Patrick Vinton Kirch, *The Evolution of the Polynesian Chiefdoms*. Cambridge: Cambridge University Press, 1984. Pp. 314. Illustrated. $44.50.

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Imagine the ideal experiment in human ecology: people from a relatively homogeneous culture are sent to live in a variety of islands that differ in size, latitude, maximum island height, mean annual temperature, flora and fauna, availability of surface water, and availability of reef resources. How would these factors affect subsequent cultural evolution, and what would be the reciprocal impact on the island ecosystems?

Patrick Kirch in *The Evolution of the Polynesian Chiefdoms* has chosen to consider the evolution of Polynesian cultures from such an ecolog-

ical perspective. Although the volume is part of Cambridge's "New Studies in Archaeology Series," Kirch states from the outset that his analysis of Polynesian prehistory is not restricted to archaeology. It is instead a synthesis of data from linguistics, ethnography, ethnobotany, population biology, ecology, and meteorology as well as archaeology. This synthetic approach leads Kirch to characterize the evolution of Polynesian cultures as following a series of dominant trends: initial settlement and subsequent population growth; modification of the island environment by the colonizers; increasing intensification of agriculture; increasing economic specialization; increasing use of storage facilities; settlement pattern changes; development of ceremonial and public architecture; development of militarism; and an uneven trend toward social stratification. These trends form the structural basis of the book.

As a foundation for his analysis, Kirch examines the nature of island ecosystems, properly emphasizing the ecological diversity of Polynesia. The islands vary seven orders of magnitude in size, ranging from tiny Anuta at 0.4 km^2 to massive New Zealand at over 400,000 km^2. Hydrographic variation is equally impressive, from tiny atolls without surface water to high volcanic islands with permanent rivers. Climate varies, from tropical Samoa to subtropical Easter Island and even to rigorous subantarctic conditions in Chatham Island. Floristic diversity is also pronounced, and given the geographical isolation of the islands, biological endemism is the rule. The resultant biotic resources differ greatly between the islands, presenting different opportunities for exploitation. Use of these resources by the early colonists tended to be both opportunistic and tragic: moas were driven to extinction by the Maoris while the endemic honeycreepers of Hawaii were killed for their bright plumage. Well-developed reefs were extensively fished, but some islands, such as Easter Island, lacked reefs and required new cultural innovations for harvesting marine resources.

What were the initial colonists like? Lexical reconstruction yields only a few clues. Similarly, even though modern ethnobotanical and ethnographic studies suggest that "the production, distribution, and consumption of food" was a "central theme" of the original colonists (p. 29), the agricultural activities upon arrival remain unclear. Although a basic horticultural kit of starchy aroids and tree crops combined with modified swidden technology undoubtedly accompanied the colonists, accurate determination of the technological skills and social structure of the ancestral Polynesians requires the analytical tools of the archaeologist.

Kirch argues convincingly from linguistic and archaeological consid-

erations for a Southeast Asian origin of the Polynesians. Ethnobotanical data tend to support this conclusion since most Polynesian plant and animal domesticates are Southeast Asian and Melanesian in origin, and appear to have been part of the adaptive strategy of the earliest Austronesians or Lapita Cultural Complex as defined by Green (1978). As Kirch demonstrates (table 3), the archaeological record is still in its developmental stage, but it is sufficient to characterize the material culture or tool kit of the early settlers and their generalizing strategy, which as previously noted, included agriculture. He emphasizes that the gradual development of this strategy in southwestern Oceania had set the stage by 1500 B.C. in the Fiji-Samoa-Tonga triangle for the settlement of greater Polynesia.

Kirch's subsequent discussion of dispersal and adaptation processes reflects a solid grasp of both the literature and primary problems of this topic. The understanding of the timing of dispersal, for example, is seen by Kirch as a sampling problem aggravated by island tectonics. Again combining linguistic and archaeological data, Kirch summarizes a familiar (see Bellwood 1979:326; Jennings 1979:3; Sinoto 1970) but refined model of Polynesian dispersal. He suggests a surge of people out of the staging area as early as 200 B.C. The earliest dates in Eastern Polynesia occur in the Marquesas (2,000 B.P.); however, Kirch and others suspect that the Societies were also settled early, although the evidence remains to be found. Following the occupation of central Eastern Polynesia, colonization occurred rather quickly, in Easter Island by A.D. 300, in Hawaii by A.D. 400, and in New Zealand by A.D. 800.

The colonization of Polynesia, Kirch concludes, was primarily a result of deliberate voyaging, probably accomplished in large (up to 25m long) double canoes capable of carrying twenty to thirty people along with provisions and breeding stock. Traditional explanation for the dispersal includes overpopulation and quarrels for chiefly titles. Kirch adds another possibility—wanderlust, or the desire to conquer new lands. Regardless of the reasons for the dispersal, the process seems to have ceased by A.D. 1000.

Kirch's discussion of the subsequent adaptation of the migrants to their new island homes draws our attention again to island diversity. Survival problems vary from island to island, but fundamentally they revolve around insuring the growth of the founder population and developing technologies appropriate to the new environmental circumstances.

As examples of contrasting environmental settings, Kirch cites the Marquesas, where the absence of broad, shallow lagoons precludes reef

foraging such as that pursued in Western Polynesia; and temperate New Zealand, where, on the South Island, hunting, fishing, and gathering became the dominant subsistence activities. Kirch also points out that the colonizers were not always successful and suggests that limited resources, especially water, were the critical limiting factors.

As noted earlier, one of the fundamental trends during early to middle periods of Polynesian prehistory was population growth. Once settled and established the new occupants quickly expanded their numbers until some limits were reached. In fact, by the time of European contact nearly all island groups were controlling population through social mechanisms. Kirch's discussion of island demographics (chapter 5) carefully considers the relationships between population growth, constraints (both cultural and ecological), and the emergence of complex societies. Certainly this is one of the essential questions of the work, that is, what are the environmental and cultural bases for the emergence of complex sociopolitical systems in Polynesia?

To answer this question, Kirch employs growth models originating from population biology such as the logistic equation. A few minor errors crop up here in his discussion; for example, on page 103, r, the intrinsic rate of growth of a population, does not decrease as N/K approaches unity, but in fact is an empirically derived constant in the logistic equation. Similarly, r does not equal zero when the population ceases to grow; rather, the first derivative of population size (dN/dT) equals zero. On page 119 Kirch uses a non-ecological (but perhaps anthropologically meaningful) definition of carrying capacity when he states that "an island's carrying capacity is the population capable of surviving a severe disaster-induced famine," and makes the unlikely claim that carrying capacity fluctuates over time in a "stochastic fashion." Analysis of the climatological data for the Western Pacific in fact indicates strong autocorrelation of climatic variables through time; thus, for example, although mean annual rainfall does indeed exhibit significant fluctuations, these fluctuations are not stochastic but rather exhibit a periodicity of known mean and prescribed variance. This minor correction, however, serves to strengthen Kirch's subsequent arguments about the need for storage technologies such as *masi* (Cox 1980), since drought and famine were not merely random events with unknown probability distributions, but rather could be counted on to occur during any particular twenty-year period (Freeman 1951).

One of Kirch's major achievements is testing the generalized features of population growth models—low initial growth, followed by rapid expansion and a subsequent leveling off of population growth—with

archaeological data from western Hawaii. Two critical assumptions were necessary: 1) there is an allometric relationship between population size and numbers of habitation sites, and 2) volcanic glass hydration wind dates are adequate to date the sites. The results of this test are positive: population growth was sigmoidal although regional variation was most likely present.

Kirch also discusses relationships between survivorship and population density by using skeletal material from Tonga, the Marquesas, and Hawaii. Unfortunately the best sample (1,163 individuals from Mokapu on Oahu) is undated and its place in the discussion is critical. Nevertheless, Kirch tentatively suggests the evidence argues for an inverse relationship between life expectancy and population density.

Finally, Kirch describes cultural mechanisms for population control in Tikopia (Firth 1967) to demonstrate the islanders' awareness of the importance of curbing growth. Kirch briefly reviews various practices that have been discussed as possible population control measures in Polynesia, including coitus interruptus, celibacy, infanticide, abortion, emigration by sea voyaging, and war.

In chapter 6 Kirch attacks the pervasive stereotype of Polynesia as an environmentally benign paradise by pointing out the frequent environmental hazards to stable agriculture such as drought, cyclonic storms, volcanic activity, and in New Zealand, frosts. Perhaps more importantly, he debunks the myth of Polynesians as practitioners of a naive but successful "conservation ethic." In many islands the indigenous forests were completely destroyed by the Polynesians. These interior forests were replaced with sclerophyllous, scrubby vegetation characterized by a *Dicranopteris/Casurina/Spathoglottis* association. Such environmental degradation and subsequent soil erosion continues to typify ever increasing areas in modern Polynesia. For example, in Futuna destruction of the forest began in the first centuries A.D. The resultant lateritic soils and species-depauperate vegetation represent an artificial pyro-disclimax of sorts; Kirch suggests that fire, purposeful or accidental, has traditionally maintained similar degraded environments in a variety of islands. The consequences of this environmental degradation cannot be overestimated. Root casts reveal that large portions of desolate Easter Island, for example, were once forested. In a grim lesson that needs to be learned by modern policymakers throughout Polynesia, Kirch demonstrates that deforestation, with the resultant loss of construction material, valuable watersheds, and loss of the soil mantle, has drastically affected carrying capacities in a number of islands. In New Zealand alone, more than eight million acres of forest were removed by anthro-

pogenic fires. Such areas, thus unfit for yam cultivation, may have caused sedentary agricultural populations to consider abandoning horticulture entirely and to rely solely on famine foods such as *Pteridium* rhizomes. Kirch suggests that "the loss of status that would accompany such an economic shift [from a high status food such as yams] would likely have been unacceptable, at least to a powerful group" (p. 146).

Habitat destruction and direct predation drove into extinction a number of endemic animal species throughout the islands, including the New Zealand moas, sixteen or so species of New Zealand raptorial and land birds, and perhaps as many as forty species of endemic Hawaiian birds.

Environmental change initiated by the colonists also led to sociological change, frequently resulting in agricultural intensification. Shifting cultivation tended to be replaced by permanent gardens with an emphasis on tree crops. Ceremonial restrictions on food use, such as *tapu,* may have accompanied such changes; for example turtles, sharks, rays, eels, and puffer fish are associated with contemporary Tikopian ecosystems but are absent from 1,300 years of the archaeological sequence, indicating that these species may have enjoyed *tapu* status. Given Kirch's ecological orientation, it is somewhat surprising to see that he dismisses out of hand (p. 166) the possibility that the *tapu* system may have evolved in the face of increasing environmental degradation as a conservation policy of sorts, with the chiefs fulfilling the role of ecological planners. Despite Oliver's (1974) suggestion that *tapu* restrictions were deliberately imposed for the benefit of the chiefs, *tapu* restrictions on dwindling resources must have greatly increased probabilities of group survival, and were often couched in survival terms. For example, throughout Eastern and parts of Western Polynesia the first crop of breadfruit was *tapu* and used to fill the large communal fermentation or *masi* pits that were frequently built in fortifications. While this tended to insure survival of the chiefdom, it also tended to insure survival of the group. Regardless of the indigenous explanations concerning their origin and purpose, cultural adaptations such as the *tapu* system that directly increase probabilities of group survival are termed "culturgens" by Lumdsen and Wilson (1981) and are predicted to be important determinants of cultural evolution.

Emphasis on tree-cropping throughout Polynesia led to intensification of *masi* technology, which, as in Micronesia (Atchley and Cox 1985), not only buffered the population from seasonal fluctuations in the food supply but also served to put surplus production as well as famine food supplies under societal control. However, surplus production

increasingly came to maintain people of rank, with *tapu* being used to raise both domestic production levels and the conscript labor needed to insure such higher production. Redistribution of the surplus through chiefly exchanges and feasts served to reassert the position of the chief. A synergistic relationship between agricultural intensification and the status of the chiefdoms therefore arose, reaching its apogee in complex systems of irrigation, swamp drainage, and fish ponds. Even depauperate Easter Island experienced an intensification in chicken husbandry with the construction of intricate stone fowl houses *(hare moa)* protected from theft by twisting passageways. Eventually, escalating demands for ever increasing levels of production led to warfare. As Kirch states, "The incessant demand for surplus production led chiefs to undertake the conquest of adjacent territories" (p. 192).

Thus at the heart of advanced stages in Polynesian cultural evolution was warfare. Conflict at some level was typical of nearly every island group. This fact is well known and has been perceived by most scholars (e.g. Goldman 1970; Vayda 1976; Suggs 1961; Cordy 1974) as integral to the social complexity of Polynesia. Kirch likewise recognizes the importance of warfare. In his discussion of the relationship between conflict and social change, however, Kirch (p. 216) is very careful to avoid any suggestion of ecological or demographic determination. The presence, a priori, of the concepts of *mana* (power) and the potentially conflicting statuses of *toa* (warriors) and *ariki* (chiefs) provided a "context and a stimulus" for the evolution of chiefdoms in Polynesia.

Relying on his now familiar format of ethnohistory, ethnography, and archaeology, Kirch tells a fascinating and convincing tale using specific examples from different island groups, At the heart of the processes of change were burgeoning populations, which placed ever increasing pressure on finite resources, and the power conflict between a rising class of warriors and the traditional chiefs who obtained their status through descent. These two classes regularly became interwoven: the highest title in Samoa, *Malietoa,* literally means "good warrior" and descends from a warrior who initiated the expulsion of the ruling Tongans from Samoa. Frequently in Polynesia, however, as populations grew and migrated to fill all niches on an island, conflict erupted, offering opportunities for the ambitious who wished to enhance their status via military prowess. Kirch notes that evidence for warfare is especially strong in the resource-poor leeward parts of the islands. He also notes that archaeological evidence in New Zealand in the form of fort *(pa)* construction suggests that those holding fertile irrigated lands were also predictably besieged.

Having developed and supported his thesis of social-change evolution following a more or less predictable sequence of stages throughout Polynesia, Kirch examines in detail three relatively well-researched groups: Tonga, Hawaii, and Easter Island.

Tonga's prehistory is, at present, the longest in Polynesia, spanning three thousand years. There is no archaeological evidence as yet for status differentiation during the early phase (pre-2000 B.P.) of occupation. By A.D. 1000, however, some large earthworks appear, suggesting corvée labor and, because of the evidence for sophisticated stone-cutting skills, task specialization. These monuments proliferate in the third millenium of occupation. Territorial expansion also occurred. As Kirch notes (p. 219), "The truly unique feature of Tongan society, in contrast with other Polynesian chiefdoms, was the integration by the Tongan polity of an extensive geographic region, extending far beyond the limits of the Tongan archipelago itself."

The need for frequent exchanges with islands outside Tonga was driven, in part, by the system of dual paramountship. With the assassination of Tu'i Tonga Takalua in the fifteenth century, the sacred aspects of the chiefdom were assumed by Tu'i Tonga, but the secular powers were transferred to his younger brother under the newly created title of Tu'i Ha'a, which eventually became known as the *hau*. Among Tongan siblings females have higher status than males, and among siblings of the same sex, age determines rank. This posed a dilemma for the patrilineal succession of the Tu'i Tonga line because Tu'i Tonga was always outranked by his sister, Tu'i Tonga Fefine. Her child, the Tamaha, in fact stood to inherit certain of Tu'i Tonga's rights and privileges. This potential conflict in succession was traditionally resolved by espousing Tu'i Tonga Fefine to a member of a Fijian polity, who, as a foreigner, was outside Tonga systems of descent. The problem of obtaining suitably ranked spouses for the *hau* was solved by the importation of chiefly women from Samoa and Fiji. Eventually a permanent entourage of foreign chiefdoms was attached to Tu'i Tonga and became known as the *Felefa* (four houses). Each house was represented by a chief of foreign origin—from Fiji, Samoa, Rotuma, or Tokelau. The frequent cultural exchanges such a system entailed affected not only Tonga but distant archipelagoes as well. In the Lau group in Fiji, for example, a form of Bauan Fijian with strong elements of Tongan is spoken, while the language of the Tongan outlier Niuatoputapu was not Tongan at the time of European contact in 1616, but subsequently became largely Tongan through social intercourse with the main Tongan islands.

The need for frequent long-distance voyaging necessitated large sea-

worthy canoes. Appropriate floristic resources and construction skills caused distant Kabara Island, for example, to become a major source of Tongan canoes (Banack and Cox 1986). Construction of large canoes, such as *camakau* or *drua,* took extended periods of time and thus necessitated semipermanent Tongan settlements in Lau. Chiefly exchanges also occurred between the archipelagoes. Fine mats *(i'e tonga)* were sent from Samoa to Fiji; and even the royal flock of flying foxes *(peka* or *Pteropus tonganus)* at Kolovai, Tongatapu, was said to have been a gift from the Samoan princess Sina to Tu'i Tonga.

Unlike Tonga, situated in the heart of Polynesia with its three-thousand-year-old prehistory, Hawaii is very isolated from the rest of Polynesia and was settled relatively late, A.D. 300-500. By A.D. 900-1100 populations were expanding into the less favorable leeward portions of the islands and by A.D. 1400-1500 virtually all land was occupied. Because of its large area and variable landscape, Hawaii did not develop uniformly, but by A.D. 1400 there was a surge of monumental construction signaling political complexity and social differentiation.

Kirch's structural comparison of Tonga and Hawaii is intriguing. He notes that these two systems, which are among the "most elaborated" of the Polynesian chiefdoms, have superficial differences, but on a more fundamental level are quite similar, a fact he ascribes in part to their common cultural heritage. As in Tonga, a rich body of tradition and genealogy makes it possible to trace major ruling lines and political events. Oral tradition in Hawaii is complex and focuses primarily on the nobility. Kirch accents the sharp division between the commoners and the chiefly class when he notes the former had no land and no genealogies or proof of descent. The commoners became the people who worked the land rather than the actual landowners. This theme of land ownership is a fundamental thread that weaves through the complicated tapestry of Hawaii's cultural forms and history.

In contrast to Tonga and Hawaii, whose systems were still developing at the time of European contact, Easter Island society was in a downward spiral after attaining some remarkable achievements. As with Tonga and Hawaii, Kirch traces the cultural history of the island from initial settlement (ca. A.D. 500) to European discovery in 1722. Kirch emphasizes the severe resource limitations of the environment, including the absence of permanent streams, the scarcity of timber for construction and fuel, the marginal rainfall, and the fringing reef. Chickens and introduced rats were almost the sole sources of protein on land, a fact that led to an emphasis on fishing.

Despite these constraints population grew until the second millenium

A.D. when the *ahu,* an elaboration of the East Polynesian marae complex, was in place. Kirch agrees with other researchers that the stone statues were quarried, transported, and raised on their platforms by local descent groups and are not evidence of a centralized, island-wide sociopolitical structure.

By A.D. 1500-1600 Easter Island was at a point of demographic stress. Environmental degradation leading to vegetation loss and soil erosion eventually brought on a period of intense conflict. *Ahu* construction ceased and eventually *ahu* began to be destroyed. As in the case of Hawaii, warfare led to the emergence of warrior leaders. However on Easter Island, the traditional *ariki-mau* lost secular power and then, with the emergence of the bird-man cult, religious power as well. When Roggevenn discovered the island on Easter Day, he found only the remnants of a once flourishing culture.

Kirch's epilogue, like the text, avoids simplistic summaries and casual statements. Evolutionary sequences can be understood only through a synthetic approach, namely one that considers "a variety of factors—structural, ecological, political, demographic, technological and social." For had the ancestral Polynesians not brought with them the developed opposition of *toa* and *ariki* as well as the concept of *mana,* these island societies would likely have had very different trajectories. Even Easter Island, Kirch argues, might not have experienced its devastating climax given a different, less competitive social structure.

The Evolution of the Polynesian Chiefdoms is undoubtedly the most important single-author synthesis of Polynesia's prehistory to date. It is very difficult for an author of such a synthesis to thread a tenuous path through the unknown mine fields of disparate disciplines. It is therefore a testimony to both the breadth and depth of Kirch's scholarship that he has been able to do this successfully. If anything, Kirch is perhaps too careful not to place primacy on a single factor. For example, his comments on Easter Island not having reached carrying capacity seem overly cautious (pp. 280-281). However, such prudence in refusing to grasp simplistic solutions has yielded rich dividends, and we believe the sociological approach taken in this book will eventually form the structural basis for research on Polynesian societies for many years to come. *The Evolution of the Polynesian Chiefdoms* represents a major intellectual triumph and should be a primary reference for all serious students of Oceanic societies.

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