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**Title**

Work, Resources and Population in Foraging Societies

**Permalink**

<https://escholarship.org/uc/item/6cv9n38x>

**Journal**

Journal of the Royal Anthropological Institute, 28(2)

**ISSN**

1359-0987

**Author**

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**Publication Date**

1993-06-01

**DOI**

10.2307/2803416

Peer reviewed



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*Man*, New Series, Volume 28, Issue 2 (Jun., 1993), 321-340.

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## WORK, RESOURCES AND POPULATION IN FORAGING SOCIETIES

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Anthropological views on the labour effort required of hunter-gatherers have flip-flopped between stereotypic positions depicting either very limited subsistence work or long exertion. This is partly because the discipline has lacked an encompassing framework for the analysis of work, resources and population in foraging societies. A computer simulation using evolutionary and population ecology models shows that at equilibrium foraging efficiency is a declining function of work effort, whereas population density responds to work effort by first increasing and then decreasing. This and other foraging theory models provide a framework which a) can explain observations of routine sharing, modest effort and limited material accumulation in hunter-gatherer societies, b) leads us to expect diversity in the expression of these characteristics and, c) is consistent with neo-Darwinian and neoclassical economic theory. Evolutionary ecology theory thus obviates the need for a 'Zen' economics as proposed by Sahlins.

### *Work and time in foraging societies*

More than ninety years ago entomologist Professor C.F. Hodge marked individual honey bees to study their activities. He observed that between sunrise and sunset no bee worked more than three and one-half hours (see Hubbell 1988: 78). Compare this observation with the commonly held belief captured in the phrase, 'busy as a bee'. In popular wisdom the honeybee stands for bustling productive effort, its labours those of nearly ceaseless toil. Only the beaver equals its reputation as an icon of industriousness.<sup>1</sup> But Hodge is right. Bees spend a lot of time doing nothing or wandering through the hive appearing to do nothing in particular. Only intermittently do they work hard (Seeley 1989). Beavers too are active foragers only a small percentage of the time (Belovsky 1984).

Here are curious rifts between cultural tales and natural facts that parallel a disagreement among anthropologists on the work effort of hunter-gatherers. As public and expert opinion diverge on the labour of bees, so too anthropologists – whose views likewise are shaped by a mixed assortment of evidence, theory and belief – diverge on the labours of foragers.

It is a dispute of long and erratic history. In his 1952 text, *Economic anthropology*, Herskovits begins chapter 5, 'Patterns of labor,' with an assault on what he calls the 'coconut tree' theory of primitive economies:

This is the point of view that holds the 'savage' to be a man who, commonly living in a climate where his needs are bountifully provided by nature, neither is required to exert himself nor is willing to do so when he can obtain even the necessary minimum to support life by abstaining from effort (1952: 88).

Herskovits draws attention to obvious examples from Marshall and Bücher, and he expresses concern about tacit acceptance of the coconut tree view, saying that we: 'risk not understanding how pervasive its influence has been, or how it may be present even in the thinking of those who agree with its refutation' (1952: 89). He cites a smattering of brief work diaries from early ethnographies<sup>2</sup> to show that non-'machine age' peoples are hard workers, especially in tasks related to subsistence. Primitive peoples, 'like ourselves, do as much work as they feel they must to meet the basic demands of getting a living, plus as much more as their desire to achieve any given end not encompassed by these basic demands calls for' (1952: 90).

However, for the food collectors he describes, 'getting a living' leaves little room for anything more:

Thus food, to a South African Bushman or a native of Tierra del Fuego, who lives always in a state of potential hunger, is always of maximum value ... since there is little surplus of energy or resources available for other activities than the food quest (1952: 15-16).

Herskovits uses the !Kung San (Bushmen) and Aboriginal Australians as illustrations of the proposition that only 'intense application makes survival possible' (1952: 69).<sup>3</sup>

By 1966 views on the economic life of foragers change dramatically (Lee & DeVore 1968). The same hunter-gatherers that Herskovits cites to refute the coconut theory, now have become illustrative of 'original affluence' (Sahlins 1968: 85). Summarizing papers delivered at the 1966 Chicago conference on hunter-gatherers, Sahlins writes:

A fair case can be made that hunters often work much less than we do, and rather than a grind the food quest is intermittent, leisure is abundant, and there is more sleep in the daytime per capita than in any other condition of society (1968: 86).

To interpret this phenomenon, Sahlins proposes the 'Zen' economy, built from an inversion and rejection of the principles underlying the neoclassical one (Robbins 1932).

The new and apparently precipitating factor in this turnabout was quantitative data.<sup>4</sup> Time allocation studies on Aboriginal Australians living in Arnhem Land (McCarthy & McArthur 1960) and on !Kung San residents of the Kalahari Desert (Lee 1968) suggest that foragers only worked from two to four hours per day in the food quest. Other, less quantitative, ethnographies (e.g. Woodburn 1968) appear to support this estimate, as do incidental statements gleaned from the accounts of explorers and missionaries. Despite Herskovits, the leisured primitive is reborn, sustained in this new life by a rain of mongongo nuts as thick as the coconuts of the earlier version.

Anthropologists continue to differ on the subsistence labour intensity required of hunter-gatherers. They sometimes disagree on facts, but more often on the explanation of the facts and the inferences and meanings to be drawn from them. This is partly because foragers, like the bees whose foraging efforts are so similar in duration each day, are potent ideological symbols of work and progress. It is partly because anthropologists have lacked a comprehensive theoretical framework and methodology for examining the relationships among work, resources and population.

In this article I contribute to the debate on hunter-gatherer work effort and its broader lessons initiated by Sahlins and continued by Riches (1982) and Bird-David (1992), among others. I present an evolutionary ecology approach to the analysis of hunter-gatherers and labour. The approach combines foraging theory and population ecology models and it predicts the essential features of limited effort foraging. Turning to a re-evaluation of original affluence, I show that the concept of a Zen economy is neither necessary to explain the work effort of hunter-gatherers, nor is it a radical alternative to analysis based on evolutionary ecology principles.

#### *Hunter-gatherer population, resources and economy*

My factual sense of the amount of time that foragers must devote to the food quest is closer to estimates by Lee, as adjusted (see Lee 1979; Hawkes & O'Connell 1981; Hayden 1981; Isaac 1990), than to the images of endless exertion found in Herskovits or Braidwood (1964). While overstated in early accounts and certainly not universal, limited effort foraging is enough in evidence to require attention. Thus, I begin with a seemingly paradoxical claim: hunter-gatherers do not have the luxury of Calvinist work habits. In the foraging economy, poverty and loneliness are the sure outcomes of long hours in the food quest.

To defend this statement, I present a dynamic analysis of the interplay between hunter-gatherers and their resources. I bring together three processes: the effects of resource acquisition on the size and growth rate of the foraging group; the effects of changing resource densities on the resource selection of the foragers; and the effects of exploitation on the population densities and productivity of their resources. With suitable modifications, foraging theory and population ecology provide the tools for this task. The essential questions are these: How do hunter-gatherer population growth and food choice respond to resource exploitation and depletion? What are the implications of the response for work?

#### *The model*

The results I present are based on a dynamic, computer simulation model. For economy, and because the mathematical details of the model are fully described in Winterhalder *et al.* (1988), I will note only its more salient structural properties. Figure 1 shows schematically the three components used in the model and their relationships.

*The resource populations.* The resource populations of the simulation are characterized by the standard population growth model, the logistic equation. An unexploited population at carrying capacity ( $K$ ) exists in an equilibrium determined by density-dependent factors; births are compensated by an equal number of deaths. However, as population size is decreased below carrying capacity, births begin to exceed the density-dependent losses, generating recruitment. Recruitment is the quantity of organisms which can be harvested without the harvest itself causing a further change in numbers. The exploitable surplus associated with such an equilibrium density is greatest – the maximal sustainable yield – when the population is one half of its size at carrying capacity ( $K/2$ ). In general, the relationship between sustainable yield and resource population size is parabolic.

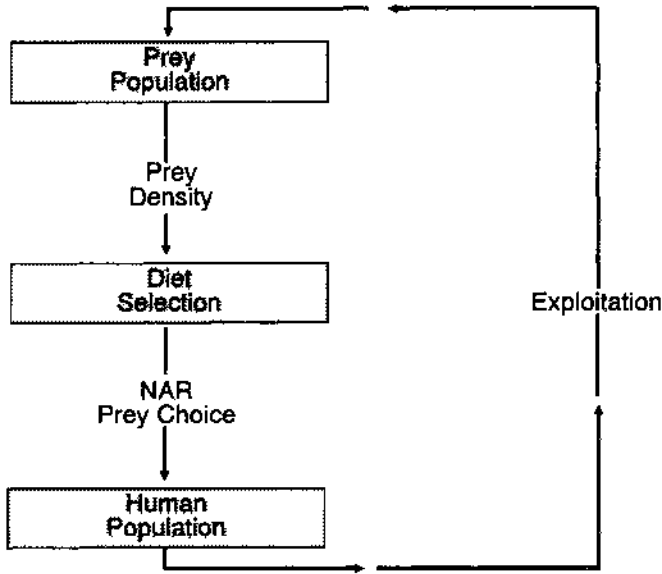


FIGURE 1. Schematic diagram of simulation model components and interactions.

Various features of exploitation can generate this type of population response from resources as diverse as grasses and fish (Starfield & Bleloch 1986). If the less robust members of the resource population – the old, infirm or the very young – are more likely to be among the first captured, the sex-age classes that remain are of higher average reproductive potential. As crowding diminishes, food and shelter become more abundant, allowing more immature animals to reach adult fecundity more quickly. Further, because their food resources are in better condition, the resource species will grow faster and reach higher weights in better condition (creating for each capture a larger and more succulent meal). These positive growth factors last until the population is about half of its size at carrying capacity, whereupon further depredation introduces negative effects. Intense exploitation creates stress. Its impact falls more heavily on the reproductive sex-age classes. It disrupts social and family groups to the detriment of the development of young animals. It becomes more difficult for adults to find mates. The logistic equation has the twin advantages that it is mathematically elegant and it summarizes observed population patterns in a broad array of species.

For each resource type and foraging interval, the simulation model takes the number of resources initially available, subtracts any harvest, then calculates logistic recovery to determine the resource population available to the forager in the subsequent round of foraging.

*Diet selection.* This component of the model receives as dynamic input the density of each resource population at the conclusion of the preceding foraging interval. It uses foraging theory (Stephens & Krebs 1986) to determine which resources

are harvested and to calculate output to the human population component of the model. That output is the number of resource types in the diet, the foraging efficiency (net acquisition rate, or NAR) in the present interval and the proportion of each resource type in the diet.

*The human population.* The equations describing human population growth assume that all individuals are both producers and consumers, productive and reproductive adults.<sup>5</sup> I define a daily maintenance energy requirement ( $\theta$  kcal) as the amount of energy which, over the long term, just enables an individual to survive and replace itself with one offspring. For any amount of time ( $w$ , hours) devoted to foraging, there is a NAR (kcal/hr) that just fulfils this (non-foraging) maintenance requirement. We designate this value by  $\sigma$  (the maintenance foraging rate) and calculate it by dividing the maintenance requirement by the hours spent hunting and gathering ( $\sigma = \theta/w$ ). Finally, I assume that if the NAR of foraging is greater than the maintenance rate, then foraging produces extra energy which is available for individual reproduction above replacement, hence population growth; if it is less, then individuals in the population do not meet their maintenance needs and the population must decline in size.

The mathematical conventions of the model create a three-stage response of the human population to its food-gathering rate. First, modest deviations above or below maintenance requirements cause corresponding deviations above and below population replacement. Birth rate moves with food availability to exceed or fall below levels which would match normal mortality. Second, if food shortfalls become severe, there is a more dramatic drop in the ratio of births to deaths. Third, if resources are so depleted that foraging NAR drops to zero or below, then the human population dies out.

To complete one cycle of the dynamic model, the energy harvest of the human population is apportioned among the resource types within the diet to determine their degree of exploitation.

*The components together.* To summarize, the simulation incorporates three components (a logistic resource population model; a diet choice model; a human population model). These are linked by four functional relationships: 1) human population growth (or decline) is a function of foraging efficiency (NAR) relative to maintenance requirements; 2) diet selection by the human foragers is a function of resource densities; 3) the absolute demand for resources is a function of the size of the human population; and 4) resource population density is a function of which resource types are harvested, in what amounts, and their capacity to recover.

The mathematical characteristics (state parameters) assigned these components have been chosen to be representative of actual hunter-gatherers (Winterhalder *et al.* 1988).

#### *Results: the effect of foraging time ( $w$ )*

An experiment with the simulation model typically means adjusting an input variable across a range of values while observing the consequences on the dynamic behaviour and equilibrium values of forager and resources. The results have been reassuring in two respects. Enough simulations produced intuitively

obvious outcomes that I am confident the model is behaving as expected. Enough have yielded novel or unanticipated results to make it worth the effort. The single variable that I will describe here, foraging time ( $w$ ), is in the category of unexpected results.<sup>6</sup>

*Single-resource systems.* A brief description of the time course of a simulation using a single resource type (CPREY) will demonstrate the basic structural properties of the model. Strictly speaking, the one-resource case is not an optimal foraging analysis. With only one resource type, the forager has no diet breadth options to exercise. It is a simple but monotonous circumstance.

The simulation begins with a hunter-gatherer density of  $0.67/100\text{km}^2$  and with the resource at its carrying capacity, as if a small foraging band had just migrated into an unharvested range. Foraging time ( $w$ ) is set at five hours. The initial NAR is  $965.3 \text{ kcal/hr}$ . As years (iterations) pass, the foraging NAR declines, the human population grows and the resource population shrinks. Each variable overshoots slightly. After about 120 years a stable equilibrium is reached at a NAR of  $400.0 \text{ kcal/hr}$  and a forager density of  $1.42/100\text{km}^2$ . At equilibrium the marginal NAR is equal to  $\sigma$ , the maintenance rate, as expected given the feedback term regulating human population size. Resource density and foraging efficiency have declined to the point that net energy production will maintain the population but will not allow it to grow further.

In a second simulation foraging time ( $w$ ) increases to 8 hours; all other parameters remain the same. As before, the foraging efficiency and resource populations decline and the hunter-gatherer population grows, but each changes more rapidly than in the previous case and overshoots more dramatically. Damped oscillations precede the equilibrium, at which NAR equals  $250 \text{ kcal/hr}$  and forager density is  $0.94/100\text{km}^2$ . As effort ( $w$ ) is increased from 5 to 8 hours, the size of the human population at equilibrium falls from 1.42 to 0.94 foragers/ $100\text{km}^2$ . The longer these hunter-gatherers forage, the fewer of them the environment can sustain.

Although it might seem odd, this result is a clear consequence of basic population ecology relationships. Longer foraging entails a greater potential to deplete resources to the low densities at which they produce disproportionately small sustainable yields. Recall that sustainable yield is a parabolic function of resource population size. The equilibrium density of the resource is determined by the maintenance efficiency of the forager, irrespective of its yield at that density and the number of foragers it can sustain.

Table 1 shows the equilibrium values for simulations ranging from  $w = 2.2$  to  $w = 9$  hours per day (see also fig. 2). These values characterize a simulation once the interactions have stabilized. Observe the steady drop in resource density and foraging efficiency, and the quick rise and then slow decline in forager density, as  $w$  (= effort) grows. Although not indicated in the table, system stability steadily diminishes in parallel. As  $w$  grows, overshoot and damped oscillations become more prominent. At  $w = 10$  hours, the foraging band initially grows rapidly but in the first downward phase of the cycle it drops below a density that would provide two individuals for the foraging group. We assume that the population dies out.



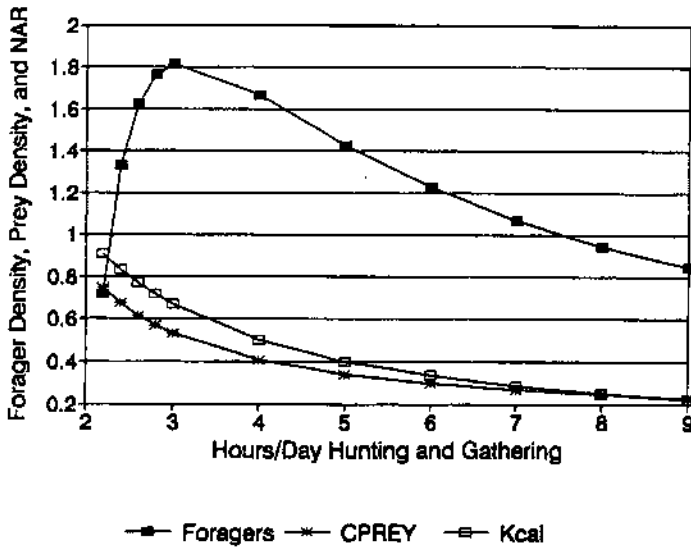


FIGURE 2. Equilibrium values for the foragers ( $\#/100\text{km}^2$ ), CPREY ( $\#/0.1\text{km}^2$ ), and NAR ( $\text{kcal}/0.001\text{hr}$ ), for a single-resource system, as a function of time spent foraging (see Table 1).

In effect, low to intermediate values of effort ( $w$ ) are associated with the largest sustainable human population and with higher food acquisition rates. Beyond a certain point, quickly reached at  $w = 3$  hours in the present example, the longer individuals hunt and gather the less rewarding is their effort and the fewer of them the environment can support. The hard-working, Calvinist forager is a lonely forager, predestined on earth at least to hardship and penury.

TABLE 1. Effect of varying foraging time ( $w$ ) on the equilibrium values of a forager and a single resource.<sup>a</sup>

( $w$ )	<u>2.2</u>	<u>2.6</u>	<u>3.0</u>	<u>4.0</u>	<u>5.0</u>	<u>6.0</u>	<u>7.0</u>	<u>8.0</u>	<u>9.0</u>
Foragers $/100\text{km}^2$	0.71	1.63	1.81	1.67	1.42	1.22	1.07	0.94	0.84
CPREY $/100\text{km}^2$	743.9	615.0	529.8	405.4	337.9	295.6	266.5	245.4	229.3
NAR	909.4	769.2	666.7	500.0	400.0	333.3	285.7	250.0	222.2

<sup>a</sup> From Table 9, Winterhalder *et al.* (1988).

CPREY = name given first resource type considered in the model; NAR = net acquisition rate.

*Two-resource systems.* A simulation with two resource species gives much the same result and allows us to observe the effects of (optimal) diet selection on the population dynamics of predator and resources. Further, as the relationship between hours and forager density is preserved in the two-resource case, then it probably will hold for yet more realistic numbers of resources.

Table 2 and fig. 3 show the results of nine simulations ( $w = 3$  to  $w = 11$  hours). Look first at  $w = 3$  hours. Foraging for this length of time gives a maintenance NAR of 667 kcal/hr. The hunter-gatherers begin by harvesting CPREY and although the foraging population grows and CPREY declines in numbers, the second prey type available, EPREY, remains outside of the equilibrium diet. Its return on pursuit and handling time is always below the marginal NAR of foraging for CPREY alone. Hence it is not worthwhile to the forager to harvest it. The foraging efficiency at which the human population ceases to grow is above the efficiency at which it would elect to pursue EPREY. The density of the hunter-gatherer population is 1.81/100km<sup>2</sup>.

At  $w = 4$  hours the situation changes. The forager's maintenance efficiency (500 kcal/hr) now is low enough that EPREY enters the optimal diet (see Winterhalder *et al.* 1988 for a full description). By about year 280 the system reaches a stable equilibrium at a density of 2.36 foragers/100km<sup>2</sup>. EPREY remains in the diet at  $w = 5$  or more hours, but as in the single resource case the equilibrium density of the foraging population steadily declines from its peak at 4 hours.

Adding a second resource species does not alter the structural result of interest. The dynamic relationships linking hunter-gatherer populations and their resources generate a production system with this key feature: over the long term, long hours portend meagre results.

TABLE 2. Effect of varying foraging time ( $w$ ) on the equilibrium values of a forager and two resources.<sup>a</sup>

(w)	<u>3.0</u>	<u>4.0</u>	<u>5.0</u>	<u>6.0</u>	<u>7.0</u>	<u>8.0</u>	<u>9.0</u>	<u>10.0</u>	<u>11.0</u>
Foragers/ 100km <sup>2</sup>	1.81	2.36	2.01	1.72	1.49	1.31	1.17	1.06	0.96
CPREY/ 100km <sup>2</sup>	529.8	378.3	290.2	236.4	200.2	174.3	154.3	139.1	126.4
EPREY/ 100km <sup>2</sup>	1200.0	923.6	865.9	830.6	806.8	790.0	776.8	766.9	759.0
NAR	666.7	500.0	400.0	333.3	285.7	250.3	222.2	200.2	181.5

<sup>a</sup> From Table 12, Winterhalder *et al.* (1988).

CPREY = name given first resource type considered in the model; EPREY, name given second resource type; NAR = net acquisition rate.

### *Structural relationships and evolutionary outcome*

This model shows how ecological relationships alone might lead to limited work effort and a state of original affluence. But as developed so far, it does not allow us to predict that hunter-gatherer societies actually will evolve to this condition. The same evolutionary ecology theory that has guided the argument to this point gives us scant reason to expect that the system will stabilize at the limited effort point maximizing population size. Quite the opposite: consistent application of an individual-level, selectionist perspective leads us to predict long toil (high  $w$ ) and hard poverty (Winterhalder *et al.* 1988).

Consider immigrants to a new habitat. As they begin to harvest resources, their foraging efficiency (NAR) declines. However modest their initial allocation of

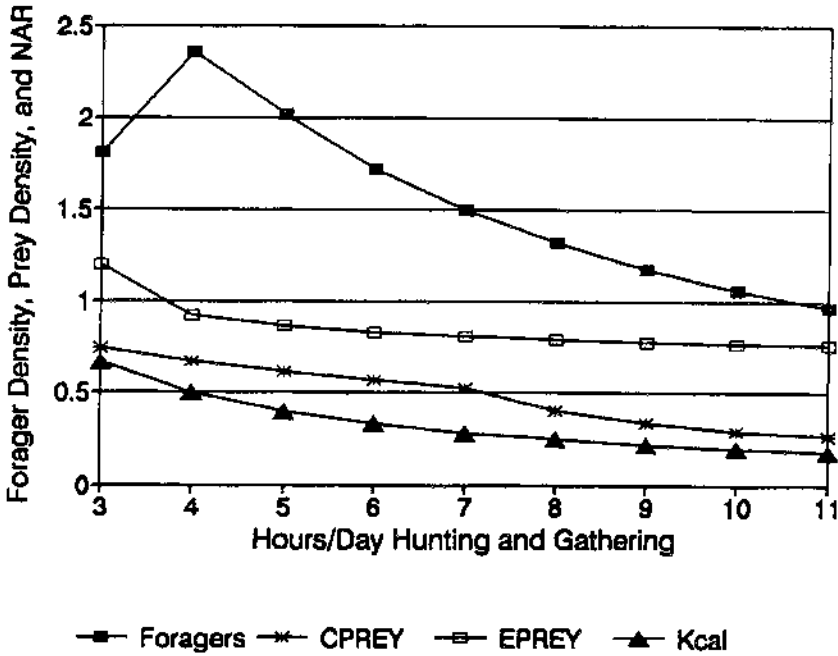


FIGURE 3. Equilibrium values for the foragers ( $\#/100\text{km}^2$ ), CPREY & EPREY ( $\#/0.1\text{km}^2$ ), and NAR ( $\text{kcal}/0.001\text{hr}$ ), for a two-resource system, as a function of time spent foraging (see table 2).

time to foraging, they would probably respond to declining rates of harvest by foraging somewhat longer each day, in order to gather sufficient food. However logical, this response exacerbates the problem. With longer foraging, resources eventually will be depleted to yet lower levels. The feedback dynamic this establishes will push the group past its optimum population and perhaps even to destruction. Rational short-term decisions by individuals about effort have unhappy long-term consequences for yield.

The population ecology relationships of the model show structurally how limited work effort can occur. But without some additional consideration or factor, the evolutionary dynamic of the model implies that it would not occur. Some part of the case is missing. I see several possible resolutions to this apparent difficulty, arranged (for the evolutionary ecologist) from least to most interesting:

1. An unsatisfactory answer first: we might observe that many societies have solved such 'open access' resource problems through common property regimes (see Ciriacy-Wantrup & Bishop 1975, for definitions), thus through socio-cultural or institutional means. We would argue that such solutions presumably are available to hunter-gatherers. This might give us confidence that the limited effort condition we seek to explain is not an anomaly, but it begs the question of evolutionary causation.
2. Somewhat better, and certainly more consistent with evolutionary ecology premisses, we might note the association of regular sharing and

foraging (Kaplan & Hill 1985). Sharing is an effective means of reducing the uncertainty of the food quest (Winterhalder 1990). We would observe along with Woodburn (1988; see also Hawkes 1992) that sharing also is a powerful disincentive to individuals who might be inclined to extra work. While this does provide a countervailing pressure to the temptation for individuals to increase foraging hours, it is difficult to gauge its effectiveness. Because sharing is not an element within the present model, we can predict its direction of action but not its strength relative to that of prey depletion and pressures to hunt and gather longer.

3. A yet more attractive solution, though with some of the same liabilities, is that of opportunity costs (Winterhalder 1983; 1987). Foraging hours will increase until reaching a margin at which alternative activities have greater benefits. Evolutionary ecologists (Hawkes *et al.* 1985; Hawkes 1987; Smith 1987) have examined at length the proposition that a 'limited needs' view of hunter-gatherers can be justified using an opportunity cost argument. Riches (1982: 214-16) has argued that time allocation decisions of hunter-gatherers are affected by cultural factors which place a high value on leisure and other non-subsistence pursuits. With a little special pleading, we might be able to argue that opportunity costs commonly set work effort within a range that is more or less optimal for population size.
4. Although the sharing and opportunity cost options are consistent with evolutionary ecology, if they are the causes of limited effort and original affluence, it is a partly incidental result. A much better case would incorporate the population variable and group-level benefit directly into an argument that is concordant with evolutionary ecology premisses. Such an explanation would have to suggest why an individual would forego the immediate benefits of greater subsistence effort in favour of the long-term benefits to the group of his or her restraint.

A promising route would adopt the dual-inheritance approach of Boyd & Richerson (1985). Their model of frequency-dependent bias (conformist cultural transmission) assumes a population subdivided into numerous small and somewhat isolated groups which live in a spatially variable habitat, just the demographic and ecological circumstances of hunter-gatherers. The model shows that selection acting in these conditions on cultural inheritance can be effective in producing traits which are beneficial at the level of groups. It thus provides a plausible mechanism for the evolution of individual restraint, social co-operation and thus group-level solution to open access problems such as that of game depletion (see Soltis *et al.* 1992).<sup>7</sup>

How these or other processes might combine to produce an equilibrium for a particular system of foragers and their resources is a question for future investigation. For the moment, empirical observations tell us what might not otherwise be evident from a strictly selectionist perspective. In at least some documented cases of hunter-gatherers, the system appears to stabilize at a low level of work effort and a relatively high level of population density.

*Framework for the analysis of work and population*

The analysis of work, population and resources within and among types of economies requires a general conceptual framework. The following scheme is provisional; it was created to facilitate explanation of limited effort foraging and original affluence. It is based on the theory and methods of evolutionary ecology (Smith & Winterhalder 1981; Smith & Winterhalder (eds) 1992b).

The factors affecting decisions about intensity of labour investment in production activities can be divided into two sets. The first set is factors which determine the characteristics of the non-foraging choices. *Constraints* (darkness, severe cold, or migration of a game species beyond the range of the forager) simply prevent some foraging activities or make them prohibitively costly under any circumstance. Constraints grade into feasible *alternative activities*, non-foraging uses of time and energy. Constraints and the value associated with non-foraging activities are time and duration dependent, and are thus subject to marginal analysis. Together they determine the characteristics and net benefits of non-foraging choices.

The second set of factors determine the time reward to foraging. They include *production dynamics*, *distribution dynamics* and *consumption dynamics*. *Production dynamics* emerge from the systematic and interactive properties of population, work and the resources that are exploited in the course of work. The model presented in this article describes a production dynamic of decreasing marginal returns (NAR) and an intermediate peak of yield, as the daily duration of the foraging effort increases. Given the population ecology of their resources, foragers who exceed a moderate commitment of time will soon encounter the impedance of low net and absolute returns. Production dynamics determine, among other things, the net reward of work as a function of its duration. *Distribution dynamics* determine how and to what degree the labourer retains or benefits from the immediate product of his or her work. A second group of foraging models (Winterhalder 1986; 1990; Smith 1988) which examine the effects of risk on resource selection help us to understand this factor. These models show that food sharing is a necessary and highly effective concomitant of dependence on unpredictable resources. Sharing is a nearly ubiquitous feature of foraging societies; it has been extensively analysed by hunter-gatherer specialists (see Kaplan & Hill 1985). It disperses among the band the products of an individual's work, dissipating his or her incentive to engage in exceptional effort. *Consumption dynamics* determine how material products are consumed and help to set their utility. The mobility-portability argument elaborated by Sahlin (1968; 1972) and others entails a sharp consumption constraint for material goods and also for reproduction. It too has at its heart relationships which can be described by evolutionary ecology models (see below). For the !Kung San there is now considerable evidence that supports this portability argument and links it to physiological and hormonal mechanisms of birth spacing (Lee 1979; Howell 1979; Blurton Jones & Sibly 1978).

Each of these factors helps to explain why foragers might in the right circumstances engage in limited effort foraging. Ethnographic analysis of work effort within or among societies almost certainly will require attention to the full set of factors. After constraints are met, this approach suggests that the opportunity costs

of alternative activities should be appraised relative to the net benefits of foraging (Hawkes 1987; Hawkes *et al.* 1985; Smith 1987; Winterhalder 1983; 1987). These in turn are determined by ecological and other variables affecting production, consumption and distribution.

### *Original affluence revisited*

#### *The Zen economy*

First stated in 1966, the idea of the Zen economy is fully developed in Sahlins's book, *Stone Age economics* (1972). Here Sahlins sets out his hope for an 'anthropological economics ... in opposition to business-like interpretations of primitive economies and societies' (p. xi). His allegiances are substantivist; Sahlins's rhetorical foe is formalist (neoclassical) interpretation. Sahlins describes the Zen 'road to affluence' in which 'human material wants are finite and few, and the technical means unchanging but on the whole adequate' (1972: 2). By this route, hunter-gatherers can 'enjoy an unparalleled material plenty - with a low standard of living' (1972: 2). He cites compelling reasons for earlier misconceptions of a difficult and precarious existence for hunter-gatherers (neolithic prejudice, bourgeois ethnocentrism, fieldwork naivete about alien diets and the extent of cultural disruption, the anomalous foraging peoples available for ethnographic study). And he offers documentation of a life of relative 'prosperity', albeit one that depends on an 'objectively low standard of living' (1972: 11). The longest section of the essay (1972: 14-32) documents the limited hours which foragers put into the subsistence quest. Buttressed by this information, Sahlins restates the original affluence hypothesis and describes its linkage to the 'real handicaps of the hunting-gathering *praxis* ... it requires movement to maintain production on advantageous terms' (1972: 33).

I will comment on three aspects of Sahlins's argument: his observations on limited effort, his interpretation, and the inferences drawn from that interpretation (see also Bird-David 1992).

*Observations on effort.* The concept of original affluence apparently arose from a general consensus at the 1966 Chicago meeting that hunter-gatherers did unexpectedly few hours of productive work, especially in the food quest. Just two years earlier Braidwood (1964: 122) had portrayed food collectors as:

small groups of people living now in this cave, now in that - or out in the open - as they moved after the animals they hunted ... no time to think of much of anything but food and protection ... all in all, a savage's existence, and a very tough one. A man who spends his whole life following animals just to kill them to eat, or moving from one berry patch to another, is really living just like an animal himself.

As later summarized by Sahlins (1972), the evidence was various. It included scattered ethnographic measurements and observations on extant hunters, and the occasional comment in reports by explorers, missionaries or travellers.

It is fairly easy to find flaws in the data. The direct information is scant. Measurements by Lee (1968), McCarthy & McArthur (1960) and others are brief, unrepresentative of seasonal or other variability, and based on small samples. Later and better data which include the ancillary support activities of the food quest (e.g. tool maintenance, food processing) have somewhat increased the

duration of the hunter-gatherer work day (Hawkes & O'Connell 1981). With these corrections, a figure of 5-7 hours per day seems more appropriate than the 2-4 hours proposed earlier.

The veracity and representativeness of the ethnohistorical accounts are also difficult to interpret. Sahlins does not say how his sample was selected, but virtually all accounts in *Stone Age economics* that emphasize privation and difficulty are dismissed as ethnocentric or misled, while those alluding to abundance and ease are accepted without similar reservations. Europeans have nurtured a variety of conflicting images of non-Western peoples that might have tipped their biases in either direction. Some accounts are redolent of ethnocentrism and the superiority of home culture, others of romanticism about 'primitives': sloth, unwitting abundance or diligent and productive application, privation – it is not easy to choose. In any case, summing up assertions scattered in miscellaneous documents will not resolve the issue.

There is one misconception that Sahlins overlooks. I suspect that bleak (and unsubstantiated) views on animal foragers sharpened the disparaging impression of their human counterparts. Recall the last line of the Braidwood quotation mentioned above: 'A man who spends his whole life following animals just to kill them to eat, or moving from one berry patch to another, is really living just like an animal himself'. It is apparent in context that Braidwood did not mean the comparison to be flattering to the capacities of either human or non-human foragers.

Ecological studies in addition to those on bees and beavers give a different sense. Non-human foragers typically invest modest amounts of time in the food quest (table 3). Observations on the San, Hadza, Australians and others would fit rather comfortably into the range of values for other organisms. Appreciated in this broader context, the limited effort of the human forager is not unusual. Indeed, we might want to name several dozens of species honorary members of the original affluent society. Of course, this would subversively affect the claim that original affluence must have a uniquely 'culturalist' explanation (Sahlins 1972: xi-xii).

In retrospect, the surprise is not about hunter-gatherers – for whom the evidence is mixed and in any case consistent with that on the foraging effort of non-human species – but about us, about anthropologists. Has ever so little information produced so rapid and pervasive a reassessment of a major analytical issue?<sup>8</sup> The data of original affluence and the interpretive load they bear are simply incommensurate (as they were, of course, prior to the 'revolution' of 1966). But even with healthy scepticism and corrections, there is something here to explain, and not just for human foragers.

*Interpretation.* Sahlins's (1972) interpretation of original affluence centres on his concept of the Zen economy; his reasoning is reconstructed as follows. There is an empirical fact: workers in a market economy put in long hours. And there is an associated neoclassical interpretation: they do so because they have unlimited wants, very limited means and as a consequence, live in a condition of scarcity (Robbins 1932). By contrast, foragers labour for only a few hours, their limited effort the antithesis of that characteristic of workers. By extension, the postulates of their (Zen) economics must negate those of Smith and Ricardo. Thus, the

forager has limited wants and sufficient means, and thereby lives in a situation of relative plenty.<sup>9</sup> Zen economics is the inversion of the neoclassical sort; the hunter is the "uneconomic man" (Sahlins 1972: 13; enclosed quotes in original).<sup>10</sup> This schematic summary is explicit in the arguments of Sahlins's essay and it is consistent with his structuralist methodology (Cook 1974).

The three properties of the Zen economy are in danger of collapsing into themselves unless at least one of them can be substantiated by independent argument. Sahlins takes it as self-evident that the foragers' means are low. To get relative affluence, he must establish that their wants are more limited still. He argues that foragers in fact never developed the insatiable appetite of economic man. Rather, in their modest material goals they have made a virtue of necessity (1972: 34). The necessity is ecological: 'movement is a condition of this [the

TABLE 3. Time allocation of non-human organisms to activity categories.

<b>Herbers 1981 (Percentage of daylight hours):</b>					
	<i>Foraging</i>	<i>Resting</i>	<i>Social/ Territorial</i>	<i>Moving</i>	<i>Other</i>
shrew <sup>a</sup>	23.1				
olympic marmot	<50	>50			
fisher	31.9	68.1			
hummingbird <sup>a</sup>	20.4	73.0	1.8	0.7	
honeycreeper	48.0	50.3	0.3	1.4	
sunbird	22.0	64.1	6.9	6.9	
moose	48.0				
lion	6.3	75.0			
walrus	17.6	66.9	12.6	0.3	2.6
lemur <sup>b</sup>	24.7	46.5	8.0	14.4	6.3
spider monkey <sup>b</sup>	16.5	58.6	3.7	21.2	0.1
howling monkey	30.0	70.0			
mangaby	42.5	37.0		21.4	
baboon	45.0				
gueraza	19.9	57.4	10.8	5.4	6.4
siamang	29.9	63.9		6.2	
orangutan	45.9	39.4	3.7	11.1	
gorilla	25.0	51.0	5.9	11.0	
chimpanzee	55.0	23.0	5.9	14.2	
<b>Belovsky and Slade 1986 (Percentage of 24 hours):</b>					
	<i>Inactive</i>	<i>Walking</i>	<i>Cropping</i>		
Range herbivores <sup>c</sup>	68.4	22.5	15.1		

<sup>a</sup> Average of four species; <sup>b</sup> Average of two species; <sup>c</sup> Average of 14 species, ranging from grasshoppers to bison; 'Inactive' combines lying, standing and ruminating; very small amounts of running and social interactions for some species are not included.



foragers'] success, more movement in some cases than others, but always enough to rapidly depreciate the satisfactions of property' (1972: 11; italics in original). Faced with diminishing returns within the range of a home base, the forager picks up camp and carries it to a more salubrious site that also will prove temporary. It is, says Sahlins, an economy 'seriously afflicted by the *imminence of diminishing returns*' (1972: 33; italics in original).

Compelled to move, the hunter-gatherer must face the hard issue of portability: tools, personal effects, other material items or infants and toddlers must be carried. This single fact ensures that surpluses both of property and dependants will be unattractive. Foragers accumulate goods and babies sparingly.

The ecological relationship that Sahlins places at the core of the Zen economy – the imminence of diminishing returns at a locality – neatly anticipates a key model of optimal foraging theory, the marginal value theorem (Charnov 1976). This model presumes that the forager inhabits a patch (for our purposes, the foraging area around a base camp) which is steadily depleted of resources. Movement entails the cost of relocating to a new camp surrounded by an undepleted patch. The model (as graph or equation) shows the marginal point on the diminishing return curve at which the cost of movement is just compensated by the net benefit of access to the unexploited resources of a new site. The optimal forager moves when the marginal return in the present locale drops to the average return for the habitat as a whole (averaged over multiple patches and moves).

How closely actual foragers might approach this optimum is an empirical issue of secondary importance here. What matters is the perfect conformation between the evolutionary ecology model and Sahlins's argument. The Zen economy's chief analytical linkage to the material conditions of foraging life anticipates and is perfectly congruent with optimal foraging theory, an analytical approach closely associated with neoclassical principles (Smith & Winterhalder 1992; Winterhalder & Smith 1992).<sup>11</sup> What has gone virtually unnoticed among anthropologists is the optimizing, marginalist (business-like) nature of Sahlins's brief for hunter-gatherer mobility.

*Inferences.* *Stone Age economics* presents itself and has been enshrined in the literature as an exorcism of neoclassical and materialist ('business' and 'commodity mentality') thinking in the realm of anthropological economics. Sahlins's professed allegiances are with substantivism, but his argument is so closely aligned to micro-economic principles that one might almost suspect it of being a cleverly disguised ruse. The Zen economy is the neoclassical formulation preceded by a minus sign, a consequence of Sahlins's structuralist framework. While Sahlins 'accepts [the] battle on formalist terms' (p. xii), he does so with a structuralist methodology that precludes victory. Because they are negations of each other, the best that his 'structural substantivism' (see Cook 1974) can do is reflect the reversed image of its neoclassical partner.

In devising the Zen economy, Sahlins simply completed in good structuralist form the myth of economic man. And while we might well attribute the rhetorical power of Sahlins's argument to its mythical formulation, it would be a surprise if the diverse types of human economies could be reduced to the structure of a tale, or accurately and exhaustively analysed as a binary opposition. Sahlins's analysis makes a good story because it is made as a story.

## Conclusion

### *The foraging mode of production*

If the case-specific dynamics of production, distribution and consumption all act to diminish the extended time-reward to foraging, the value of competing activities does not have to be high in order to deflect the forager from the food quest. After a few hours of hunting and gathering each day, the opportunity costs to other activities, including leisure, may be low. In some foraging economies (e.g., the !Kung San) all three dynamics may act together; in others (e.g. coastal Indians of California), the mobility factor may be absent but the production or distributional factors may still have an effect. While possibilities such as these will require ethnographic substantiation, the framework outlined has the capacity to recognize that diverse environmental circumstances and causal possibilities may affect hunter-gatherer time allocation, presumably with equally diverse outcomes. Some foragers routinely will face circumstances that compel long hours of hard work. All probably will experience such pressures on occasion. But the overall tendency of the foraging economy appears to be one of limited effort.

Beginning with an evolutionary ecology approach (see Foley 1985; Richerson & Boyd 1987; Smith & Winterhalder (eds) 1992), we can explain three features of the foraging economy that seem most anomalous from the perspective of market capitalism: limited production effort, routine sharing, and lack of interest in material accumulation. We retain scarcity as an axiom because it helps to explain a society in which scarcity as a perception of inadequate provisions or as a material fact is less common than we might expect. We must acknowledge that materialist analysis need not entail the culture of accumulative materialism so evident in Western industrial societies.

The foraging theory used to reach these conclusions is based on methodological assumptions (optimization, rational choice) and simple models much like those of neoclassical economics. But rather than examine, say, the actions of a consumer with a wage constraint choosing among goods with differing prices and utilities, these models might examine a hunter-gatherer's choice of subsistence resources, given the distribution, abundance and relative food value of resource species, and the costs and effectiveness of the forager in locating and capturing them. It is a micro-economic approach, but applied in an ecological rather than a market setting. It suggests that the systematic properties of the material setting, not fundamental assumptions about human motivation and choice, make the critical difference for the behaviours observed in these two modes of production.

Bird-David's (1992) recent critique of Sahlins's analysis shares some elements with this one.<sup>12</sup> However, contrary to the present approach, Bird-David seeks to reconceptualize a purely culturalist interpretation of original affluence with the claim that immediate-return hunter-gatherers have a 'cosmic economy of sharing.' This is one of the 'primary metaphors' (1992: 28-9) that guides their subsistence behaviour and that accounts for the ethnographic observation of limited effort and sharing. While thorough comparison of the Bird-David proposal and this one must wait, I do want to highlight two salient differences. First, Bird-David offers no explanation of the *origin* in hunter-gatherers of the 'cosmic

economy'. The phrase appears to be a means of describing (in highly abstract cultural terms) certain hunter-gatherer beliefs and behaviours, but it does not provide an explanation of their occurrence in these societies. Secondly, as with Sahlins's (1972) culturalist account, Bird-David gives us no reason to expect (nor means of explaining) the observed *diversity* among foragers in the subsistence behaviours related to effort and sharing.

By contrast, an evolutionary ecology account provides a logically sufficient explanation of the origins of limited effort foraging and of sharing. Moreover, it both anticipates diversity in the relevant behaviours and links predictions about their particular form to well-defined differences in the material environment. Culturalist analyses like that of Bird-David neatly demonstrate congruence between forager beliefs and behaviours, but until they address questions of origins and diversity it will be difficult to assess how they can be combined with evolutionary ecology approaches in a broader contribution to explanation of hunter-gatherer subsistence behaviour.

### *Beasts and humans at work*

Anthropologists perhaps were too eager to accept that foragers were anti-workers, that a Zen alternative could decisively negate the applicability of neoclassical economics to hunter-gatherers, and that anti-materialism had triumphed even for that form of economic life most thoroughly set within the workings of nature. Few foragers, or few animals for that matter, gather food for much of the day. Many appear to spend significant portions of their potentially productive hours at rest. When Braidwood made his simile between human foragers and animals, the comparison was apt but the inference wrong about both.

Leisure is the condition of original affluence and in the right circumstances the choice of the rational, optimizing forager. In an ecological context, economic man (*viz.* foraging man *and* woman) may remain productive only by curtailing the urge to work. We need not make hunter-gatherers uneconomic beings to shorten their hours; we just have properly to characterize and understand the dynamics of their material, ecological context.

Sahlins insists that we must choose 'between the perspective of Business, for the formalist method must consider the primitive economies as underdeveloped versions of our own, and a culturalist study that as a matter of principle does honor to different societies for what they are' (1972: xi-xii). But neither the exclusiveness of the methodological choice nor the characterizations of the two approaches is acceptable. Formalist methods can be applied in ways that consider hunter-gatherer economies as qualitatively different from (and thus incommensurate with) market systems. And a culturalist study, whatever its proclaimed principles, can easily betray the true differences among societies by misplacing or exaggerating them. It is an odd approach that finds its honour in making an 'unworker' of a forager, and that assumes ethnocentrism is purged by the simple structuralist device of inverting Adam Smith.

Hunter-gatherers may find no great disparity between their means and ends because they are rational creatures who, to the extent possible, make optimizing choices. It just happens that the production, distribution and consumption

dynamics of their foraging subsistence system may often direct those choices to successful but modest material goals.

If the foraging way of life is viewed as a mode of production in its own right and not as a set of contrasts with which to highlight the advantages (or evils) of our own system, our understanding will be enhanced (Lee 1979: 454)

Much of this understanding can be gained from within an evolutionary ecology framework.

#### NOTES

Robert Bailey, Robert Bettinger, Sheryl Gerety, Carol Goland, Raymond Harnes, Brian Hayden, Robert Hunt, Tim Ingold, Anne Larme, William Mitchell, Eric Alden Smith and the reviewers for *Man* have been generous with both supportive and critical comments during the development of this article. Funding was provided by the National Science Foundation (BNS#8313190) and the UNC-Chapel Hill, University Research Council.

<sup>1</sup> American journalism, verse and letters from the seventeenth to the nineteenth century regularly used variants on the phrases 'busy as bees [in a barrel of tar]', or 'worked like [industrious as] beavers' to suggest unusually diligent application to a task (see, for instance, Thornton 1962 and Whiting 1977).

<sup>2</sup> The groups are: Siang Dyak (Borneo), Wogeo (Solomon Islands?), Hopi, Yakö (eastern Nigeria), Chippewa (Great Lakes); all, incidentally, appear to be horticultural societies.

<sup>3</sup> The discussion in chapter 5 in the 1952 edition of the book is nearly identical to that in the first (1940) edition, entitled *The economic life of primitive peoples*. The chapter title in the earlier book was 'Work and its reward'.

<sup>4</sup> Which, as noted by Herskovits (1952: 64): 'vivify discussions of any phase of economic life'.

<sup>5</sup> The simulation can allow for non-productive individuals, children, the incapacitated and perhaps the very elderly, in a simple way by raising the maintenance requirements of the productive adults to a level that covers dependants.

<sup>6</sup> See Winterhalder *et al.* (1988) for the results of manipulating other variables.

<sup>7</sup> For details of the mechanism, the reader is referred to Boyd & Richerson (1985: 204-40).

<sup>8</sup> This despite Sahlins's 1966 prediction that 'it will be extremely difficult to correct [the] traditional wisdom' (1968: 85).

<sup>9</sup> Albeit, as Sahlins is careful to add, 'at an objectively low standard of living' (1972: 11).

<sup>10</sup> Sahlins continues (1972: 13), 'At least as concerns nonsubsistence goods, he is the reverse of that standard caricature immortalized in any *General Principles of Economics*, page one' (italics in original).

<sup>11</sup> This is not the first notice that Sahlins has ensconced neoclassical arguments within a substantivist analysis which professes to repudiate them. See Cook (1974: 356-62) and Donham (1981).

<sup>12</sup> The Bird-David paper and this one were first presented in the session "'Original affluence" revisited', held at the Sixth International Conference on Hunting and Gathering Societies (Fairbanks; May, 1990).

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## Travail, ressources et démographie dans les sociétés de chasseurs-cueilleurs

### Résumé

Les anthropologues ont utilisé deux positions aussi stéréotypées l'une que l'autre pour caractériser l'effort de travail nécessaire dans les sociétés de chasseurs-cueilleurs; on parle d'activités de subsistance qui ne demandent que très peu de travail, ou, au contraire, d'efforts prolongés. Cela s'explique en partie par l'absence d'un cadre théorique permettant l'analyse globale du travail, des ressources, et de la démographie dans ces sociétés. Une simulation informatique utilisant des modèles empruntés à l'évolutionnisme et à l'écologie des populations montre que, au point d'équilibre, la courbe d'efficacité des activités de chasse et de cueillette est une fonction décroissante de l'effort de travail, alors que la courbe de densité de population commence par croître relativement à l'effort de travail, avant de décroître. Ce modèle et d'autres modèles similaires fournissent un cadre méthodologique (a) qui permet d'expliquer toute une série de pratiques observées chez les chasseurs-cueilleurs, comme le partage, l'effort de travail limité, et l'accumulation réduite de possessions matérielles; (b) qui permet d'anticiper sur la diversité des manifestations de ces caractéristiques; (c) et qui finalement correspond aux théories économiques néo-darwiniennes et néo-classiques. De ce fait, la théorie évolutionniste écologique rend caduque l'approche 'Zen' prônée par Sahlin.