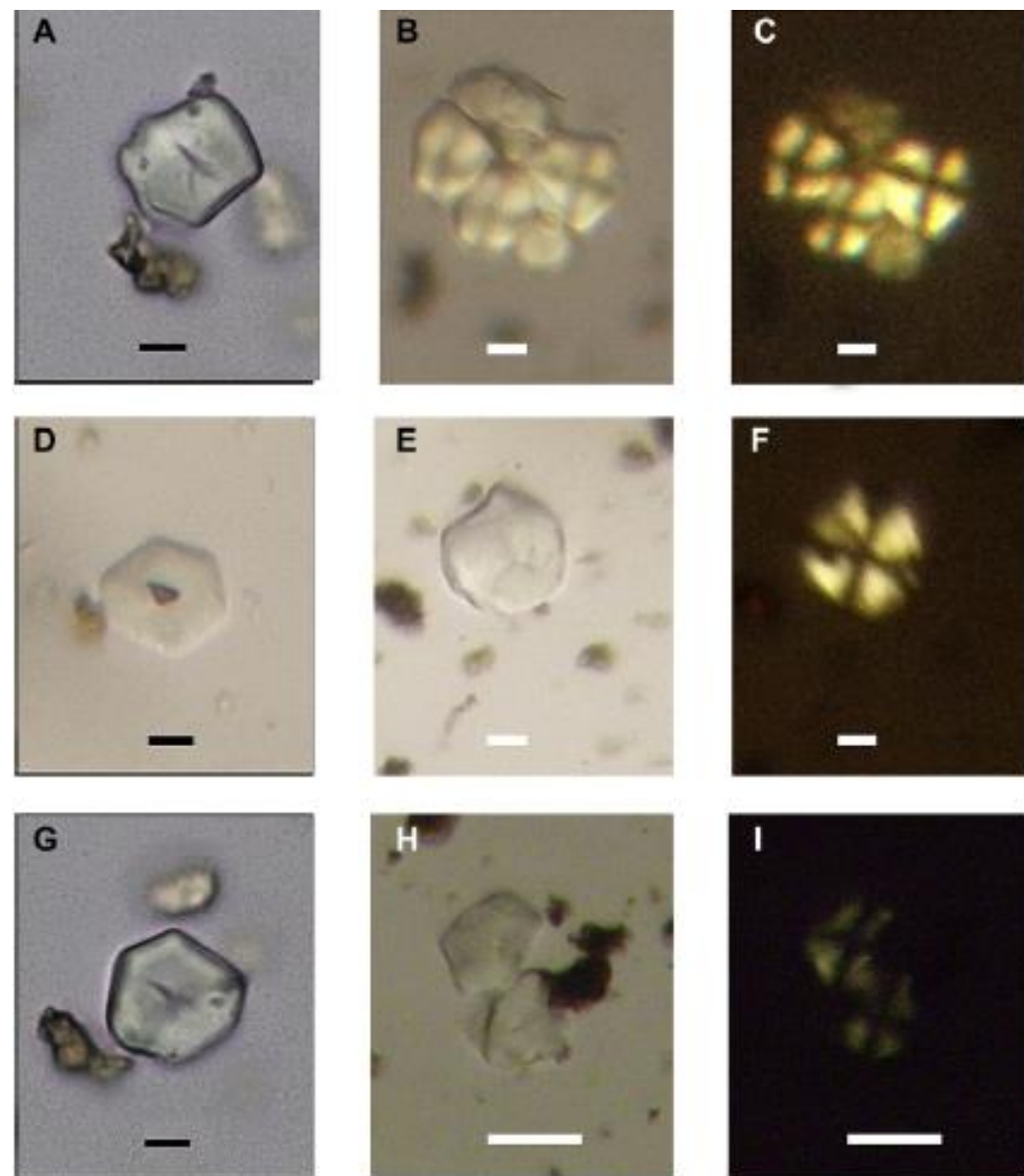


Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Zea mays

## Starch

Fig. 2. Range of variation in archaeological maize starch. A, D and G: Simple starch grains, five to six two-dimensional polygonal sides. B: Assemblage of simple starch grains. C: Same starch grains with polarized light. E: Irregular starch grain with deep compression facets. F: Same starch grain with polarized light. H: Assemblage of simple starch grains. I: Same starch grains with polarized light (Scale bars: 10 mm)

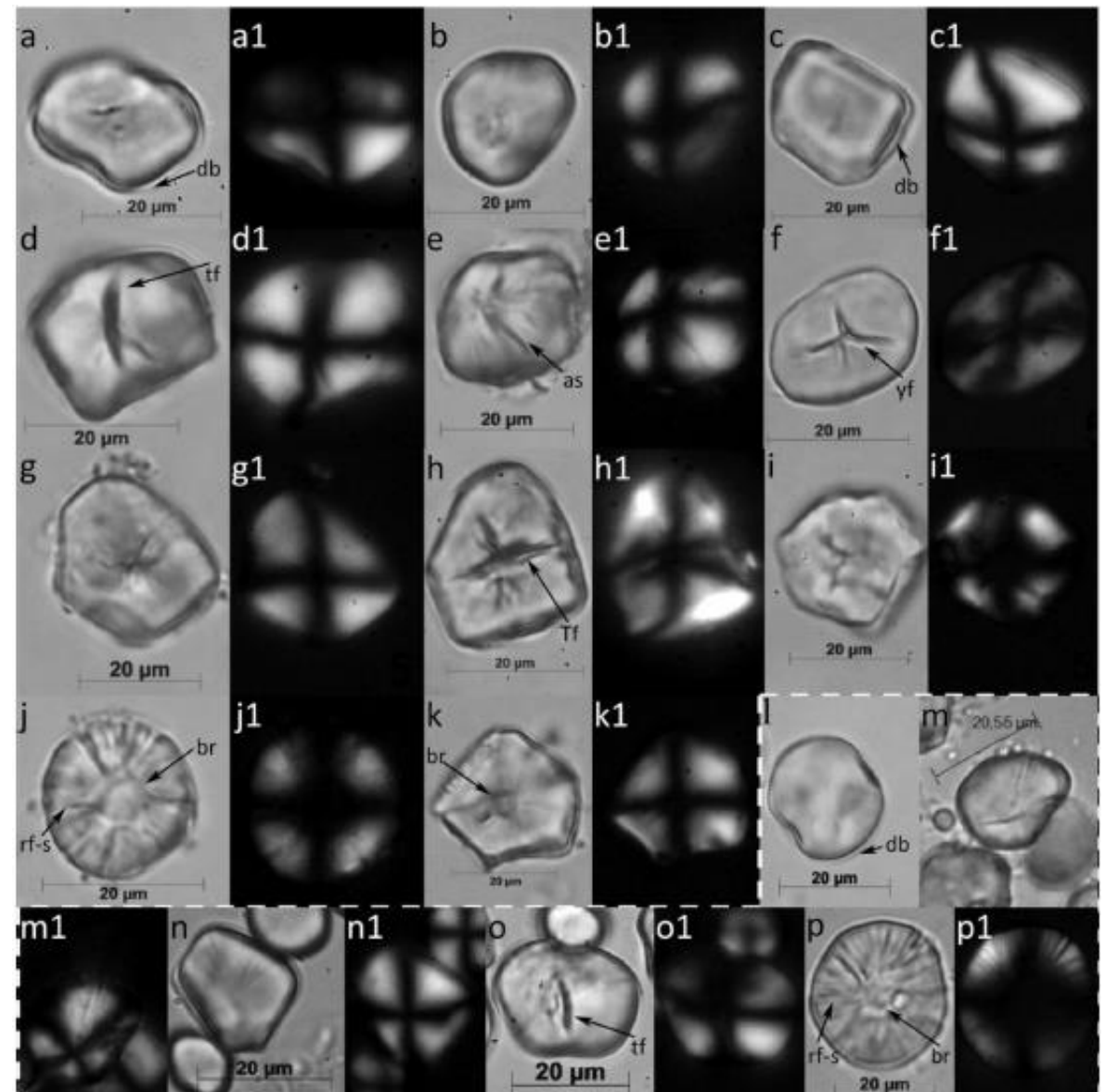


Musaubach, María Gabriela, Anabela Plos, and María Del Pilar Babot. 2013. Differentiation of Archaeological Maize (*Zea Mays* L.) from Native Wild Grasses Based on Starch Grain Morphology. Cases from the Central Pampas of Argentina. *Journal of Archaeological Science* 40 (2). Elsevier Ltd:1186–93. <http://dx.doi.org/10.1016/j.jas.2012.09.026>.

# Zea mays

## Starch

Fig. 4. Ancient (a-k) and modern (l-p, framed by a dashed line) maize starch grains. a-h, and k are secure identifications; i and j are tentative identifications due to surface damaging. a1-k1 are the same ancient maize starches labeled with unnumbered letters, but under polarized light and dark field. Provenances: starches a-b (artifact E-1); h (artifact E-3); c, e, f (artifact SJ-4); d, g, i, j and k (artifact SJ-5). Modern maize starch grains come from comparative indigenous landraces (Pagan-Jimenez reference collection): l, n-o (Pollo, Colombia); m (Cabuya, Colombia); p (Nal-Tel, Mexico, intentionally affected by heavy grinding experiments). m1-p1 are the same modern maize starches labeled with unnumbered letters, but under polarized light and dark field. Figure legend: “tf” ¼ transverse fissure; “Tf” ¼ fissure with a “T” shape; “as” ¼ asymmetric fissure; “yf” ¼ fissure with a “Y” shape; “rf-s” ¼ radial fissure/striation; “db” ¼ double-border; “br” ¼ bright ring.



Pagán-Jiménez, Jaime R., Reniel Rodríguez-Ramos, Basil A. Reid, Martijn van den Bel, and Corinne L. Hofman. 2015. Early Dispersals of Maize and Other Food Plants into the Southern Caribbean and Northeastern South America. *Quaternary Science Reviews* 123:231–46. <http://www.sciencedirect.com/science/article/pii/S0277379115300445>.

# Zea mays

## Starch

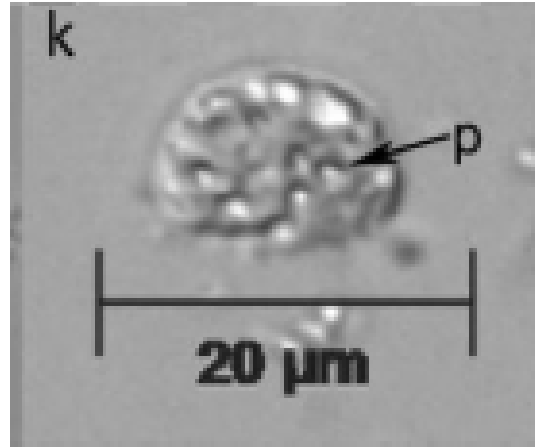


Fig. 9. k, modern maize starch with pits made by enzymatic (amylase) digestion during fermentation with saliva (Pagan-Jimenez lab notes).

Pagán-Jiménez, Jaime R., Reniel Rodríguez-Ramos, Basil A. Reid, Martijn van den Bel, and Corinne L. Hofman. 2015. Early Dispersals of Maize and Other Food Plants into the Southern Caribbean and Northeastern South America. *Quaternary Science Reviews* 123:231–46. <http://www.sciencedirect.com/science/article/pii/S0277379115300445>.



# Zea mays

## Phytolith

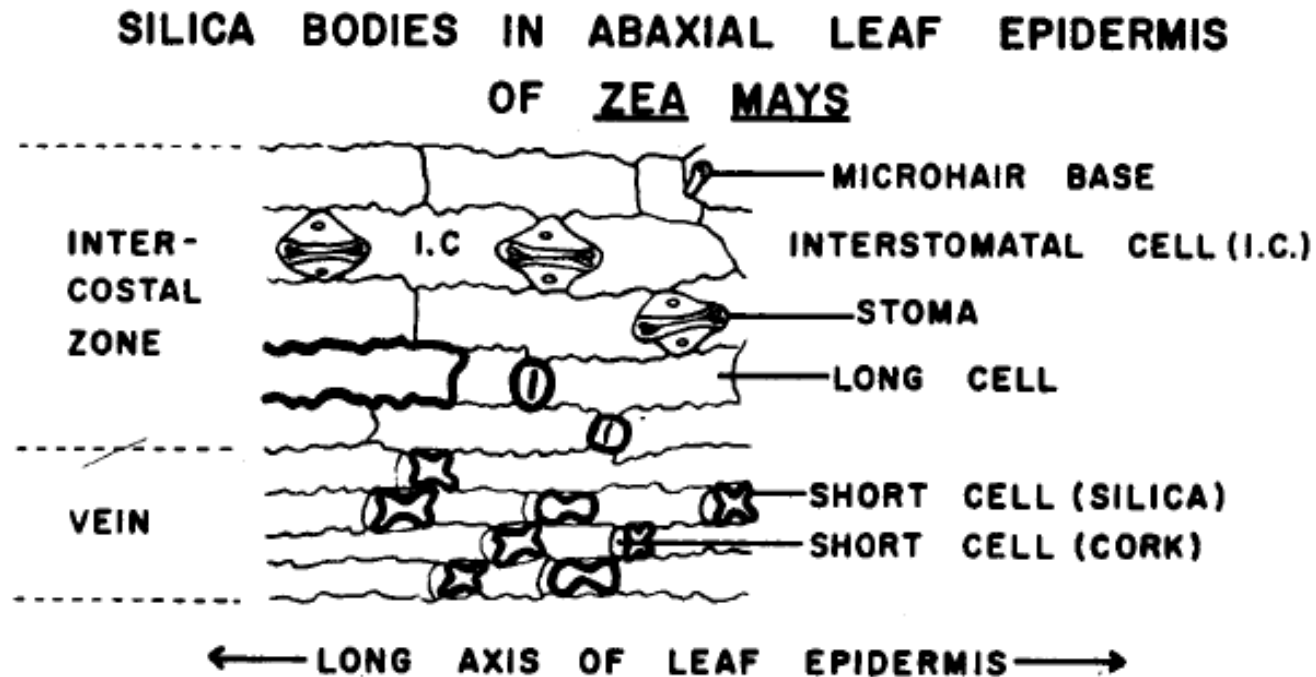
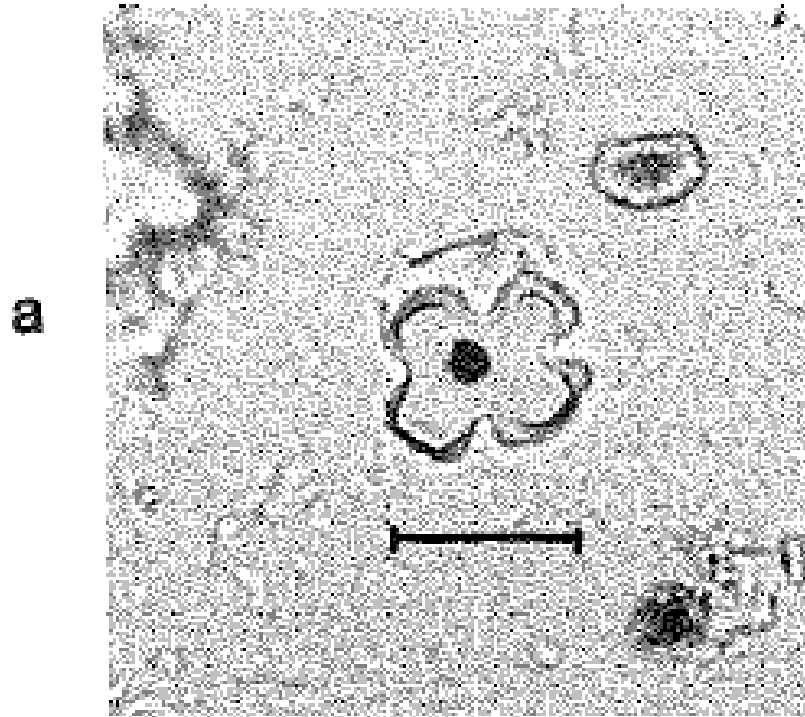


Fig. 1—Spodogram of *Zea mays* L. (after Metcalfe, 1960).

Twiss, Page C., Erwin Suess, and Robert M. Smith. 1969. "Morphological Classification of Grass Phytoliths." In *Soil Science of America Proceedings*, 33:109–15. Madison, Wisconsin. doi:10.1007/s00702-011-0732-4.

# Zea mays

## Phytolith



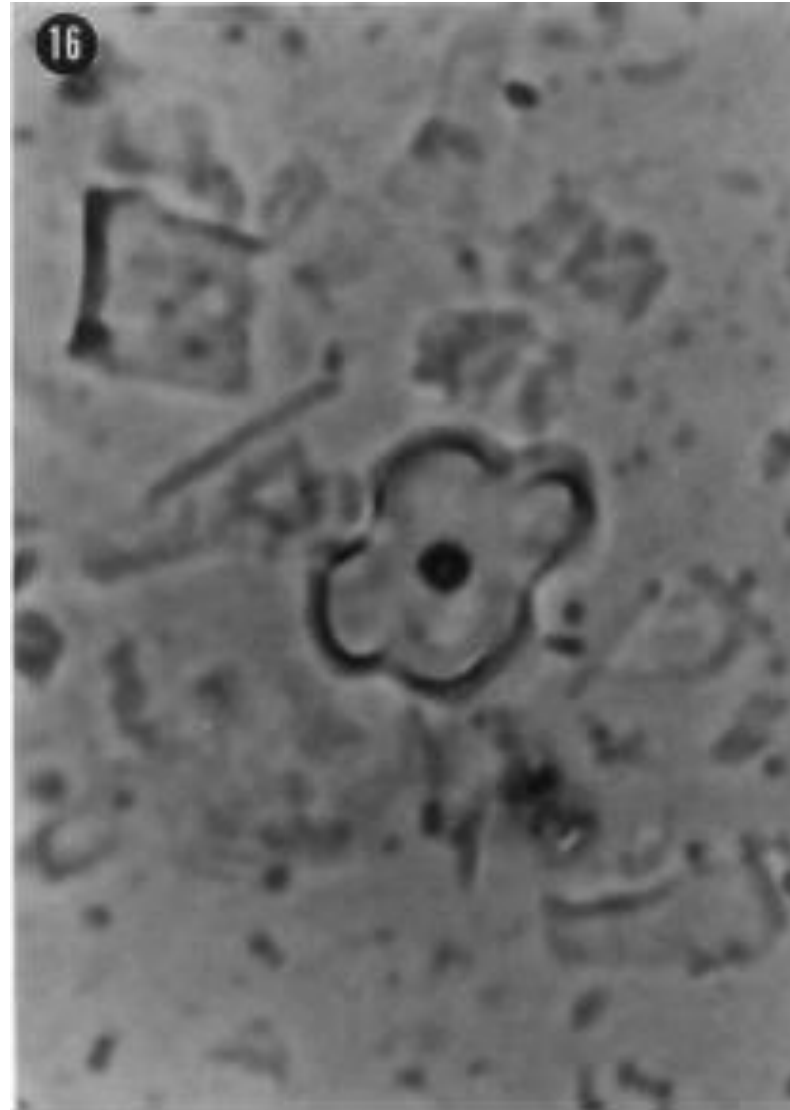
a. Variant 1 cross of Zea mays

Pearsall, Deborah Marie. 1993. Contributions of Phytolith Analysis for Reconstructing Subsistence: Examples from Research in Ecuador. *Current Research in Phytolith Analysis: Applications in Archaeology and Paleoecology*. MASCA.

# Zea mays

## Phytolith

FIGURES 13-16. 16, A Variant 1 (mirror-image) cross-shaped phytolith from *Zea mays* (x400).



Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Zea mays

## Phytolith

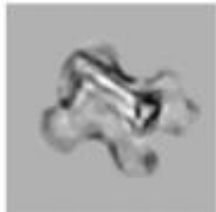
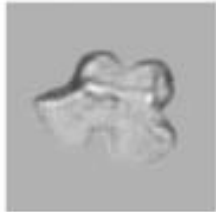
### Leaf Cross-shaped bodies 3-D Variants

Var. 1



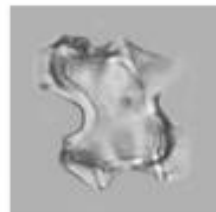
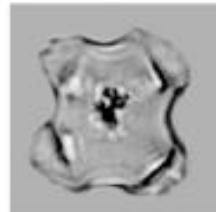
Mirror-image  
Maize

Var. 2



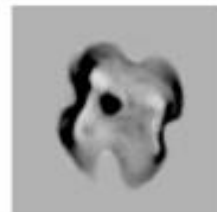
Tent-like arch  
Balsas Teosinte  
Many non-Zea grasses

Var. 3/8/10



Nodules/Blocky  
Bambusoideae

Var. 5 and 6



Sloping Trapezoids/  
Rectangular  
Many non-Zea grasses

Other Variants



Scooped/Concave/Other  
Bambusoideae/  
Ehrhartoideae/Pooideae

Ball, T. B., K. Chandler-Ezell, R. Dickau, N. Duncan, T. C. Hart, J. Iriarte, C. Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <https://doi.org/10.1016/j.jas.2015.08.010>.

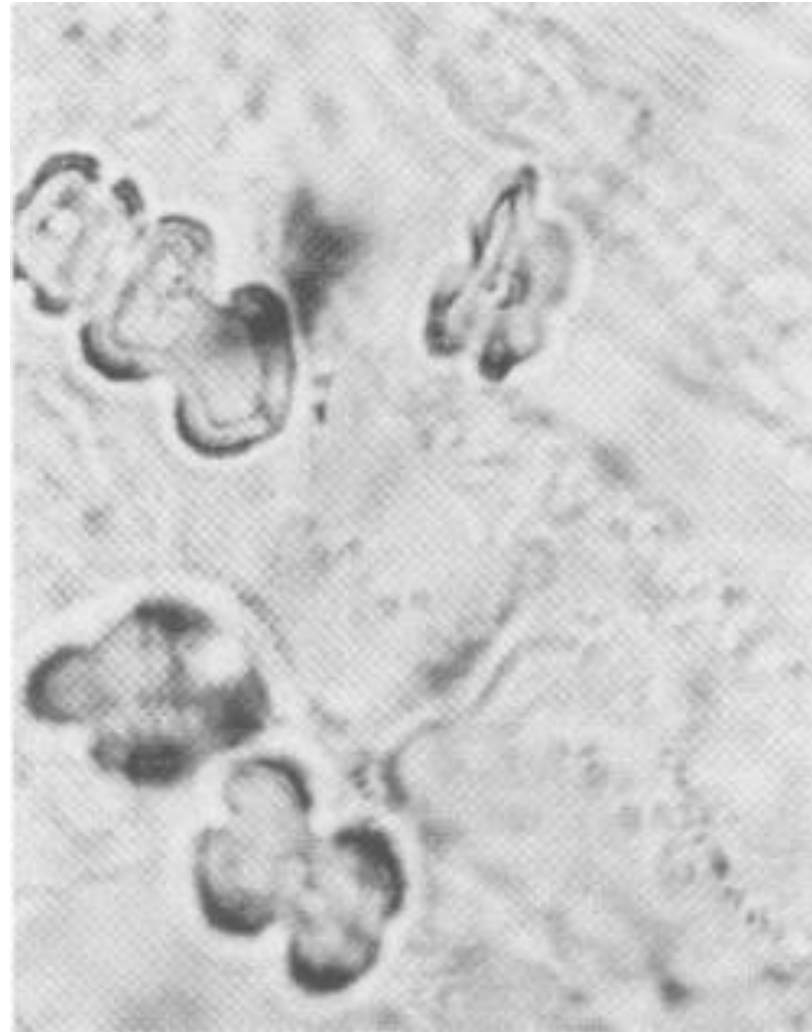
Piperno, D. R. 2006. *Phytoliths: A Comprehensive Guide for Archaeologists and Paleoecologists*.

Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

# Zea mays

## Phytolith

Fig. 21. Top center and bottom, three cross-shaped phytoliths enclosed in the leaf epidermis of maize. The two Variant 1 cross-bodies at the bottom are wider than the Variant 6 cross body at the top. This difference in the size of different cross-body variants typifies maize and other grasses, and also contributes to accurate identification archaeologically.

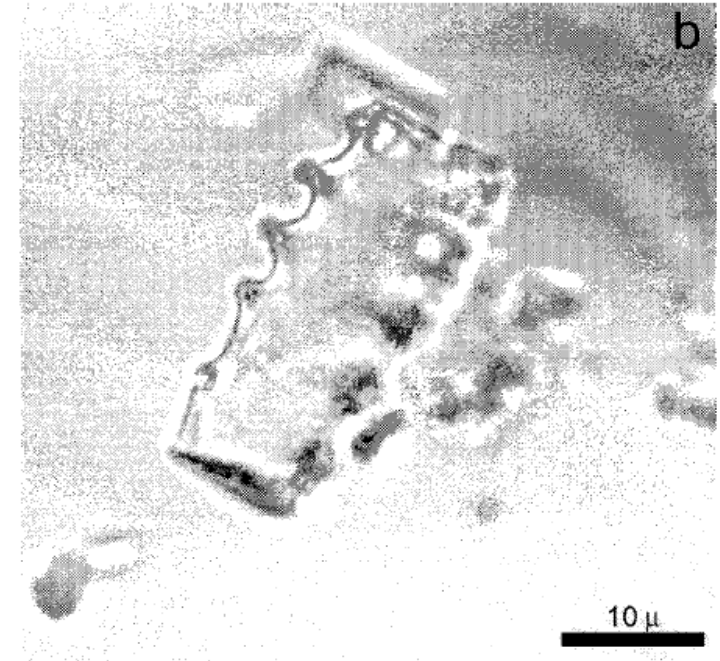
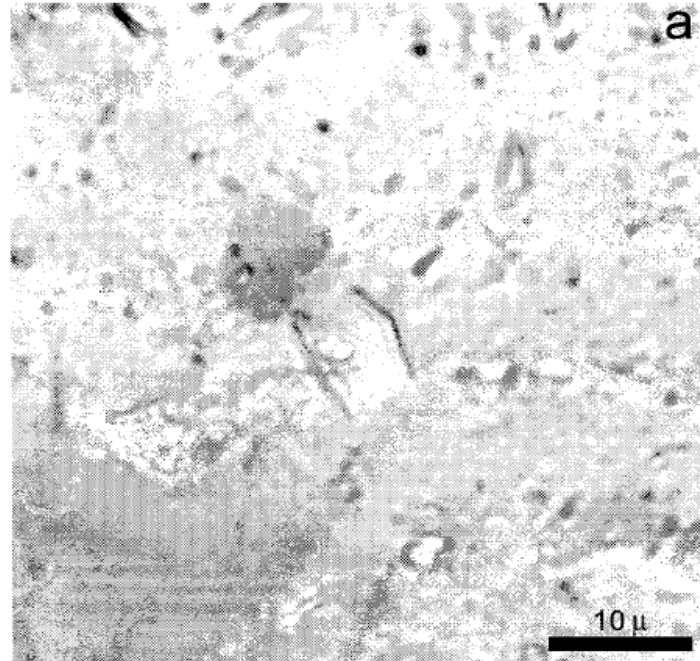


Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449. <http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Zea mays

## Phytolith

Figure 3. Cob bodies from Real Alto samples. A, wavy top rondel; B, wide rectangular IRP. Photographs taken at 400 x.



Pearsall, Deborah Marie. 2002. "Maize Is Still Ancient in Prehistoric Ecuador: The View from Real Alto, with Comments on Staller and Thompson." *Journal of Archaeological Science* 29: 51–55. doi:10.1006/jasc.2001.0736.

# Zea mays

## Phytolith

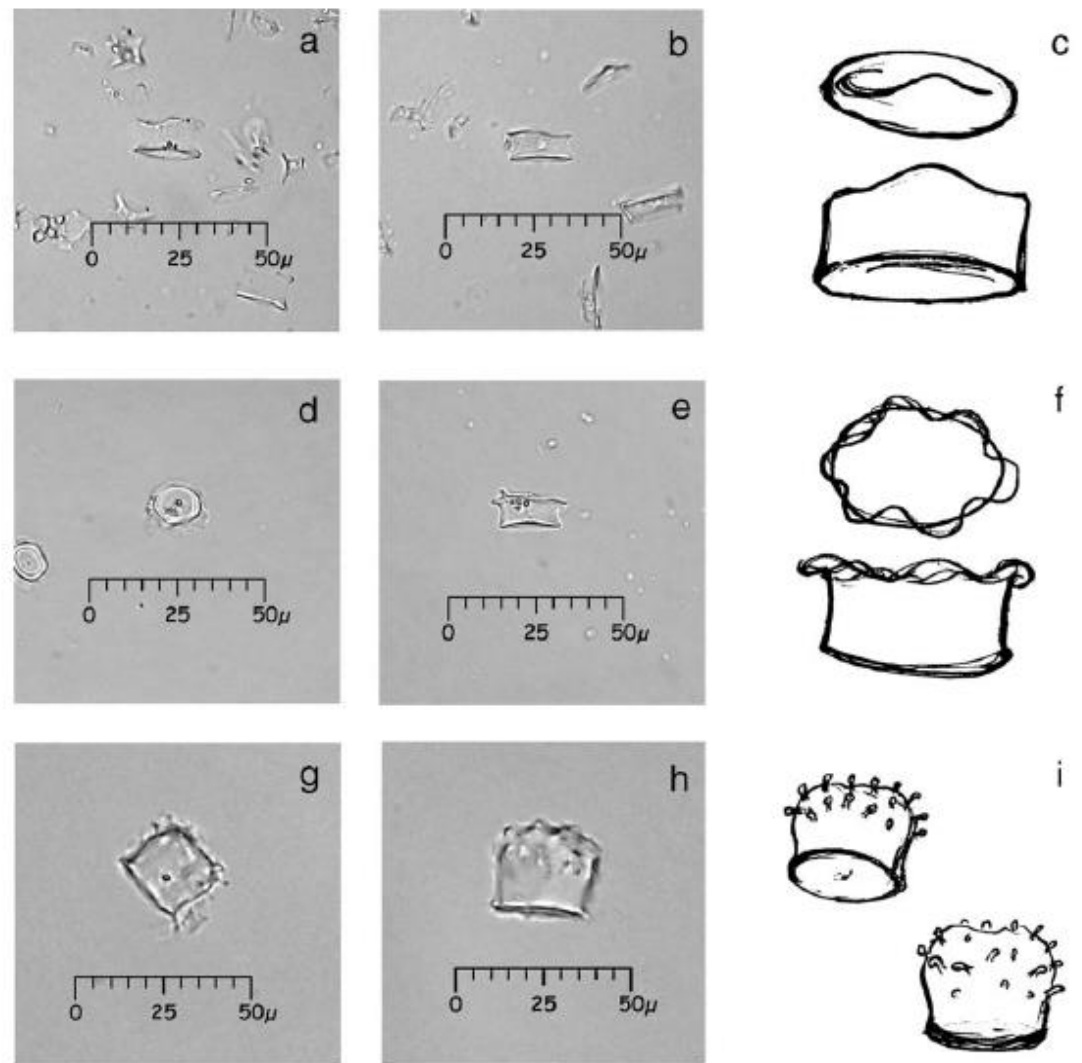
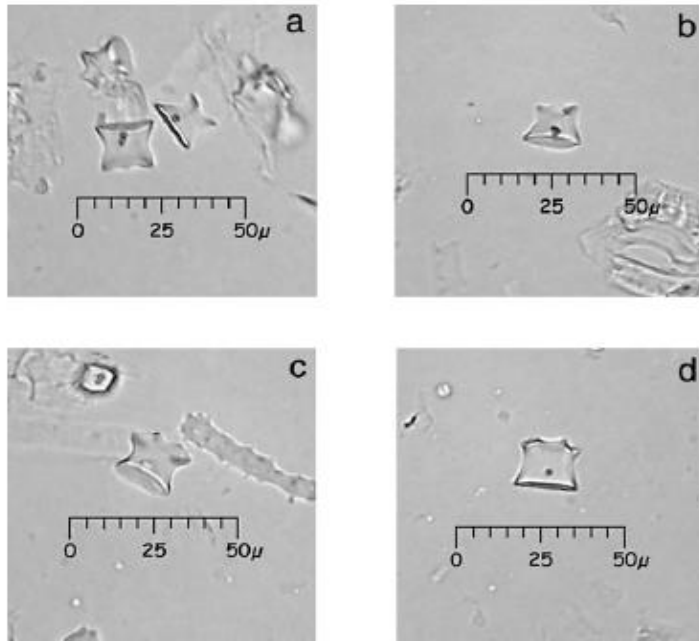


Fig. 1. Zea rondel phytoliths, bottom and side views of each type. (a–c) Wavy-top rondel; (d–f) ruffle-top rondel; (g–i) half-decorated rondel. See text for diagnostic features.

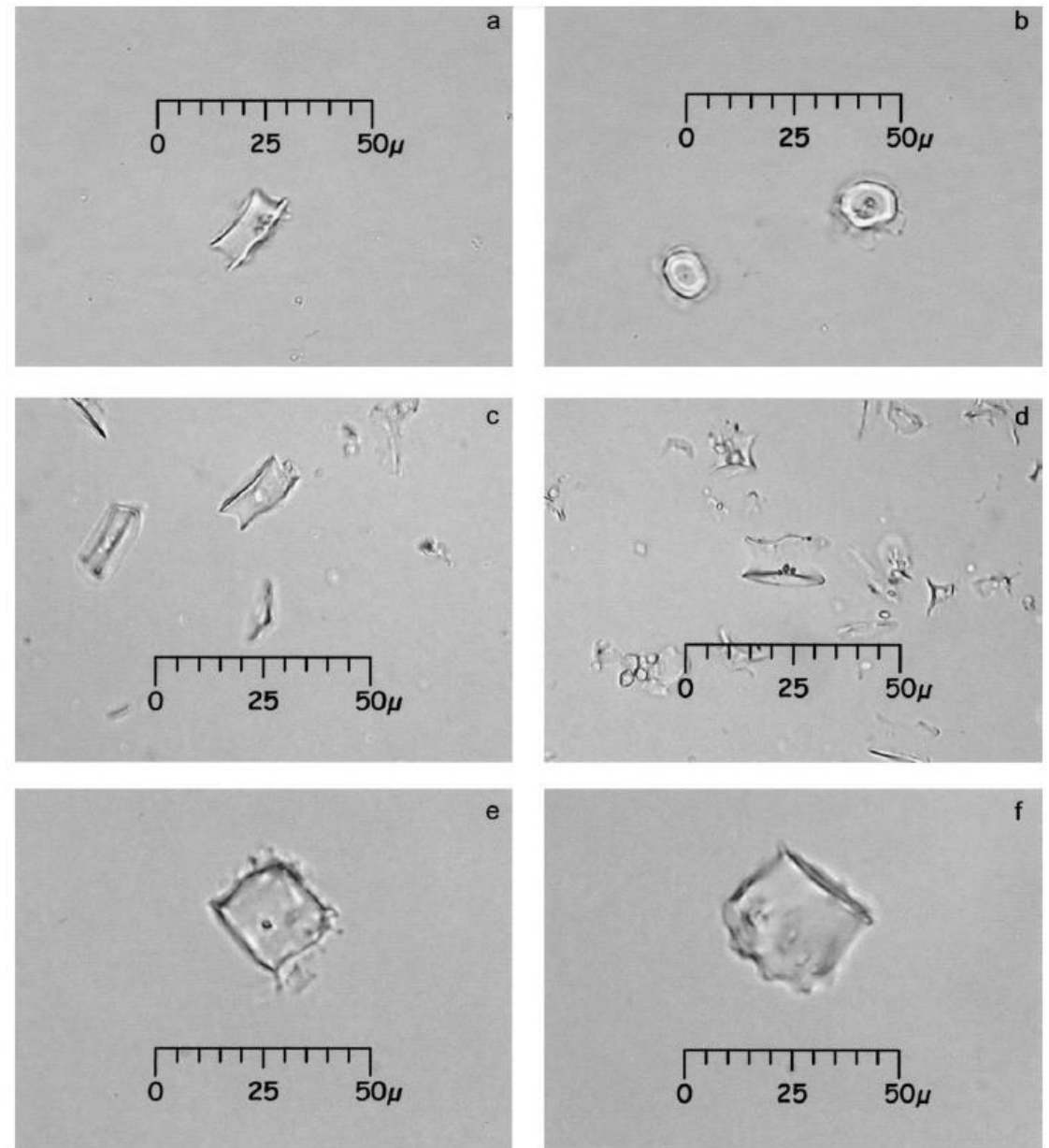
Fig. 2. Potential ‘confuser’ rondels from *G. angustifolia*. (a) Side view of three-spiked rondel. Note the solid, darkened lines of the edge spikes indicating their solid nature; (b) rotation of a three-spiked rondel showing the solid upper surface with solid spikes; (c) solid-topped decorated rondel showing angular edges and solid surface of the top; (d) solid-topped decorated rondel in side view, showing the angularity of the top edge.

Pearsall, Deborah Marie, Karol Chandler-Ezell, and Alex Chandler-Ezell. 2003. “Identifying Maize in Neotropical Sediments and Soils Using Cob Phytoliths.” *Journal of Archaeological Science* 30 (5): 611–27. doi:10.1016/S0305-4403(02)00237-6.

# Zea mays

## Phytolith

Fig. 2. Examples of wavy-top rondels, ruffle-top rondels, and half-decorated rondels, which were the subject of the study by Pearsall et al. [17]. a: ruffle top rondel, side view, ruffled top is to the right; b: ruffle-top rondels, rondel faces are up (sharp focus), ruffled faces are down; c: wavy-top rondel, wavy top is to the right; d: wavy-top rondel, wavy top is up; e, f: half-decorated rondels.



Pearsall, Deborah M., Karol Chandler-Ezell, and Alex Chandler-Ezell. 2004. "Maize Can Still Be Identified Using Phytoliths: Response to Rovner." *Journal of Archaeological Science* 31 (7): 1029–38. doi:10.1016/j.jas.2003.11.007.



# Zea mays

## Phytolith

Fig. 8. Archaeological maize cob phytoliths, a: wavy top rondel, side view, from 3294-A; b: wavy top rondel, top view, 3415-A; c: wavy top rondel, house floor sample; d: ruffle top rondel, 3294-B, e: ruffle top rondel, top view, 3415-B; f: wide IRP, 3331-B; g: wide IRP, house floor sample; h: half-decorated rondel, 3292-A; i: half-decorated oblong, 3292-A.

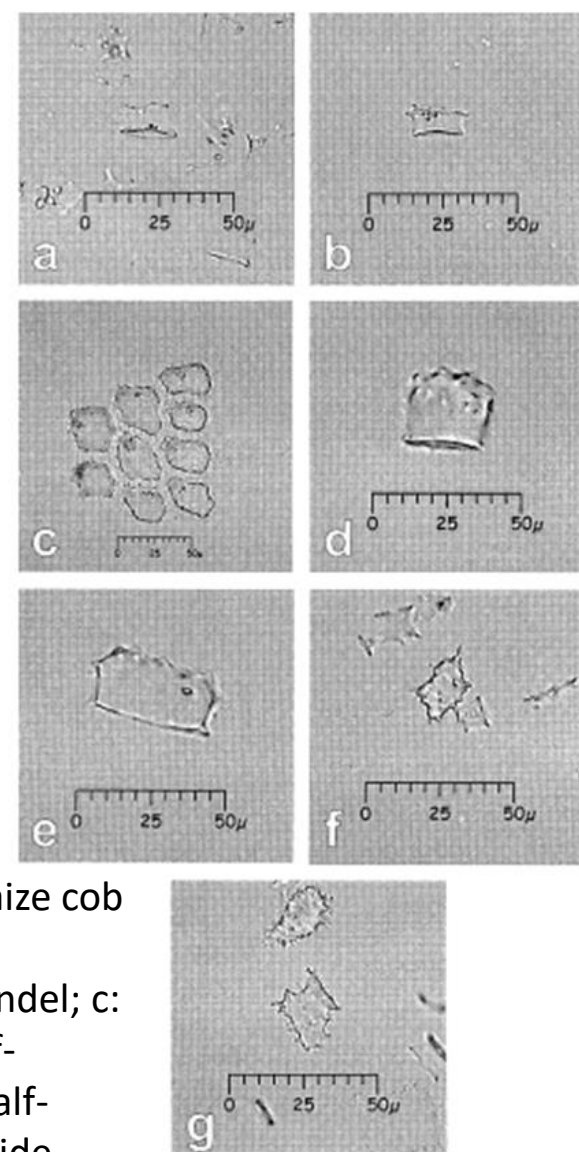
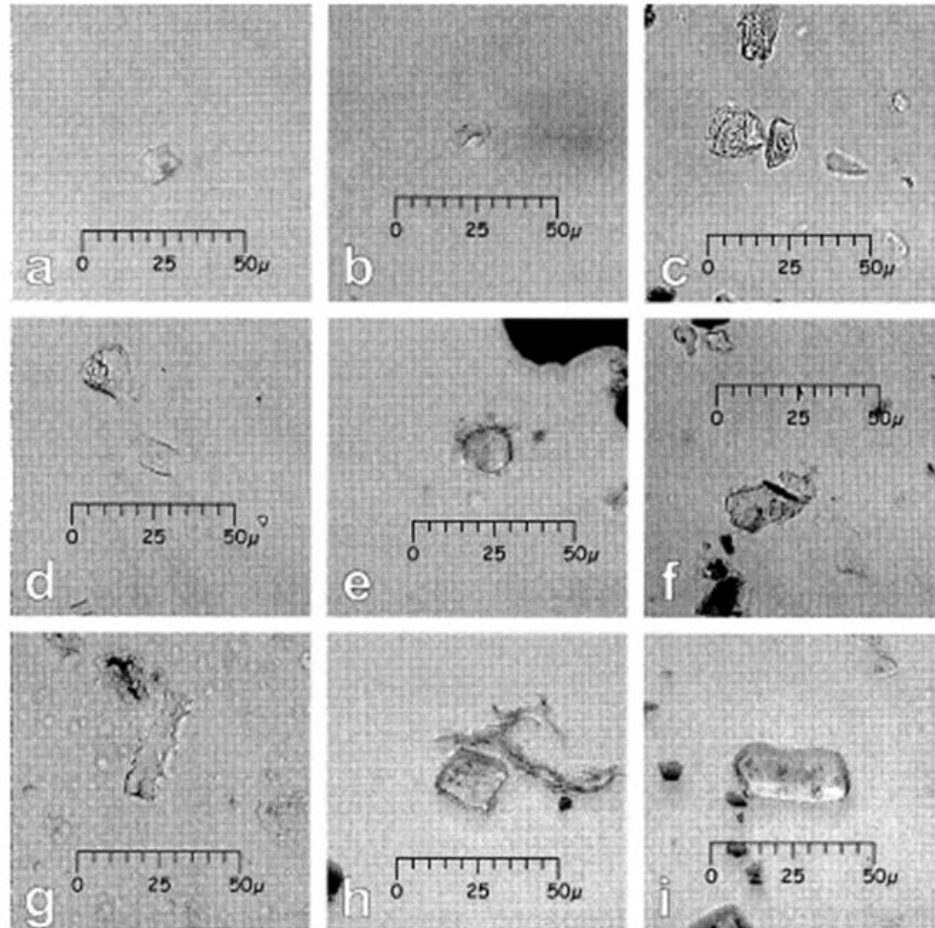


Fig. 6. Comparative maize cob phytoliths, a: wavy top rondel; b: ruffle top rondel; c: robust globular; d: half-decorated rondel; e: half-decorated oblong; f: wide IRP; g: irregular IRP.

# Zea mays

## Phytolith

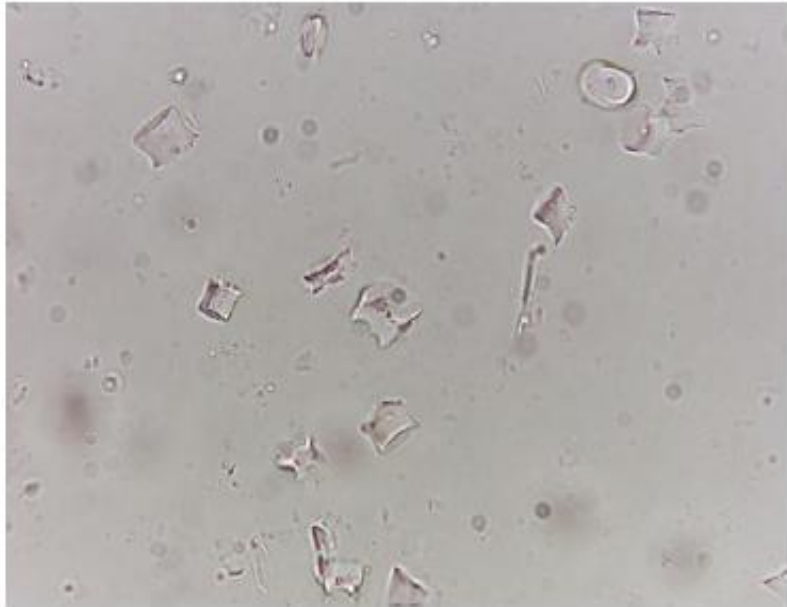


Fig. 7. Phytoliths from the glumes and cupules of maize, Race Amarillo. In contrast to teosinte, phytolith assemblages under the control of the maize allele of Tga1 predominantly contain short cell phytoliths (rondels) with few to no other types present.



Fig. 11. A “spooled” type of rondel phytolith recovered from a maize cob from San Andre’s, Mexico. It is like phytoliths typically found in modern maize races.

# Zea mays

## Phytolith

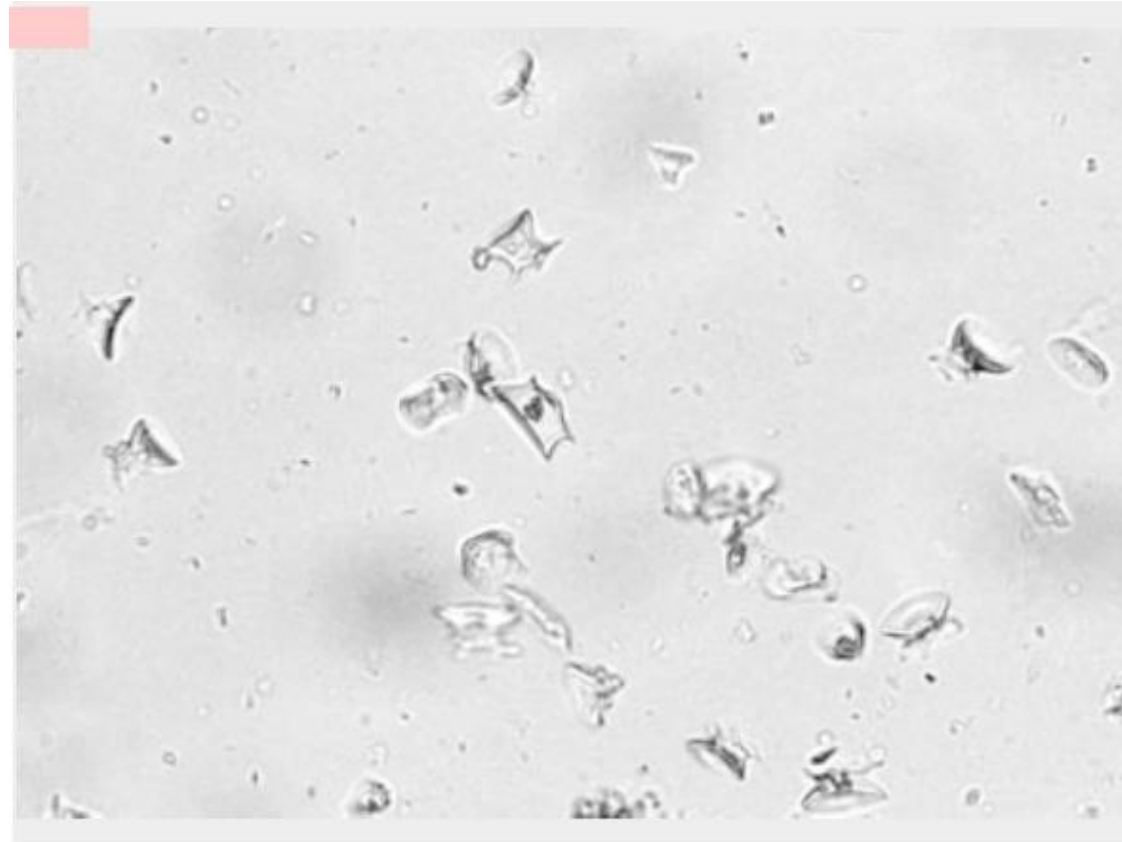
wavy top rondel:

Rectangular bases, bilobate bases, and saddle bases are excluded from this type.

Occur only in maize.

Good maize indicator even within the range of teosinte.

Diagnostic level: species, domesticated



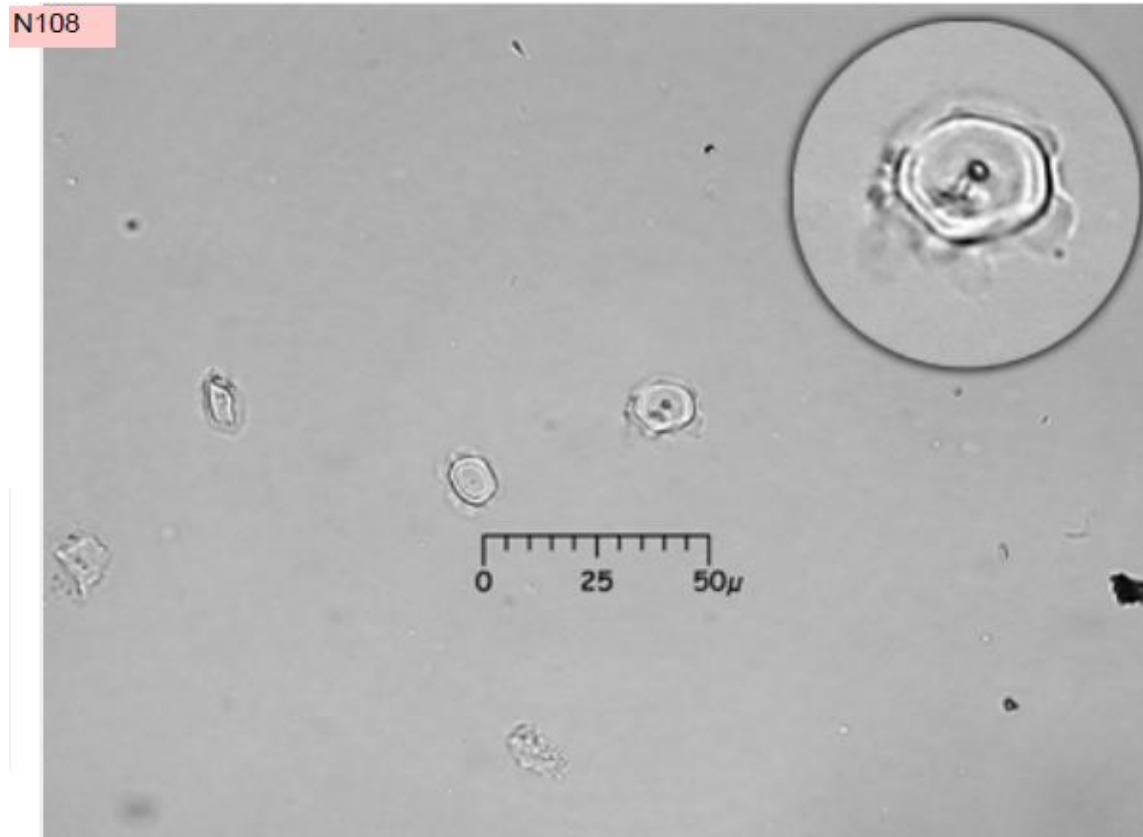
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea mays

## Phytolith

Ruffle-top rondel

Described by Bozarth (1993) Occurs in  
genus Zea. Diagnostic level: genus



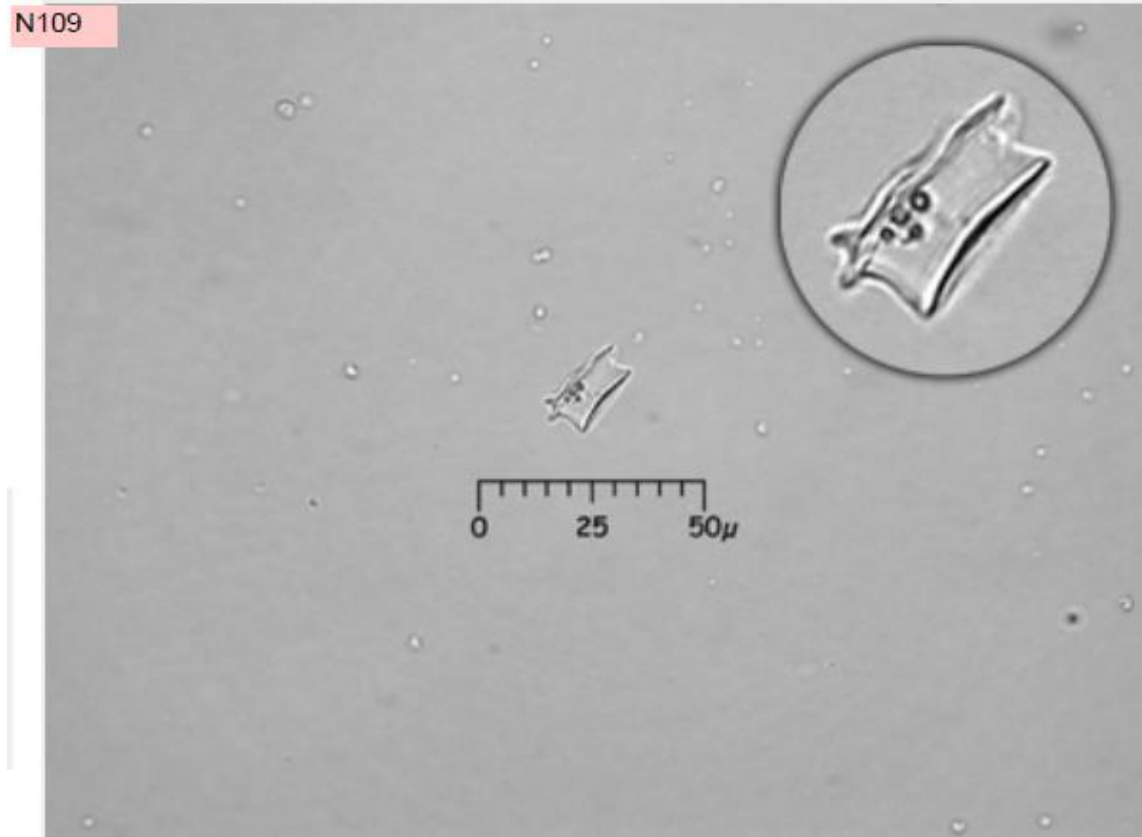
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea mays

## Phytolith

Ruffle-top rondel

Described by Bozarth (1993) Occurs in  
genus Zea. Diagnostic level: genus

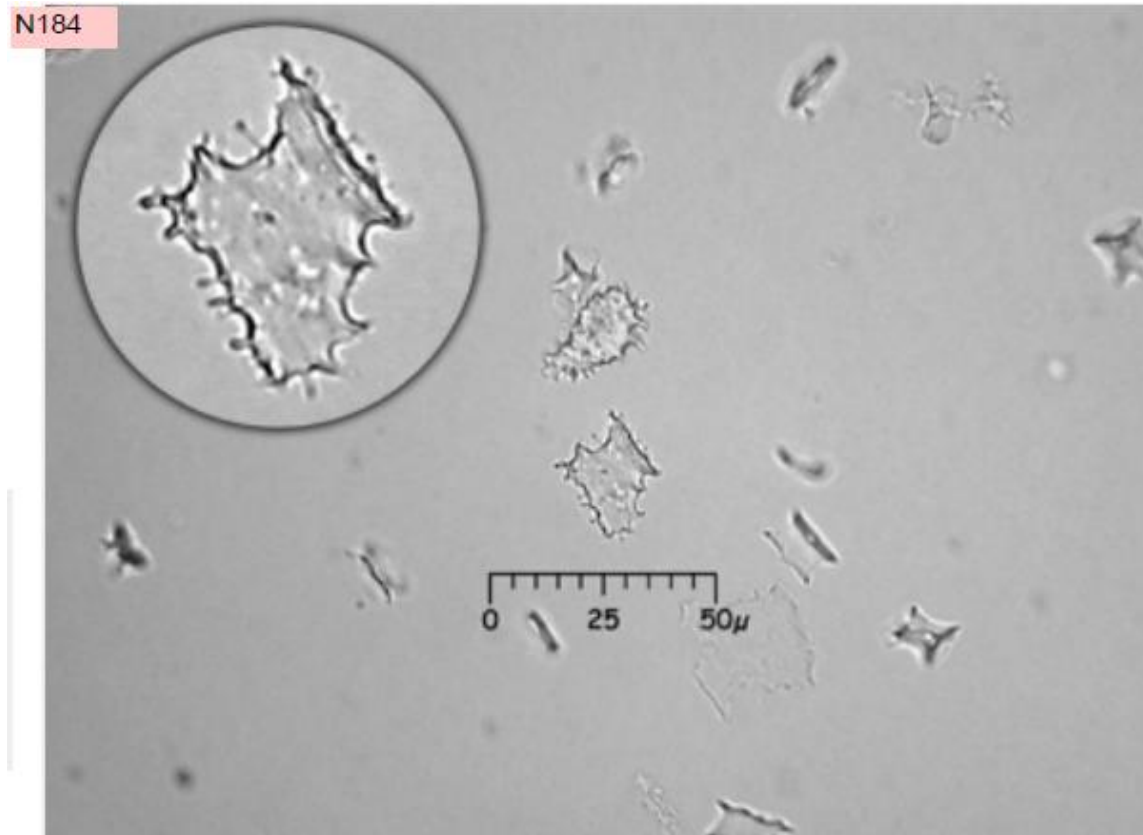


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea mays

## Phytolith

Diagnostic level: *Zea* spp. and some other panicoid grasses. Irregular IRP, IRP type was first described by Piperno and Pearsall (1993). IRP bodies are the product of epidermal silicification in the fruitcase, cupule, glume, and other infl. tissues. Found in *Zea* spp., *Panicum bulbosum*, and *Lasiacis* spp. (panicoid grasses), and *Neurolepis pittieri* (bamboo)



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea mays mays

## Phytolith

wavy top rondel: Described by Bozarth (1993). Rectangular bases, bilobate bases, and saddle bases are excluded from this type. Occur only in maize. Good maize indicator even within the range of teosinte. Diagnostic level: species, domesticated



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea mays mays

## Phytolith

wavy top rondel: Described by Bozarth (1993). Rectangular bases, bilobate bases, and saddle bases are excluded from this type. Occur only in maize. Good maize indicator even within the range of teosinte.  
Diagnostic level: species, domesticated



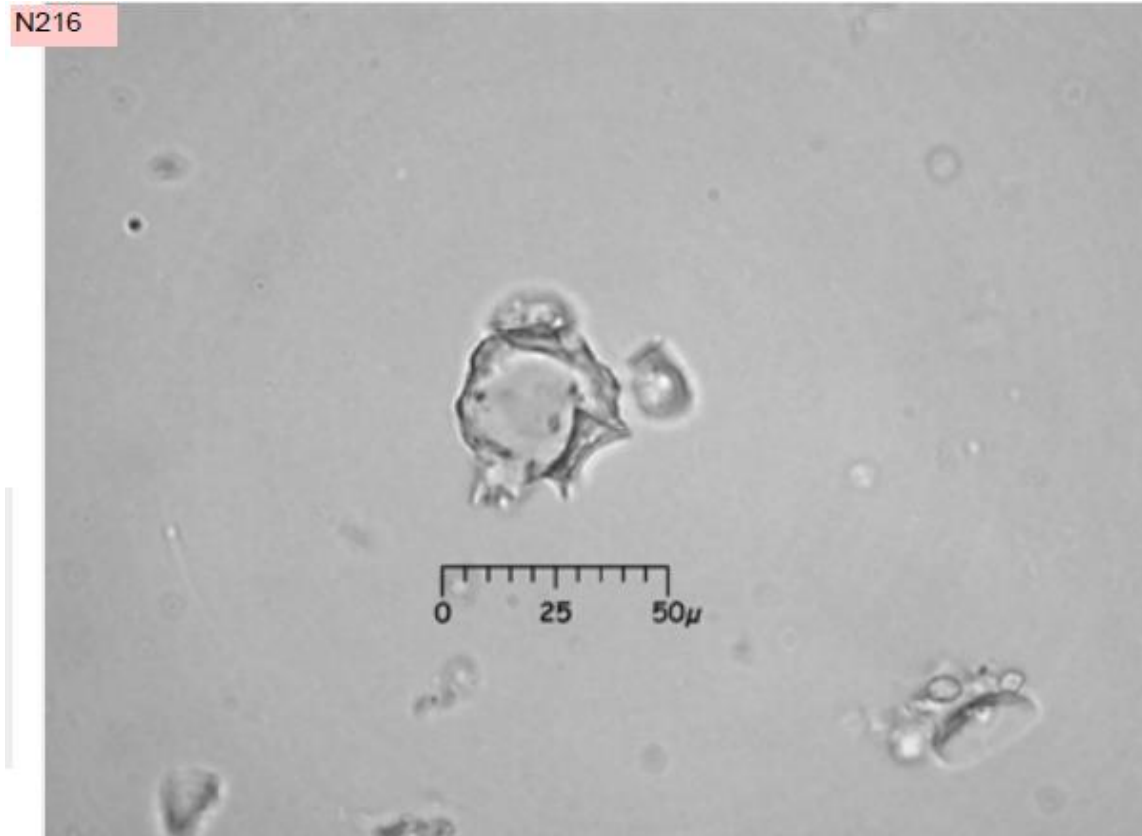
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Zea mays mays

## Phytolith

Diagnostic level: species, domesticated  
Gracile spherical body  
This is a relatively rare type that occurs  
in maize, and not in teosinte or other  
wild panicoid grasses.  
Compare to their robust cousins  
(Robust globular bodies) in size, nature  
of projections, and degree of  
silicification

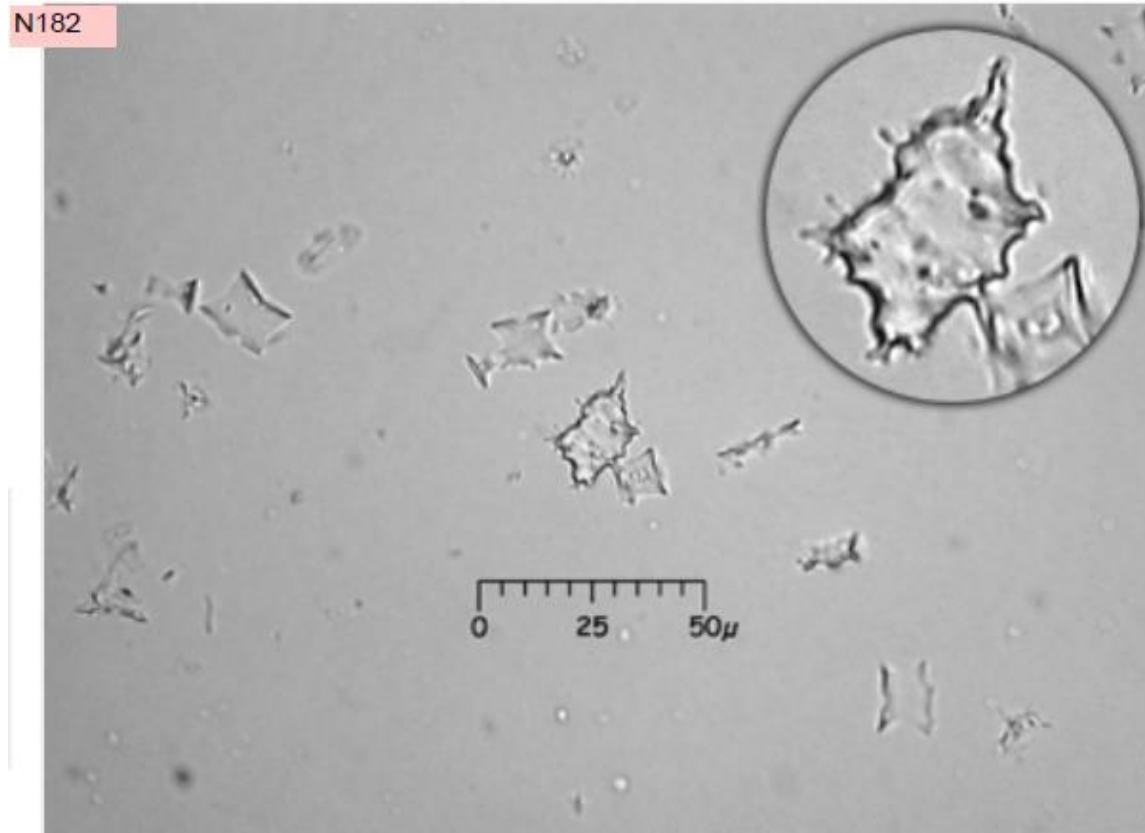


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea mays, race "pemitillo"

## Phytolith

Rectangular IRP, Wide (>7.5 microns width). IRP type was first described by Piperno and Pearsall (1993). IRP bodies are the product of epidermal silicification in the fruitcase, cupule, glume, and other infl. tissues. Diagnostic level: Zea spp. and some other panicoid grasses

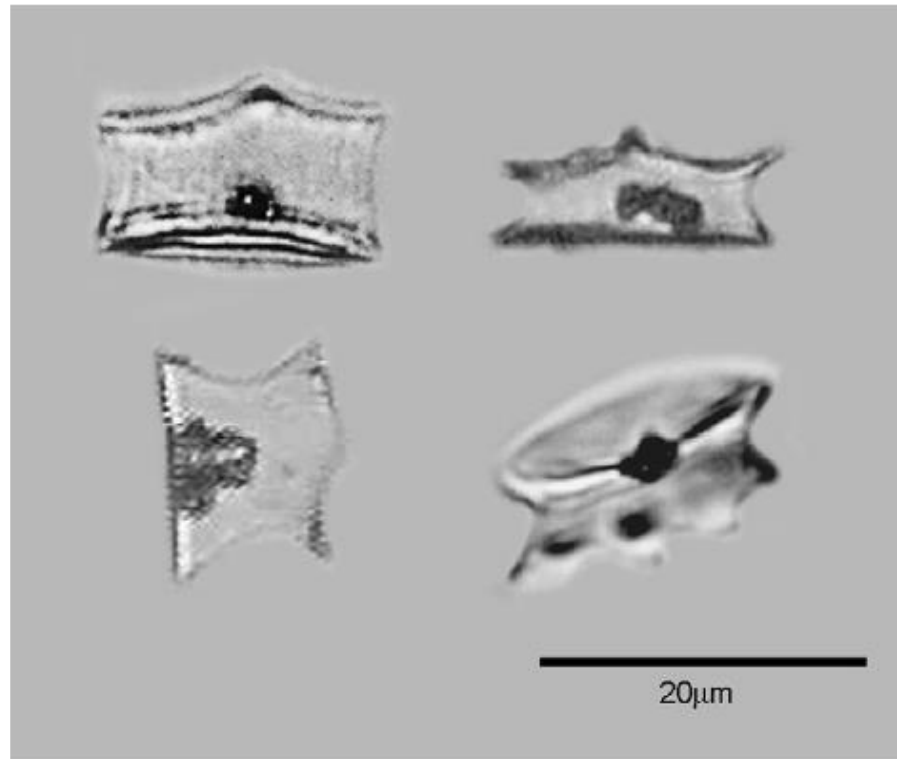


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Zea mays

## Phytolith

Fig. 8. Examples of wavy-top rondels from maize. The phytolith on the bottom right is a ruffle-top rondel from maize, for comparison. Reprinted from Piperno (2006a), Copyright AltaMira Press.



Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

# Zea mays

## Phytolith

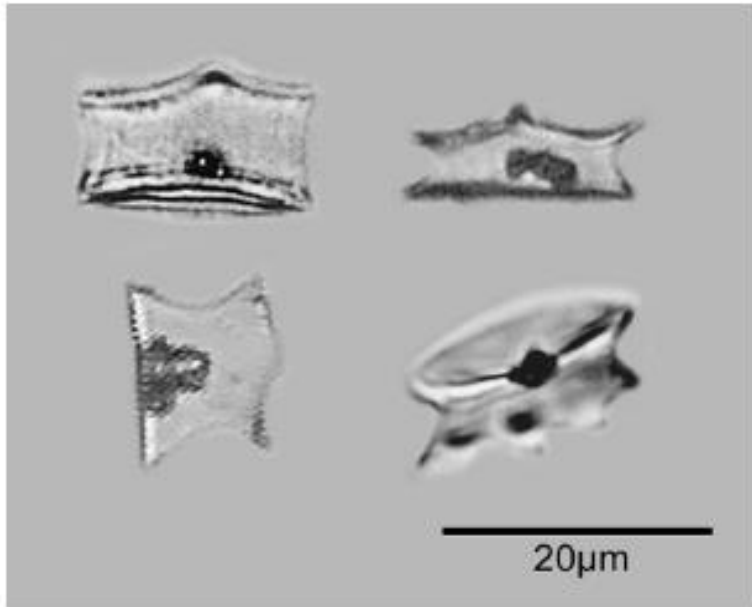


Fig. 2. Wavy-top (top, bottom left) and ruffle-top rondels (bottom, right) from maize. Ruffle-top rondels occur much more frequently in teosinte than maize. From Piperno, 2006

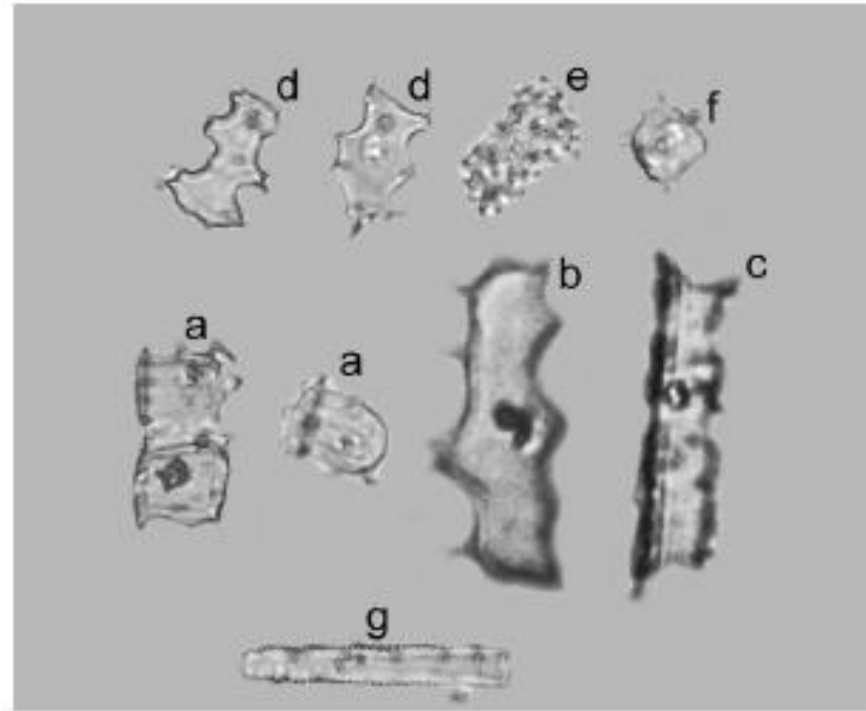


Fig. 3. The various kinds of non-rondel phytoliths found in teosinte fruitcases. Those diagnostic of teosinte are in the center (a, oblong, one-half decorated; b, elongated spiny; c, elongated with one wavy and one serrated edge). Phytoliths aef occur in some non-Zea grasses, but they like the others are always produced in teosinte and can be used to rule out its presence if absent from samples. The phytoliths range in size from about 10 (phytolith f) to 35 mM in diameter (phytolith b). From Piperno, 2006.

Ball, T. B., K. Chandler-Ezell, R. Dickau, N. Duncan, T. C. Hart, J. Iriarte, C. Lentfer, et al. 2016. Phytoliths as a Tool for Investigations of Agricultural Origins and Dispersals around the World. *Journal of Archaeological Science* 68. Elsevier Ltd:32–45. <https://doi.org/10.1016/j.jas.2015.08.010>.

# Zea mays

## Phytolith

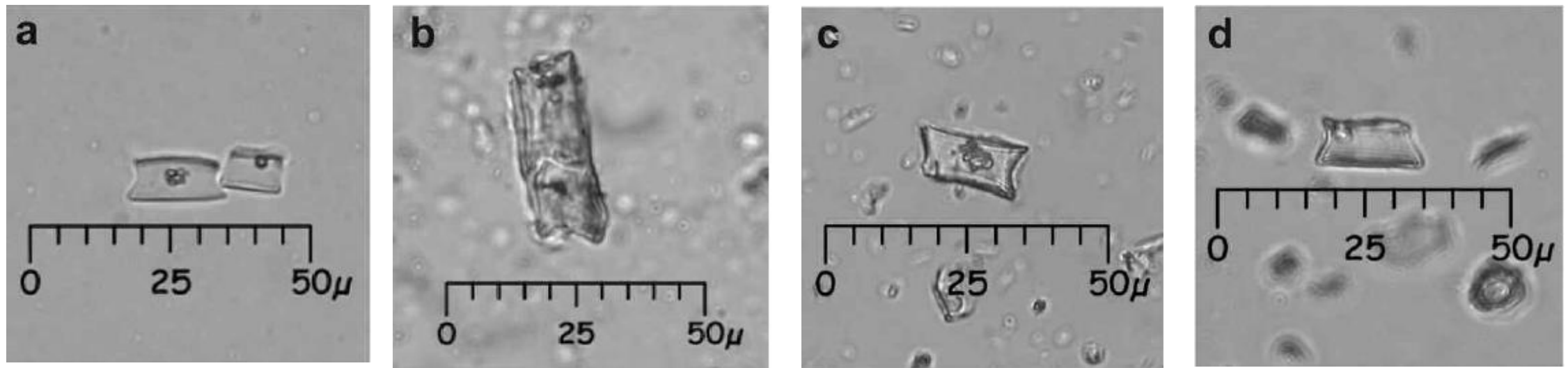


Figure 3. Maize diagnostic phytolith (narrow elongate rondel) for Andes: (a) narrow elongate rondel from modern reference maize; (b) two narrow elongate rondels in tissue from teeth of possible human sacrifice (Locus 5282) from Kala Uyuni; (c) and (d) narrow elongate rondels from manos (Loci 3132, 3110) from Chiripa Quispe.

Logan, Amanda L., Christine A. Hastorf, and Deborah Marie Pearsall. 2012. "Let's Drink Together": Early Ceremonial Use of Maize in the Titicaca Basin. *Latin American Antiquity* 23 (3):235–58.

# Zea mays

## Phytolith

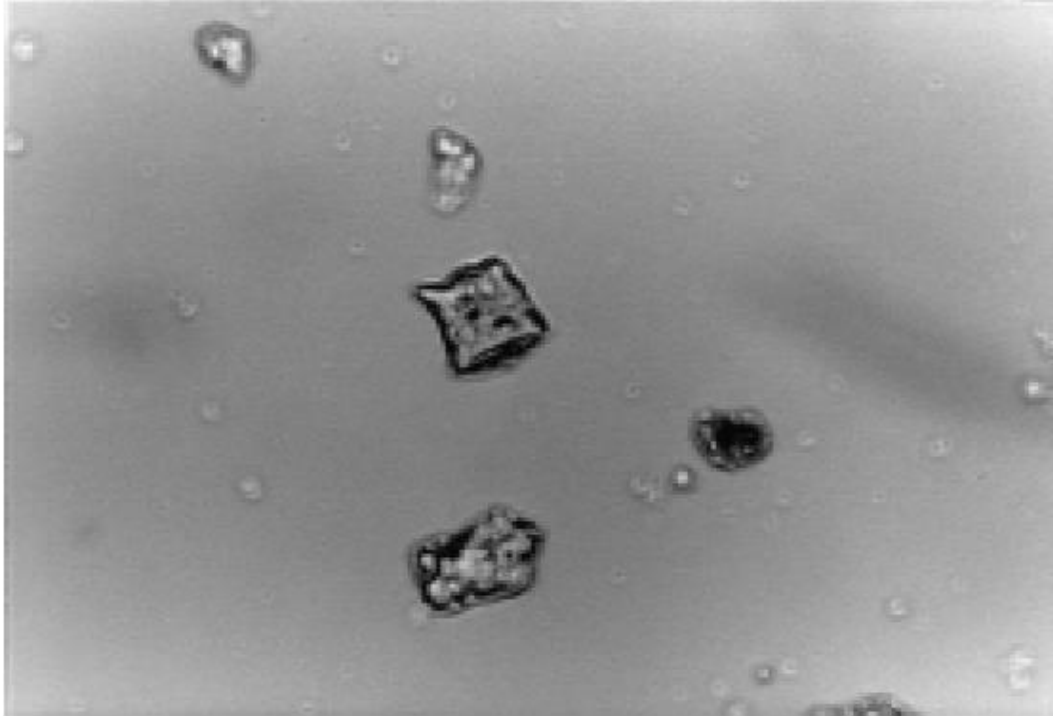


Rondels from the cob of *Zea mays* L., race Maiz Ancho (400x). As the rondel phytoliths from maize, and especially bamboos tend to be thick when formed in plant, the rondel faces that are oriented toward the investigator in plant tissue become the lateral edges of the phytoliths after they are removed from the plant and mounted on slides

Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Zea mays

## Phytolith



A phytolith from the glumes of maize cobs from the Aguadulce shelter. 160x. The phytolith is 14 microns long.

Piperno, Dolores R., and Irene Holst. 1998. The Presence of Starch Grains on Prehistoric Stone Tools from the Humid Neotropics: Indications of Early Tuber Use and Agriculture in Panama. *Journal of Archaeological Science* 25:765–76.

# Zea mays

## Phytolith

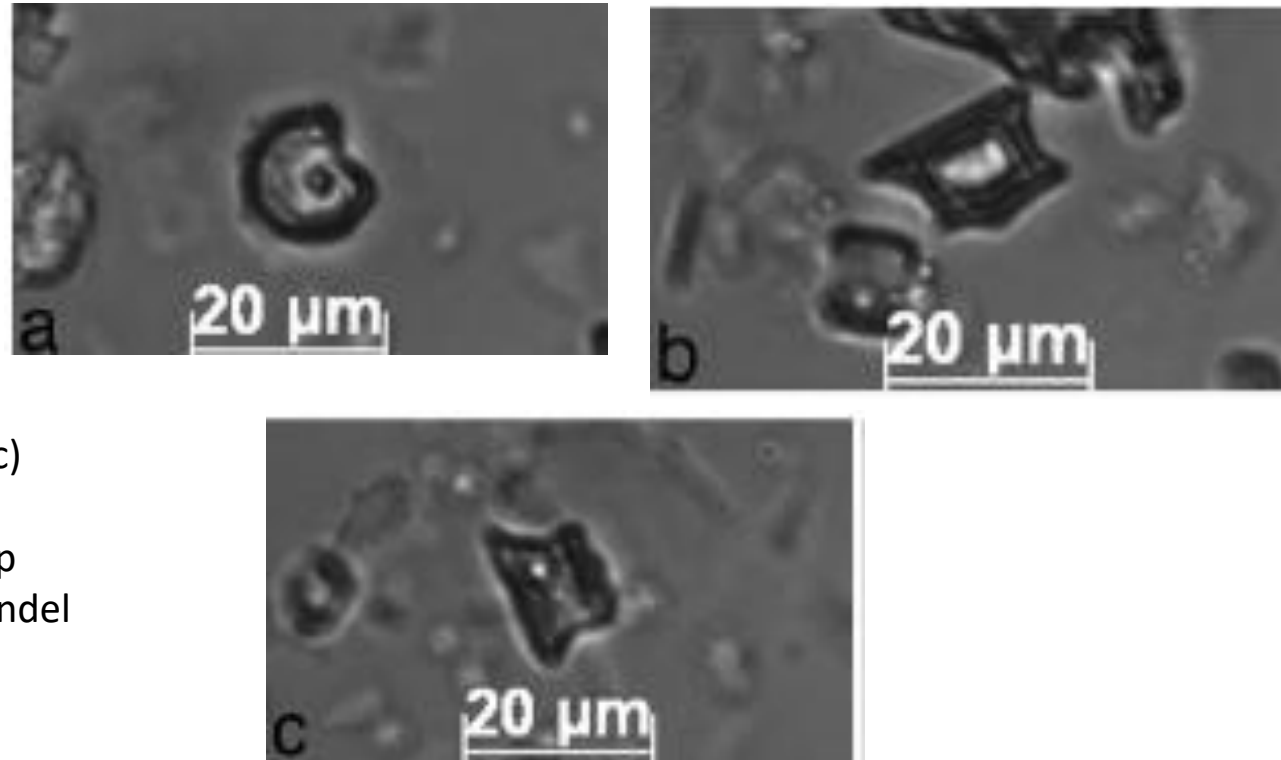


Fig. 3. Phytoliths from San Andre ´s. (a–c) Maize cob phytoliths. (a) A ruffle top rondel from 1,115 cm. (b) A wavy top rondel from 1,115 cm. (c) A ruffle top rondel from 1,140 cm.

Pohl, Mary E. D., Dolores R. Piperno, Kevin O. Pope, and John Glendon Jones. 2007. Microfossil Evidence for Pre-Columbian Maize Dispersals in the Neotropics from San Andres, Tabasco, Mexico. *Proceedings of the National Academy of Sciences* 104 (16):6870–75. <http://www.pnas.org/cgi/doi/10.1073/pnas.0701425104>.



# Zea mays

## Phytolith

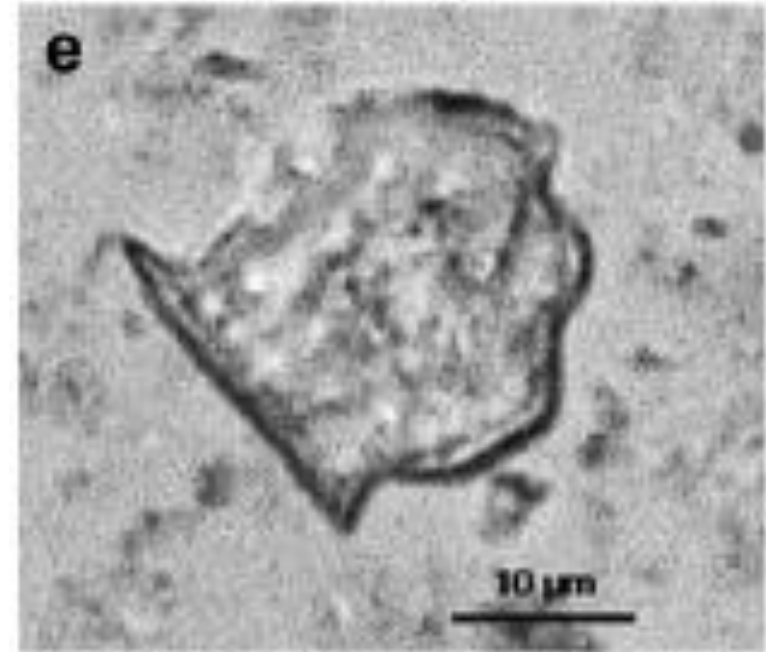
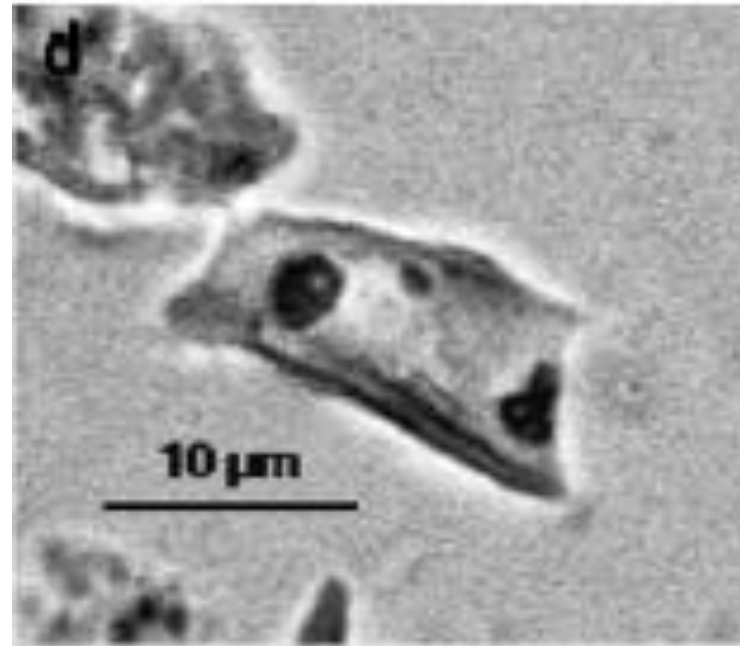


Fig. 3. Scale photomicrographs of phytolith morphotypes defined in the analysis. d) *Z. mays* cob wavy-top rondel (K-VIII M. 1.1, 0e10 cm). e) *Z. mays* cob half-decorated rondel (P Ridged Field 2, 0e10 cm).

Iriarte, José, Bruno Glaser, Jennifer Watling, Adam Wainwright, Jago Jonathan Birk, Delphine Renard, Stéphen Rostain, and Doyle B. McKey. 2010. Late Holocene Neotropical Agricultural Landscapes: Phytolith and Stable Carbon Isotope Analysis of Raised Fields from French Guianan Coastal Savannahs. *Journal of Archaeological Science* 37. Elsevier Ltd:2984–94. <http://dx.doi.org/10.1016/j.jas.2010.06.016>.

# Zea mays

## Phytolith

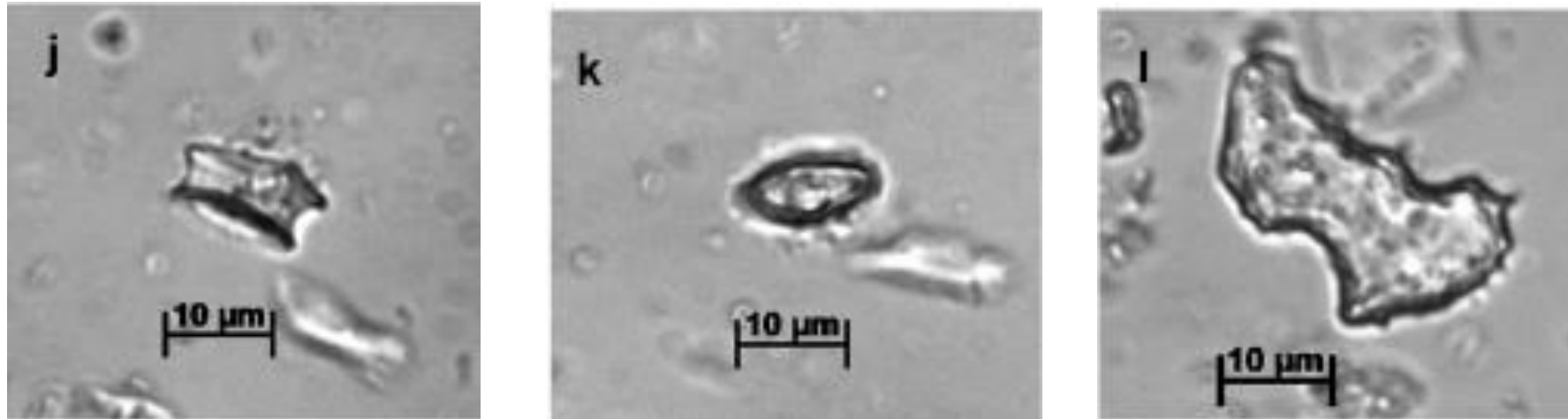


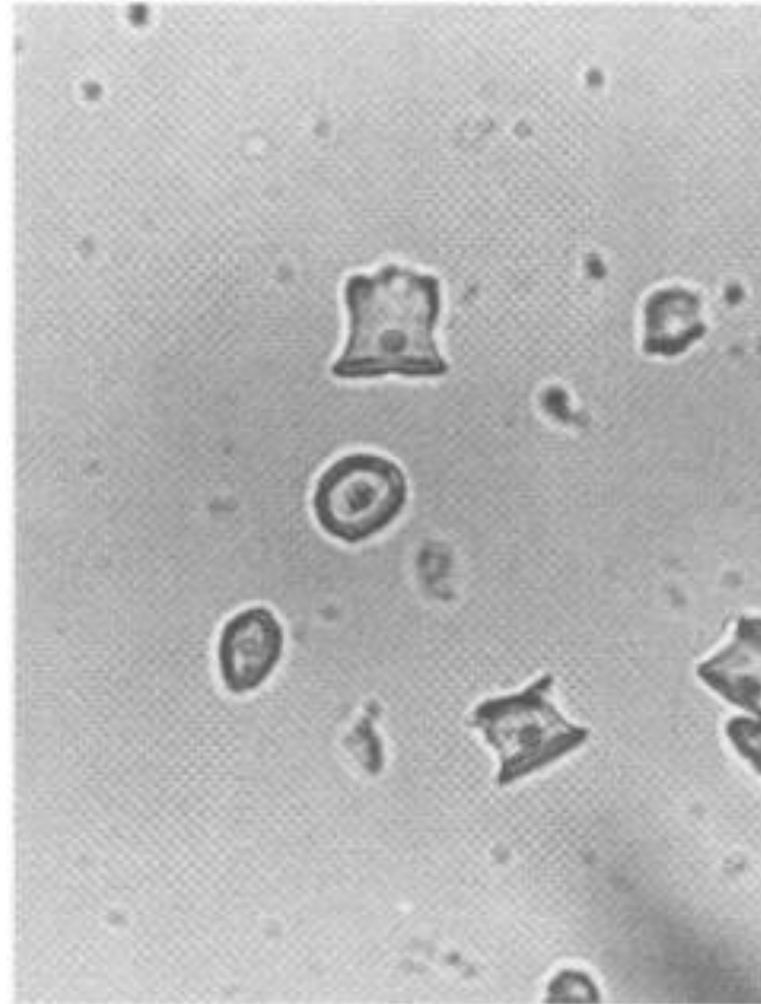
Fig. 5. Selected microbotanical remains. Phytoliths: j) *Z. mays* cob wavy-top rondel, profile view (Sed. Sample 4), k) The same phytolith, rotated to top view, l) *Z. mays* cob IRP (Sed. Sample 3)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Zea mays

## Phytolith

Fig. 10. Undecorated circular phytoliths from a cob of maize, Race Maiz Ancho from Mexico.



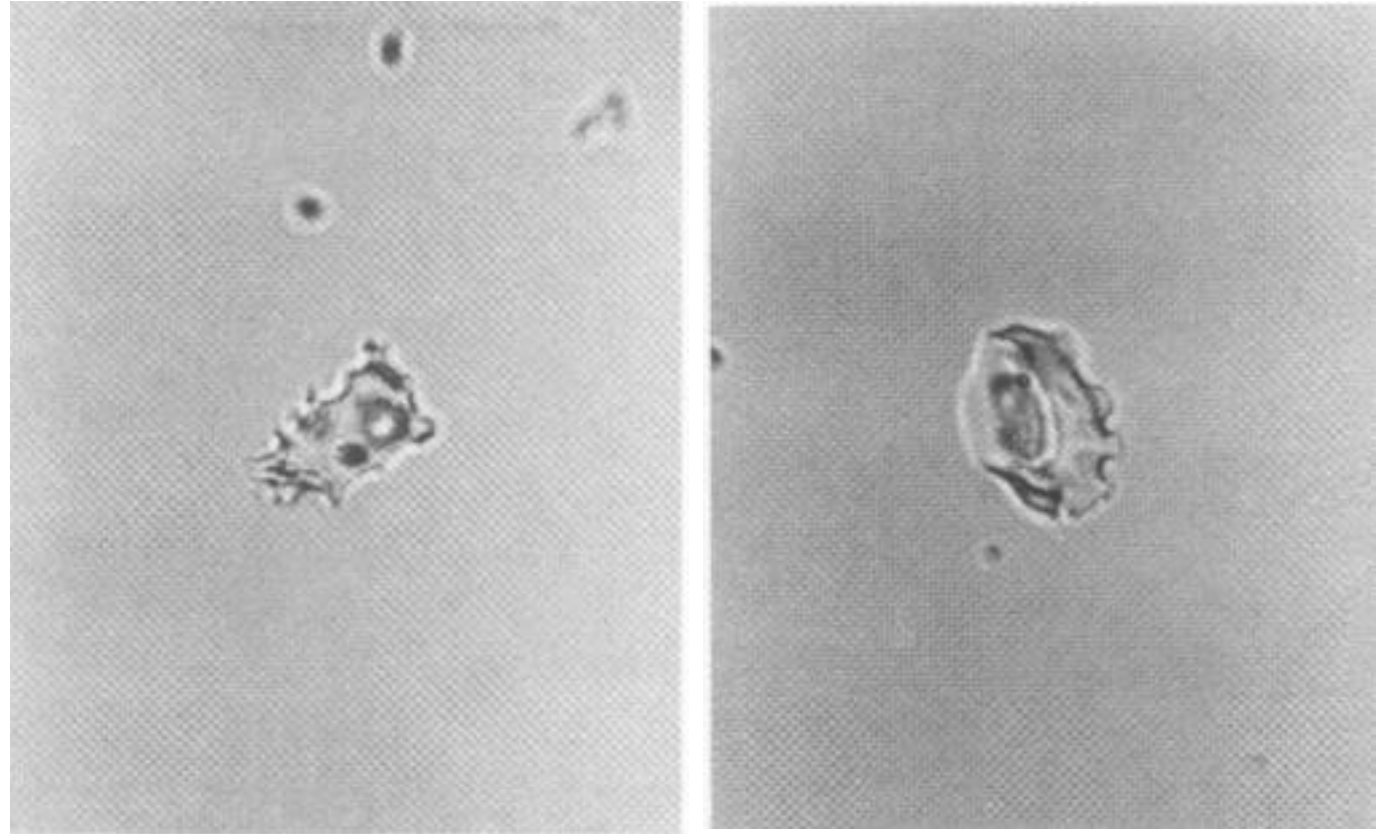
Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449.  
<http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.

# Zea mays ssp. parviglumis

## Phytolith

Fig. 8. A fruitcase phytolith from Balsas teosinte. It is produced in the same tissue as phytolith illustrated from *Tripsacum* but lacks serrated edges and ridges along the top.

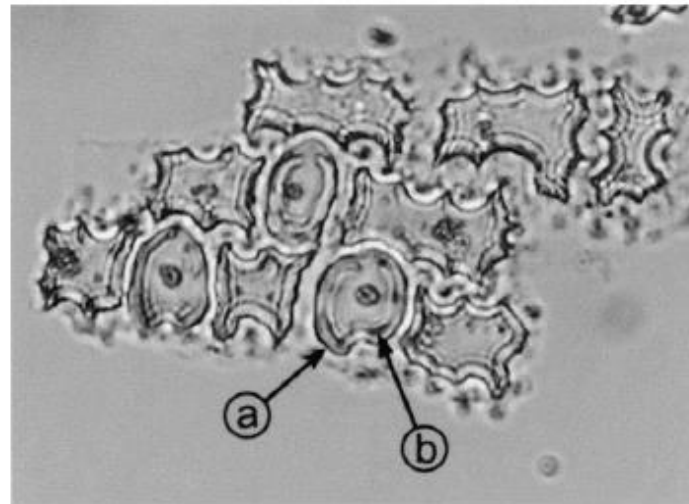
Fig. 9. A decorated circular phytolith from the fruitcase of Balsas teosinte.



# Zea mays ssp. parviglumis

## Phytolith

Fig. 5. Articulated phytoliths from a teosinte fruitcase. The lower image is a magnified view of the upper image. The “a” arrow points to the upper face of the rondel (sharp focus): this is the ruffle-top, which extends out beyond the base. The “b” arrow points to the lower face of the rondel, which is the rondel base. Photograph courtesy of I. Holst, Smithsonian Tropical Research Institute, Panama.

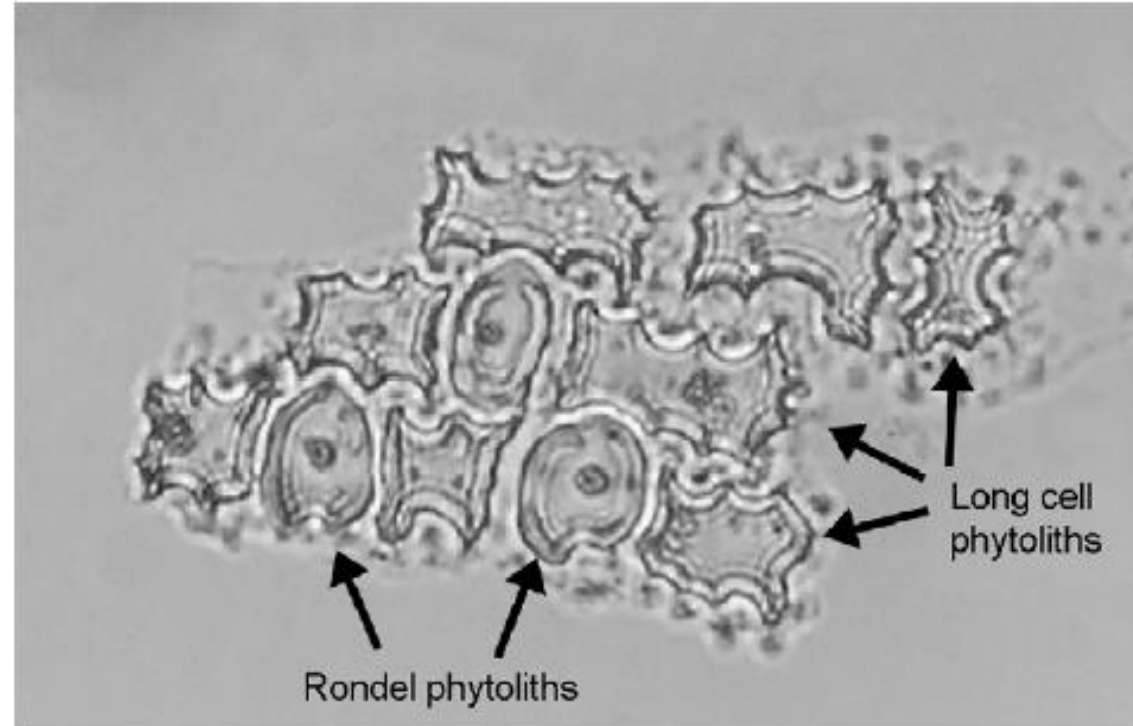


Pearsall, Deborah Marie, Karol Chandler-Ezell, and Alex Chandler-Ezell. 2004. “Maize Can Still Be Identified Using Phytoliths: Response to Rovner.” *Journal of Archaeological Science* 31 (7): 1029–38. doi:10.1016/j.jas.2003.11.007.

# Zea mays ssp. parviglumis

## Phytolith

Fig. 6. Phytoliths from the fruitcases of teosinte, Race Balsas (*Zea mays* ssp. *parviglumis*). Both the long and short cells (producing rondel phytoliths) are silicified. This process is under the control of the gene *tga1*. Reprinted from Piperno (2006a), Copyright AltaMira Press

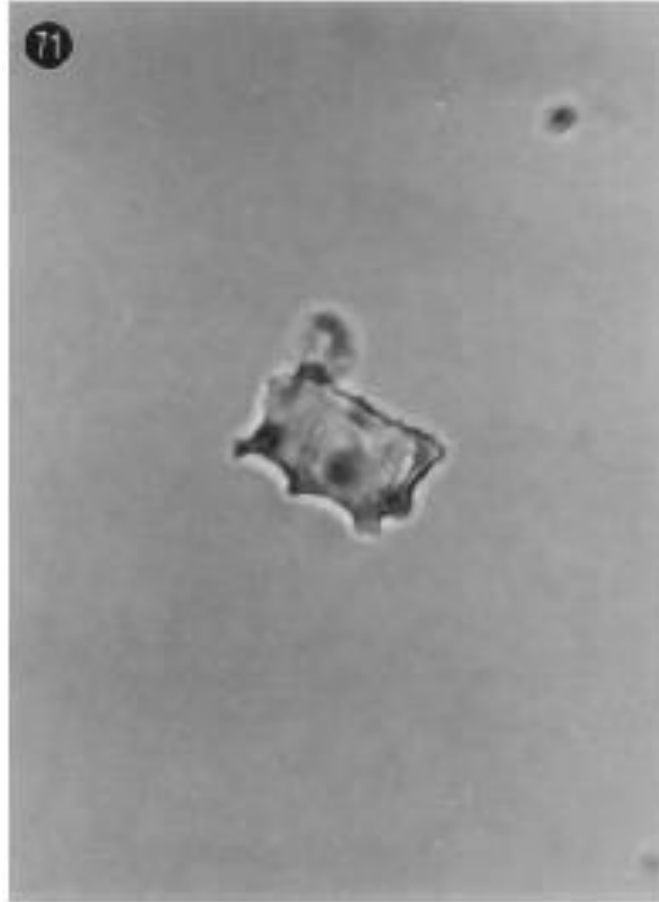


Piperno, Dolores R. 2009. Identifying Crop Plants with Phytoliths (and Starch Grains) in Central and South America: A Review and an Update of the Evidence. *Quaternary International* 193 (1–2):146–59.

# Zea mays ssp. parviglumis var. parviglumis

## Phytolith

FIGURES 69-72.-71, A teosinte-specific epidermal-cell phytolith from the fruitcase of Balsas teosinte (*Zea mays* ssp. *parviglumis* var. *parviglumis*) (x400)



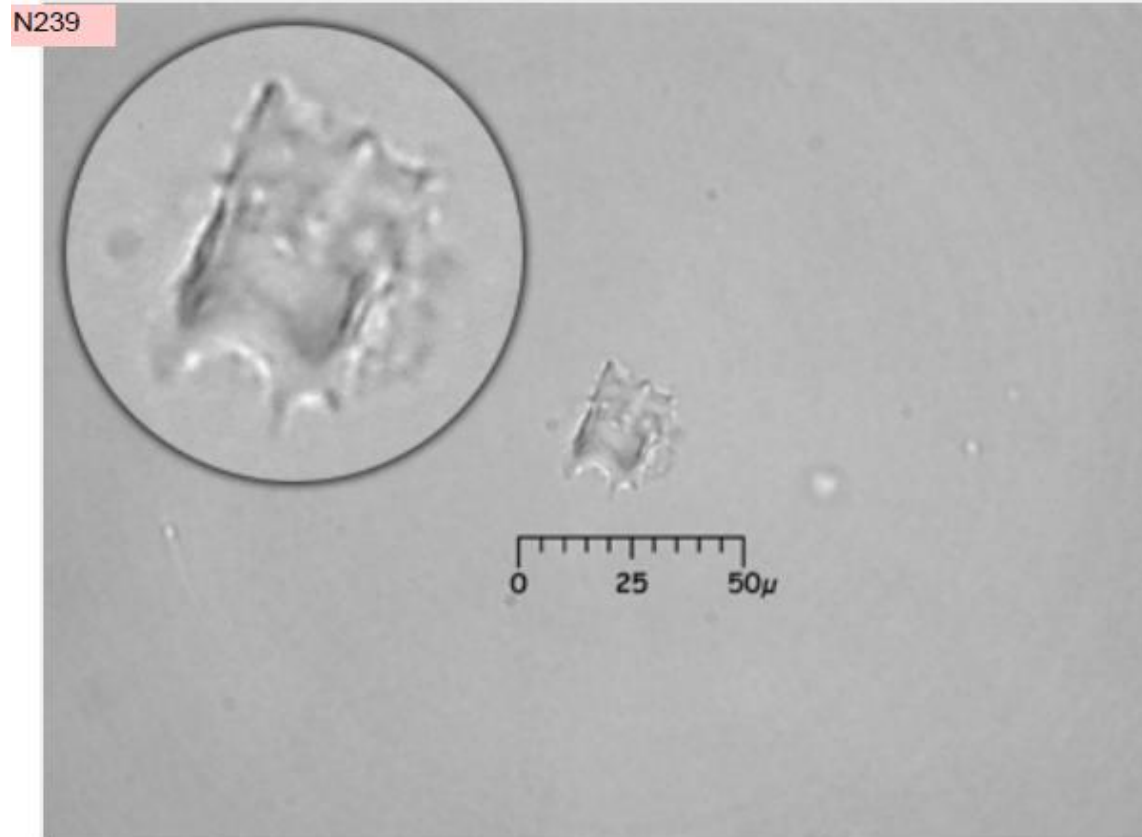
Piperno, Dolores R., and Deborah Marie Pearsall. 1998. The Silica Bodies of Tropical American Grasses: Morphology, Taxonomy, and Implications for Grass Systematics and Fossil Phytolith Identification. *Smithsonian Contribution to Botany* 85:1–40.

# Zea perennis

## Phytolith

Body with semi-circular cuts. Teosinte indicator.

Diagnostic level: wild Zea spp.



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



PTERIDACEAE

# Pityogramma calomelanos

## Phytolith

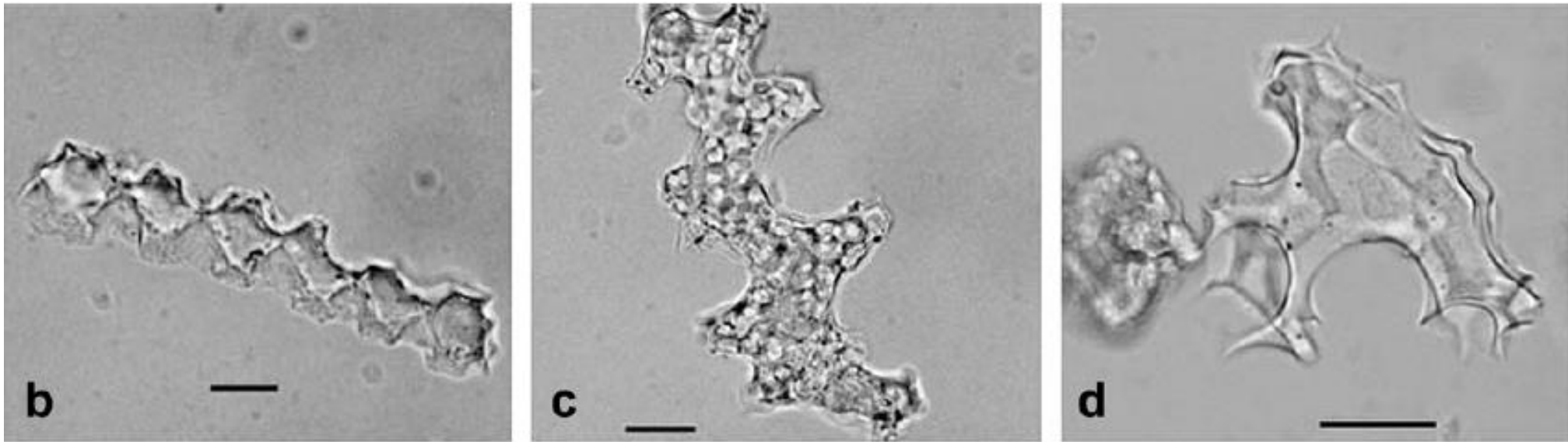


Fig. 6. Phytoliths from Pteridophytes. b) Elongated undulating body from *Pityogramma calomelanos*, c-d) Pitted bodies from *P. calomelanos*

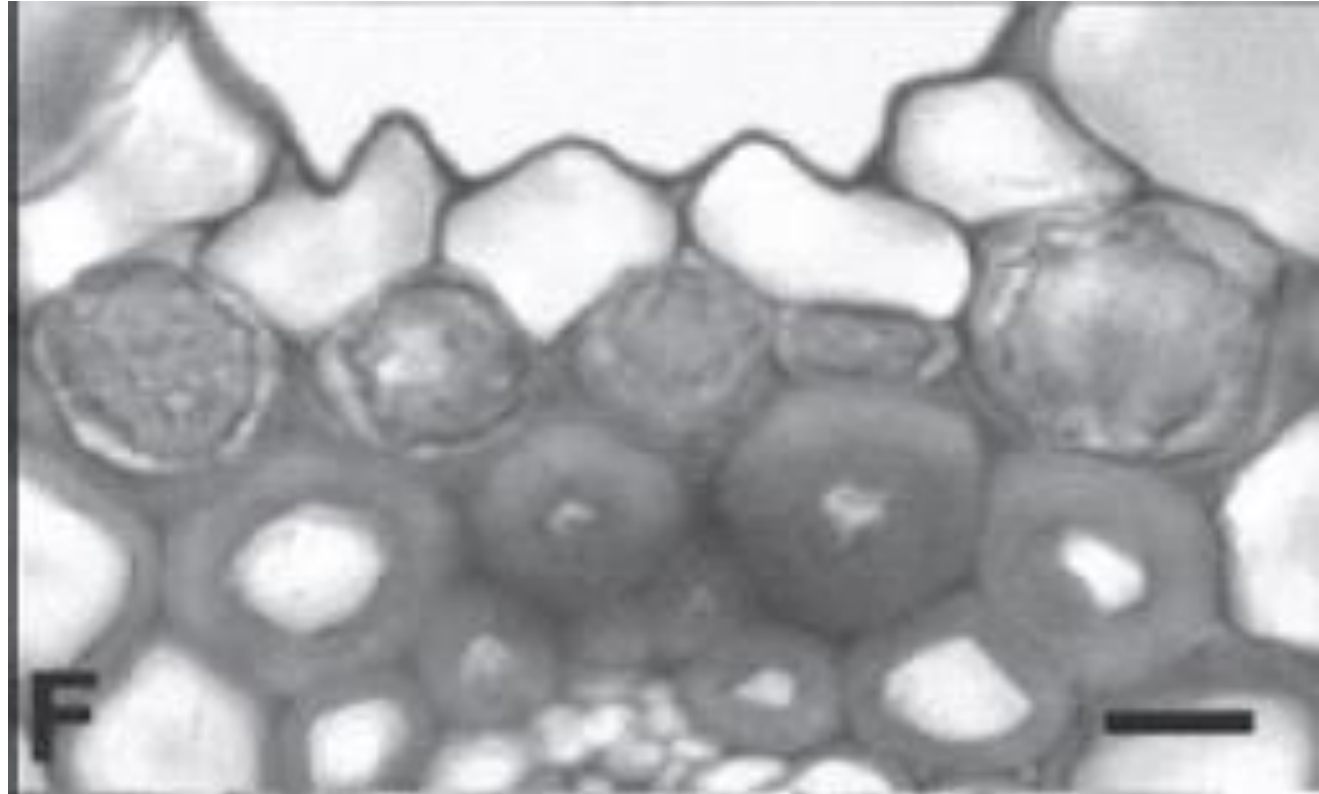
Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

RESTIONACEAE

# Anthochortus ecklonii

## Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasyopogonaceae. F. *Anthochortus ecklonii* (Restionaceae), spherical silica bodies overlying the sclerenchymatous bundle sheath (bar = 10 $\mu$ m).

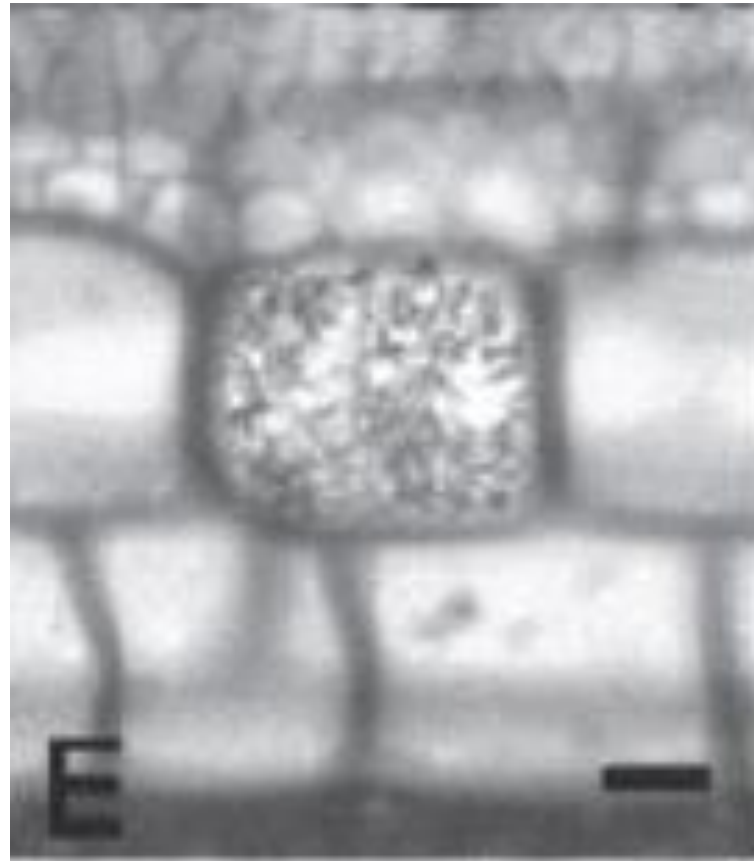


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Thamnochortus floribundus

## Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasyopogonaceae. E. *Thamnochortus floribundus* (Restionaceae), an irregular or granular form of silica observed in epidermal cells (bar = 10 $\mu$ m).



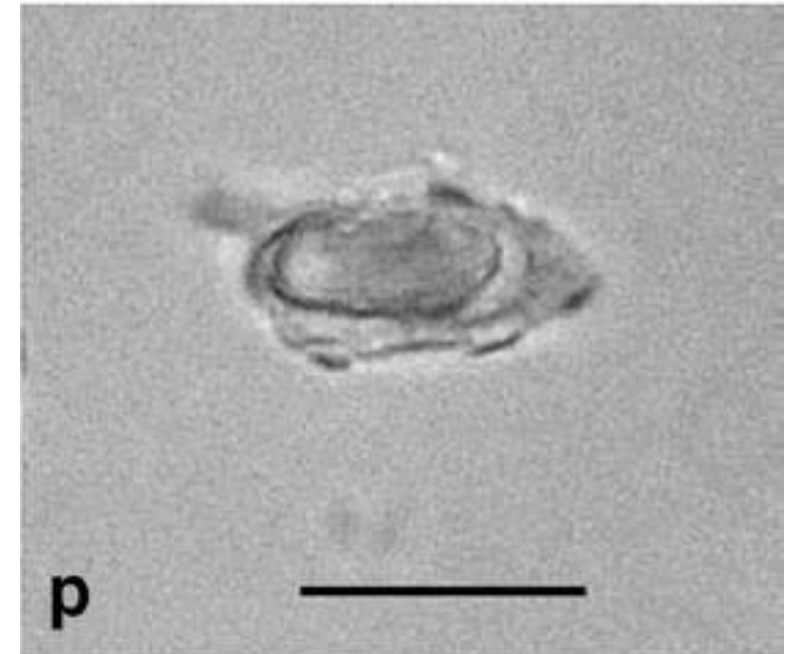
Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

SIMAROUBACEAE

# Simarouba amara

## Phytolith

Fig. 2. Phytoliths with little or no taxonomic value. n) Trichome with V1 material from *S. amara* o) Vesicular infilling from *Simarouba amara*.

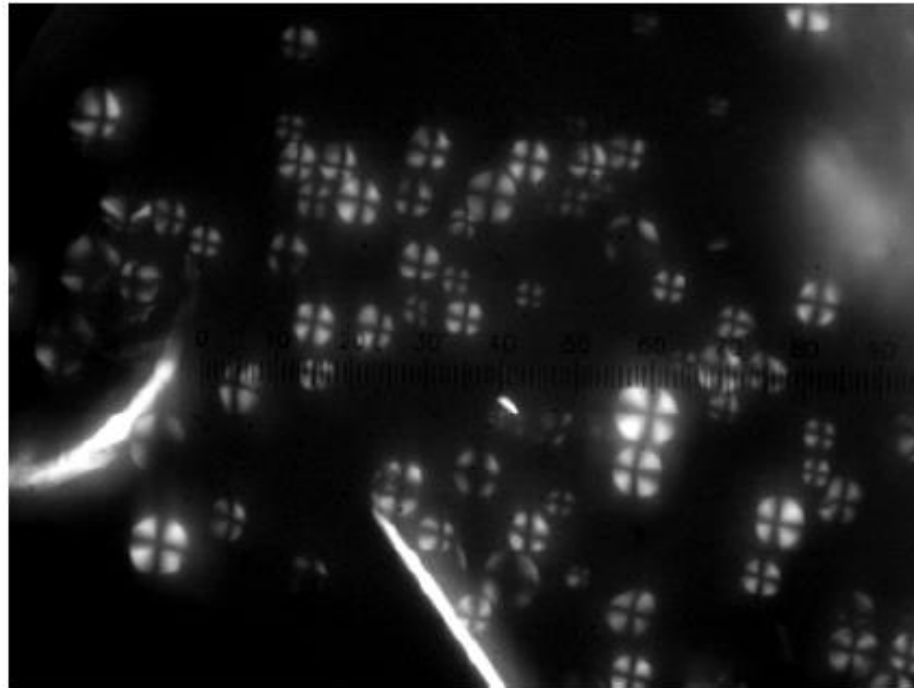


SMILACACEAE



# Smilax dominguenensis

## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

SOLANACEAE

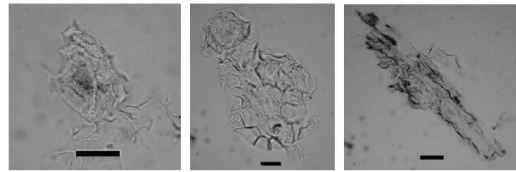
# Capsicum annum

Solanaceae *Capsicum annum* "aji"

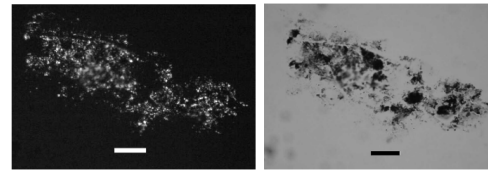
## Phytolith assemblage characterization

Non diagnostic phytoliths:

a) Irregular epidermal silica cells.



b) Sub-spherical calcium oxalate phytoliths.



**References:** Reported as not present in Piperno 1988:35 (no specific part mentioned).

flower

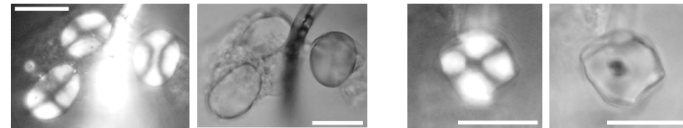
stem

No phytoliths.

**References:** Reported as not present in Piperno 1988:35 (no specific part mentioned).

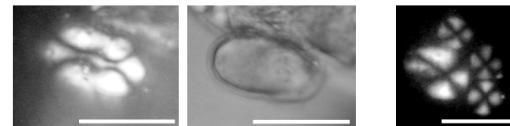
## Starch assemblage characterization

a) Mainly single grains, variable in shape, commonly oval, but also spherical, ellipsoidal, kidney-shaped, polyhedral and triangulate, with rounded sides; variable in size from 10µm to 23µm long length; rarely distinct hilum as a dot; not visible lamella; centric cross, with four arms visible, intersecting at a point or line, or meeting two by two.



fruit and seed

b) Some compound grains, oval, ca. 22µm, compounded by two granula, with a single external packing. Granula different in size, ranging from 12µm to 15µm, distinct cross with four arms visible, meeting two by two.



Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Capsicum sp.

Starch

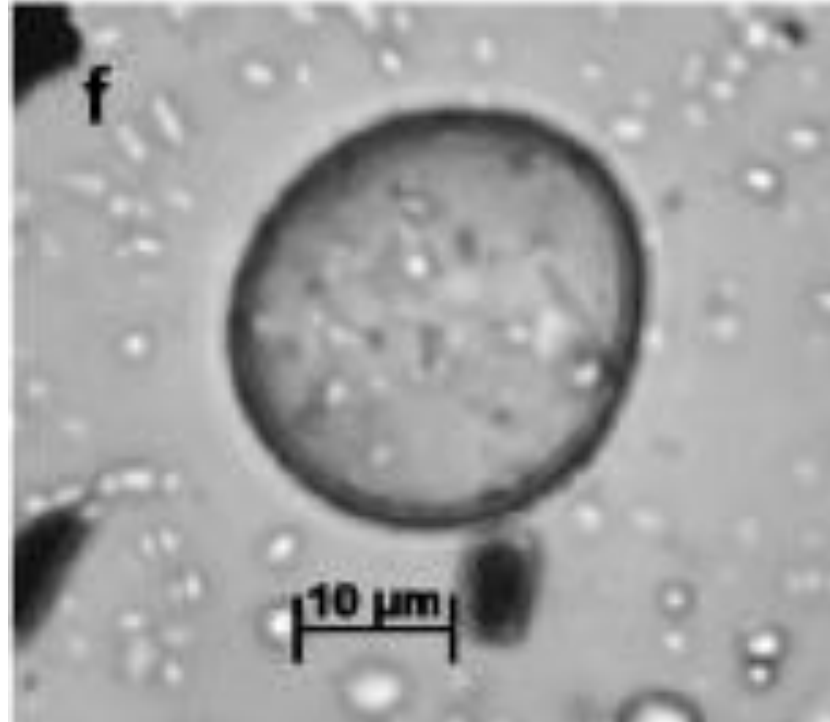


Fig. 5. Selected microbotanical remains. Starch grains: f) cf. *Capsicum* sp. (SAL 06-2-1671)

Dickau, Ruth, Maria C. Bruno, José Iriarte, Heiko Prümers, Carla Jaimers Betancourt, Irene Holst, and Francis E. Mayle. 2011. Diversity of Cultivars and Other Plant Resources Used at Habitation Sites in the Llanos de Mojos, Beni, Bolivia: Evidence from Macrobotanical Remains, Starch Grains, and Phytoliths. *Journal of Archaeological Science*. Elsevier Ltd, 1–14.

# Capsicum sp.

## Starch

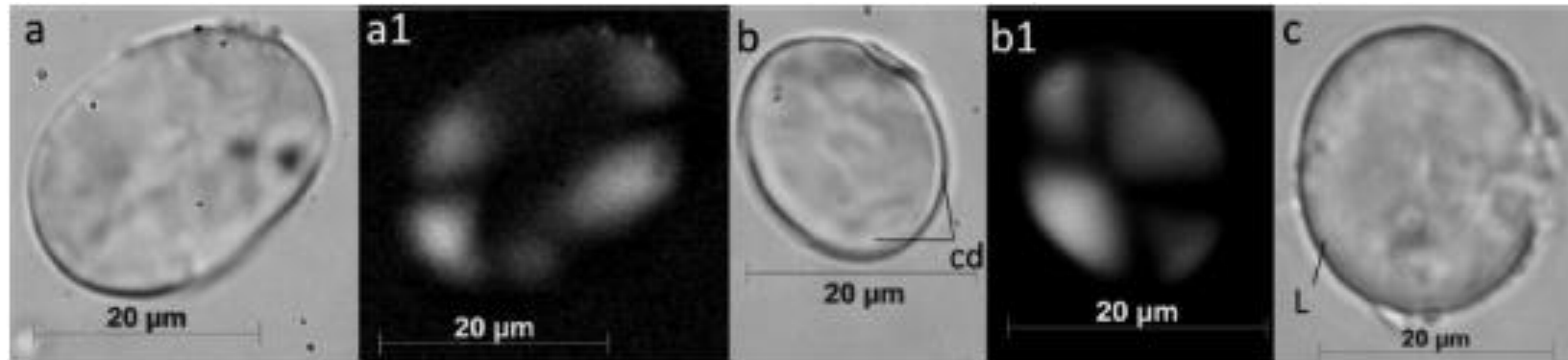


Fig. 7. Chili pepper starch grains from St. John and Eva 2. a, lenticular starch showing a lightly rough surface; a1, the same starch with smooth extinction cross; b, lenticular starch with a big central depression (“cd”); b1, the same starch with bright extinction cross; c, lenticular starch with partially exposed lamellae (“L”). Provenances: starches a and b (artifact E-4); c (artifact SJ-4).

# Nicotiana tabacum

Solanaceae *Nicotiana tabacum* "tabaco"

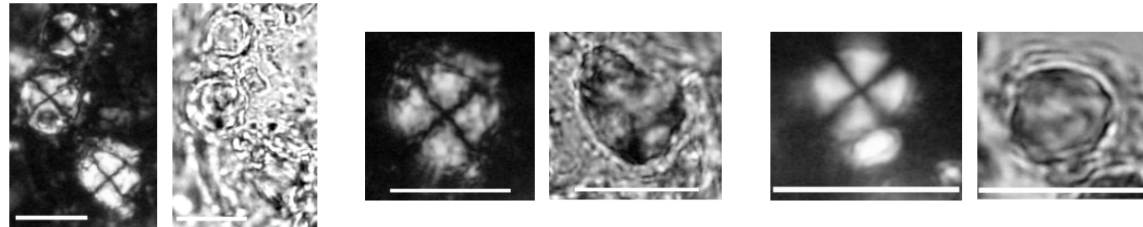
## Phytolith assemblage characterization

leaf  
No silica phytoliths.

**References:** Mentioned but not reported in Bozarth 1987 and 1990.

## Starch assemblage characterization

leaf  
a) Single grains, oval, spherical, polyhedral, and bell-shaped grains, with wavy end; variable in size from 12µm to 20µm long length; not visible hilum and lamella; centric cross, with four arms visible.

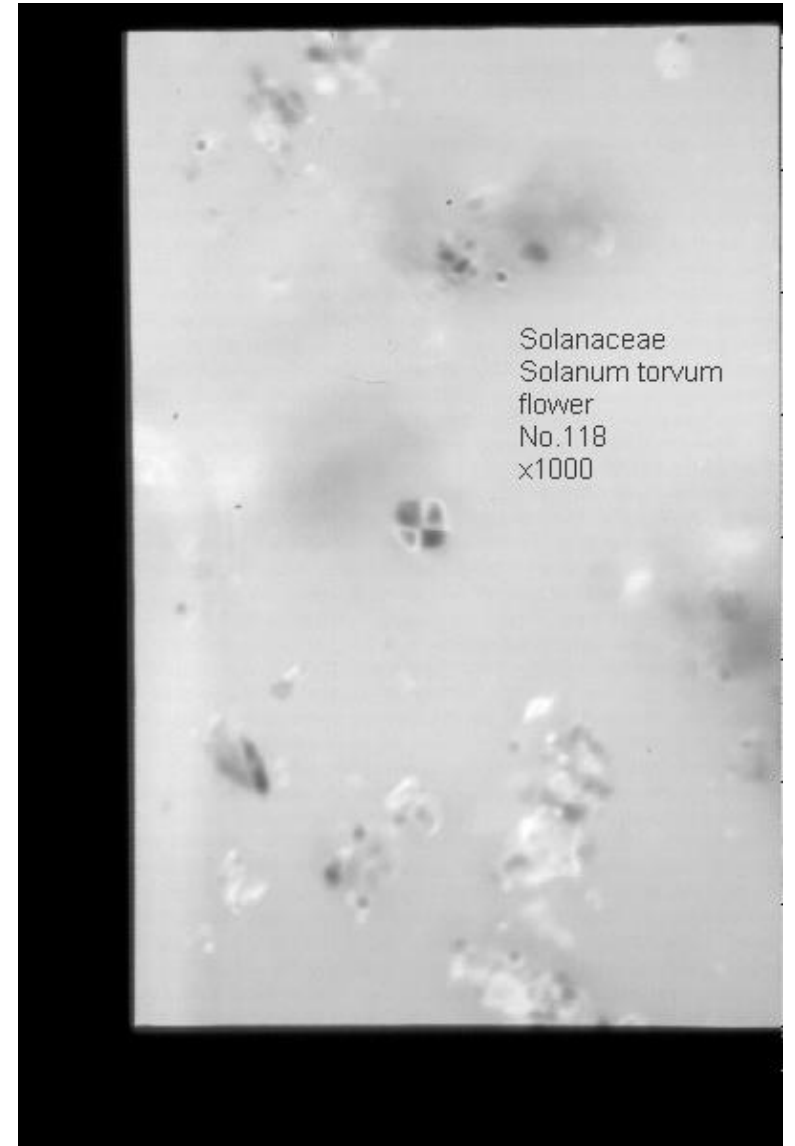
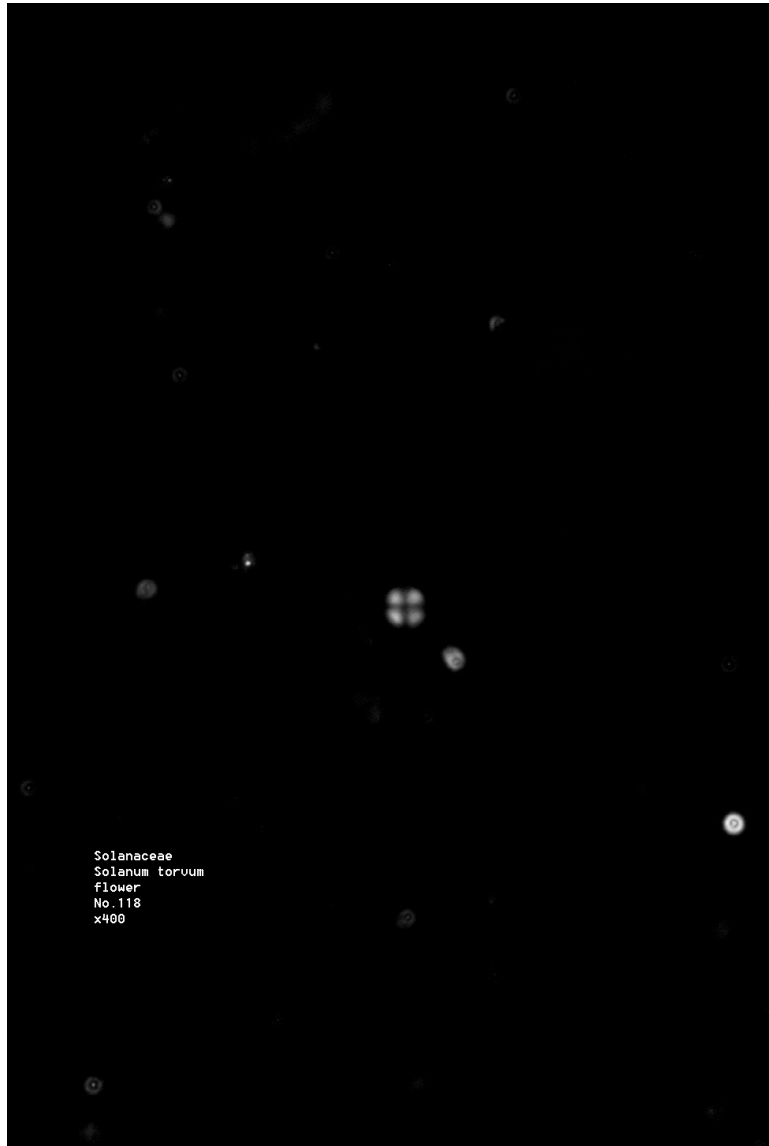


Scale bar = 20µm.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

# Solanum torvum

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



# Solanum tuberosum

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

## Solanaceae *Solanum tuberosum* "papa"

### Phytolith assemblage characterization

tuber, stem and leaf

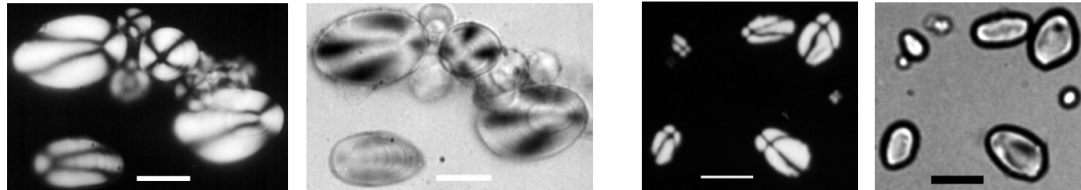
No silica phytoliths.

**References:** Reported as not present for *Solanum nigrum* (no specific part mentioned) (Piperno 1988:35).

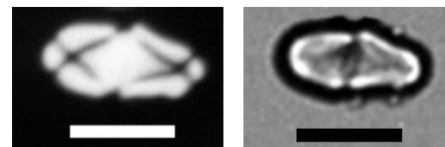
### Starch assemblage characterization

tuber

a) Single grains, oval, ellipsoidal, ovoid, spherical, sausage- and pear-shaped, with a narrow end generally rounded or truncated; variable in size, frequently over 100µm, to 120µm long length; distinct highly eccentric hilum, usually at rounded end, occasionally double, as a circle or line; very distinct lamella; distinct eccentric cross, to the broader end, with four arms visible, two long and two short.



b) Compound grains, compounded by two granula. Granula similar in shape and size, bell- and bowl-shaped, with one truncated, concave or convex end.



**References:** Partially based on Fitt and Maywald Snyder 1984, Reichert 1913, Shannon and Garwood 1984, Winton and Winton 1932.

Scale bar = 20µm.



# Solanum tuberosum

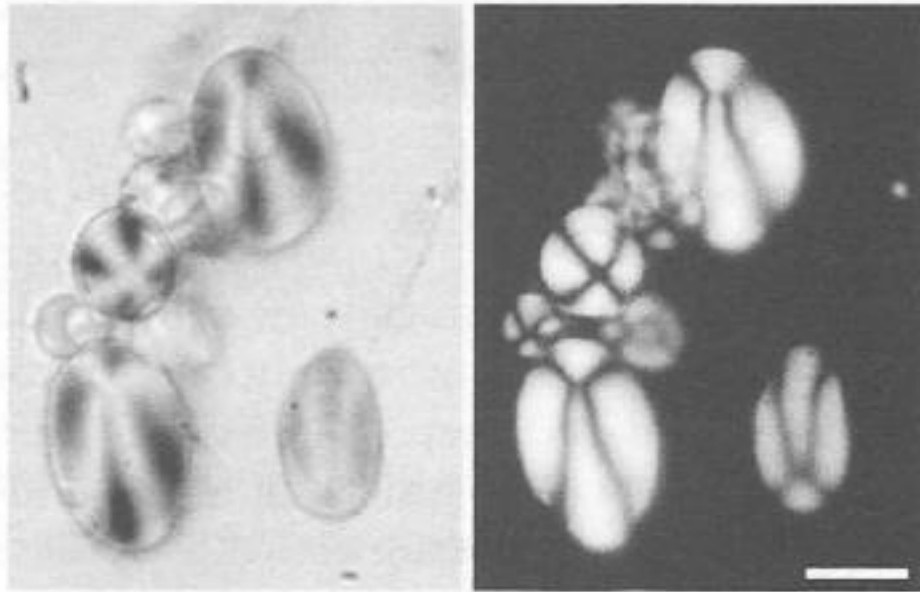
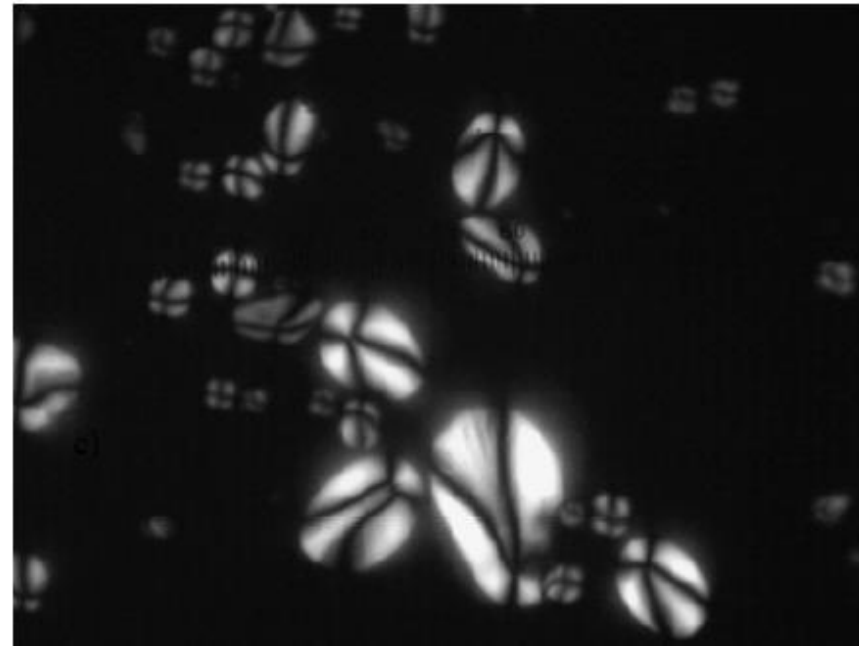
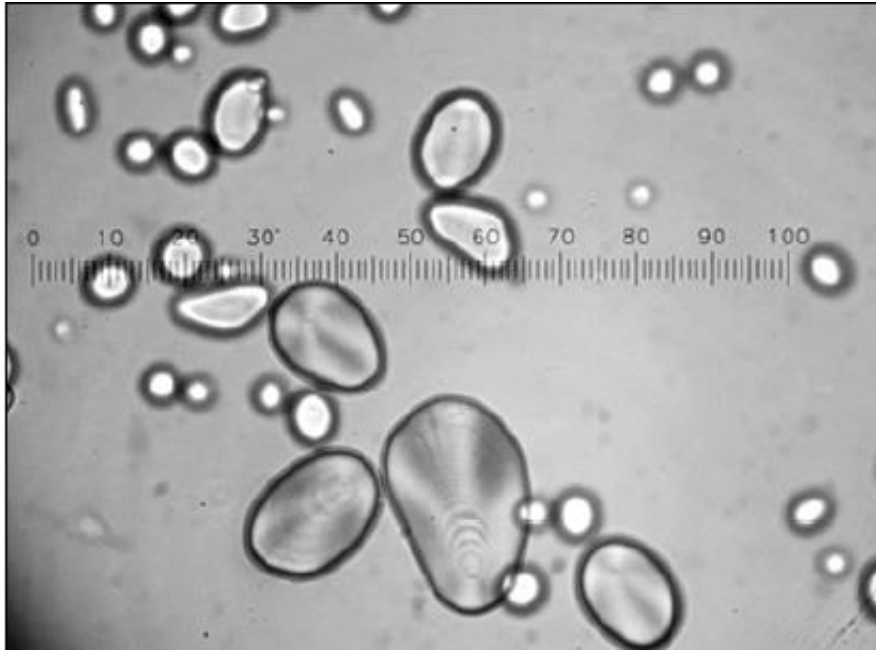


Figure 4. White potato non-processed starch grains. Views with normal (left) and polarised light (right). Scale bar = 20µm.

Babot, María del Pilar. 2003. Starch Grain Damage as an Indicator of Food Processing. In *Phytolith and Starch Research in the Australian-Pacific-Asian Regions: The State of the Art*.

# Solanum tuberosum

## Starch



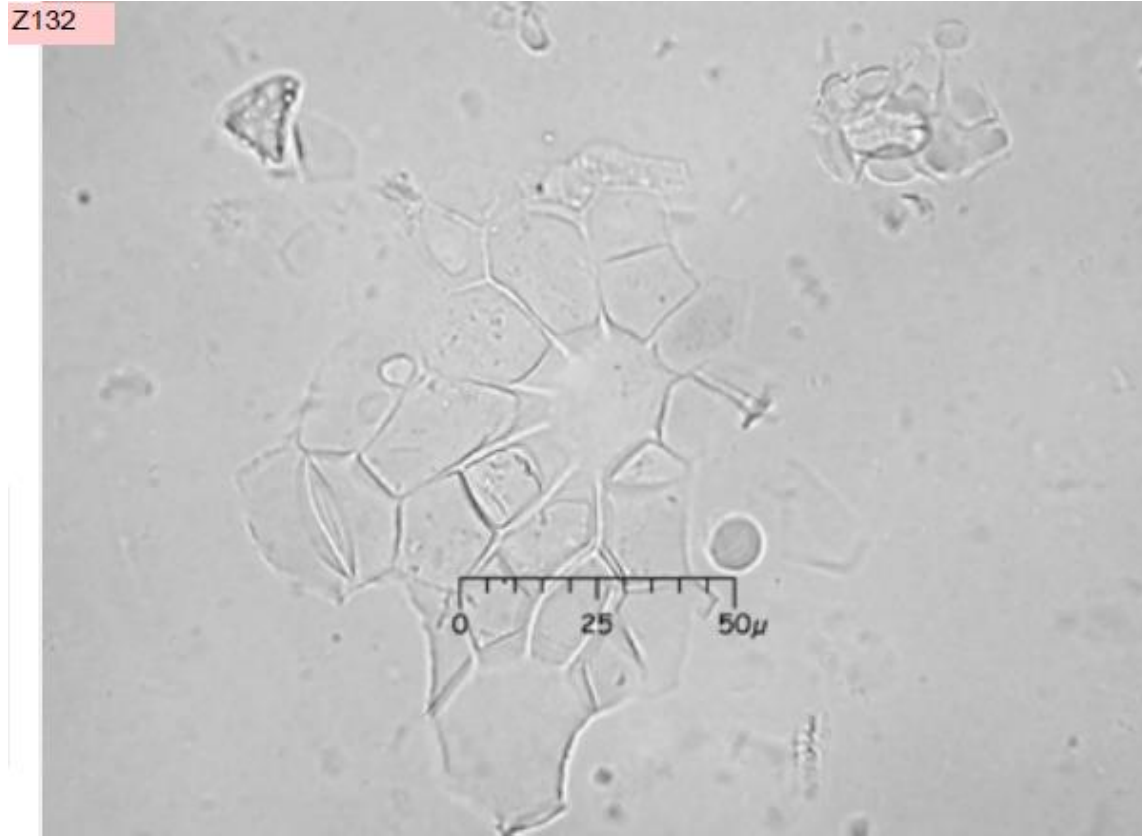
Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

STERCULIACEAE

# Guazuma ulmifolia

## Phytolith

Hair base. Lightly silicified. First described by C. Veintimilla, 1991.  
Diagnostic level: mixed Guazuma, Erythrina, Lithospermum

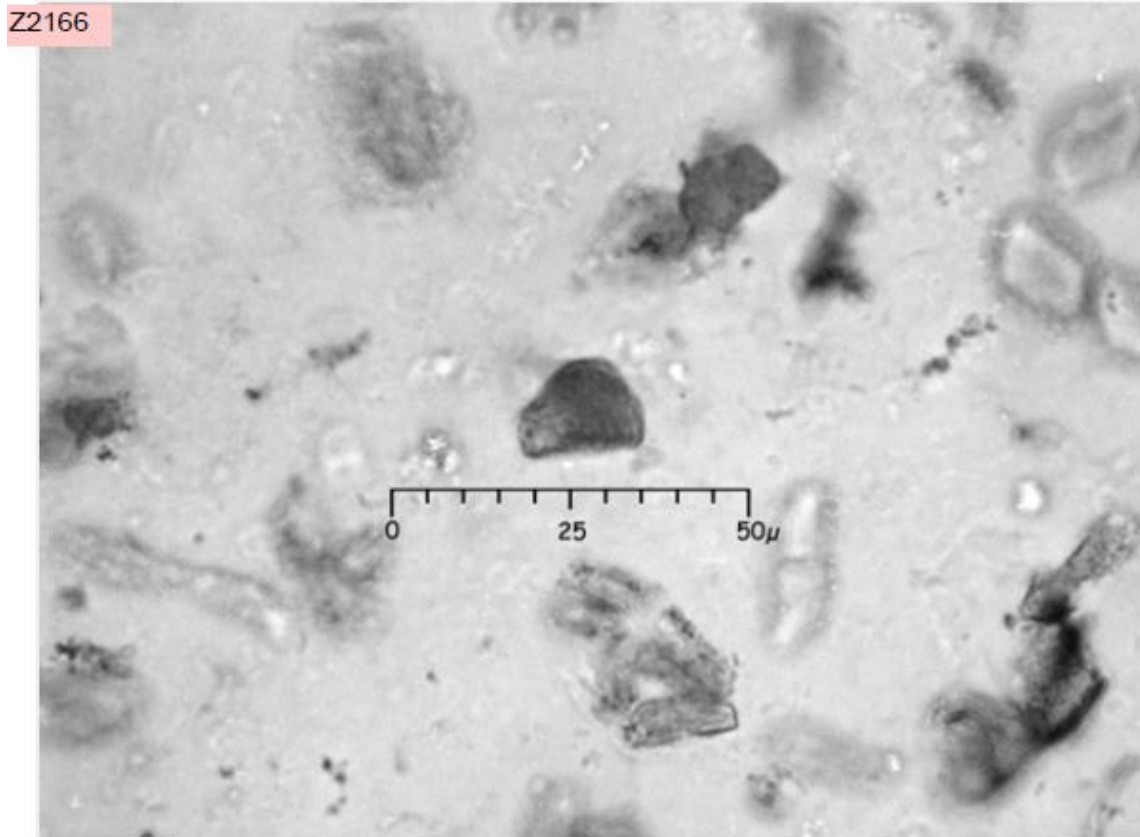


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Guazuma ulmifolia

## Phytolith

PC 2870, wood specimen  
Diagnostic level: under study

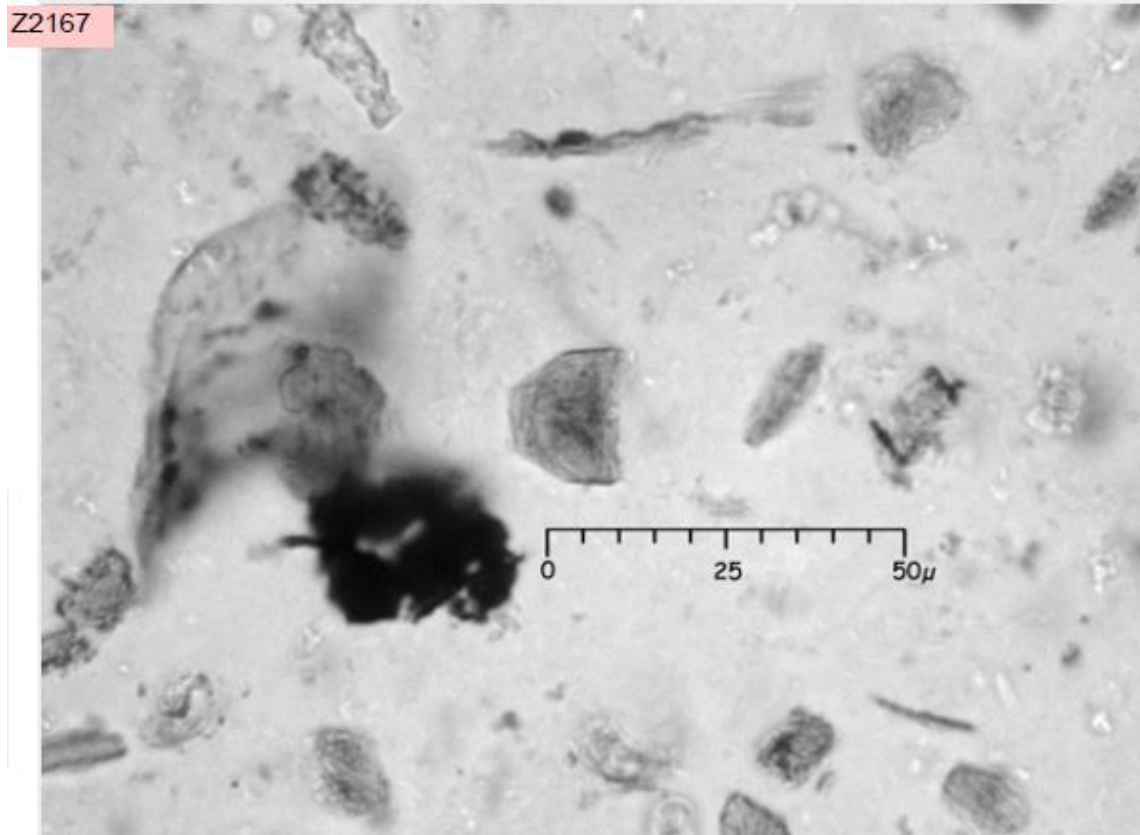


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Guazuma ulmifolia

## Phytolith

PC 2870, wood specimen  
Diagnostic level: under study



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Guazuma ulmifolia

## Phytolith

PC 2870, wood specimen  
Diagnostic level: under study



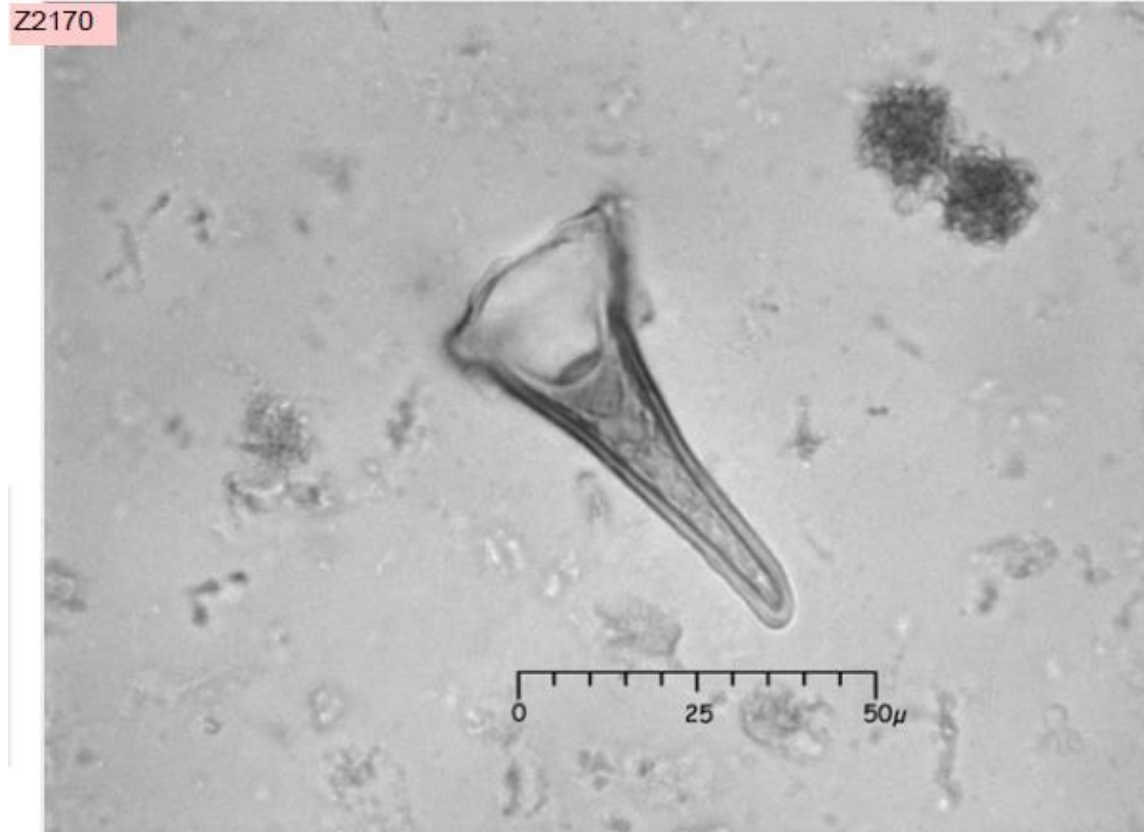
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Wattheria americana

## Phytolith

PC Clark 33

Diagnostic: Watteria, Sterculiaceae



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Waltheria indica

## Phytolith

4. Silicified tracheid from  
Waltheria indica (400 x).



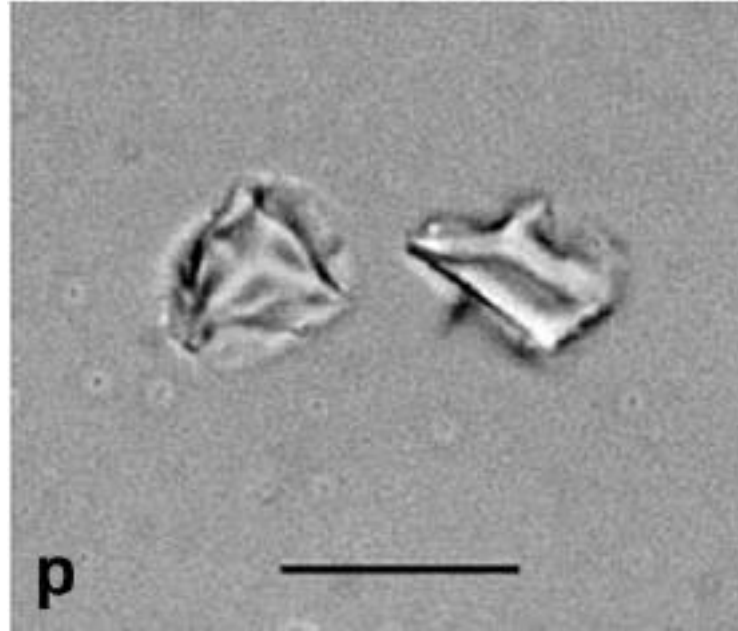
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

STRELITZIACEAE

# Phenakospermum guianensis

## Phytolith

Fig. 3. Phytoliths from non-grass monocots. p) Druse-like bodies from *Phenakospermum guianensis*

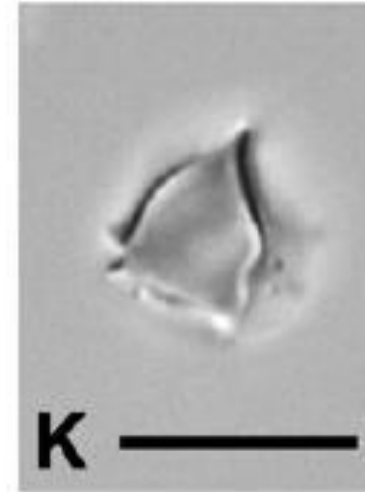
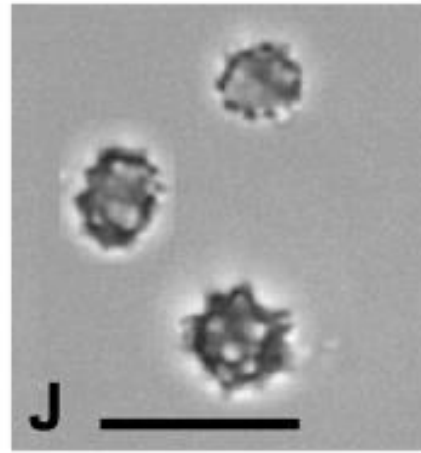


Watling, Jennifer, and José Iriarte. 2013. Phytoliths from the Coastal Savannas of French Guiana. *Quaternary International* 287:162–80.

# Phenakospermum guyannense

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). J, globular-microechinate from *Phenakospermum guyannense* floral bract. K, non-fringed D1 druse from *Phenakospermum guyannense* floral bract. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .

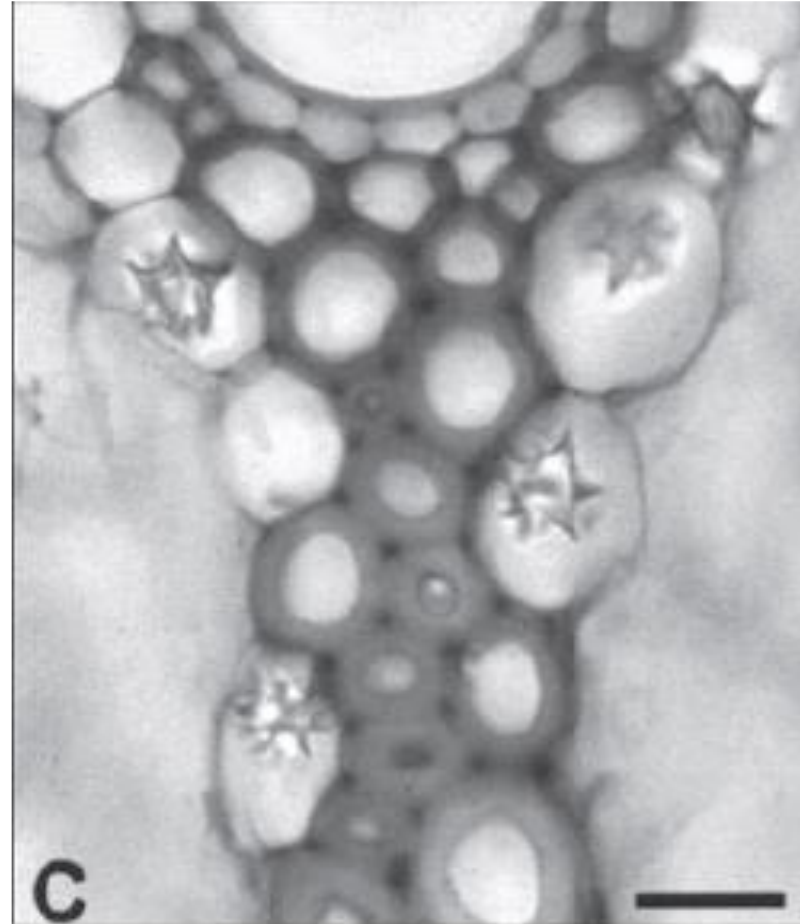


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Ravenala madagascariensis

## Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued.  
C. *Ravenala madagascariensis* (Strelitziaceae), spiny silica bodies in vascular bundle-sheath cells (bar = 10 $\mu$ m).

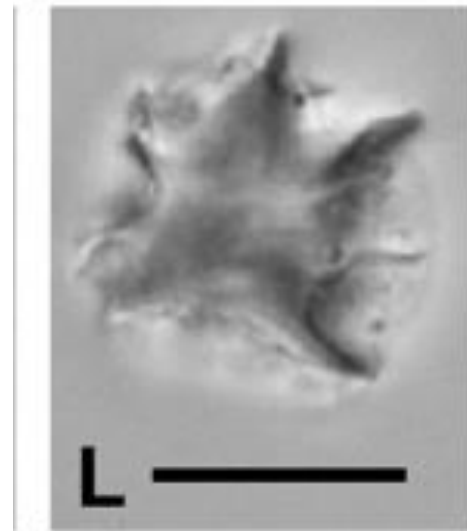


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Ravenala madagascariensis

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). L, fringed D1 druse from *Ravenala madagascariensis* leaf. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .

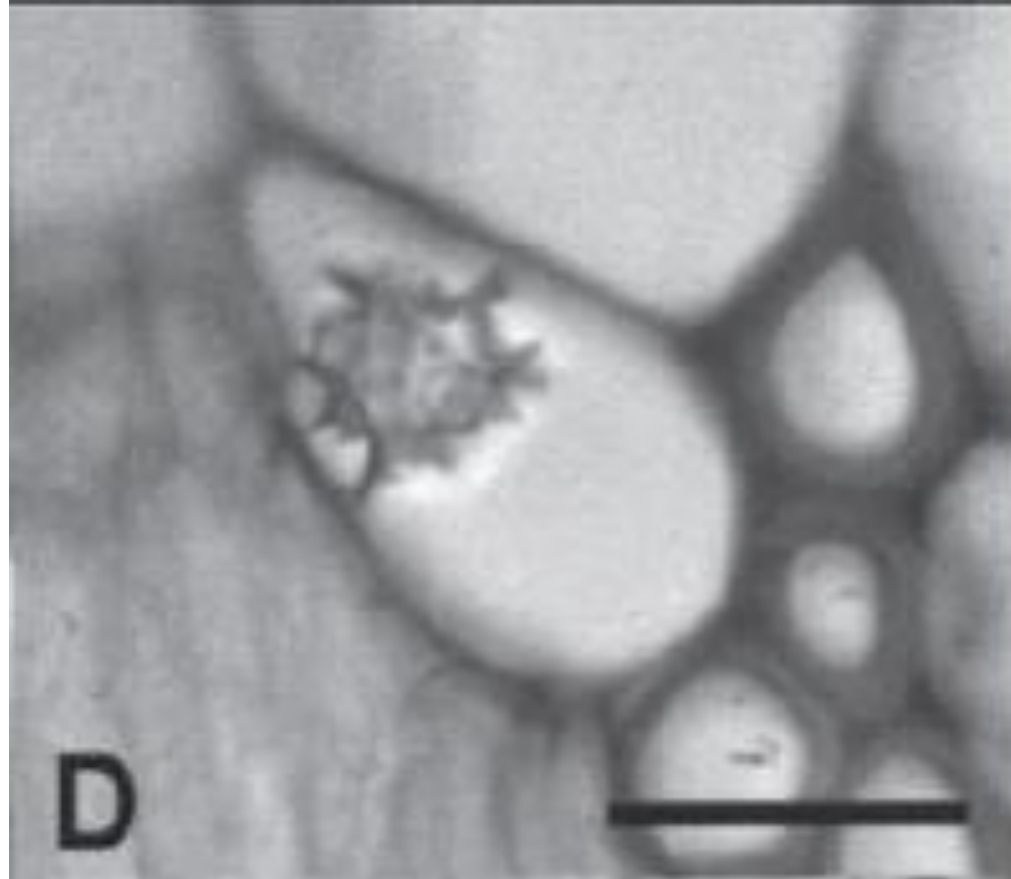


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Strelitzia augusta

## Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. D. *Strelitzia augusta* (Strelitziaceae), a bundle-sheath cell containing a druse-like silica body (bar= 20 $\mu$ m).

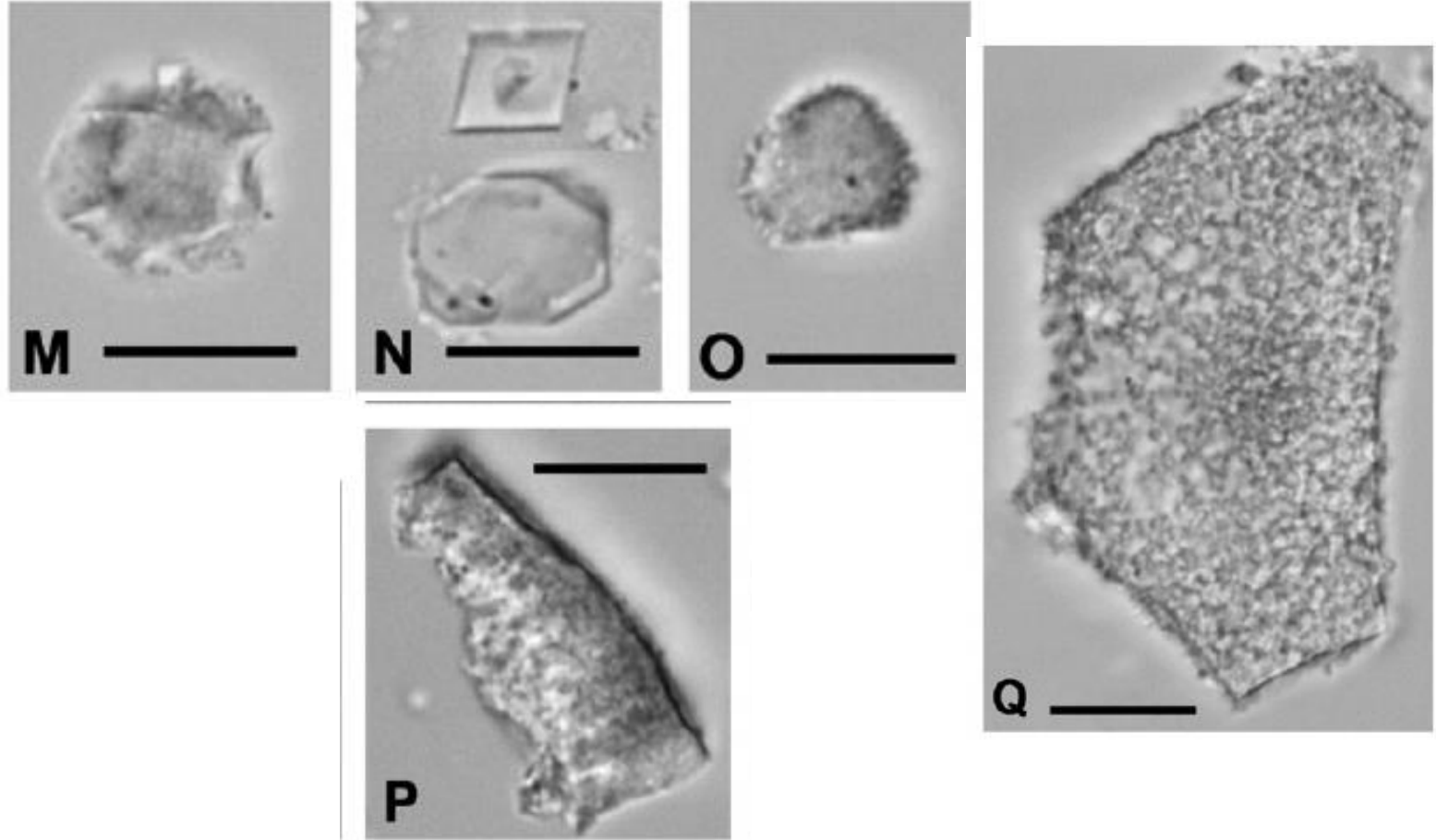


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Strelitzia reginae

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). M, D2 druse from *Strelitzia reginae* leaf. N, small, Ta4 (tabular-psilates) from *Strelitzia reginae* leaf. O, globular-microrugulate from *Strelitzia reginae* seed. P, side-view of Ta2 (tabular-ruminate) from *Strelitzia reginae* seed. Q, top-view of Ta2 tabular from *Strelitzia reginae* seed. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .



Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

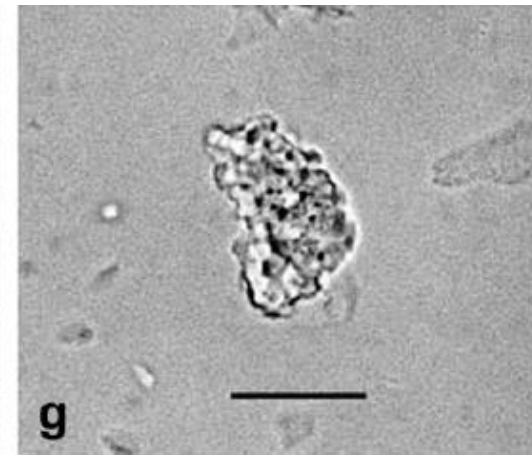
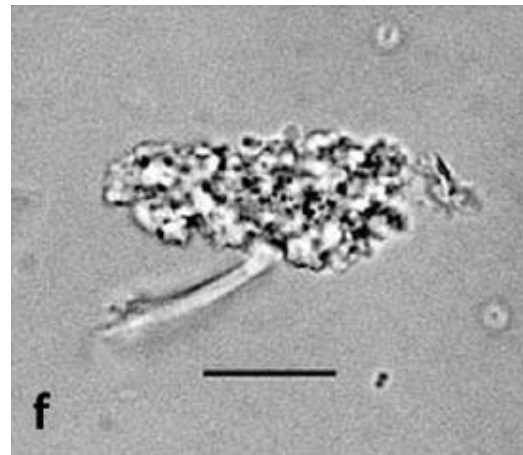
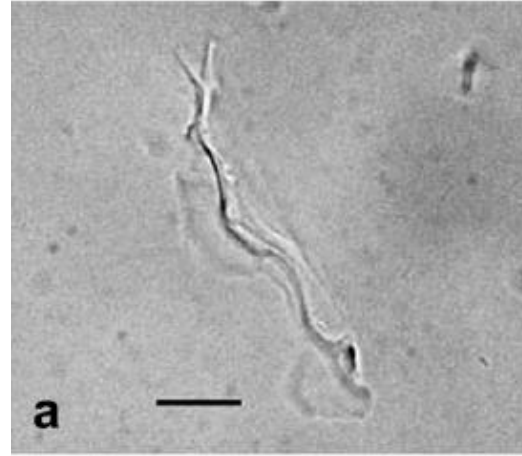


THELYPTERIDACEAE

# Thelypteris confluens

## Phytolith

Fig. 6. Phytoliths from Pteridophytes. a) Epidermal phytolith from *Thelypteris confluens*, f-g) Aspherical granulate bodies from *T. confluens*

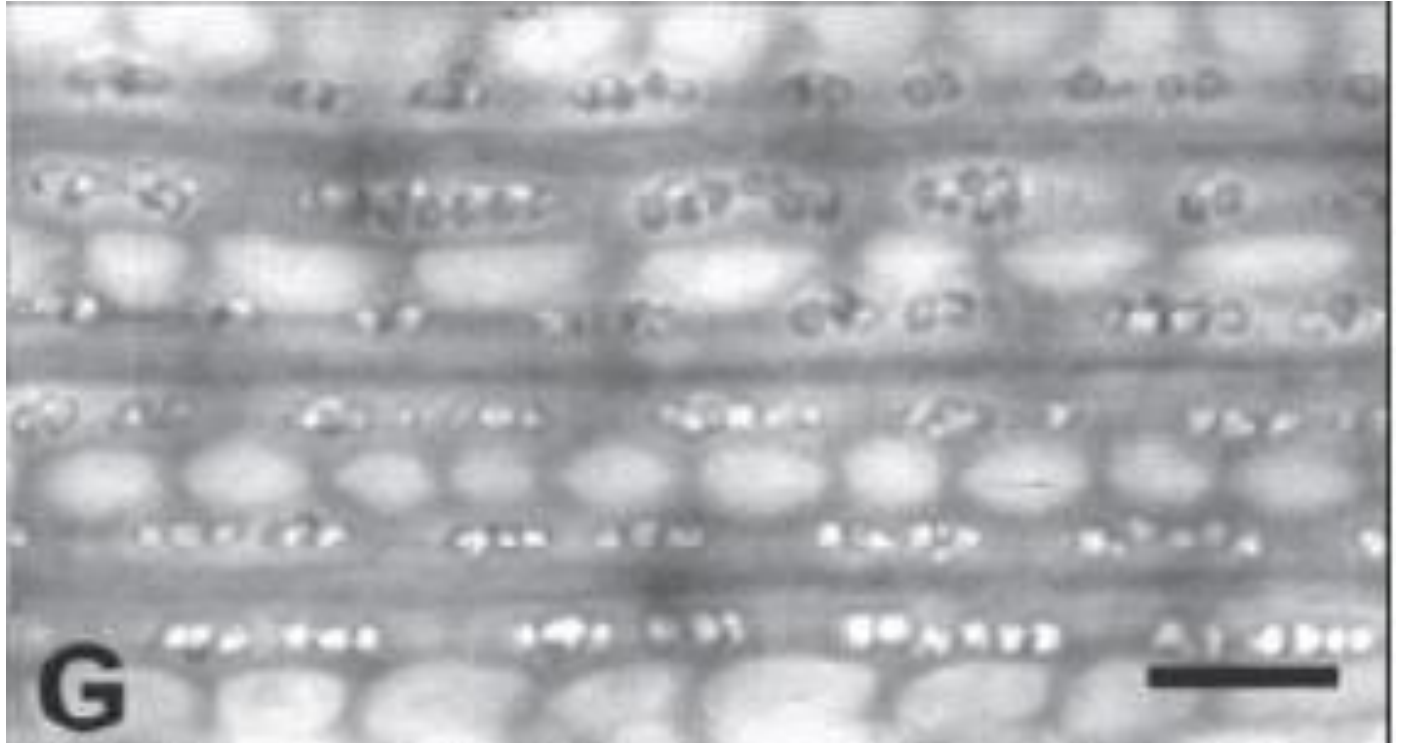


THURNIACEAE

# Thurnia jenmanii

## Phytolith

Fig. 5. Various silica body morphologies found in the order Poales and in Dasygongonaceae. G. *Thurnia jenmanii* (Thurniaceae), numerous small spherical/nodular bodies in epidermal cells (bar = 10  $\mu\text{m}$ ).



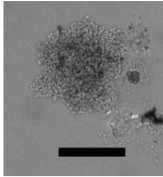
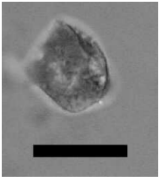
Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

TROPEOLACEAE

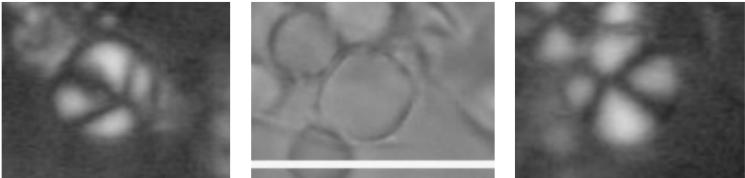
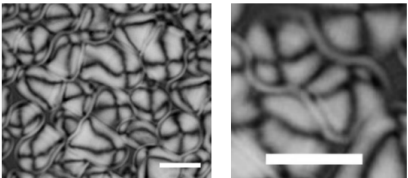
# Tropeolum tuberosum

Tropeolaceae *Tropeolum tuberosum* "mashua"

## Phytolith assemblage characterization

tuber	No silica phytoliths (*): a) Amorphous granulate oxalates. Rare.	stem	No diagnostic phytoliths (*): a) Semi-spherical dense silica phytolith.	leaf	No phytoliths (*).
					

## Starch assemblage characterization

tuber	a) Single grains, globular or subglobular; less than 7µm.
	b) Single grains, generally symmetrical, globular, subglobular, truncated, ovoid, spherical and bell-shaped; from 4µm to 28µm long length; very distinct lamella; distinct eccentric cross to the rounded end, with well definite dark arms intersecting at one point, two long and two short.
	
c) Compound grains compounded by two-three granula. Granula, generally unequal, with at less a symmetry axis.	
	
	<b>References:</b> Partially based on Cortella and Pochettino 1995.

Korstanje and Babot,  
McCown Archaeobotany  
Laboratory Collection

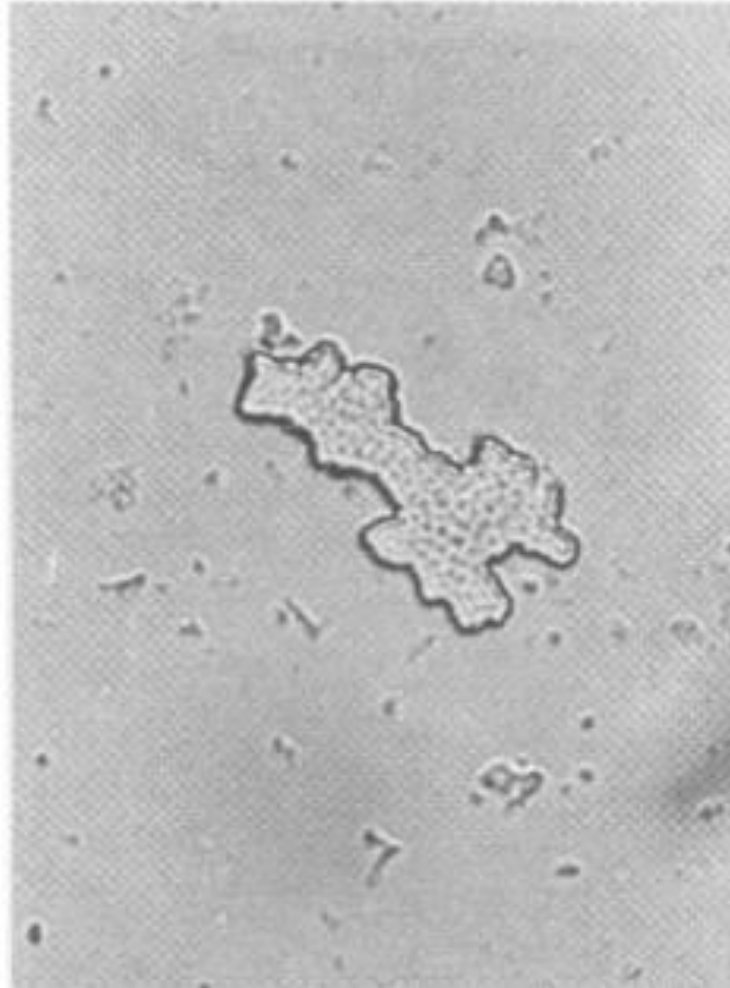
Scale bar = 20µm.

ULMACEAE

# Altis spinosa

## Phytolith

Fig. 6. A family-specific phytolith from the fruit of *Altis spinosa* (Ulmaceae).



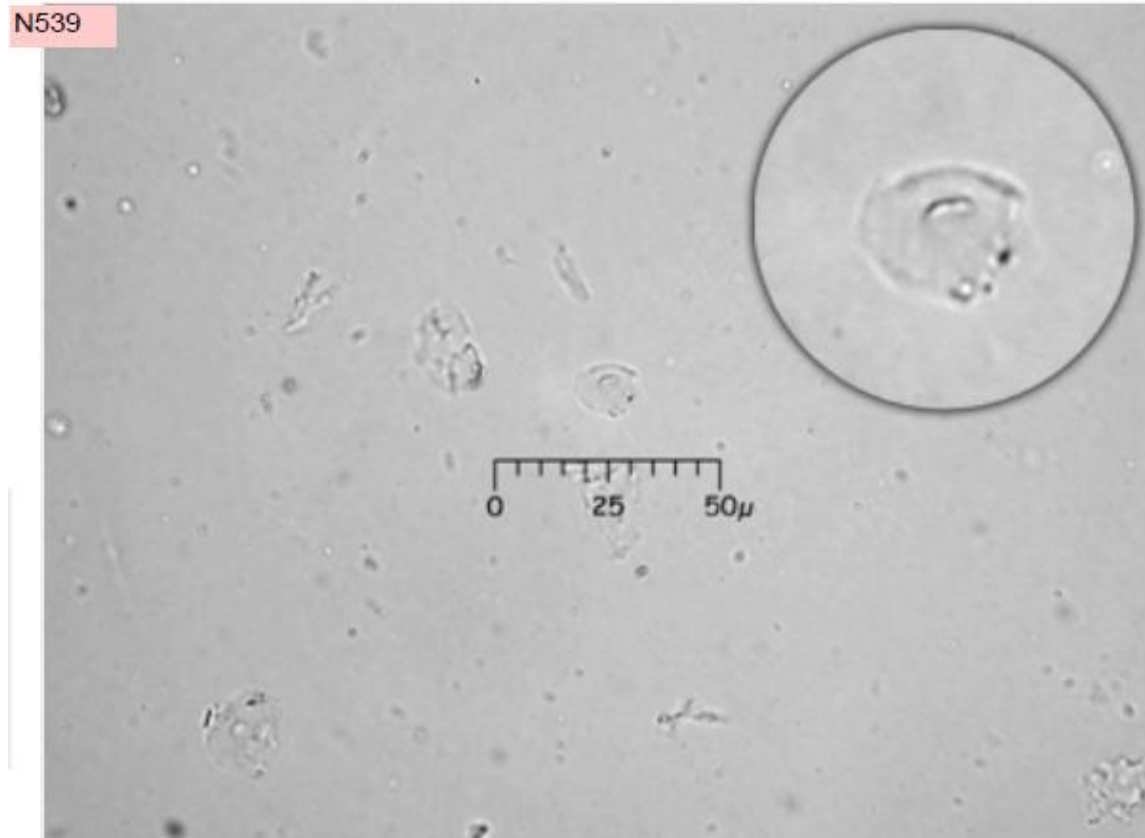
Piperno, Dolores R. 1998. Paleoethnobotany in the Neotropics from Microfossils: New Insights into Ancient Plant Use and Agricultural Origins in the Tropical Forest. *Journal of World Prehistory* 12 (4):393–449.  
<http://www.tandfonline.com/doi/abs/10.1080/07352680490273220>.



# Celtis schippii

## Phytolith

20 V a,b, and c separated only by arrangement of conical bodies. 20 V Ca describes when these conical bodies occur singly. Diagnostic level: species



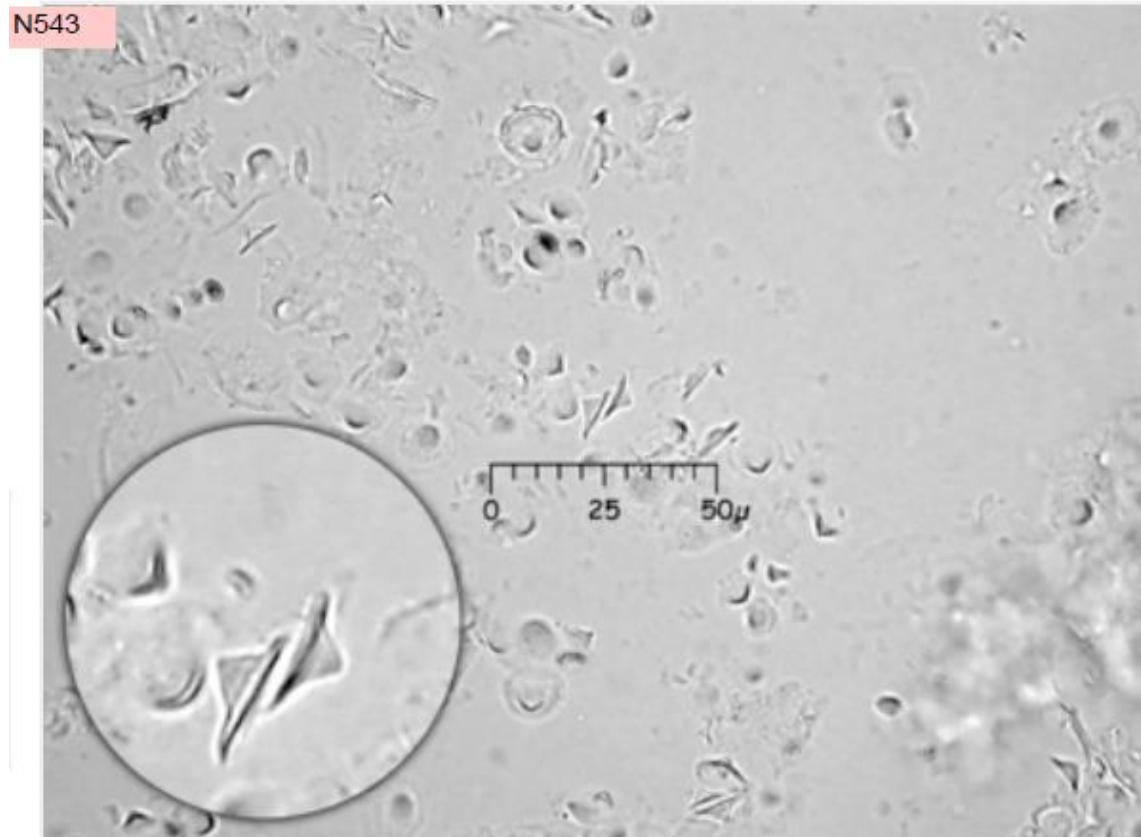
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Celtis schippii

## Phytolith

Occurs singly in *Celtis schippii* leaf and fruit.

20 V a,b, and c separated only by arrangement of conical bodies. 20 V Ca describes a singly occurring conical body. 20 V Cb describes when 2 of these bodies are fused along their flat surfaces. 20 V Cc describes when these conical

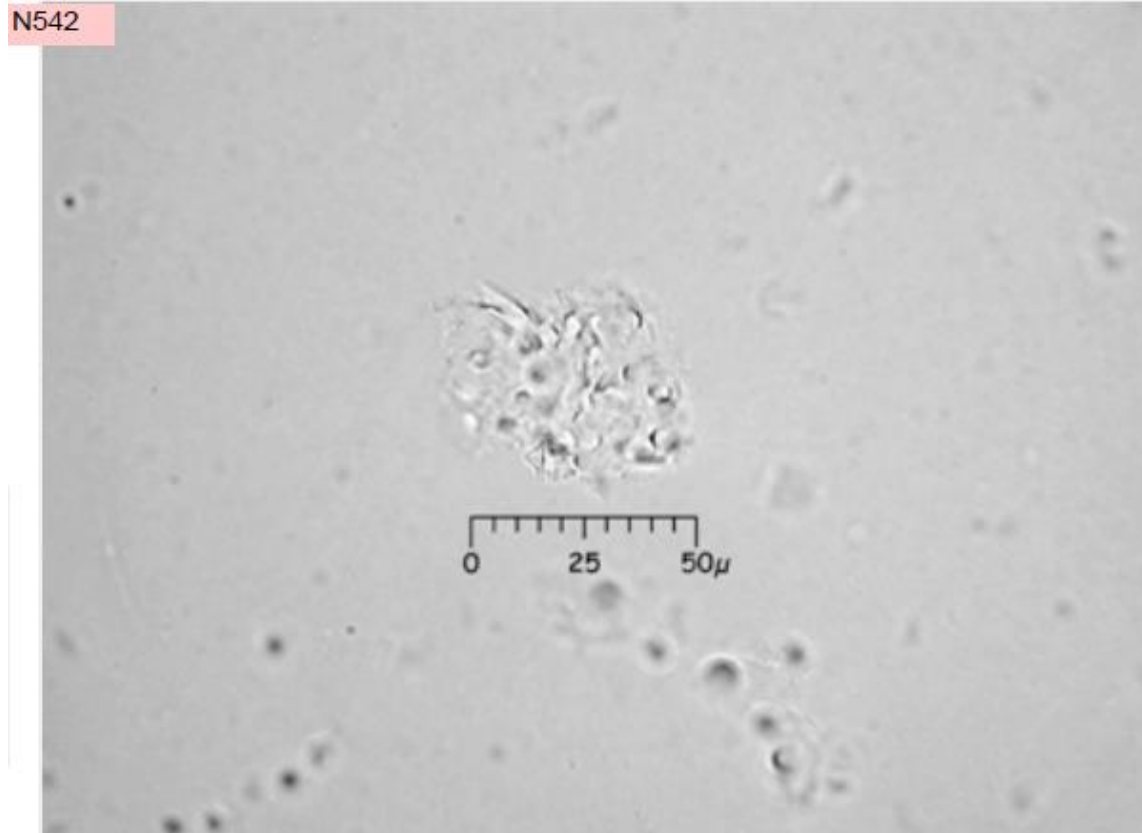


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Celtis schippii

## Phytolith

20 V a,b, and c separated only by arrangement of conical bodies. 20 V Cc describes when these conical bodies occur in fused masses. Diagnostic level: species

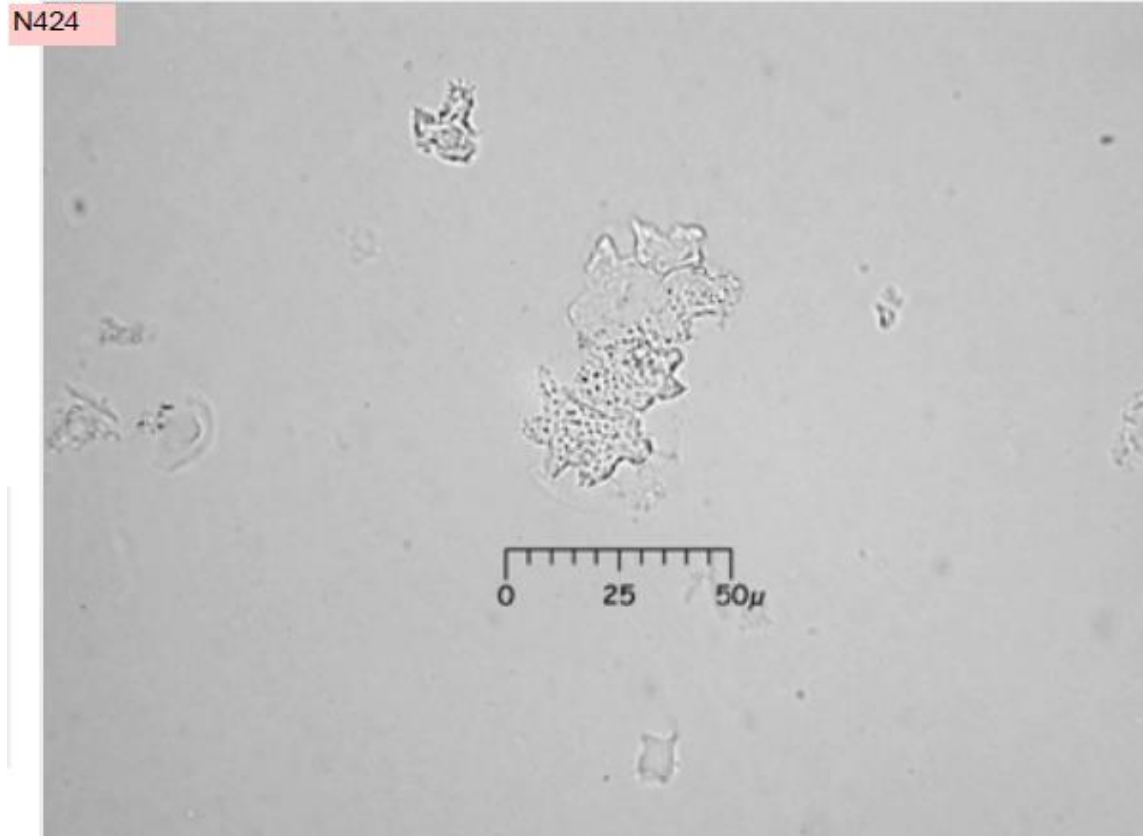


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Celtis schippii

## Phytolith

Seed or fruit epidermal cells. Diagnostic level: species



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Celtis schippii

## Phytolith

See Record #61 for another view. 20 V a,b, and c separated only by arrangement of conical bodies. 20 V Ca describes when these conical bodies occur singly. Diagnostic level: species

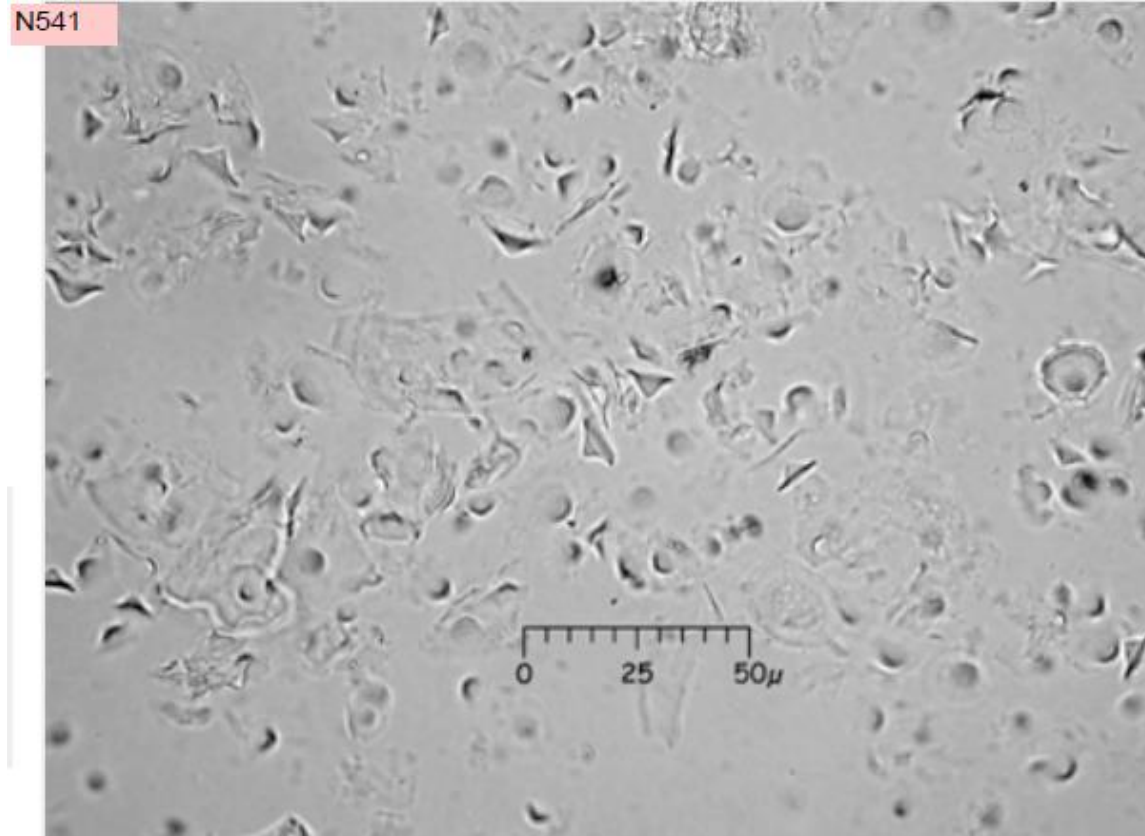


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Celtis schippii

## Phytolith

See Record #63 for another view. 20 V a,b, and c separated only by arrangement of conical bodies. 20 V Cc describes when these conical bodies occur in fused masses. Diagnostic level: species

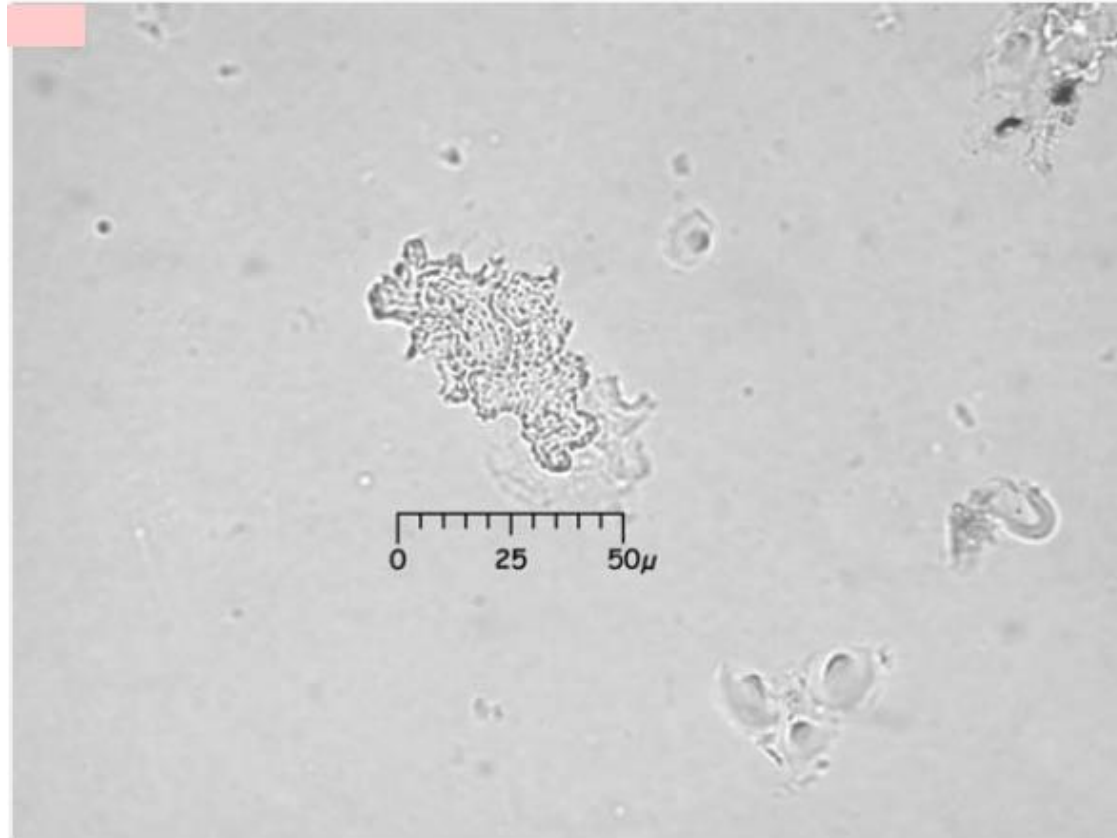


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Celtis schippii

## Phytolith

Occurs in fruit. Type defined by Cesar Veintimilla 05/1991. Diagnostic level: species



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trema integerrima

## Phytolith

Type defined by Cesar Veintimilla  
06/1991.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Trema integerrima

## Phytolith

Type defined by Cesar Veintimilla  
06/1991.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trema micrantha

## Phytolith

Hair often has cystoliths inserted in base. Some examples have slight surface texturing, but most are smooth. Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trema micrantha

## Phytolith

Hair. Note cystoliths inserted in the base.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trema micrantha

## Phytolith

Hair base. Only some of the smaller cells are still with the hair base in this example.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trema micrantha

## Phytolith

Type defined by Cesar Veintimilla  
05/1991.

Diagnostic level: genus



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Trema micrantha

## Phytolith

Slide 466 leaf.

Diagnostic level: generalized arboreal



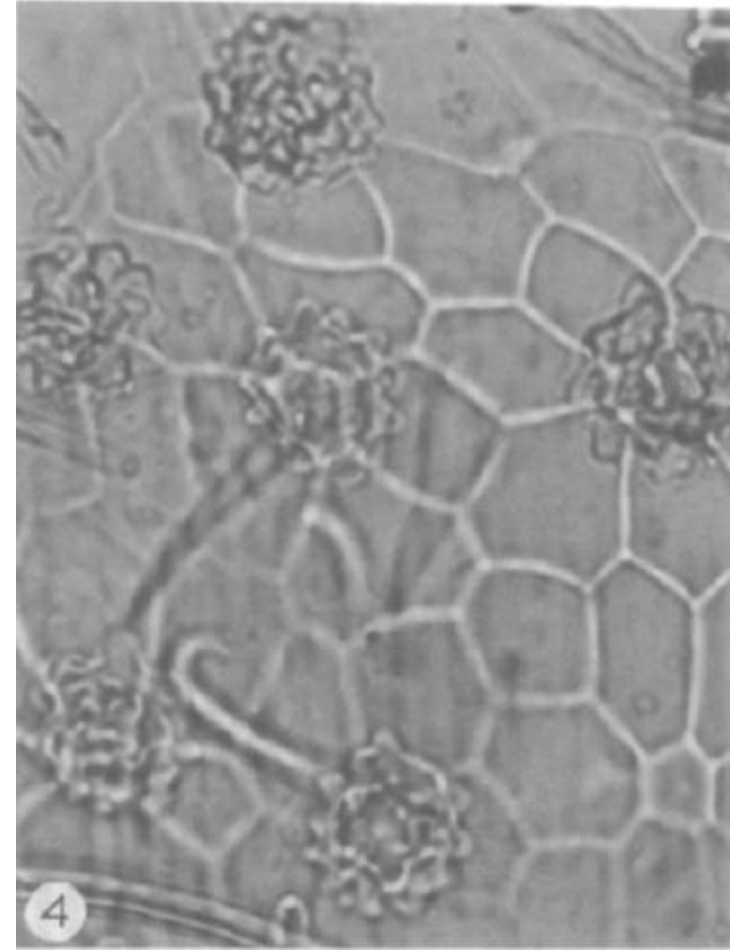
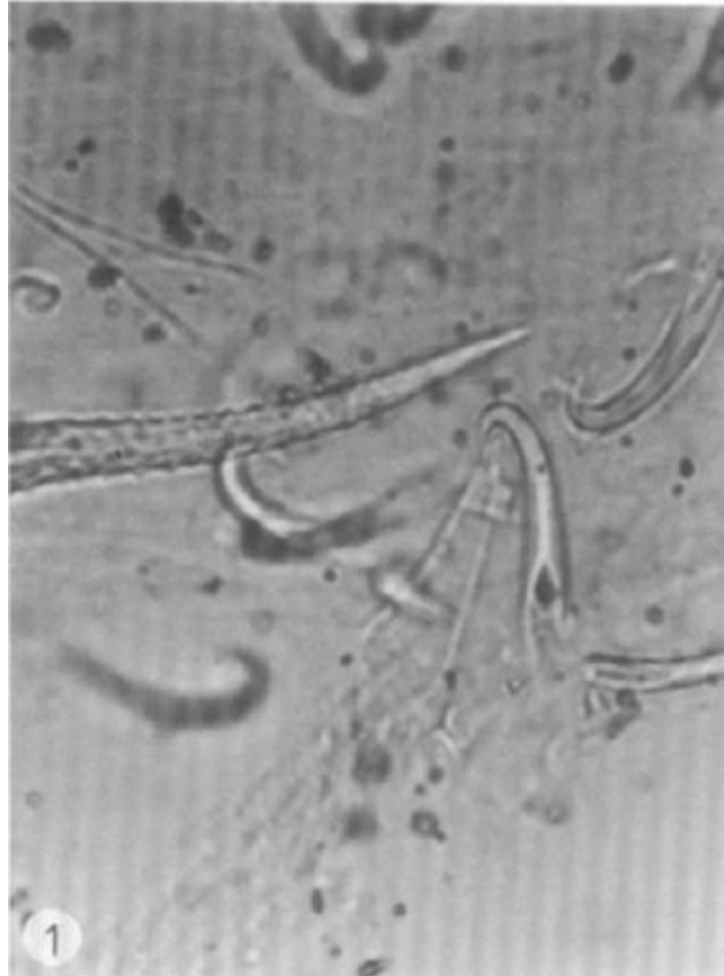
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

URTICACEAE

# Boehmeria aspera

## Phytolith

1. Thin, curved hairs from *Boehmeria aspera* (200 x ). Also present is a partially armed hair.
4. Spherical nodular cystoliths from *Boehmeria aspera*. They are attached to polyhedral epidermis (200 x ).



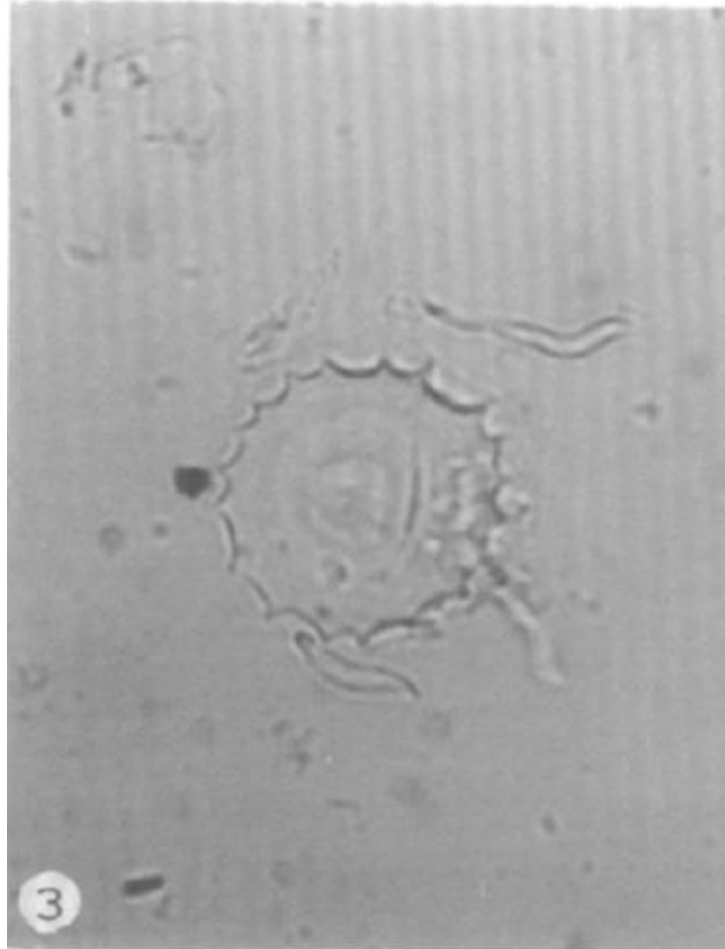
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.



# Cecropia peltata

## Phytolith

3. Hair base with short lines projecting from the perimeter from *Cecropia peltata* (200x)

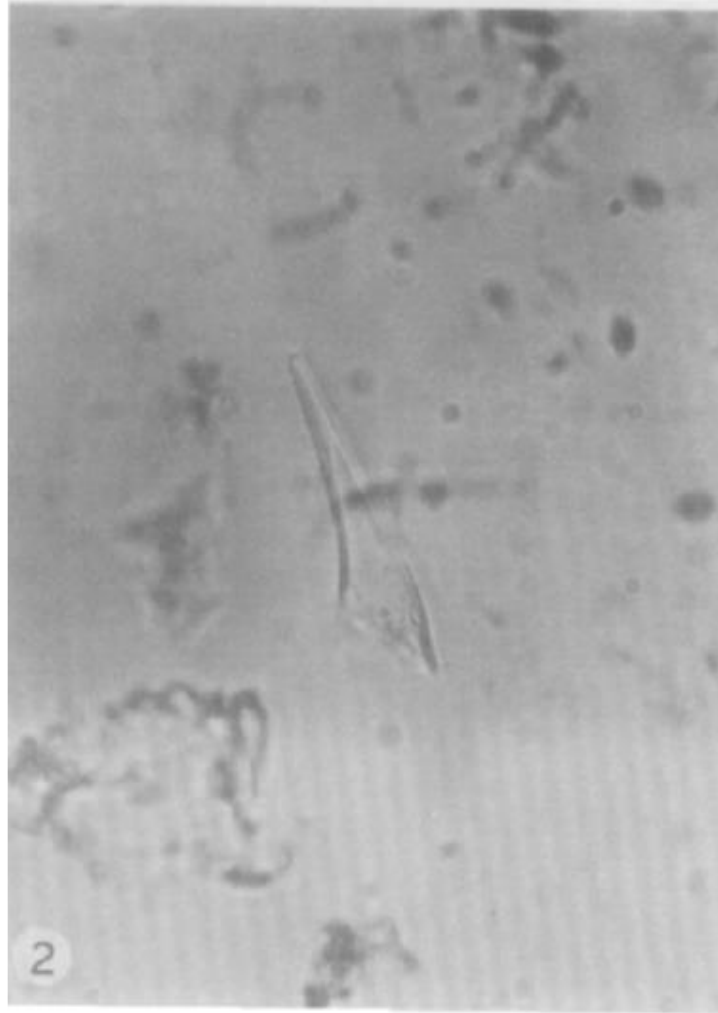


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Laportea aestuans

## Phytolith

2. A non-segmented hair cell from *Laportea aestuans* (400 ×).



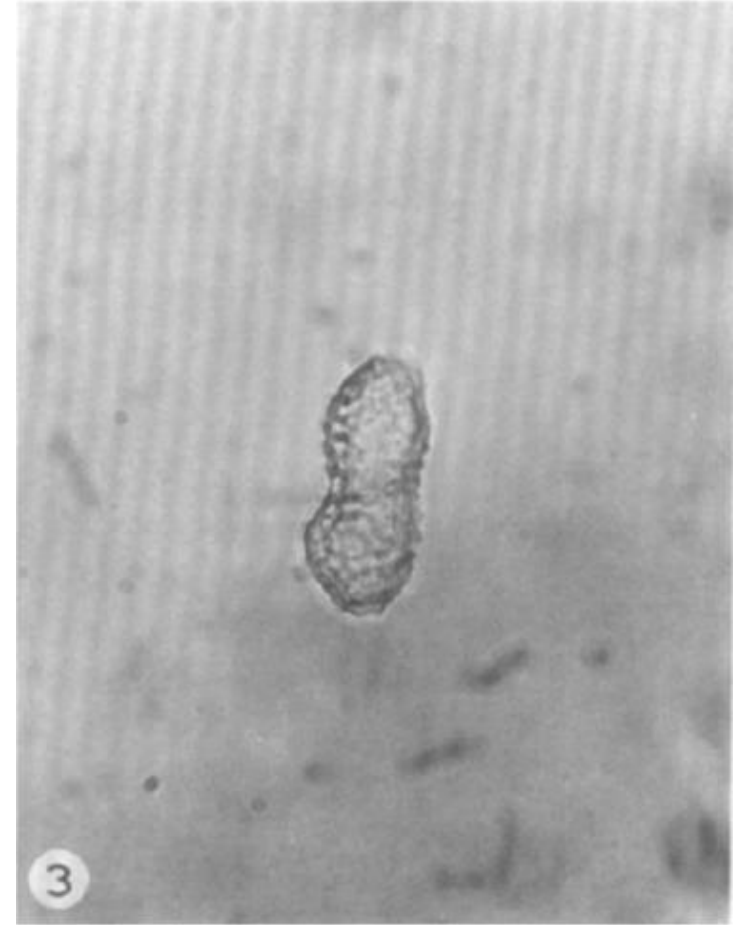
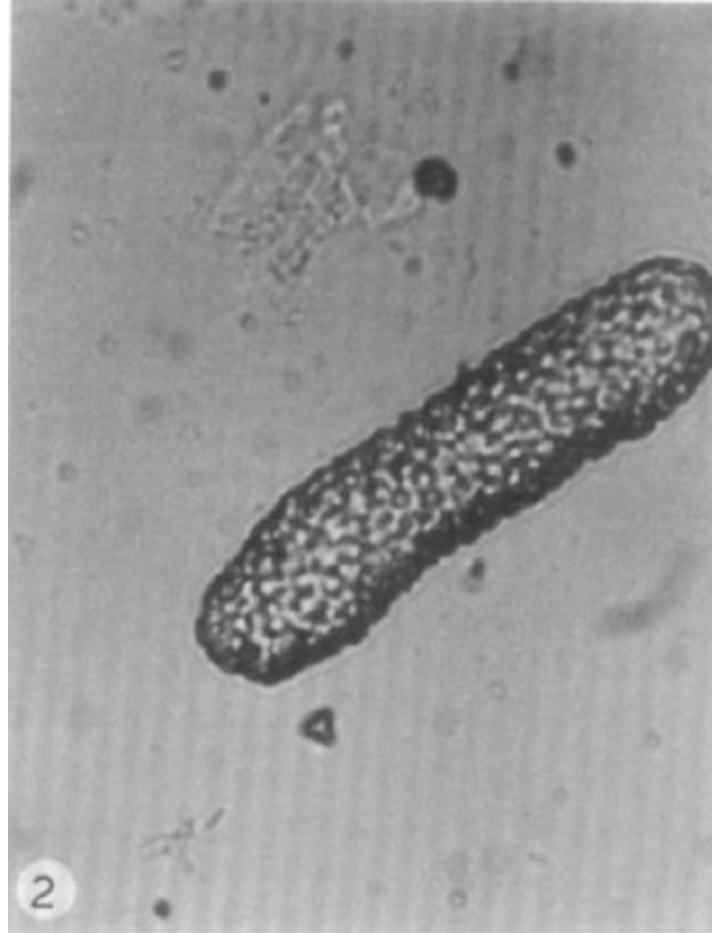
Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Laportea aestuans

## Phytolith

2. An elongate cystolith with two blunt ends and dense surface nodulation from *Laportea aestuans* (400 X ).

3. An elongate cystolith with an indented middle from *Laportea aestuans* (400 x ).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Pilea acuminata

## Phytolith

1. A curved, nodular cystolith from *Pilea acuminata* (250 X )



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Pouzolzia obliqua

## Phytolith

3. Non-segmented armed hairs from *Pouzolzia obliqua*. Also present are unarmed hairs, and in the middle a cystolith (156 × )

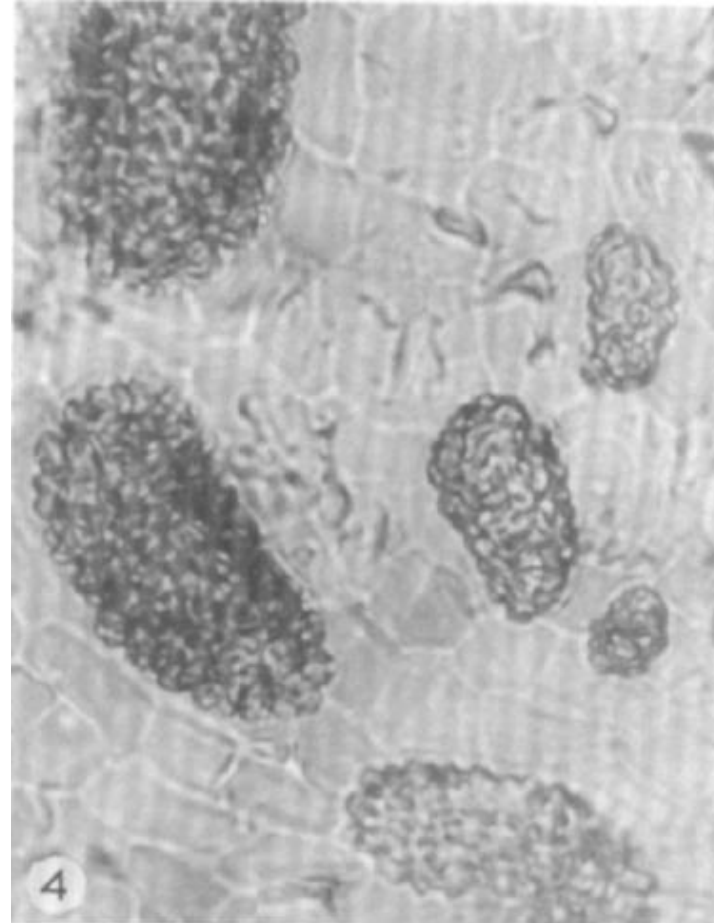


Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

# Urera elata

## Phytolith

4. Cystoliths from *Urera elata*  
(156 x).



Piperno, Dolores R. 1985. Phytolith Analysis and Tropical Paleo-Ecology: Production and Taxonomic Significance of Siliceous Forms in New World Plant Domesticates and Wild Species. *Review of Palaeobotany and Palynology* 45:185–228.

ZAMIACEAE

# Zamia sp.

## Starch

Fig. 2. Selected archaeological starch grains. (F) *Zamia* sp. starch from Hornito, scraper E18, ?7000 cal BP. Additional examples of starch grains from the sites are provided in supporting information (SI) Figs. 3–8.



Dickau, Ruth, Anthony J. Ranere, and Richard G. Cooke. 2007. Starch Grain Evidence for the Preceramic Dispersals of Maize and Root Crops into Tropical Dry and Humid Forests of Panama. *Proceedings of the National Academy of Sciences of the United States of America* 104 (9):3651–56.



# Zamia sp.

## Starch

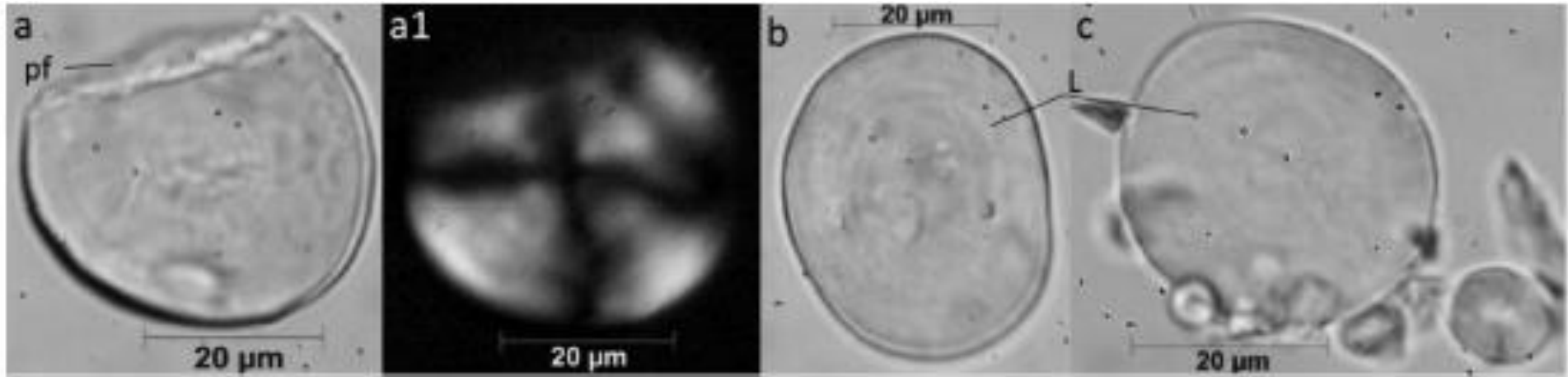
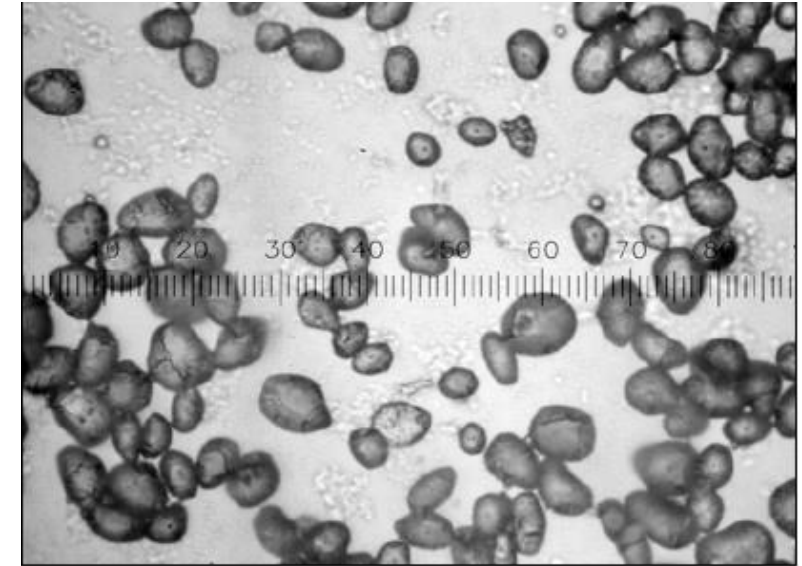
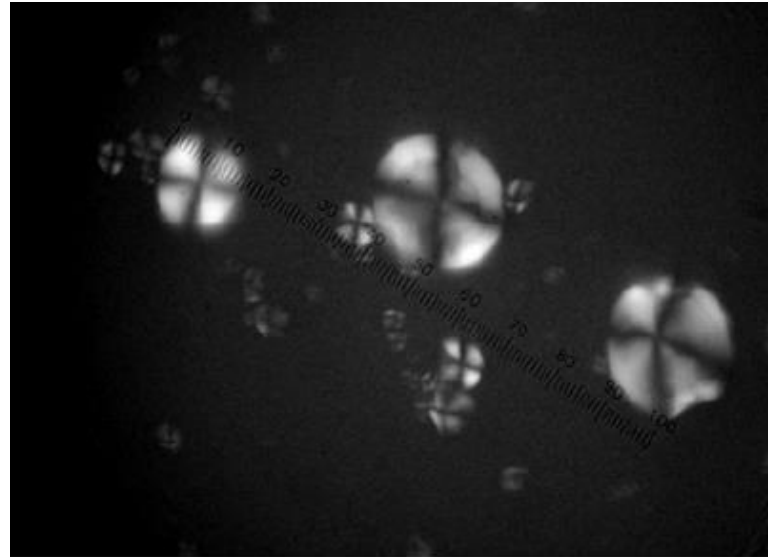
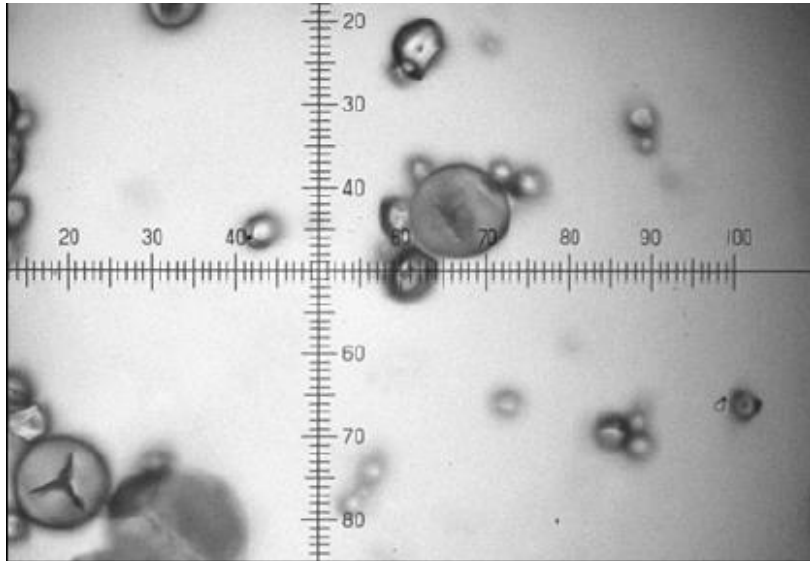


Fig. 8. Marunguey starch grains from Eva 2. a, truncated starch diagnostic to the genus showing smooth lamellae and a single pressure facet (“pf”) at the distal end; a1, the same starch showing the particular extinction cross defined for the genus; b, oval starch with concentric rings or lamellae (“L”) lightly undulated; c, oval starch of cf. *Zamia* spp. showing undulated lamellae (“L”) and 5 smaller starches partially attached. Provenances: a (artifact E-1); b and c (artifact E-2).

# Zamia amblyphyllidia

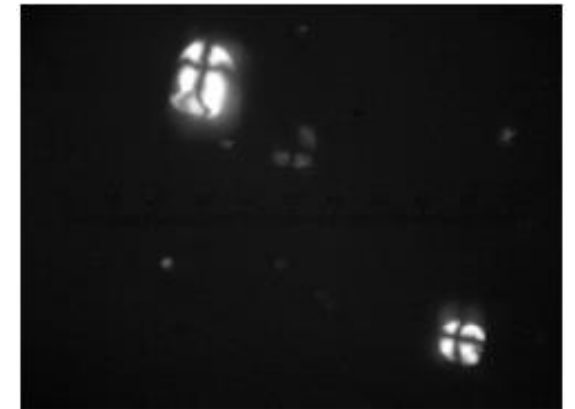
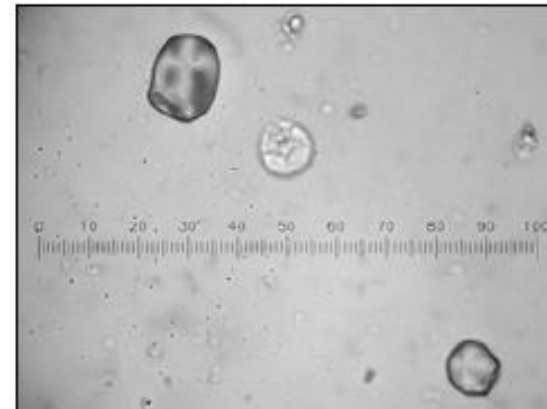
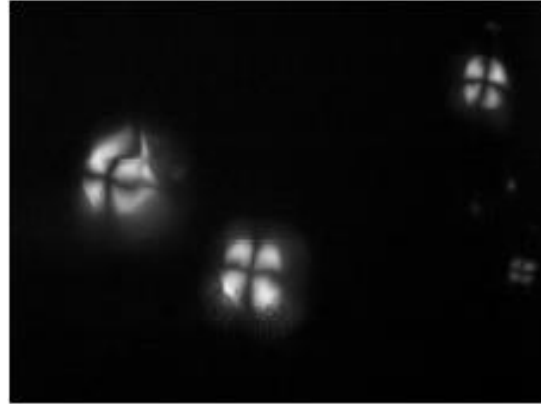
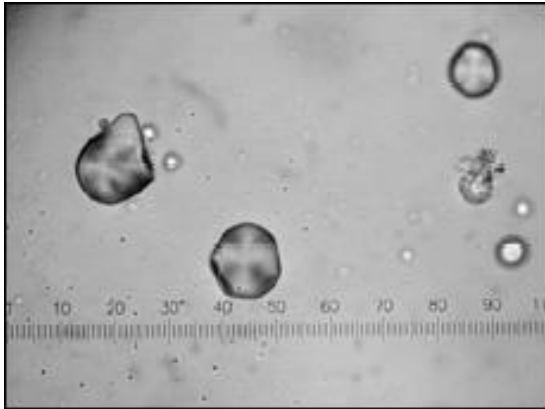
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Zamia portoricensis

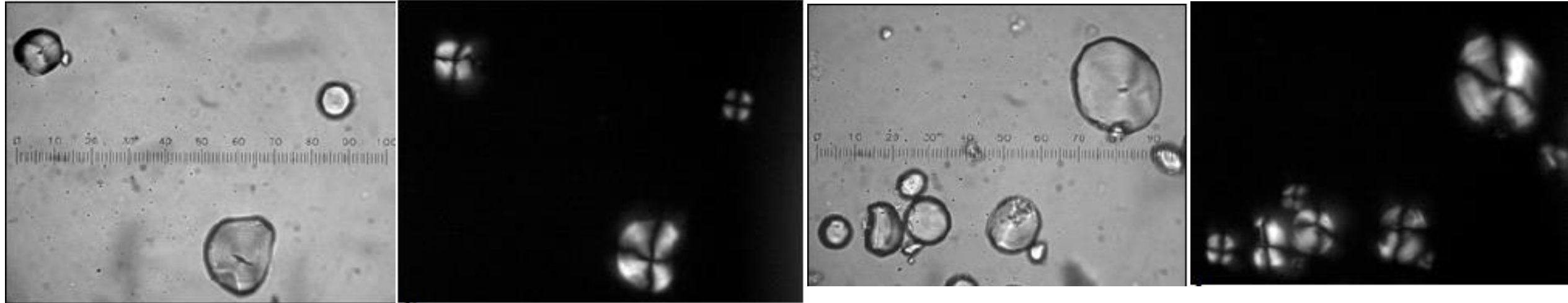
## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

# Zamia pumila

## Starch



Pagán-Jiménez, Jaime R. 2007. De Antiguos Pueblos y Culturas Botánicas En El Puerto Rico Indígena: El Archipiélago Borincano y La Llegada de Los Primeros Pobladores Agroceramistas. Vol. 1067. Oxford: British Archaeological Reports Limited.

ZINGIBERACEAE

# Zingiberaceae cf.

## Starch



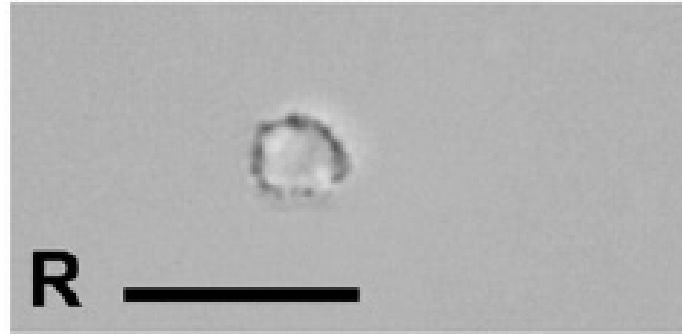
Fig. 9. Other ancient starch grains (a-g) recovered at St. John and Eva 2. f, cf. Zingiberaceae starch with multiple crackings and fissures on the surface, and remarkable lamellae.

Pagán-Jiménez, Jaime R., Reniel Rodríguez-Ramos, Basil A. Reid, Martijn van den Bel, and Corinne L. Hofman. 2015. Early Dispersals of Maize and Other Food Plants into the Southern Caribbean and Northeastern South America. *Quaternary Science Reviews* 123:231–46. <http://www.sciencedirect.com/science/article/pii/S0277379115300445>.

# Aframomum angustifolium

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). R, globular-microgranulate from *Aframomum angustifolium* leaf. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .

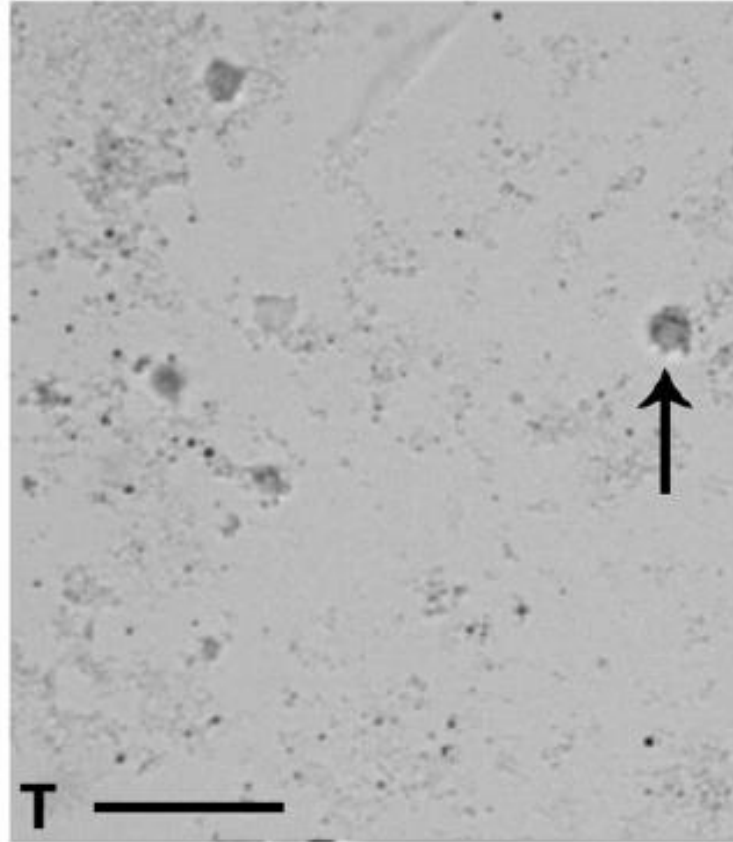


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Alpinia blepharocalyx

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). T, globular-microrugulates (arrow) and silica sand from *Alpinia blepharocalyx* leaf. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .



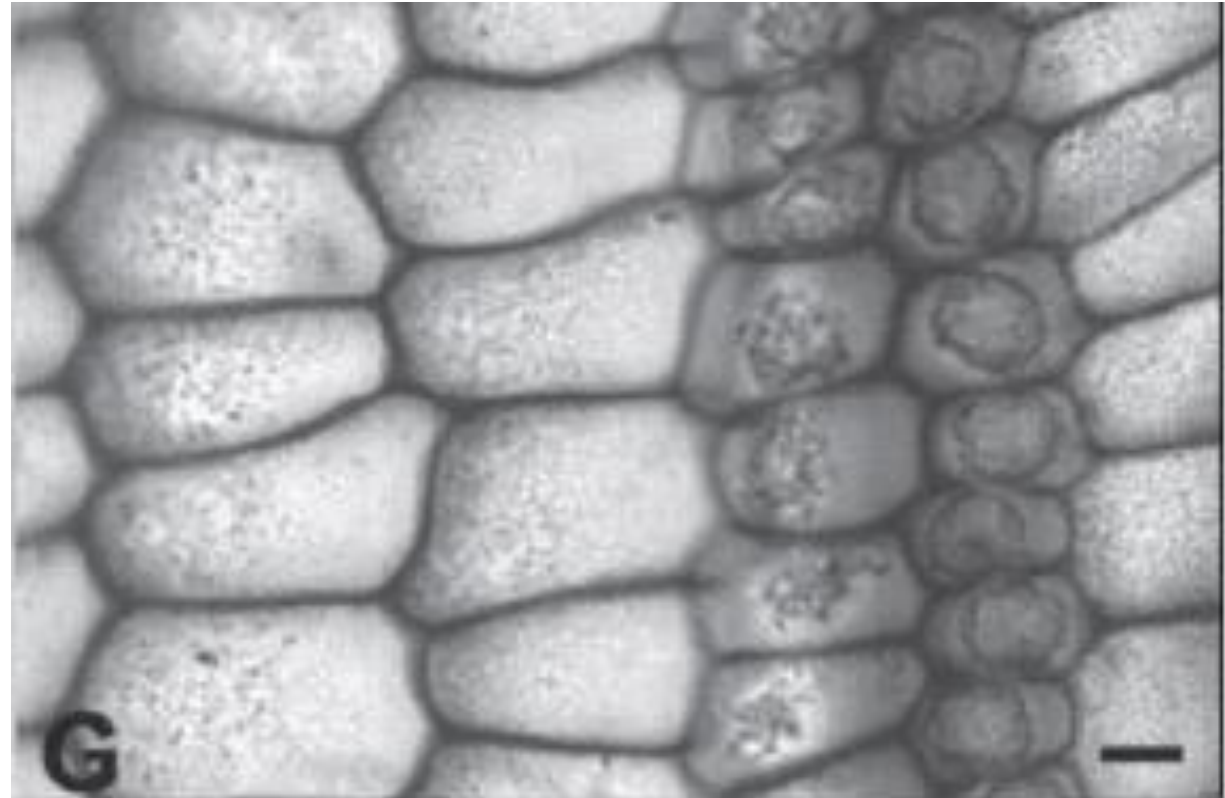
Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.



# Alpinia conchigera

## Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. G. *Alpinia conchigera* (Zingiberaceae), two forms of silica: intercostal silica sand and costal spherical bodies in epidermal cells (bar = 10  $\mu$ m).

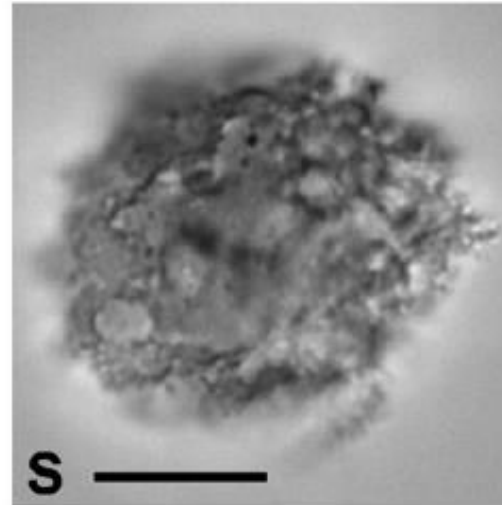


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Alpinia galanga

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). S, globular-rugulate from *Alpinia galanga* fruit. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .

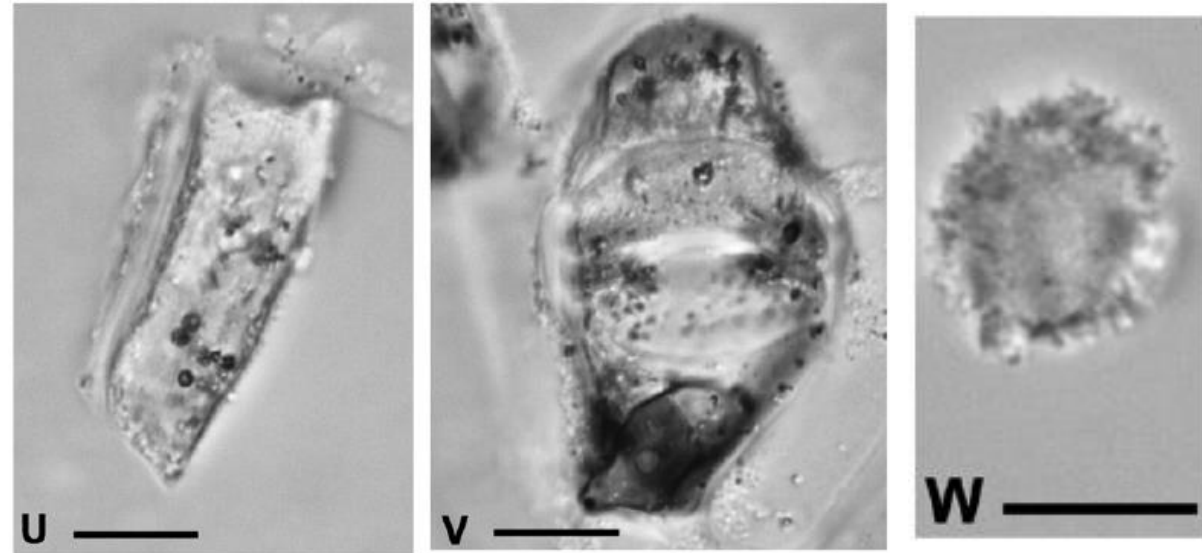


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Amomum lepicarpum

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). U, Ta4 (tabular-psilate) from *Amomum lepicarpum* leaf. V, stomatal complex from *Amomum lepicarpum* leaf. W, globular-rugulose-granulate from *Amomum lepicarpum* fruit+seed. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .



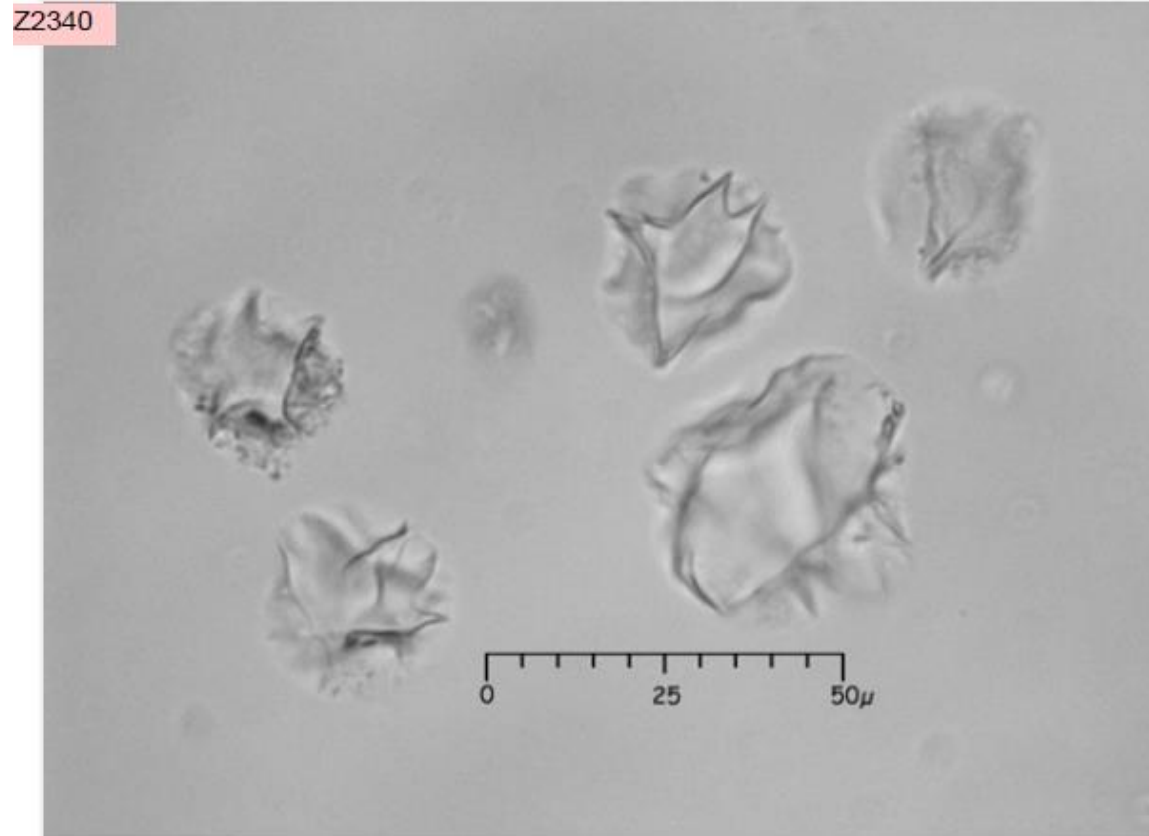
Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Costus guanaianis

## Phytolith

Diagnostic level: Potential species-level diagnostic, under study. Type overlaps with 80IKa, but is distinguished by larger size.

Occurs in rhizome



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Costus guanaianis

## Phytolith

Diagnostic level: Potential species-level diagnostic, under study. Type overlaps with 80IKa, but is distinguished by larger size.

Occurs in rhizome.



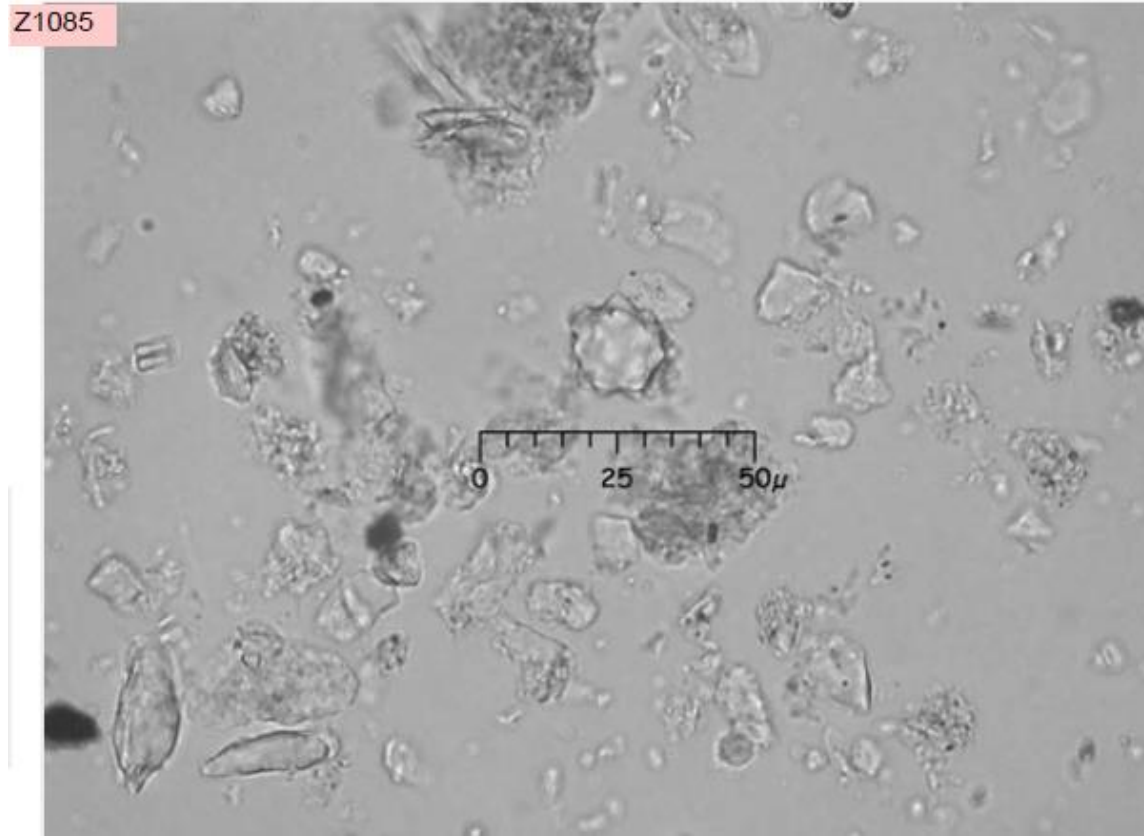
Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Costus guanaiensis

## Phytolith

Large nodular sphere, 18 microns and larger in size, with short projections with large basal diameter. Sphere can be slightly irregularly shaped.

Diagnostic level: Family

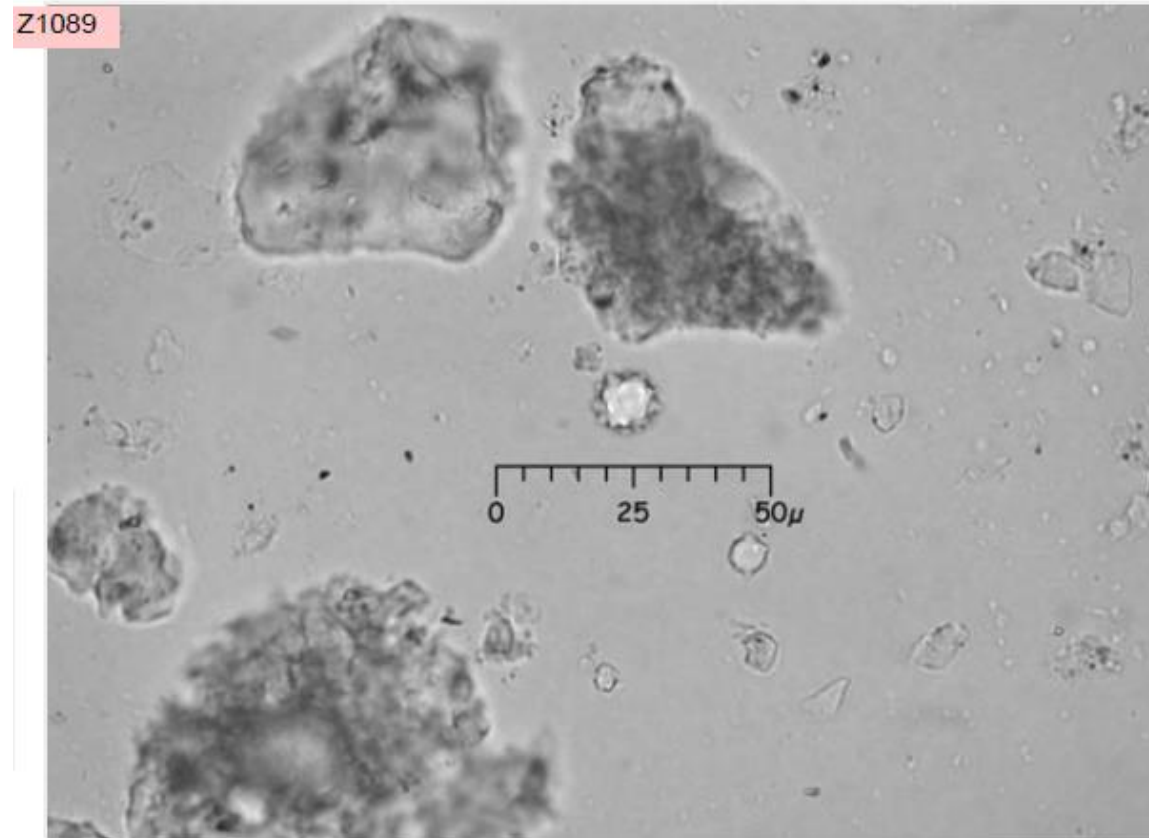


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Costus guanaienis

## Phytolith

These spheres have nodular and spinulose projections or silia. Nodular projections outnumber spinulose or cilia. Projections are tightly spaced. Diagnostic level: Under investigation.

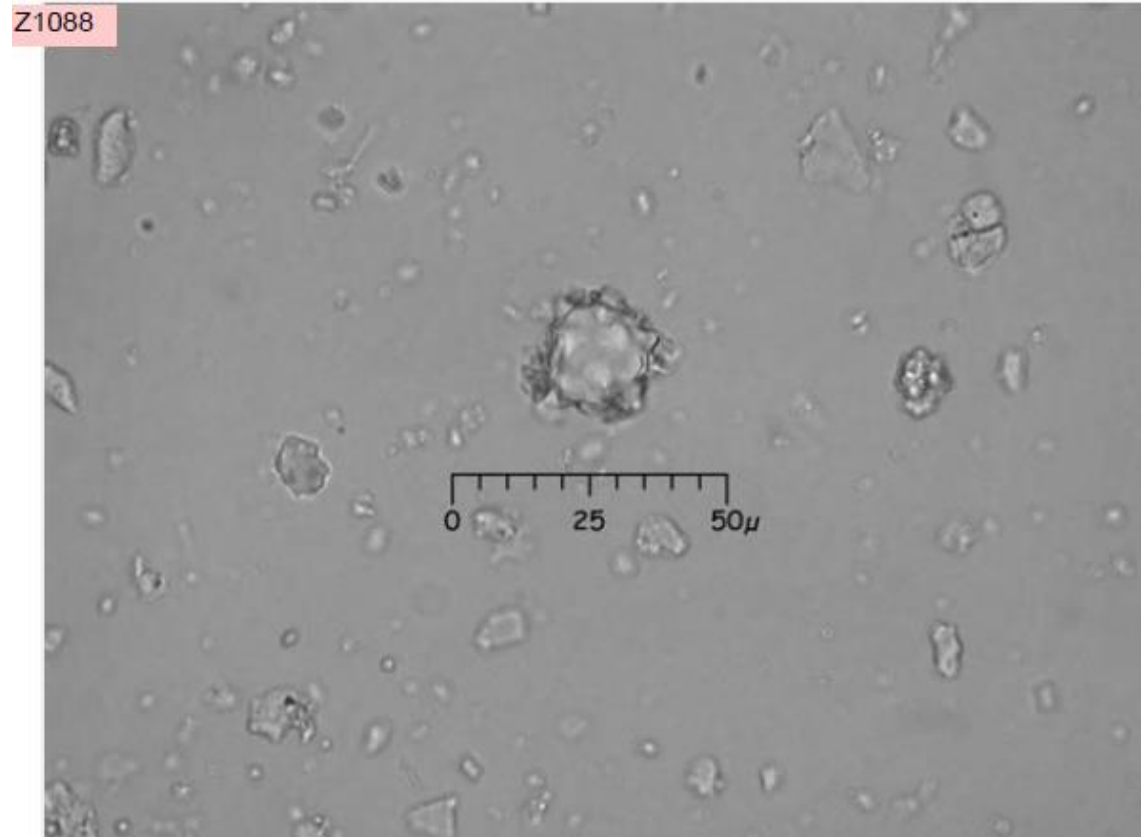


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [<http://phytolith.missouri.edu>]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Costus scaber

## Phytolith

Also occurs in the Bombacaceae.  
Diagnostic level: mixed, Zingiberaceae,  
Bombacaceae. There are subtle  
differences in the smoothness and  
abundance of nodules between the two  
families.



Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.



# Costus scaber

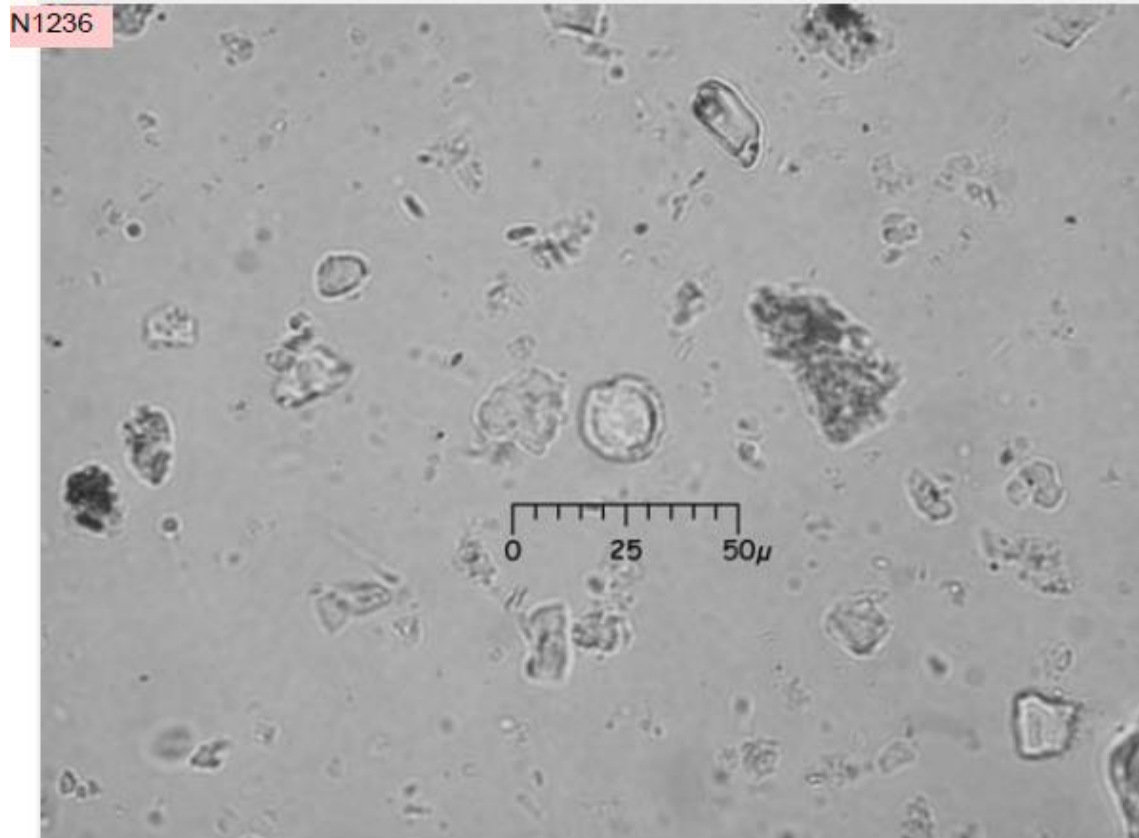
## Phytolith

PC2744, root

Type originally defined by Karol  
Chandler-Ezell.

Image shows top view; note the narrow  
rim.

Diagnostic level: under study

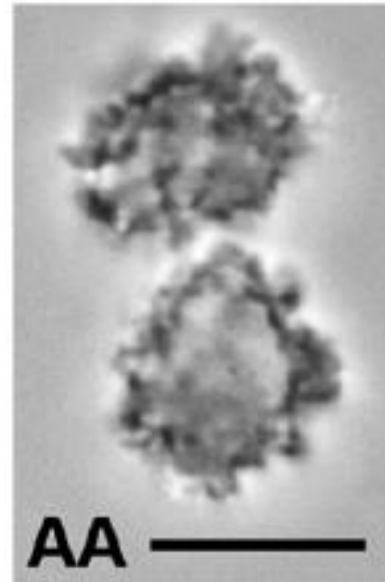


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Globba maculata

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). AA, globular-rugulose-granulates from *Globba maculata* leaf. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .

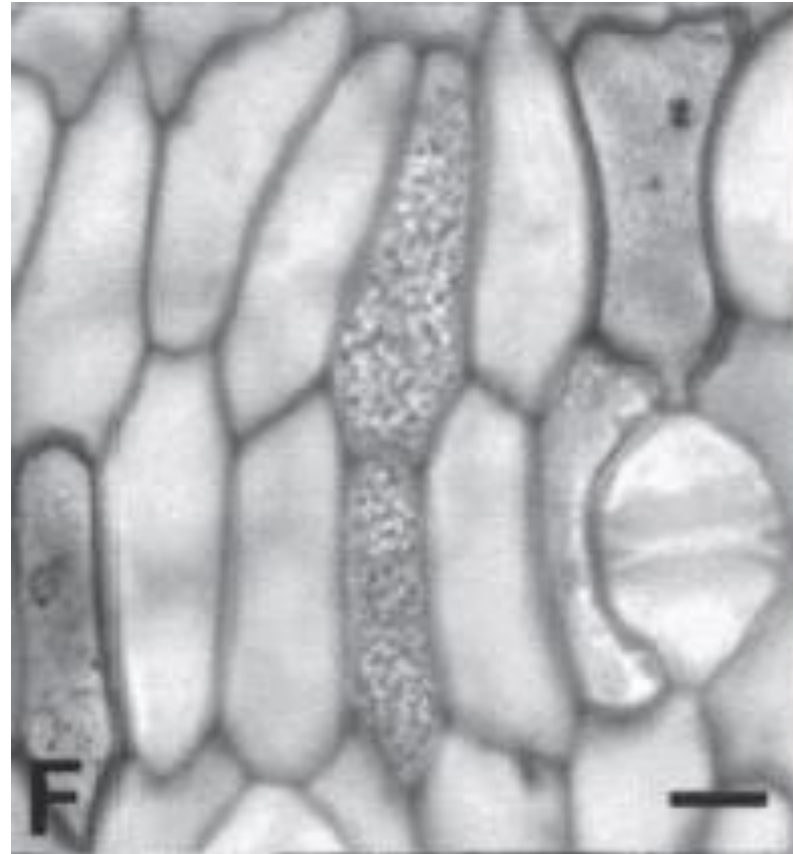


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Hornstedtia conica

## Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. F. *Hornstedtia conica* (Zingiberaceae), epidermal, intercostal silica sand (bar = 10  $\mu\text{m}$ ).

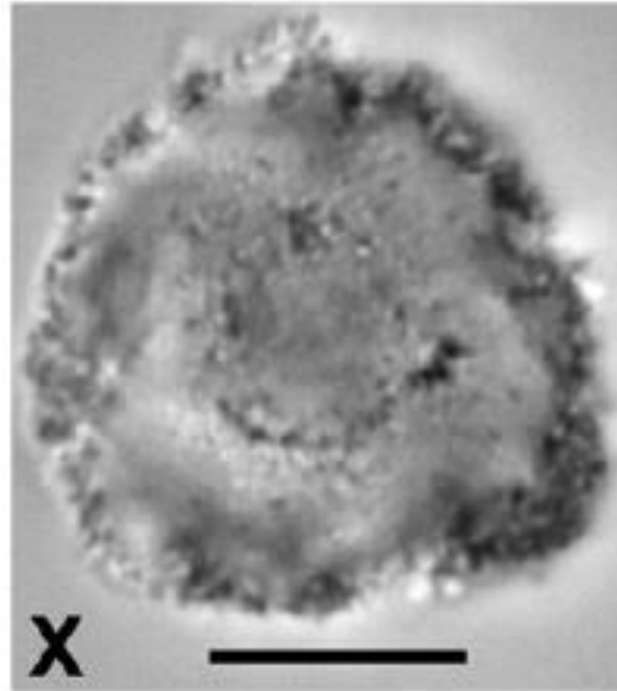


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Hornstedtia spathulata

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). X, globular-rugulose-granulate from *Hornstedtia spathulata* fruit+seed. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .

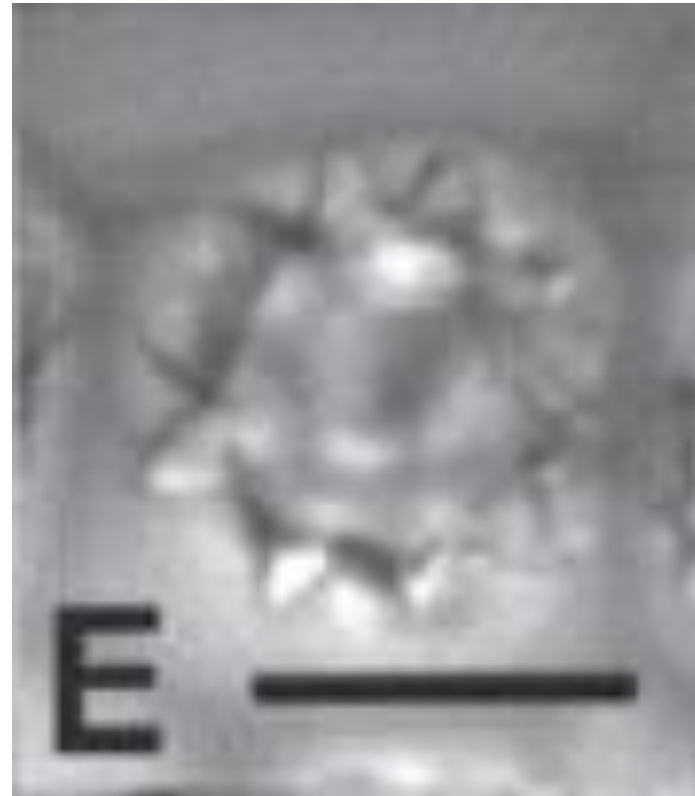


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Kaempferia aethiopia

## Phytolith

Fig. 4. Various silica body morphologies found in the order Zingiberales, continued. E. *Kaempferia aethiopia* (Zingiberaceae), an internal costal silica body (bar = 10 $\mu$ m).

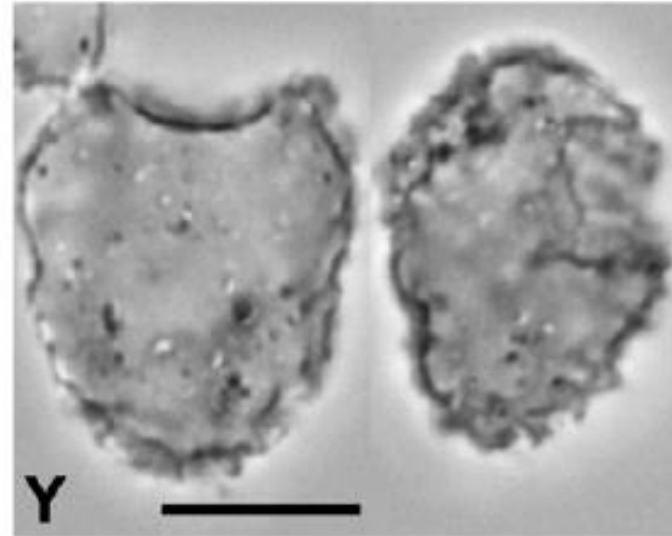


Prychid, Christina J., Paula J. Rudall, and Mary Gregory. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *The Botanical Review* 69 (4):377–440.

# Renealmia occidentalis

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). Y, globular-rugulose-granulates from *Renealmia occidentalis* fruit+seed. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .

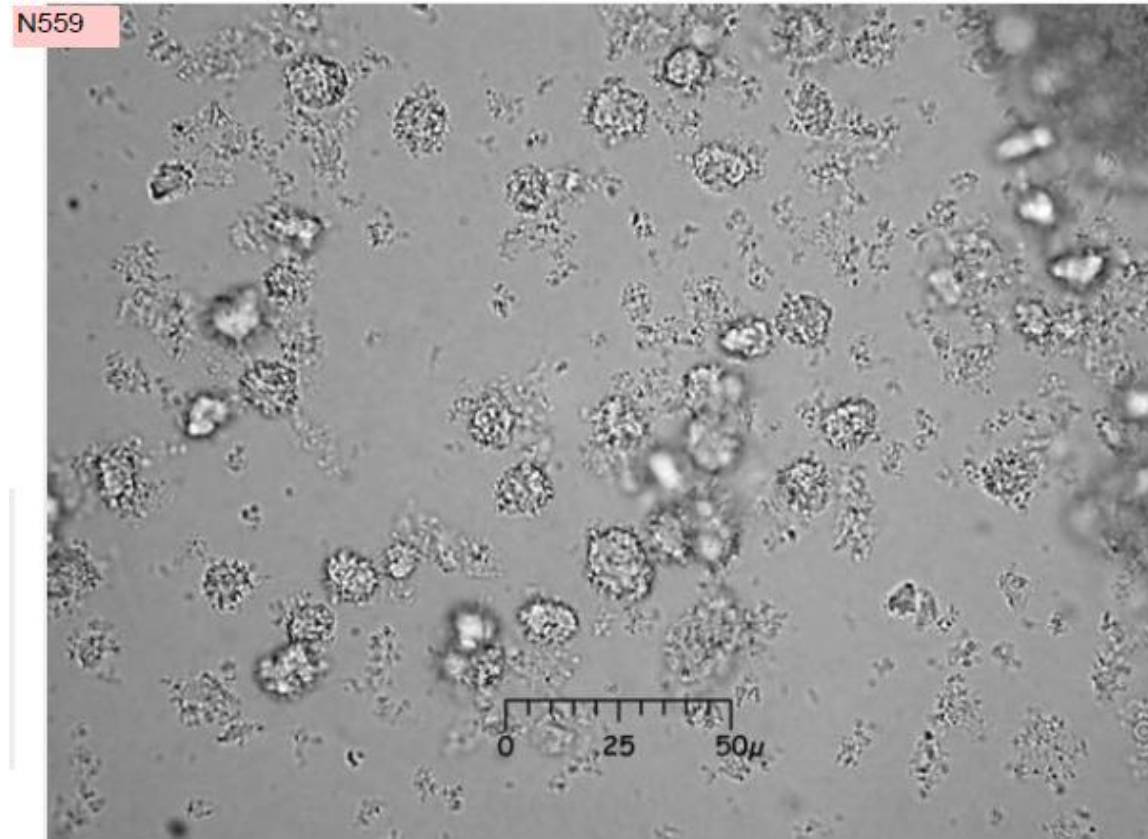


Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Renealmia oligosperma

## Phytolith

Diagnostic level: under study. Also observed in Donax, Thalia (Marantaceae)

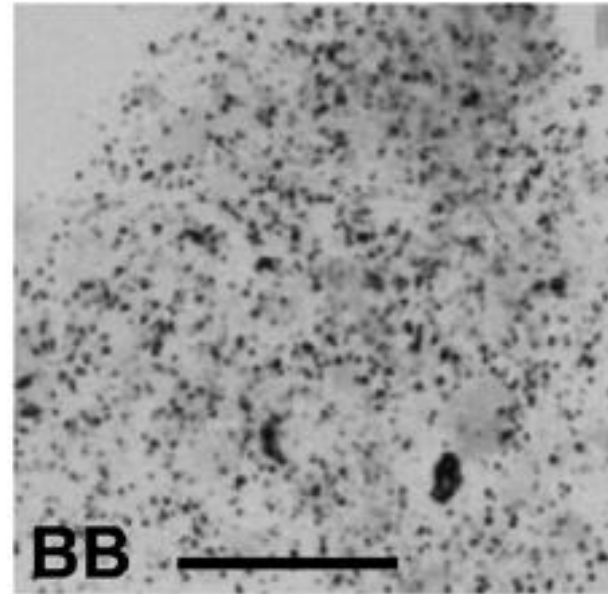


Pearsall, Deborah Marie. "Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database." [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar Veintimilla, and Dr. Zhijun Zhao.

# Spirematospermum sp.

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). BB, silica sand from Spirematospermum seed (Fasterholtz, Germany). Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .



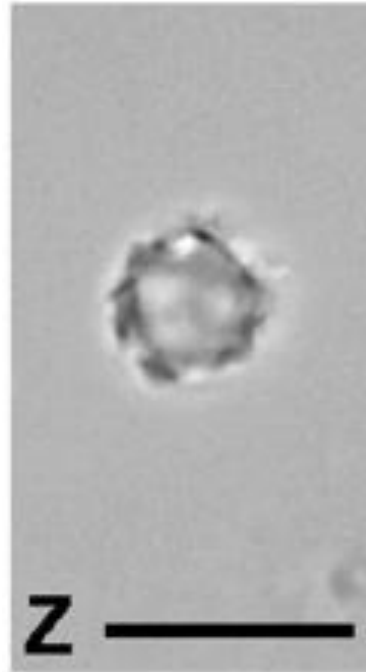
Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.



# Zingiber officinale

## Phytolith

Fig. 4. Musaceae (A–I), Strelitziaceae (J–Q), Zingiberaceae (Alpineae: R–Y, Zingibereae: Z, Globbeae: AA), and Spirematospermum (BB). Z, globular-microechinate from *Zingiber officinale* rhizome. Scale bars=A, C–S, U–AA=12  $\mu\text{m}$ ; B, T, BB=23  $\mu\text{m}$ .



Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Zingiber officinale

Australian Museum,  
McCown Archaeobotany  
Laboratory Collection



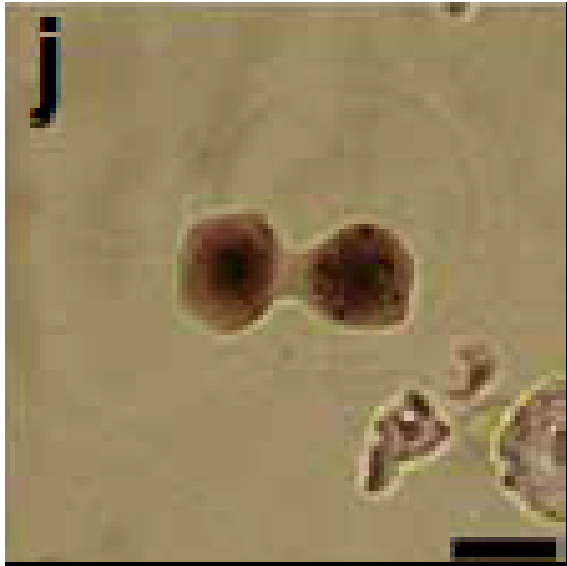
# Zingiber officinale



Australian Museum,  
McCown Archaeobotany  
Laboratory Collection

# Zingiberales

## Phytolith



j. Irregularly angled rugulose chain fragment diagnostic of the order Zingiberales, and possibly derived from *Canna*.

Abramiuk, Marc A., Peter S. Dunham, Linda Scott Cummings, Chad Yost, and Todd J. Pesek. 2011. Linking Past and Present: A Preliminary Paleoethnobotanical Study of Maya Nutritional and Medicinal Plant Use and Sustainable Cultivation in the Southern Maya Mountains, Belize. *Ethnobotany Research and Applications* 9:257–73.

# Zingiberales Phytolith

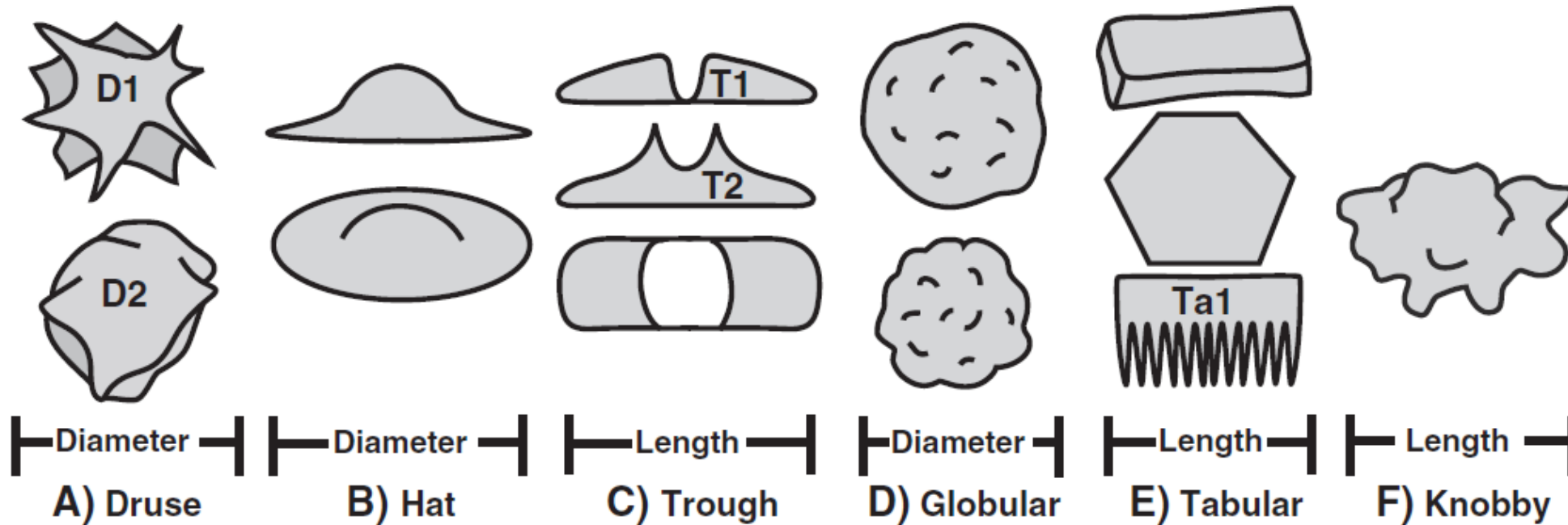


Fig. 1. Stylized drawings of selected phytolith morphotypes. A, D1 and D2 druses, distinguished by visible spikes on D1 druses. B, hat-shapes, defined by a relatively flat and trans-lucent base. C, T1 and T2 troughs, identified by height of central process. T1 troughs are generally flat while T2 rise rapidly. D, two textures of globulars, although they can exist in a larger range of textures. E, tabular-type phytoliths, with Ta1 example. F, knobby-type phytoliths, with Kn2 example. All reported measurements are made along the longest axis

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.

# Zingiberales

## Phytolith

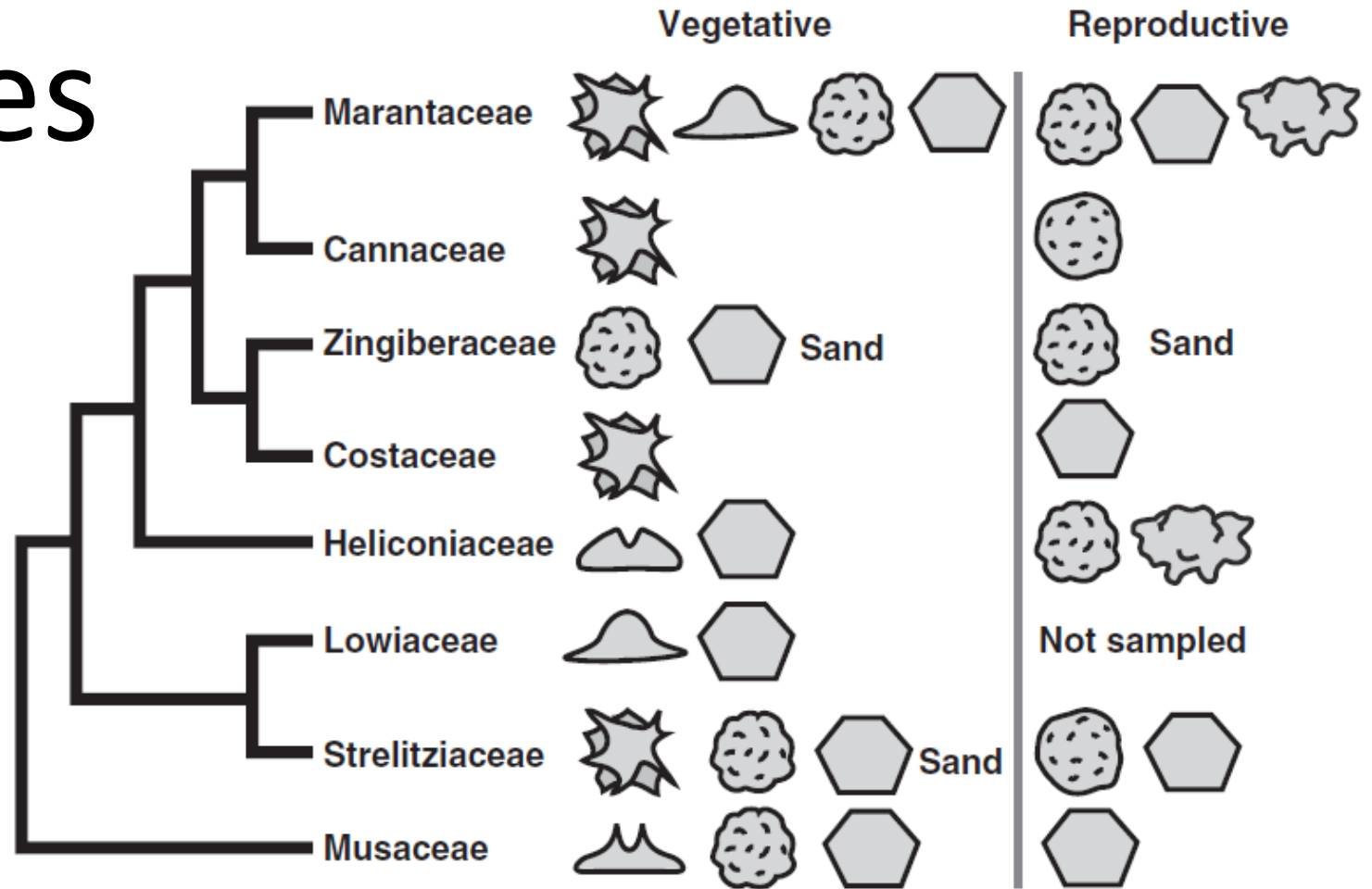


Fig. 5. A comparison of family-level morphotype production against phylogeny. There is no apparent correlation of morphotype to phylogenetic relationship. Phylogenetic tree based on Kress et al. (2001). Symbols are as in Fig. 1, except differences within tabular and druse morphotypes was not made as the subcategories often intergrade.

Chen, Stephanie T., and Selena Y. Smith. 2013. Phytolith Variability in Zingiberales: A Tool for the Reconstruction of Past Tropical Vegetation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 370.