

TOM DYE

Population Trends in Hawai'i Before 1778

TWO GENERAL MODELS OF Hawaiian population trends before 1778 can both claim support from archaeological data. A model of arrested population growth finds corroboration in archaeological censuses of abandoned habitation sites on leeward Hawai'i Island and Kaho'olawe Island, which indicate that population levels reached a peak in the seventeenth century and remained fairly constant or declined slightly in the century before Cook.¹ Arrested population growth is variously interpreted by prehistorians as a consequence of island life, especially the restricted amount of land available for agriculture, or as due to one or more of several possible factors, including population pressure on resources, climate change, and political competition.² The arrested-growth model fits well with an estimated contact-era population of between 200,000 and 250,000, derived primarily from the study of historical records.³

The idea that Hawaiian population growth stopped in advance of Cook directly competes with a frequently hypothesized model of constant population growth that was halted only with European contact and the introduction of diseases to which the Hawaiians lacked immunity.⁴ This model gains some support from population estimates derived from an archaeological site census along a sparsely populated portion of the Kona coast on Hawai'i Island, which indicate growth throughout the prehistoric period.⁵ A model of constant population growth contains the potential for larger populations than

Tom Dye is an archaeologist in the Historic Preservation Division of the Hawai'i Department of Land and Natural Resources.

The Hawaiian Journal of History, vol. 28 (1994)

does the arrested-growth model and is used to support an estimate of between 800,000 and 1,000,000 in 1778.⁶

These two competing models of population growth and the contact-era population estimates they support are sufficiently different to be tested with the oftentimes fragmentary and incomplete data of archaeology, but to date no attempt has been made to build upon the earlier site censuses. In part, this is due to the magnitude and costs of field work needed to complete a census of dated sites. The bulk of the leeward Hawai'i Island sites were censused during planning for a highway from Waimea to Kawaihae, and the Kaho'olawe data came from the long-term effort to inventory historic sites on that island that was funded by the U.S. Navy at the behest of the Protect Kaho'olawe 'Ohana. It is also due, however, to strident criticism that the site-census approach to estimating population is inaccurate, with many sources of uncertainty that are extremely difficult to control.⁷ These concerns stimulated use of a different archaeological method to develop a model of Hawaiian population trends before 1778.⁸ The method, as it is applied to Hawai'i, is based on the premise that changes in population are reflected in changes in the abundance of wood charcoal recovered from archaeological contexts associated with the everyday domestic activities of cooking, lighting, and heating. Put briefly, the method posits that more people require more food, light, and heat; that preparation of more food and production of more light and heat require more or larger fires; and that more or larger fires produce more of the wood charcoal that archaeologists recover in their excavations. Thus, other things being equal, archaeologists should recover more domestic charcoal produced during periods of high population than they do from periods of low population.⁹ Population estimates derived with this method are based on 599 radiocarbon dates collected from all of the major islands except Lāna'i and Ni'ihau and represent more than thirty years of radiocarbon dating by Hawaiian archaeologists (fig. 1).

The population estimates derived from these data contradict a model of constant population growth. Instead, the estimated population curve can be divided into three sections (marked in fig. 1 and subsequent figures with dashed vertical lines), each of which shows a different pattern of growth. The first section, from about A.D. 400¹⁰ to 1150, defines the temporal limits of the Foundation Phase, an

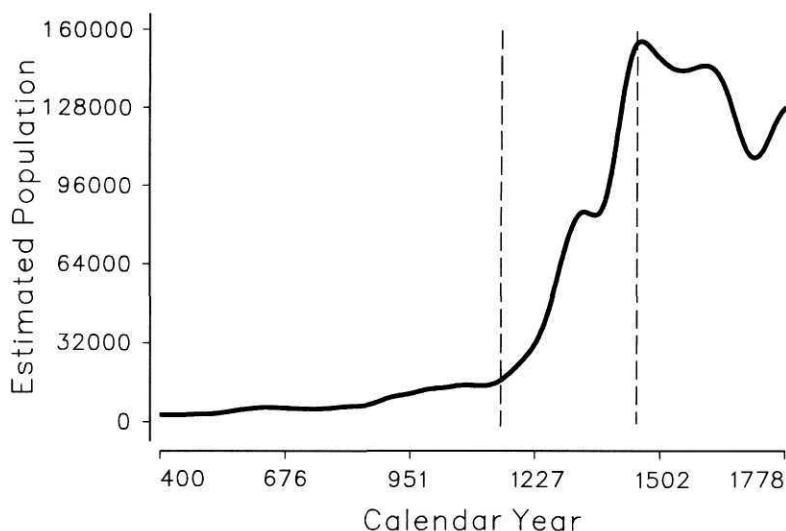


FIG. 1. Estimated population of Hawai'i from the time of first settlement to Captain Cook's visit (Tom Dye and Eric Komori, "A Pre-censal Population History of Hawai'i," *New Zealand Journal of Archaeology* 14 [1992]).

extended period during which the islands were settled, colonies were established in various coastal areas, and population grew from a few hundreds to about 20,000. The second section, from A.D. 1150 to 1450, is the Growth Phase, a period of three centuries during which the size of the population increased approximately ten-fold to its maximum prehistoric size of between 140,000 and 200,000. Growth rates during this period were among the highest in the world and reflect the behavior of a population growing in a favorable environment.¹¹ The last section, from A.D. 1450 to 1778, is the Equilibrium Phase, a period marked by a large, relatively stable population, where apparent declines were followed by periods of growth. The estimated population in 1778 is between 110,000 and 150,000, quite a bit smaller than the frequently cited figure of 400,000 provided by Cook's crew.¹² This supports the conclusions of generations of scholars that Cook's crew overestimated the size of the contact-era population and weighs heavily against the hypothesis that population was near a million in 1778.¹³

The model of Hawaiian population trends carries with it implications for other processes at work in old Hawai'i. Foremost among

these, from an archaeological point of view, is the process of transforming the natural environment of the islands into a cultural landscape, whose elements were assembled and put into place during the long course of Polynesian voyaging and migration.¹⁴ This Polynesian cultural landscape, dominated by an orderly system of agricultural fields centered on the production of starchy plant foods, such as taro, sweet potato, breadfruit, banana, and yams, was itself part of a well-ordered cosmos where the good works of society both made possible, and were made possible by, the good works of the gods. Over time, a landscape of agricultural fields and small settlements, presumably each with its own temple, was created at the expense of lowland forests rich in endemic species. Its creation is revealed to archaeologists in evidence for expansion of agricultural fields, the effort expended in *heiau* construction, and the decline of certain plants that once were common in native lowland forests. Common sense indicates that these three types of evidence should reveal dependent patterns, with forests retreating in the face of agricultural expansion accompanied by increased levels of effort expended in *heiau* construction, and that the onset of major changes should coincide with the beginning of the Growth Phase, when a growing population provided both labor for *heiau* construction and increased demand for agricultural products. During the Equilibrium Phase, with population growth no longer fueling change, the pace of environmental modification should slow. There can be no doubt that Hawaiian society and its environment were both changing during this period, but with population growth checked, the impetus for change would have come from other quarters.

AGRICULTURE

The first Polynesian colonists of Hawai'i found islands cloaked in a variety of forests, from the lush rain forests of the wet uplands to the open, dry forests of the leeward lowlands. These forests offered little in the way of plant food, but birds were abundant and easily captured at nesting grounds, and fish and other sea life were plentiful.¹⁵ It is easy to imagine that, amply satisfied with the meat of birds and fish, a colonizing party's first priority was to establish gardens of the starchy plants that comprise the bulk of the typical Polynesian diet.¹⁶ As pop-

ulation grew, agricultural production increased, either by cutting and burning new gardens out of the native forest, or by intensifying production on a given piece of land by investing more labor in cultivation and by constructing agricultural facilities such as irrigation works. The results of forest clearing were evident to Cook and others, who described vast grasslands and extensive agricultural fields throughout the once-forested arable lowlands.¹⁷ Production intensification is evidenced by irrigated taro *lo'i* and their associated *'auwai*, today found abandoned in the upper reaches of many valleys where modern development has not reached, but formerly distributed much more extensively throughout the lowlands as well.

Recent advances in the study of traditional Hawaiian agriculture include a compilation of eighty-four radiocarbon dates on wood charcoal from agricultural sites, including both dryland fields and irrigated pond fields, or *lo'i*.¹⁸ The dates are mostly from O'ahu, primarily from agricultural fields on windward O'ahu where much field work was recently completed, but also from Kaua'i, Moloka'i, and Hawai'i Island (fig. 2).

The charcoal collected from these agricultural fields was produced by Hawaiians carrying out traditional gardening tasks, primarily burning to clear a garden for planting. It is unlikely that natural forest fires contributed significantly to the charcoal found in these agricultural fields. Paleo-environmental investigations show that charcoal is rare in sediments that date prior to Polynesian colonization, and this has been interpreted as evidence for the rarity of natural fires in Hawai'i.¹⁹ Because there is much more wood in a climax forest than there is in second growth after agriculture, it is likely that more charcoal was produced during the initial clearing of virgin forest than there was preparing dryland fields or *lo'i* for replanting.²⁰ In much the same way that changes in the amount of domestic charcoal recovered by archaeologists are interpreted as reflecting population trends, changes in the amount of agricultural charcoal are interpreted as reflecting changes in the frequency with which new gardens were cleared from virgin forest. Thus, rising segments of the fig. 2 curve indicate periods of increased forest clearing, and falling segments indicate periods in which forest clearing was in decline. Interpreted in this way, the pattern of agricultural burning fits well with the population estimates. During the Foundation Phase there is evidence for a low level of forest

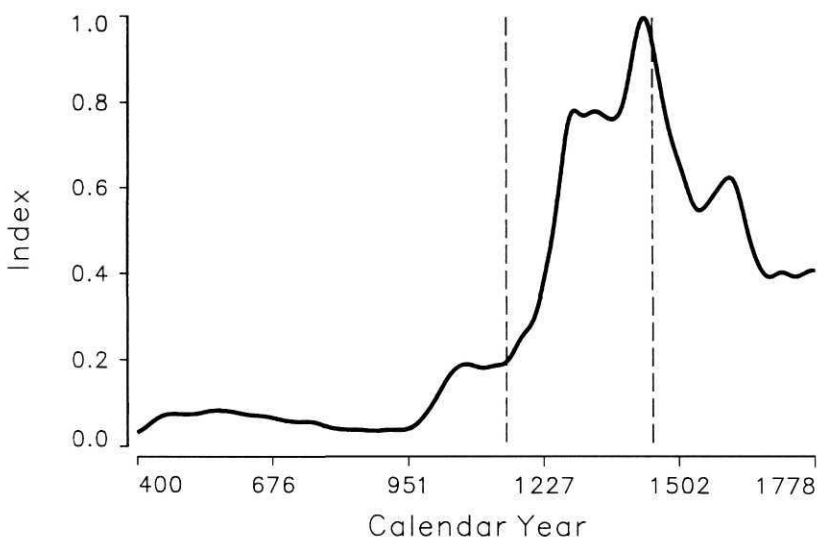


FIG. 2. An index of agricultural burning through Hawaiian prehistory (Jane Allen, "Farming in Hawai'i from Colonisation to Contact," *New Zealand Journal of Archaeology* 14 [1992]).

clearing commensurate with the small population size. Slightly elevated levels, to about 20 percent of their eventual peak, are evident by A.D. 1000, about 150 years before the Growth Phase. The amount of agricultural burning increases markedly throughout the Growth Phase, reaching its peak at the end of the period. Agricultural burning falls to about 50 percent of its peak level during the Equilibrium Phase and remains fairly constant for its duration. This is what would be expected if pressures to create new gardens had eased because population was no longer growing and fires were used primarily to burn off second growth from fallow fields. The agricultural intensification that is often cited as a hallmark of this period²¹ may well have involved the construction of irrigation works in areas where the native forest had long given way to agricultural fields and which would have required little burning in old forests.

VEGETATION

By the time of Cook's visit, the lowland forests of the Hawaiian islands had been greatly altered by more than a millennium of indus-

trious gardening.²² The tempo of change quickened in the historic period, especially with the introduction of grazing animals, and little now remains of the lowland forests that greeted the initial Polynesian colonists. Paleo-environmentalists have spent much effort reconstructing the composition of the native lowland forest through investigation of relict forest stands, recovery and identification of ancient pollen, seeds, fruits, and woods preserved in wet environments such as marshes, and identification of woods from charcoal recovered during archaeological excavations.²³ Paleo-environmental studies, which apply these techniques to dated soil and sediment deposits, are making impressive strides in documenting changes to the lowland forest, many of which are likely responses to traditional Hawaiian uses of the land.

Figure 3 charts the decline of three plant species that were common in the prehuman lowland forest on O'ahu, identified by the presence of their pollen in a sediment core taken from the middle of Kawai Nui Marsh.²⁴ These plants include *loulou*, or fantail palm (*Pritchardia* spp.), species of which vary in height from 2 to 30 feet and produce an edible raw fruit, 'a'ali'i (*Dodonaea viscosa*), a polymorphous species that ranges from a shrub to a tree 30 feet tall and produces a hardwood that can be used for construction and firewood,²⁵ and a legume, previously unknown to science but recently discovered at a remote sea cliff on Kaho'olawe and whose uses in traditional Hawaii'i, if any, are still unknown. Although the exact nature of the native lowland forest cannot be inferred with confidence from the pollen data, it is likely that a lowland palm forest dominated by *loulou*, such as that reconstructed from the Kawai Nui pollen core, was the original native vegetation on O'ahu, and possibly on the other Hawaiian Islands as well.²⁶ Figure 3 shows this forest in decline by the end of the Foundation Phase, a decline precisely coincident with the rise in agricultural burning. The decline leads to the apparent loss of the native lowland forest in the vicinity of Kawai Nui marsh by the middle of the Growth Phase. This suggests that agricultural clearing, whose pace was still quickening, had by this time spread to upland forests distant from Kawai Nui, a process apparently evident in vegetation changes reconstructed from pollen preserved in a small marsh in upper Maunawili Valley.²⁷ Today, a small seastack off Moloka'i Island's north coast supports the lone relict *loulou* palm forest in the islands,

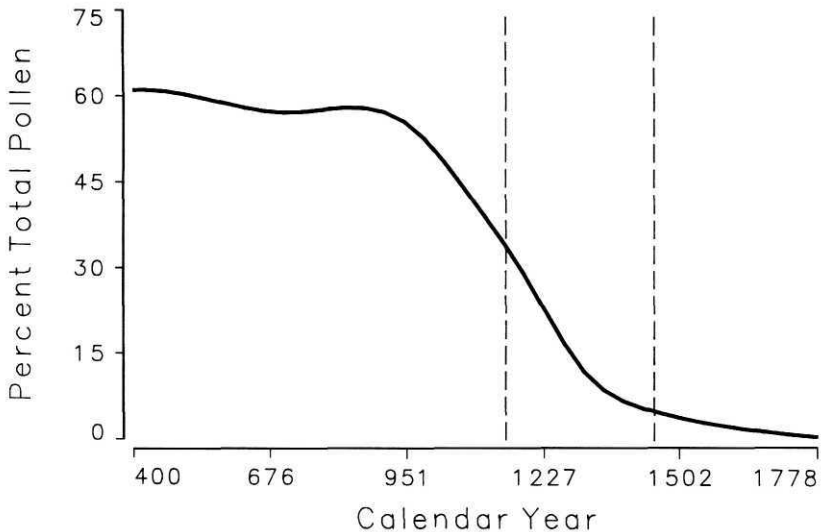


FIG. 3. Decline of the native forest in the vicinity of Kawai Nui Marsh, Kailua, O'ahu. The graph is a weighted average smooth of data on pollen from three species of plants common in the native forest (J. Stephen Athens and Jerome V. Ward, "Environmental Change and Prehistoric Polynesian Settlement in Hawai'i," *Asian Perspectives* 32.2 [1993]:212).

although disjunct stands of *loulou* in upland regions of O'ahu and Kaua'i have been noted, and the palm is prominent in two valleys on distant Nihoa island.²⁸

HEIAU CONSTRUCTION

In traditional Hawai'i, a healthy population and productive gardens were achieved with the help of gods secured at a wide variety of religious temples.²⁹ The smallest of these, consisting of a single upright stone and known as *pōhaku o Kāne*, were used by individuals in their communications with household gods. Larger *heiau ho'ōlululu* were built by local chiefs to carry out the rites that ensured community success in agriculture and other pursuits. The largest structures, built at the direction of the highest chiefs, were either *heiau luakini*, at which human sacrifices were made, or residences of high chiefs and *kāhuna*.

Early archaeological studies of *heiau* were guided by traditional Hawaiian historical accounts of a migration to Hawai'i of southern Polynesians around the eleventh century A.D.³⁰ According to tradi-

tion, this period saw the immigration of Pa'ao, a priest, chief, navigator, and magician generally credited with establishing the line of chiefs that ruled Hawai'i Island until 1893, and with introducing a new religion that expanded the pantheon of deities and practiced human sacrifice. According to Abraham Fornander, Pa'ao was also responsible for a change in temple architecture from open platforms, where ceremonies were in full view of the people, to walled temples where ceremonies could be carried out in secret.³¹ The archaeological effort to distinguish early platform temples from late walled temples failed, primarily because it proved impossible to define clear-cut architectural types from the incredible variety of *heiau* architectural forms. According to J. F. G. Stokes, a Bishop Museum archaeologist who carried out extended field surveys of *heiau*, the cause of this variability was revealed by traditional accounts of the role of temple architects, the *kāhuna kuhikuhipu'uone*. Stokes believed that these *kāhuna* not only determined the overall form of the *heiau*, but also the choice of features and their arrangement, and that as their work continued, "so continued the confusion of temple plans."³²

The degree to which the continuing work of *kāhuna* altered the forms of temples was discovered in the 1960s during excavations in *heiau* at Hōnaunau, Hawai'i, and Mākaha, O'ahu.³³ These excavations showed that *heiau* foundations were frequently rebuilt, modified, and expanded over extended periods of time. Excavations in Kāne'āki Heiau at Mākaha, for example, revealed that the temple had been subject to at least six modifications between the time of its mid-sixteenth century construction and the overthrow of the *kapu* system in 1819.³⁴

Recently, the incremental nature of *heiau* construction was used to investigate changing patterns of labor investment in foundation construction at seven Maui Island *heiau*.³⁵ Excavations in *heiau* foundations revealed a variety of structural components, such as platforms, pavements, and walls, whose relative ages could be deduced from their positions relative to one another. The ages of discrete construction episodes were determined by dating bits of charcoal recovered from beneath the structural components, and the amount of labor invested in construction during each episode was estimated from the sizes of the structures. Estimated labor expenditures were tallied for

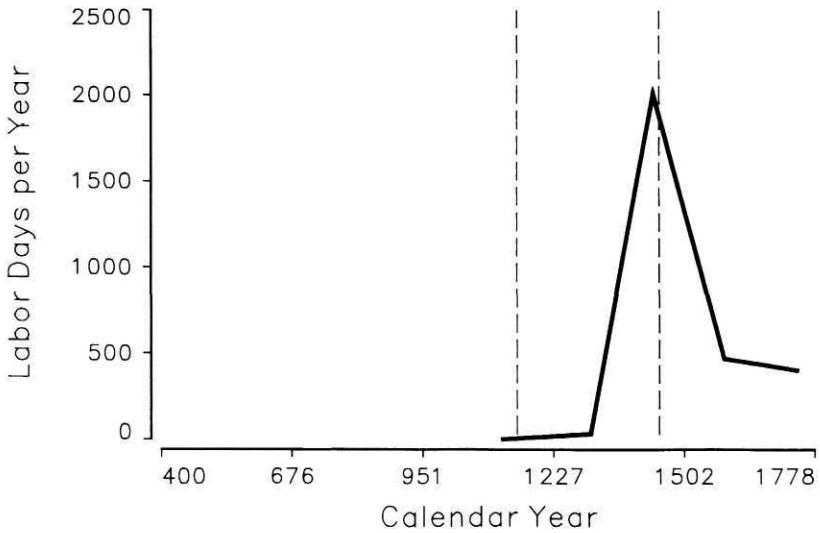


FIG. 4. Annual labor investment in heiau construction estimated from excavations at seven Maui Island *heiau* (Michael J. Kolb, "Social Power, Chiefly Authority, and Ceremonial Architecture in an Island Polity, Maui, Hawaii," Ph.D. diss., U of California, Los Angeles, 1991, p. 257).

each of five prehistoric/early historic periods, and these are shown in fig. 4 as estimates of average labor days per year plotted at the midpoint of each period.

The labor estimate for the Foundation Phase is nil because none of the excavated *heiau* date to this period.³⁶ This is not unusual; archaeologists still have not identified a religious temple that dates to a time before the traditionally recorded arrival of Pa'ao.³⁷ The first archaeological evidence for *heiau* construction on Maui comes at the beginning of the Growth Phase, when a moderate amount of effort was expended in the construction of small temples. This is followed by a sixty-fold increase in labor expenditure during the second half of the Growth Phase. Some of this increased burden was absorbed by a growing population, which doubled over this period, but much of it was shouldered by individuals devoting more time and effort to *heiau* construction. It is not possible with the data at hand to estimate the time devoted by an average individual to *heiau* construction, but it is unlikely, even during this period of increased labor expenditure, that it would have been overly burdensome. The *heiau* construction boom

was quite short, and the Equilibrium Phase is characterized by a relatively constant level of labor expenditure about 20 percent of the peak figure. The decrease in labor expended on *heiau* construction did not preclude the construction of great works. Instead, *heiau* construction during the Equilibrium Phase is characterized by minor changes at some *heiau* and large-scale enterprises at others, primarily those located near the seats of traditional chiefly power. During this period, massive additions were made to Pihana Heiau, a *luakini*, and Haleki'i Heiau, a chief's residence, both located in Wailuku, one of the most thickly populated regions of old Hawai'i and home to some of the islands' most powerful chiefs.³⁸

DISCUSSION

A three-phase history of Hawaiian population is supported by archaeological evidence for trends in agriculture, deforestation, and *heiau* construction. These trends not only fit commonsense notions about their relationships to the population phases, but also begin and end in virtual synchrony with them. It must be counted as extremely unlikely that such detailed correspondences in independent data could arise solely by chance. Instead, the archaeological evidence for population, agriculture, deforestation, and *heiau* construction collectively paint a plausible picture of what happened in Hawaiian prehistory.

Data from the Foundation Phase support other characterizations of the early centuries of Hawaiian prehistory.³⁹ Hawaiian society in the first centuries after colonization resembled its ancestral society in eastern Polynesia more than it did traditional Hawai'i as described by Europeans and native historians many hundred years later. Speculations on the nature of early Hawaiian society are based primarily on comparative ethnography because few traditions from this time survived the vagaries of history, and the archaeological evidence is extremely spotty. At the end of the Foundation Phase, the islands must have looked pretty much as they did when Polynesians first arrived several centuries earlier. Now, however, the lowland forests were broken here and there along the coast by small settlements, identifiable from a distance by their stands of coconut trees and surrounded by modest gardens of introduced food plants.

Virtually every account of Hawaiian prehistory posits an extended Growth Phase, in part because a period of rapid population increase is predictable with reference to principles of population growth.⁴⁰ In most of these accounts, the Growth Phase lasts at least six centuries and ends at most a century before Cook's visit. In contrast, the Growth Phase estimated by the data in fig. 1 lasts only three centuries and ends more than three centuries before Cook. The brevity of this phase might provide a solution to interpretive difficulties faced by prehistorians in reconciling traditional histories with archaeological data, in particular the traditional history of Pa'ao. Tradition claims Pa'ao arrived in Hawai'i at a time reckoned genealogically to the early years of the Growth Phase, although these estimates vary considerably because of uncertainty over the average length of a generation, and that he was responsible for radically altering the developmental course of Hawaiian society. The possibility that one man had such far-reaching effects on Hawaiian society was ignored by most prehistorians and resisted by others, in part because Pa'ao's arrival and exploits appeared to be fleeting events set within the context of a long period of change characterized, and in part driven, by inexorable population growth.⁴¹ A brief Growth Phase means that Pa'ao's ideas were introduced during a period of accelerated change, thus favoring their chances of having a widespread and lasting effect. Ideas on temple design attributed to Pa'ao, for instance, were apparently introduced at Hawai'i Island just before a boom in *heiau* construction, which presumably saw *heiau* established in newly settled regions. Thus, these ideas became an established part of the cultural landscape which could serve as the basis for later elaboration and spread to other islands. If Pa'ao had arrived a few centuries later, after the Growth Phase had run its course, it is unlikely that the ideas of this extraordinary man would have left such a mark on Hawaiian tradition.

The unexpectedly early end of this phase raises interpretive problems that cannot be solved with the data at hand. In particular, the mechanisms that slowed population growth, related to fertility, mortality, and migration, cannot be investigated with the radiocarbon data. Study of human skeletal remains has the potential to investigate these mechanisms,⁴² but this potential is not yet realized, and might never be realized given the often vocal opposition to osteological

analysis of Hawaiian skeletal remains. Instead, several possible explanations, none of which can be rejected as a contributing factor, might be considered. Primary among these in the archaeological literature are environmental constraints associated with the small size of the islands. These constraints are often expressed in archaeological interpretations of prehistory as the possibility that agricultural productivity failed to keep pace with the rapid growth of population during the Growth Phase. If this were the case, then population equilibrium was, at least in part, a response to "pressure on local food supplies and the limitations of agricultural land."⁴³ These presumed pressures arose either because all arable land had been put into production, or because the horticultural techniques needed to make marginal lands productive were not perfected in time to sustain population growth.⁴⁴ This possibility has clear implications for the archaeological study of agricultural technology in old Hawai'i, which might help to explain the popularity of this line of explanation among archaeologists, despite specialist opinion that lands cultivable with traditional technology, and hence available to feed a growing population, were not developed.⁴⁵

Another environmental constraint, rarely considered today, is a change of environment with the pre-Cook introduction of diseases to which Hawaiians lacked immunity. This possibility requires some sort of culture contact prior to Cook's "discovery" of the islands, an idea that was once thought to be highly probable, but that has fallen so far out of fashion that archaeological summaries of Hawaiian prehistory don't discuss it.⁴⁶ For many years, the possibility of pre-Cook culture contact was supported with references to traditional history and by assertions of correspondences between Hawaiian culture and the culture of the posited contact group. Lately, however, archaeological and paleopathological research have opened up the possibility that direct evidence for culture contact can be gained from identification of diseases in skeletons that date to the period before Cook. The diseases possibly introduced by culture contact include syphilis and other venereal diseases, tuberculosis, diphtheria, diarrhea and dysentery caused by pathogenic enterobacteria, typhoid, scarlet fever, rheumatic fever, meningitis, hepatitis, and polio.⁴⁷ The most visible of these in skeletal material is syphilis, which can leave a variety of distinctive marks on bone. Pietrusewsky and Douglas differentially diag-

nosed congenital syphilis in a young woman buried at O‘ahu Island’s ‘Ewa plain between A.D. 1422 and 1664, according to a radiocarbon date on a piece of the woman’s skeleton.⁴⁸ There are good reasons to be cautious about these data, including the possible presence of yaws, a disease closely related to syphilis, and the possibility that the bone yielded a too old date due to contamination with humic acids in the soil.⁴⁹ If the diagnosis and the radiocarbon date are both correct, however, then contact with a population in which syphilis was established would be necessary to explain its appearance in Hawai‘i, where, through most of prehistory, syphilis was absent.

A century ago, evidence for a period of population stasis and for syphilis in the pre-Cook era might have been explained with reference to traditional Hawaiian accounts of foreign shipwrecks.⁵⁰ Although Hawaiian tradition does not record the nationalities of the shipwrecks, many scholars believed that they were Spanish. Maps captured by Anson from a Spanish galleon were generally interpreted through the nineteenth century as indicating that Spaniards, possibly Gaetano (A.D. 1555) or Mendaña (A.D. 1568), had located the Hawaiian Islands, but these theories are now discredited.⁵¹ The maps are sufficiently ambiguous that plausible arguments can be made on both sides of the question.⁵² The questions of Spanish knowledge of Hawai‘i and Spanish contact with Hawai‘i are not the same, however, and the possibility that Spanish vessels were wrecked at Hawai‘i without having made further contact with Spain is a possibility that recent historical scholarship rates as “very likely.”⁵³ If so, it is likely that diseases, including syphilis, would have been introduced.

Another possibility for culture contact prior to Cook is the Japanese. Many years ago, parallels between Hawaiian and Japanese cultures, especially the similarity of Japanese knives and iron blades in the possession of Hawaiians at the time of Cook’s first landing at Kaua‘i, were thought to have developed through culture contact, most likely drift voyages from Japan to Hawai‘i in the period A.D. 1550–1630.⁵⁴ Historically recorded drifts from Japan to Hawai‘i indicate that the probability of successful drifts in the prehistoric period is quite high, especially since shipping practices in shogunate Japan were highly regulated, changing little through the seventeenth, eighteenth, and early nineteenth centuries.⁵⁵ A straightforward extrapolation of the historically recorded rate of successful drifts leads to the

conclusion that there were between two and twelve successful drifts to Hawai'i from Japan between 1600 and 1778, with greatly reduced probabilities before this time. Knives, such as those seen by Cook on Kaua'i, would be taken from a drift vessel regardless of the state of the crew, of course, but if crew members survived the long drift from Japan, then it is likely that syphilis, among other diseases new to Hawai'i, was carried on board. Syphilis was introduced to Japan about 1512, most likely by mariners who contracted the disease while at port on the east coast of China. The prevalence of prostitution in Japan at that time apparently led to the quick spread of the disease through the population, and it is estimated that between 39.4 percent and 69.7 percent of the adult Japanese population of the Edo period (1603–1867) contracted syphilis. The incidence of syphilis among Japanese mariners, the likely vector for the introduction of the disease to Japan, would likely be higher than these figures.⁵⁶

In contrast to explanations based on environmental constraints are those in which population and its dynamics are products of social relations. These explanations can take a variety of forms, but one possibility formulated for Hawai'i is that population growth was controlled by the rising power of chiefs. In this view, the chiefs' increasing control over commoners' access to land made it difficult for commoners to add to their holdings. In response, commoners limited the size of their families, thereby slowing population growth. This type of social control over population can function even when population size does not strain the technological capacity to produce food. In this view

“population pressure” is generated at a very low level, at the level of the household or the small local group of related households, by the intrusion of political authorities in the disposition of land and labor. Thus there can be a “shortage” of land, which is to say of desirable tenures, even as great areas are lying waste.⁵⁷

One advantage of explanations framed in social terms, as opposed to those in which the history of society is explained by the negative effects of environmental constraints, is that there is no need to suggest that Hawaiians were not a prosperous, healthy people.⁵⁸ Development of social controls for population growth might be stimulated by

perceived resource shortages, before resource depletion jeopardized the health of the population. The suggestion that archaeologists can only support a period of no population growth with evidence for “severe malnutrition” or restrictions on “strenuous leisure activities” to avoid “unnecessary caloric expenditures” need not be entertained.⁵⁹ Viewed from the perspective of today’s rapidly growing and overcrowded world, the ability of Hawaiians to maintain a population size at which individuals could lead healthy, prosperous lives appears a signal success.

NOTES

- ¹ Robert John Hommon, “The Formation of Primitive States in Pre-contact Hawaii” (Ph.D. diss., U of Arizona, 1976); Robert John Hommon, *Multiple Resources Nomination Form for Kaho’olawe Archaeological Sites* (Washington, D.C.: National Register of Historic Places, 1980); Patrick V. Kirch, *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory* (Honolulu: U of Hawaii P, 1985).
- ² Patrick V. Kirch, *The Evolution of the Polynesian Chiefdoms*, New Studies in Archaeology, ed. Colin Renfrew and Jeremy Sabloff (Cambridge: Cambridge UP, 1984); Hommon, “The Formation of Primitive States.”
- ³ Robert C. Schmitt, “New Estimates of the Pre-censal Population of Hawaii,” *Journal of the Polynesian Society* 80.2 (1971):237-43; Robert C. Schmitt, *The Missionary Censuses of Hawaii*, Pacific Anthropological Records, 20 (Honolulu: Department of Anthropology, B. P. Bishop Museum, 1973); Kirch, *Feathered Gods and Fishhooks* 286ff.
- ⁴ Robert C. Schmitt and Lynn Y. S. Zane, “How Many People Have Ever Lived in Hawaii?,” unpublished typescript (Honolulu: Hawai’i State Department of Business and Economic Development Library, 1977); Eleanor C. Nordyke, *The Peopling of Hawai’i*, 2nd ed. (Honolulu: U of Hawaii P, 1989); David E. Stannard, *Before the Horror: The Population of Hawai’i on the Eve of Western Contact* (Honolulu: Social Science Research Institute, U of Hawaii, 1989) 66-69.
- ⁵ Ross H. Cordy, *A Study of Prehistoric Social Change: The Development of Complex Societies in the Hawaiian Islands*, Studies in Archaeology (New York: Academic P, 1981).
- ⁶ Stannard, *Before the Horror* 32-37.
- ⁷ Jeffrey T. Clark, “Paleodemography in Leeward Hawaii,” *Archaeology in Oceania* 23 (1988):22-30; Stannard, *Before the Horror* 66ff.
- ⁸ Tom Dye and Eric Komori, “A Pre-censal Population History of Hawai’i,” *New Zealand Journal of Archaeology* 14 (1992):113-28; John W. Rick, “Dates as Data: An Examination of the Peruvian Preceramic Radiocarbon Record,” *American Antiquity* 52.1 (1987):55-73.
- ⁹ Dye and Komori, “A Pre-censal Population History of Hawai’i” 116.

- ¹⁰ Cf. Kirch, *Feathered Gods and Fishhooks* 68; Geoffrey Irwin, *The Prehistoric Exploration and Colonisation of the Pacific* (Cambridge: Cambridge UP, 1992) 216; Terry L. Hunt and Robert M. Holsen, "An Early Radiocarbon Chronology for the Hawaiian Islands: A Preliminary Analysis," *Asian Perspectives* 30.1 (1991):147-61; Matthew J. T. Spriggs and Atholl J. Anderson, "Late Colonization of East Polynesia," *Antiquity* 67 (1993):200.
- ¹¹ Dye and Komori, "A Pre-censal Population History of Hawai'i" 123-24.
- ¹² Robert C. Schmitt, *Demographic Statistics of Hawaii: 1778-1965* (Honolulu: U of Hawaii P, 1968).
- ¹³ Cf. Schmitt, "New Estimates of the Pre-censal Population of Hawaii"; Stannard, *Before the Horror*.
- ¹⁴ D. E. Yen, "Environment, Agriculture and the Colonisation of the Pacific," in *Pacific Production Systems: Approaches to Economic Prehistory*, Occasional Papers in Prehistory, 18, ed. D. E. Yen and J. M. J. Mummery (Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National U, 1990) 258-77; Kirch, *The Evolution of the Polynesian Chiefdoms* 83ff.
- ¹⁵ Tom Dye and David W. Steadman, "Polynesian Ancestors and Their Animal World," *American Scientist* 78 (1990):207-15; Peter H. Buck, *Arts and Crafts of Hawaii*, Bernice P. Bishop Museum Special Publication, 45 (Honolulu: Bishop Museum P, 1964) 6; Elwood C. Zimmerman, "Nature of the Land Biota," in *Man's Place in the Island Ecosystem: A Symposium*, ed. F. R. Fosberg (Honolulu: Bishop Museum P, 1965) 57-63.
- ¹⁶ Samuel Manaiakalani Kamakau, *Tales and Traditions of the People of Old: Nā Mo'olelo a ka Po'e Kahiko*, trans. from the newspapers *Ka Nupepa Kuokoa* and *Ke Au Okoa* by Mary Kawena Pukui; ed. Dorothy B. Barrère (Honolulu: Bishop Museum P, 1991) 110; E. S. Craighill Handy and Elizabeth Green Handy, *Native Planters in Old Hawaii: Their Life, Lore, and Environment*, Bernice P. Bishop Museum Bulletin, 233, ed. Genevieve A. Highland and Sadie J. Doyle, with the collaboration of Mary Kawena Pukui (Honolulu: Bishop Museum P, 1972) 156.
- ¹⁷ Handy and Handy, *Native Planters* 406-9.
- ¹⁸ Jane Allen, "The Role of Agriculture in the Evolution of the Pre-contact Hawaiian State," *Asian Perspectives* 30.1 (1991):117-32; Jane Allen, "Farming in Hawai'i from Colonisation to Contact: Radiocarbon Chronology and Implications for Cultural Change," *New Zealand Journal of Archaeology* 14 (1992):45-66.
- ¹⁹ J. Stephen Athens and Jerome V. Ward, "Environmental Change and Prehistoric Polynesian Settlement in Hawai'i," *Asian Perspectives* 32.2 (1993): 205-23.
- ²⁰ H. I. Manner, "Biomass: Its Determination and Implications in Tropical Agroecosystems: An Example from Montane New Guinea," in *Subsistence and Survival: Rural Ecology in the Pacific*, ed. T. P. Bayliss-Smith and R. G. Feachem (London: Academic P, 1977) 215-32.
- ²¹ Kirch, *Feathered Gods and Fishhooks* 305.
- ²² Linda W. Cuddihy and Charles P. Stone, *Alteration of Native Hawaiian Vegetation: Effects of Humans, Their Activities and Introductions* (Honolulu: U of Hawaii Cooperative National Park Resources Studies Unit, 1990).
- ²³ J. Stephen Athens, Jerome V. Ward, and Stephen Wickler, "Late Holocene Low-

- land Vegetation, O'ahu, Hawai'i," *New Zealand Journal of Archaeology* 14 (1992): 9-34; Cuddihy and Stone, *Alteration of Native Hawaiian Vegetation*; Gail M. Murakami, "Identification of Charcoal from Archaeological Sites in Upland Kane'ohe, O'ahu," in *Five Upland 'Ili: Archaeological and Historical Investigations in the Kane'ohe Interchange, Interstate Highway H-3, Island of O'ahu*, Departmental Report Series, 87-1, ed. J. Allen (Honolulu: Department of Anthropology, Bernice P. Bishop Museum, 1987) 219-27.
- ²⁴ J. Stephen Athens and Jerome V. Ward, *Paleoenvironmental and Archaeological Investigations, Kawainui Marsh Flood Control Project, O'ahu Island, Hawai'i* (Guam, Mariana Islands: Micronesian Archaeological Research Services, 1991).
- ²⁵ Marie C. Neal, *In Gardens of Hawaii*, Bernice P. Bishop Museum Special Publication, 50 (Honolulu: Bishop Museum P 1965) 97-99, 566-67; I. H. Burkill, *A Dictionary of the Economic Products of the Malay Peninsula*, 2 vols. (Kuala Lumpur, Malaysia: Ministry of Agriculture and Co-operatives, 1966) 861-62.
- ²⁶ Athens and Ward, "Environmental Change and Prehistoric Polynesian Settlement" 211.
- ²⁷ Athens and Ward, "Environmental Change and Prehistoric Polynesian Settlement" 213.
- ²⁸ Cuddihy and Stone, *Alteration of Native Hawaiian Vegetation* 7-8.
- ²⁹ John F. G. Stokes, *Heiau of the Island of Hawai'i: A Historic Survey of Native Hawaiian Temple Sites*, Bishop Museum Bulletin in Anthropology, 2, ed. and introduced by Tom Dye (Honolulu: Bishop Museum Press, 1991); Michael John Kolb, "Social Power, Chiefly Authority, and Ceremonial Architecture, in an Island Polity, Maui, Hawaii" (Ph.D. diss., U of California, Los Angeles, 1991); Valerio Valeri, *Kingship and Sacrifice: Ritual and Society in Ancient Hawaii*, trans. Paula Wissing (Chicago: U of Chicago P, 1985).
- ³⁰ Tom Dye, "A Reputation Unmade: J. F. G. Stokes's Career in Hawaiian Archaeology," in Stokes, *Heiau of the Island of Hawai'i* 3-20.
- ³¹ Abraham Fornander, *An Account of the Polynesian Race: Its Origins and Migrations*, 3 vols. (Rutland, Vermont: Charles E. Tuttle, 1969 [1878-1885]) 58-67.
- ³² Stokes, *Heiau of the Island of Hawai'i* 21.
- ³³ Edmund J. Ladd, "Alealea Temple Site, Honaunau: Salvage Report," in *Archaeology on the Island of Hawaii*, Asian and Pacific Archaeology Series, 3, ed. R. J. Pearson (Honolulu: Social Science Research Institute, U of Hawaii, 1969) 95-130; Edmund J. Ladd, "Kaneaki Temple Site—An Excavation Report," in *Makaha Valley Historical Project: Interim Report No. 4*, Pacific Anthropological Records, 19, ed. Edmund J. Ladd (Honolulu: Department of Anthropology, Bernice P. Bishop Museum, 1973) 1-30; Edmund J. Ladd, *Excavations at Site A-27: Archeology at Pu'uhoonua o Honaunau National Historical Park*, ed. Gary F. Somers, Western Archeological and Conservation Center Publications in Anthropology, 43 (Tucson: National Park Service, U.S. Department of Interior, 1987).
- ³⁴ Ladd, "Kaneaki Temple Site" 30.
- ³⁵ Kolb, "Social Power" 252-57; Michael J. Kolb, "Diachronic Design Changes in Heiau Temple Architecture on the Island of Maui, Hawai'i," *Asian Perspectives* 31.1 (1992): 9-37.

- ³⁶ Kolb, "Diachronic Design Changes" 25.
- ³⁷ Tom Dye, "Tales of Two Cultures: Traditional Historical and Archaeological Interpretations of Hawaiian Prehistory," *Bishop Museum Occasional Papers* 29 (1989):3-22.
- ³⁸ Kolb, "Diachronic Design Changes" 27.
- ³⁹ Robert John Hommon, "Social Evolution in Ancient Hawai'i," in *Island Societies: Archaeological Approaches to Evolution and Transformation*, New directions in Archaeology, ed. Patrick V. Kirch (Cambridge: Cambridge UP, 1986) 55-68; Ross H. Cordy, "Cultural Adaptation and Evolution in Hawaii: A Suggested New Sequence," *Journal of the Polynesian Society* 83.2 (1974):180-91; Irving Goldman, *Ancient Polynesian Society* (Chicago: U of Chicago P, 1970) 200-242; Kirch, *Feathered Gods and Fishhooks* 298ff.
- ⁴⁰ Edward O. Wilson and William H. Bossert, *A Primer of Population Biology* (Sunderland, Massachusetts: Sinauer, 1971) 93ff.
- ⁴¹ Dye, "Tales of Two Cultures" 18ff.
- ⁴² Douglas G. Sutton and Maureen A. Molloy, "Deconstructing Pacific Palaeodemography: A Critique of Density Dependent Causality," *Archaeology in Oceania* 24 (1989):31-6; Kirch, *The Evolution of the Polynesian Chiefdoms* 111-16.
- ⁴³ Kirch, *Feathered Gods and Fishhooks* 287.
- ⁴⁴ Robert J. Hommon, "The View from Out on a Limb, or Confessions of a Generalist," *New Zealand Journal of Archaeology* 14 (1992):151-58.
- ⁴⁵ Douglas E. Yen, "The Origins of Oceanic Agriculture," *Archaeology and Physical Anthropology in Oceania* 8 (1973):68-85; Handy and Handy, *Native Planters* 280.
- ⁴⁶ H. David Tuggle, "Hawaii," in *The Prehistory of Polynesia*, ed. Jesse D. Jennings (Cambridge, Massachusetts: Harvard UP, 1979) 167-99; Kirch, *Feathered Gods and Fishhooks* 305.
- ⁴⁷ Francis L. Black, "Review of *Before the Horror*," *Pacific Studies* 13.3 (1990): 269-79.
- ⁴⁸ Bertell D. Davis, *Archaeological and Paleontological Investigations at the Proposed HECO Barbers Point Generating Station, Honouliuli, 'Ewa, O'ahu* (Honolulu: International Archaeological Research Institute, Inc., 1990).
- ⁴⁹ Peter N. D. Pirie, "The Consequences of Cook's Hawaiian Contacts on the Local Population," in *Captain Cook and the Pacific Islands*, ed. Jane N. Hurd and Michiko Kodama (Honolulu: U of Hawaii Pacific Islands Studies Program, 1978) 81; Thomas W. Stafford et al., "Study of Bone Radiocarbon Dating Accuracy at the University of Arizona NSF Accelerator Facility for Radioisotope Analysis," *Radiocarbon* 29.1 (1987):24-44.
- ⁵⁰ Fornander, *An Account of the Polynesian Race* 106-7.
- ⁵¹ James Jackson Jarves, *History of the Hawaiian or Sandwich Islands* (Boston: Tappan & Dennet, 1843) 98-105; Henry A. Peirce, *The Spanish Discovery of the Hawaiian Islands: Evidences of Visits by Spanish Navigators during the Sixteenth Century*, Paper presented to California Academy of Sciences on June 7, 1880 (Honolulu: Hawaiian Printing Company, 1940).
- ⁵² E. W. Dahlgren, *Were the Hawaiian Islands Visited by the Spaniards before Their Discovery by Captain Cook in 1778?* Kungl. Svenska Velenskapsakademiens Han-

- dlinger, band 57 no. 4 (Stockholm: Almqvist and Wiksells Boktryckeri-A.-B., 1916); John F. G. Stokes, "Hawaii's Discovery by Spaniards: Theories Traced and Refuted," *Papers of the Hawaiian Historical Society* 20 (1939):38-113; John Cawte Beaglehole, *The Exploration of the Pacific*, 3rd ed. (Stanford: Stanford UP, 1966) 296; Bern Anderson, *Surveyor of the Sea: The Life and Voyages of Captain George Vancouver* (Seattle: U of Washington P, 1960).
- ⁵³ O. H. K. Spate, *The Spanish Lake* (Minneapolis: U of Minnesota P, 1979) 109; cf. Beaglehole, *The Exploration of the Pacific* 39.
- ⁵⁴ John F. G. Stokes, "Japanese Cultural Influences in Hawaii," *Proceedings of the 5th Pacific Science Congress* (1934):2792-2800.
- ⁵⁵ Wythe E. Braden, "On the Probability of Pre-1778 Japanese Drifts to Hawaii," *Hawaiian Journal of History* 10 (1976):75-89.
- ⁵⁶ Takao Suzuki, *Palaeopathological and Palaeoepidemiological Study of Osseous Syphilis in Skulls of the Edo Period*, Bulletin no. 23 (Tokyo: University Museum, U of Tokyo, 1984).
- ⁵⁷ Patrick V. Kirch and Marshall Sahlins, *Anahulu: The Anthropology of History in the Kingdom of Hawaii*, vol. 1, Historical Ethnography, by Marshall Sahlins (Chicago: U of Chicago P, 1992) 200.
- ⁵⁸ O. A. Bushnell, *The Gifts of Civilization: Germs and Genocide in Hawaii* (Honolulu: U of Hawaii P, 1993); Sutton and Molloy, "Deconstructing Pacific Palaeodemography."
- ⁵⁹ Stannard, *Before the Horror* 66ff.