"THE ABORIGINAL POPULATION OF TROPICAL AMERICA: PROBLEMS AND METHODS OF ESTIMATION"

by William M. Denevan
Department of Geography
University of Wisconsin

The size of Pre-Columbian native populations in the New World has long been a subject of vigorous discussion. In contrast to the sixteenth-century chroniclers who reported tens of millions of Indians, most modern scholars have been very conservative. Kroeber, for example, estimated only 8,400,000 for the entire hemisphere in 1500.[1] However, the latest estimates have been much higher: Woodrow Borah has suggested 100 million and Henry Dobyns 90 million.[2] The implications of such high numbers for interpretations of the social, economic, and demographic history of both the pre-Columbian and Colonial New World are, of course, vast.

Attention thus far has been mainly focused on the highland civilizations of Mexico and Peru where the densest native populations were located. The purpose of this paper, instead, is to examine the lesser known aboriginal situation of the humid tropical lowlands, particularly at the time of initial European contact. For the New World as a whole, good reviews of the literature on estimating native populations and critical discussions of the problems

and methodology have been recently provided by Dobyns and Borah,[3] and as little as possible of this material will be repeated here.

The areas of concern are those with humid tropical climates below about 5,000 feet elevation.[4] The greater part of these lowlands is generally considered to have been sparsely settled, as evidenced by (1) relatively simple socio-economic levels, (2) general lack of documentary evidence of large populations, (3) present low population densities, and (4) low levels of food production by surviving tribes. Nevertheless, a review of a variety of forms of evidence does reveal that locally there were relatively dense populations, in some areas greater than at the present time, and that even allowing for a sparse population density, the areas involved are so immense that very low densities still project into millions of people.

RATE OF DEPOPULATION

At the outset, it should be emphasized that there are very few counts, estimates, or even partial enumerations of the various tropical tribes for the early sixteenth century. The first such figures generally do not appear until many years or even centuries later. Even today, the size of many Amazonian tribes can only be guessed. For example, estimates for the Campa, the largest tribe in

eastern Peru, range from 10,000 to 35,000. The critical problem is then, how much did a given group decline in numbers from the time of initial contact until the time a reasonable estimate or count became available? Only occasionally are there statements from contemporary observers that the native population had declined by perhaps 50 or 90 percent of what it was when the Europeans arrived, and these are only rough approximations.

A major cause of aboriginal population decline was epidemics of introduced Old World diseases to which the New World natives had no immunity.[5] The rate of decline was rapid - an estimated 90-95 percent in many areas within the first 100 years after initial contact in the opinion of Borah.[6] Dobyns has estimated an average depopulation ratio from first contact to nadir (date of population recovery - usually 100-150 years after contact) of 20 to 1 or 95 percent. He suggests a much higher rate of decline for the tropical lowlands, including complete extinction for many tribes.[7] I have suggested an average for tropical America of about 35 to 1 from contact to nadir.[8] The higher tropical rate was partly due to the introduction of malaria and yellow fever; but, in addition, the main highland killers of smallpox and measles may have been even more virulent in the lowlands. Different dietary patterns may have been a factor, and also viruses tend to survive better in warmer climates.

However, in the interior tropical lowlands, especially Amazonia, European contacts for the first 100 years or more were sporadic and epidemics absent or infrequent. Phelan points out that in the Jesuit province of Mainas in eastern Ecuador, no epidemics were reported from the time Spanish settlers arrived in 1618 until 1660, after which epidemics were frequent and reduced the mission population from 100,000 to only 18,000 by 1762.[9] Whether epidemics occurred before 1618 is not known. In contrast, in the Jesuit Province of Mojos in eastern Bolivia, numerous epidemics broke out even before the first mission was established in 1682.[10] On the basis of the probable depopulation in Mojos I have estimated a conservative ratio of decline of at least 3.5 to 1 during the first 100 years after initial contact for those tropical areas where contact was infrequent.[11] Steward admits to a probable reduction in tropical South America by "half or more" during the first 50 to 200 years after initial white contact.[12]

Where contact was more intense or frequent, as along most tropical coasts, a much higher rate of depopulation occurred. For example, the calculations by Borah and Cook indicate a depopulation ratio of 48 to 1 on the tropical Mexican coasts during only the first 50 years of contact.[13] Edwards has determined a decline equal to 28 to 1 for the Island of Cozumel (Mexico) between 1518 and 1587.[14] Even

these ratios are low compared to those of other areas where there was near extinction within a few years. For Hispaniola, population estimates for 1492 range up to 5 or 6 million, but even if the very conservative calculation of only 100,000 by Rosenblat is used, the depopulation rate was still tremendous (200 to 1 in 56 years) since only about 500 Indians were left by 1548.[15] The large native population of Jamaica was gone by this time and that of other islands nearly so.

DOCUMENTARY EVIDENCE

The main forms of evidence for estimating aboriginal populations at the time of initial European contact are documentary, archaeological, and ecological. The documentary material, which has received the greatest attention, consists of (1) general estimates by eye witness participants in the early conquests, (2) reasonably reliable but usually late dated estimates and counts, and (3) early but partial enumerations such as baptisms, tribute records, and mission figures.

The early sixteenth-century chroniclers spoke of populations numbering in the millions on the tropical coasts of Mexico, in western Central America, in Panama, and in the Caribbean Islands. Sauer, for example, is able to cite six Spaniards who gave figures for the Island of Hispaniola,

or part of it, of "over a million" or 1,100,000, possibly on the basis of a partial census of adults for tribute purposes ordered by Columbus in 1496. And there had already been severe depopulation in 1494-1495. Las Casas, who arrived on the scene in 1502, said the original population in 1492 had been 3 million.[16]

How much credence can be given to such estimates? Were they gross falsifications as claimed by many scholars? The figures of Las Casas, Oviedo, and others are invariably said to be much too high as a result of ulterior motives, or because these authors magnified their own deeds by exaggerating the number of natives.[17] However, an a priori assumption of intentional exaggeration for any reason or because of ignorance is not justified in many instances. Certainly the high early estimates for central Mexico have been at least partly supported by the work of Cook, Borah, and Simpson.[18] In treating the initial Spanish activities in the Caribbean (1492-1519), Sauer argues convincingly that the chroniclers had no reason to distort their population estimates, and that they were well qualified to make estimates. "There was neither reason of vanity nor of practical ends to inflate the native numbers."[19] True, most of the early totals were only general estimates, but they should be neither accepted nor rejected without good cause.

Modern historians and anthropoligists, such as Rosenblat, Kroeber, and Steward, obtained their low population totals by examination of what they thought to be the first reliable counts for different tribes or areas. For the tropics in particular, these figures are usually for dates long after first contact, and the initial massive depopulation mentioned earlier was not fully taken into consideration.

One tribe by tribe calculation is the total of 2,987,060 Indians for tropical South America derived by Steward.[20] He pointed out the difficulties in making estimates and the lateness and unreliability of the documentary figures. His "earliest data that appear to be reliable" for given groups are extended to other groups of similar culture and habitat. In some instances the documentary figures are enlarged to take into account some population reduction since initial contact, but in other instances they are reduced because they are believed by Steward to be an exaggeration. Usually the earliest figure itself is used, even though most date one hundred years or more after first contact, by which time tribal numbers had been reduced by amounts ranging up to full extinction. Steward admits to a possible reduction by half or more during the first 50 to 200 years; however, he fails to apply this to his own calculations, although he does say his estimates are probably too low. If doubled, his total becomes 5,974,000, which is

comparable to the rough figure of 6,000,000 for tropical South America given by Dobyns.[21]

That many of Steward's tribal figures are far too low is now quite evident. He gives only 6,000 for Mojos in 1680, whereas Jesuit accounts indicate many times that amount in the 1690's.[22] He gives a figure of 42,500 mission Indians in the Jesuit Province of Mainas, whereas Phelan has found sources which give about 100,000 mission Indians in Mainas in 1660.[23] Other examples could be cited.

The densest populations in the American tropics were probably in southern Mexico (Chiapas, Gulf Coast, Maya lowlands of Yucatán), and for some of this area there are partial enumerations for the conquest period. The statistical extrapolition of this data is the most recent and most precise form of use of documentary evidence. Borah and Cook obtained a population of 1.9 million for the central Gulf Coast north of Tehauntepec, mainly present day Vera Cruz.[24] This is part of their total of 25.2 million for central Mexico based on three early colonial records of tribute payments to the pre-conquest Indian rulers. Several arbitrary decisions had to be made in converting the tribute data into population figures, and this has led to considerable discussion of the figures, both for and against.[25] But even allowing for a 50 percent error on the high side, the population would still have been quite substantial.

ARCHAEOLOGICAL EVIDENCE

Except for the Gulf Coast of Mexico, documentary evidence is mostly scanty, late, and of limited value for the humid tropics in view of the unknown but generally drastic early declines. Still, there is need for much more archival research if only to provide secure points of reference along incomplete depopulation curves. However, there are other types of evidence which, although imprecise, can provide some idea of relative population density. One is archaeology. The number and size of village or temple sites give some indication of the number of people required to build them or occupy them. In the Classic Maya area of Yucatán, house sites have been carefully enumerated for dispersed village areas around temples. For a 0.3 square mile area around the Uaxactún temple, Ricketson found 78 house mounds, and then multiplied by 5, which is the average number of persons per house in the area today.[26] The problem, of course, is estimating how many house sites were occupied at any one time. Ricketson assumed only 1/4, giving a density of 270.8 per square mile, but Brainard reduced this to only 1/8 for a density of 136 per square mile or only 68 per square mile if each family had two dwellings.[27] But the latter is still a sizeable population density for the tropics.

For Amazonia, where the settlement pattern was one of compact villages rather than dispersed settlement as in Yucatán, it is more difficult to identify individual house sites, but village size can be determined from refuse distribution and converted to rough village population size.[28] In interior Amazonia the potential of archaeology is greatly lessened by the fact that former habitation sites, having been predominantly located in the river floodplains or on adjacent bluffs, have usually been destroyed by the characteristic meandering of the rivers. Lathrap has calculated that most habitation sites in a given riverine area will be destroyed during a meander cycle of about 500 years. He concludes, therefore, that only a small portion of pre-Columbian sites have survived, and that the failure to find many sites is by no means indicative of a sparse pre-Columbian population.[29]

SUBSISTENCE AND ECOLOGY

Another indirect method of estimating aboriginal population is that of determining potential and actual human carrying capacities in relation to the resource base and subsistence technology and then estimating to what extent the ecological maximum was reached. Such models can be developed with some success for areas with fairly uniform resources and subsistence patterns, although even then it is hazardous to project uniform densities.

There is considerable variation in the distribution of agricultural and wild life resources in the tropics. But for the most part lowland soils are infertile, and once the protective forest is removed cropping is only possible for a few years before yields drop drastically or crop growth is inhibited by weeds. Fertilization was and remains rare, and the common agricultural system both past and present has been shifting cultivation. However, more permanent and intensive forms of shifting cultivation are possible on certain superior soils, such as the alluvial soils of floodplains, the limestone soils of Yucatán, and the volcanic soils of western Central America. Furthermore, the period of necessary forest fallow after a field is abandoned varies from only a few years to several decades, depending on soil conditions, temperature, and on the quantity and seasonal distribution of rainfall. For example, shorter fallow periods are possible (1) in the foothills where fresh mineral soil is exposed by erosion and where organic decomposition is slowed down by lower temperatures than in the low plains, and (2) in areas of marked dry seasons where leaching by rainfall is reduced. Theoretically, the more permanent the agriculture, or the shorter the period of fallow, the more land there is available at a given time for agriculture, and hence the greater is the population that can be supported, as long as there is sufficient fallow

time for renewal of fertility.

Population density is not correlated just with agricultural productivity in the American tropics. For much of the area, especially in South America and the Caribbean, the staple crops were starchy tubers, mainly manioc, which are very low in protein content. Since these tubers dominated the plant food diet, with only small amounts of the more protein-rich plant foods, the Indians had a strong dependency on animal protein. Domesticated animals were of little importance and game was generally sparse, but fish and other aquatic life were abundant in and along the large rivers, poorly drained savannas, and coastal waters. Thus, population tended to be greatest adjacent to water bodies. A model of an ecological zonation of population along these lines has been suggested.[30] However, it is only applicable to the root-crop oriented cultures. In Meso-America the staple crop was maize with a strong emphasis also on beans. Both are much higher in protein content than is manioc, and so the maize cultures, such as the Maya, were not as dependent on animal protein, and an extreme aquatic orientation of settlement did not develop. Reichel-Dolmatoff has pointed out the archaeological evidence for a substantial growth of population in the foothills away from rivers in western Colombia after maize replaced manioc as the staple crop.[31]

On the basis of settlement stability, three broad economic categories of aboriginal culture can be distinguished

for the American tropics: nomadic, semi-nomadic, and village farmers. The few nomadic tribes were mostly in the interior of South America, in the interflueve forests and scrub savannas where they were dependent on hunting and gathering. Population densities were very low, often less than 0.5 per square mile. The semi-nomadic tribes were found in similar ecological situations but practiced some agriculture as well as intensive hunting. Villages and fields were moved frequently, probably not so much because of soil decline and social factors as for the pursuit of dispersed game. Densities ranged up to possibly 2 or 3 persons per square mile, depending on the local resource situation and village stability. While the densities of both nomadic and semi-nomadic tribes were quite low, they occupied such vast territories that they may well have totaled over a million prople in Amazonia at the time of European contact.[32]

In contrast, the village farmers were tribes with relatively stable villages and often fairly dense populations, ranging up to 100 or more per square mile. In South America and the Caribbean the root crop farmers were great fishermen with much less stress on hunting than the nomadic and semi-nomadic tribes. In the Meso-American tropics, where the maize farmers were not dependent on animal protein, agriculture was generally much more important than either fishing or hunting, and nomadic and semi-nomadic cultures

were rare. For all farming cultures, shifting cultivation was the usual farming system. There were instances of relatively stable and intensive agriculture, but unfortunately not too much is known about them.[33]

FIELD REMNANTS: NEW EVIDENCE FOR FORMER DENSE POPULATIONS

In the drier lands of Peru and Mexico, where the high civilizations were found, the agricultural past is still clearly revealed by well preserved remnants of terraces and irrigation systems. However, most traces of Indian fields in the tropical lowlands were rapidly obliterated by heavy rains or covered by forest soon after abandonment. True, secondary vegetation can identify a former field site long after abandonment but generally not for as long as 400 years. Also, we know that some tropical savannas were created by Indian agricultural activities in pre-European times.

Our concepts about aboriginal tropical agriculture have been most radically altered by recent discoveries of extensive systems of pre-Columbian fields in lowland South America in open savannas and areas recently cleared of forest.[34] The fields consist of earth ridges or platforms alternating with ditches which were dug out as the ridges were built up. They are all found on level terrain subject to seasonal flooding and undoubtedly served to provide dry ground for cultivation. The ridges number in

the hundreds of thousands and range in size up to 80 feet in width, over a mile in length, and up to six feet in height. They have been found in the Llanos de Mojos of eastern Bolivia, the San Jorge floodplains of northern Colombia, the Guayaquil area of Ecuador, in coastal Surinam, and may also exist in the Orinoco Llanos.

The existence of the ridged fields is alone indicative of dense former populations. Their construction and cultivation required much more effort than shifting cultivation in the forests on well-drained ground. They must have been built because the population had become too dense to be supported on the available high ground and the people had to turn to the less suitable seasonally flooded ground. And, of course, the great extent of the fields is indicative of relatively dense populations. In Mojos there are at least 50,000 acres of ridge and ditch surface. In northern Colombia the total is about 80,000 acres, and there are at least 10,000 acres each in Ecuador and Surinam. Since many fields have been destroyed by sedimentation and erosion while others have not yet been mapped, it is likely that they once covered a total of several hundred thousand acres.

As with house and village sites, it is difficult to know or to estimate what portion of the ridges were under cultivation at any given time. For the San Jorge fields, assuming a conservative two acres of land and water surface per person, Parsons obtained a total population of 80,000

and a density of 320 per square mile.[35] However, the ridges were undoubtedly fallowed, and if only cultivated one year out of five, the density would still have been a substantial 64 per square mile. For the Llanos de Mojos, there is documentary evidence in the form of Jesuit counts and estimates for about 112,000 people in the 1690's over 100 years after initial contact and after at least 20 years of epidemics. There must have been several hundred thousand Indians at the time of initial contact in 1580, in contrast to only about 120,000 in the entire region in 1961. Using a contact figure of 350,000 would give a density of 5.0 persons per square mile, but much of the region is uninhabitable marsh. Densities must have been considerably higher in the areas of ridged fields.[36]

Undoubtedly, more complete air photo coverage and refinement of photographic techniques, such as infrared photography, will reveal more traces of ancient field patterns in the tropics. We do know that many tribes raised mounds (montones) for their crops, and there should be some remnants of them. The Spaniards on Hispaniola reported that the Arawak villages had fields each containing many thousands of large montones, averaging some 9 to 12 feet in circumference and about 3 feet in height.[37] This would indicate a tremendous amount of food production and help support claims for a large population on the island in 1492. Unfortunately, little effort has yet been made to find remains of these montones and determine their quantity.

Techniques may yet be developed for dating the field traces and for determining the probable population supported by them. In any event, the known ridged fields, almost all found where there is no cultivation today, do indicate a considerable underestimation of the possibilities for sizeable aboriginal populations in less than optimum tropical habitats.

POPULATION DENSITY UNDER SHIFTING CULTIVATION

How dense a population can shifting cultivation support on an aboriginal subsistence level on a permanent basis without soil and vegetation deterioration? Obviously, this will vary with the length of fallow time needed for soil fertility to be replenished; with the amount of unusable land; with the crop acreage required per person, which varies with technology, soils, and type of crops; and, where plant food protein is low, with the availability of animal protein.[38] Actual and potential densities range from only a few persons to over 100 per square mile. For the present day Kuikuru Indians of the upper Xingu in Brazil, Carneiro's calculations indicate a potential of 97 persons per square mile, allowing for a 25 year fallow period.[39] Whether the game and fish resources are adequate for such a density is doubtful, however. Carneiro also calculated an average for the general tropical forest environment of Amazonia,

allowing for much more conservative variables including only 1/3 of the land suitable for cultivation, and arrived at 16 persons per square mile. For the southern Maya lowlands of Petén, Cowgill studied contemporary shifting cultivation with a maize staple and a fallow period of 4 to 8 years and arrived at a potential permanent population of 100 to 200 per square mile.[40] For northern Yucatán, where a longer fallow period is necessary, the population limit was estimated by Hester at only 60 per square mile.[41] For La Venta Island (Tabasco) Heizer calculated a potential maximum density of 20 per square mile, and for southern Vera Cruz, Sanders gave the same figure.[42] Theoretically, only densities greater than those just cited would result in permanent vegetation and soil damage and, eventually, reduced population carrying capacity, as has happened in much of the modern tropical world. This is one explanation for the population shift away from temple sites by the Classic Maya of Yucatán.[43]

Actual aboriginal population densities, both past and present, are mostly well below the postulated potentials. Cowgill estimated that a density as low as 30 per square mile could have accounted for all the ceremonial centers in the southern Maya lowlands.[44] The Tupinamba density on the island of Maranhão in the late sixteenth century was 23 per square mile, but must have been even higher prior to

European contact.[45] The present Kuikuru density is only 7 persons per square mile.[46] For semi-nomadic tribes, the Yaruro density (Orinoco Llanos) is 2 persons per square mile,[47] and the Campa density (east-central Peru) is about 3 per square mile.[48] The modern Bayano Cuna density in eastern Panama is 4 persons per square mile.[49]

As previously indicated, the densest populations in the Caribbean and Amazon Basin were along the coasts and large rivers where fish were plentiful. For all the Amazon river valleys, I have calculated a conservative average contact density of 14 per square mile, with possibly double that on the broader floodplains.[50] For the Caribbean islands of Hispaniola, Puerto Rico, and the lesser Antilles, Steward and Rosenblat give contact densities of 13 to 14 per square mile, but other scholars would increase this considerably.[51] Thus there is some justification for speaking of moderate population densities for village farmers (5 to 30 per square mile) in much of the Caribbean and South American tropics, with even higher densities (30 or more per square mile) in the Maya lowlands and locally elsewhere, and with low densities under 5 per square mile where tribes were nomadic or semi-nomadic.

For greater Amazonia (tropical interior of South America), I have estimated a total aboriginal population of 5,750,000, with an average density of 1.5 persons per square mile.[52] The method used was that of determining

conservative population densities, ranging from 0.3 to 25 per square mile, for different ecological situations, based on known densities for representative tribes. The method has limitations, of course, because of the impossibility of knowing whether a density used is truly representative. But I believe that the average densities arrived at are more likely too low than too high. Certainly, the overall average of 1.5 per square mile is very low compared to known aboriginal densities in difficult habitats elsewhere in the world.

CONCLUSIONS

In reviewing the wide range of population estimates for tropical America and the arguments and methods supporting them, my own conclusion is that the early eye-witness figures were probably substantially correct, and that the total tropical population was at least 15 million and probably much more than that. This is more than the totals for the entire New World by some scholars but is well in line with the recent much larger Hemispheric estimates of Borah and Dobyns. In comparison, the present day (1960) Indian population for the same area is roughly between 1,000,000 and 1,500,000, and the overall population is about 65 million.[53]

The arguments for high populations rest on several, admittedly imprecise, forms of evidence rather than only the much criticized estimates of the chroniclers: archaeology, aboriginal carrying capacity, field remnants, tribute and baptismal records, and known massive depopulation. But neither do the arguments against large populations stand up well. They are based on assumptions of low carrying capacity, exaggeration, unreliability of various forms of evidence, and very low cultural levels outside the Maya area. The alternative is to rely on the first reliable counts available, and hence the problem of determining the preceding degree of depopulation since initial contact. Too often in the past initial depopulation was not considered at all, but recently rough depopulation ratios or curves have been suggested. However, evidence also has been presented to show that depopulation rates varied considerably, and more thorough documentary studies of the early post-contact history of individual tribes is needed to clarify this.

There has been considerable concern over the probable size of the aboriginal population of the New World. A major reason is that much of our thinking about New World native peoples will have to be revised if populations were as large and as dense as some now claim. Several of the more significant issues are briefly reviewed below.

First, if a New World population numbering tens of millions was reduced by 90 percent or more within a century

or two, a massive depopulation with few precedents in world history, then we need to do a much better job of analyzing the factors responsible. In the past the greater blame was placed on Spanish mistreatment (the "Black Legend"), while more recently epidemic disease has been considered the over riding factor. But now the universality of epidemic disease is being questioned. The lateness of the first reported epidemics in Hispaniola and Mainas has been mentioned. Sauer believes that the depopulation of Hispaniola was largely associated with a breakdown in the native economy resulting in malnutrition, mainly because of suppression of fishing and hunting which provided essential protein for starchy diets.[54] Consequently, the natives were much more susceptible to death from brutality, overwork, and sickness. Friede reaches similar conclusions for the Province of Muzo in Colombia - that "it was the hard mining life not the plague" that was the chief cause of Indian extinction, and that "when there were epidemics in Spanish America, these were neither general nor of identical consequence."[55] Reproduction declined markedly in many regions, and Sauer associates this with social and family disruption leading to a lack of desire to live and reproduce. In addition, Harvey has found that for some Indian tribes, the decline of reproduction can be explained by population displacements that destroyed traditional marriage pools.[56] Thus the impact of different depopulation factors clearly

varied in time and space, with culture, habitat, and European administration, and much more research is needed to demonstrate and explain these variations.

Second, assuming with Kroeber and Carneiro that a rich culture with a complex social organization is usually an index of a high density of population and vice versa, large tropical populations would suggest greater cultural achievements than many assumed existed outside of Mexico.[57] For Amazonia, the typical tropical forest farming community, on the basis of the historical record and present survivals, is usually seen as small in size, temporary in location, and lacking class structure and craft specialization. However, recent archaeological evidence indicates that along the large rivers and in the low savannas this pattern was not representative of the situation prior to European contact.[58] There is also considerable evidence for well developed societies ("chiefdoms") in the Caribbean, Central America, eastern Bolivia, and the north coast of South America.[59] Hence, arguments for large tropical populations, at least locally, would not necessarily be in conflict with the cultural evidence.

Third is the question of whether aboriginal subsistence technology or intensity was able to support fairly dense populations in the humid tropics. As indicated, the answer is clearly yes, providing there was a balanced diet.

Where starchy tubers are the staple, however, limits to population density may be determined more by the availability of animal protein than by agricultural productivity. Otherwise, population density would have an ultimate maximum determined largely by the agricultural system. The maximum may be reduced, however, if there is land deterioration because of an excessively short period of forest fallow or conversion of forest to grassland by burning. The maximum may be increased by changes in ecological or dietary patterns; for example, the introduction of maize as a major food, the reclamation of marginal lands such as by ridging, or by more intensive forms of agriculture, such as the use of fertilizers or mulches, which reduce or eliminate the need of long periods of forest fallow. But even in terms of the historically known aboriginal carrying capacities, the population of tropical America could have been considerably larger than the 15 million previously suggested.

On the other hand, it has been argued that for preindustrial societies an increasing population density results from factors other than increased food production; agricultural intensification is more likely to be the result of population growth than the cause.[60] It is true that high rural population densities (over 1,000 per square mile in parts of tropical Africa and Asia) do reflect a

change from long-fallow forms of shifting cultivation, which require a large amount of land per capita, to much more intensified forms of agriculture. For the tropics this usually means a greater frequency of use of any given plot of land, with a shift from using a plot once every 25 years or more (long fallow) as in most of Amazonia today, to a short fallow of only 6-8 years as with the present Maya, to no fallow period or even several crops a year as in some paddy rice and horticultural areas of Asia. Since more intensive forms of tropical cultivation usually require a greater initial labor input, with lower yields per man hour, than does long-fallow shifting cultivation, it is unusual for intensive agriculture to be practiced as long as there is adequate land for long-fallow cultivation.[61] In fact, in central Africa intensive agriculturalists have been known to revert to simple shifting cultivation when they move from an area of very dense population to one of sparse population and available land.[62] The same may well have been true in the New World in the past. Once intensive agriculturalists came in contact with Europeans and suffered drastic population reductions, more extensive forms of agriculture could be turned to. This seems to be the only explanation for the termination of the construction and use of ridged fields in the poorly drained savanna lands. The question that needs to be asked, then, is whether pre-Columbian native

agriculture was at times more intensive than what is known historically.[63] And where such can be demonstrated, as in Mojos, populations denser than those recorded should be suspected.

Fourth, what is the relevance of aboriginal population patterns in the American tropics to economic development of these areas today? Particularly striking is the fact that some areas were even more densely settled in pre-Columbian times than they are now (i.e., Mojos, Darién, San Jorge). The underdeveloped nations of Central and South America are making great efforts to open up empty tropical regions, and frequently the new settlers find evidence that they were preceded by substantial numbers of Indians centuries ago. Archaeology and air photo studies of former settlement and field locations could show the way to the better lands for modern settlers and to a reappraisal of some lands now considered unsuitable for cultivation. Also, much of the present day farming technology is derived from native shifting cultivation practices. However, the details of native crop assemblages and systematic fallowing have often been lost, and now there is pressure to convert forest to pasture, the result often being serious soil-vegetation break down. Furthermore, changes in diet have led to severe malnutrition in some of the new colonies. A knowledge of the native subsistence ecologies that allowed for substantial and stable agricultural settlement in the American

tropics is of potentially great value today.

Finally, what were the aboriginal population trends prior to European contact, and what have they been subsequently? Presumably there was a steady accelerating increase in population in the New World up to European contact. There were undoubtedly local reversals at times, but little is known about them. The Classic Maya period may have been followed by a reduction in population. In Amazonia, social deterioration, as suggested by ceramic sequences, might have been associated with population reduction.[64] Locally, then, the maximum native populations may well have preceded the European arrival.

The population trends in six areas of the New World during the first 100 years after contact are shown by Lipschultz.[65] For each there was a sharp reduction during the first 25-35 years and then a more gradual decline. Dobyns found that most nadirs or low points in native populations were reached between 1570 and 1650, after which there was usually slow recovery, in part associated with acquisition of disease immunity.[66] In many of the tropical lands, however, there was no recovery; dozens of tribes became extinct by 1650. On the other hand, some isolated tribes suffered little loss until the nineteenth or twentieth centuries when they were abruptly wiped out or nearly so. The remnants of such tribes still have little disease immunity, and many will not survive. Since World

War II, however, many isolated tribes have received resident missionaries with access to modern medicines and the means (airplanes) to deliver them to remote villages faced with epidemics. The result has been a great population surge among many jungle tribes. A good example is the Shipibo (eastern Peru), which now has one of the highest rates of population increase of any group in Latin America. But where contact was early and constant and native populations were large, population recovery was early and significant. The lowland Mayas are the prime example, as they now number over half a million. Elsewhere in the tropics where there has been long contact there has been a tendency towards absorption of the Indian survivors into the mestizo class, both culturally and physically. It would seem, then, that for many tropical areas the post-conquest aboriginal population curves are more extreme and irregular than in temperate lands.

In summary, the native demography of tropical America has scarcely been touched by scholars for either the contact period or thereafter. Much more is known about the highlands of Mexico and Peru, which is understandable in view of the much greater documentary material existing. The native population patterns and trends in the tropics do seem to have been somewhat different from those in the highlands, and every effort should be made to gain a better understanding of them utilizing the variety of forms

of evidence available. In this paper I have focused on the size of the tropical native population at the time of initial contact. Contrary to general belief, while much of the tropical lowlands were very sparsely occupied, it is quite clear that many areas did contain substantial numbers of Indians. Unfortunately, the size of these populations has been masked by their very rapid destruction during the early years of European conquest and settlement.

FOOTNOTES

1. A. L. Kroeber, Cultural and Natural Areas of Native North America. University of California Publications in American Archaeology and Ethnology 38 (Berkeley, 1939), p. 166.

2. W. Borah, "America as Model: The Demographic Impact of European Expansion Upon the Non-European World," Actas y Memorias, XXXV Congreso Internacional de Americanistas (Mexico, 1964), Vol. 3, pp 379-387, esp. p. 381; H. F. Dobyns, "Estimating Aboriginal American Population: An Appraisal of Techniques with a New Hemispheric Estimate," Current Anthropology, Vol. 7, 1966, pp. 395-416, esp. p. 415.

3. Dobyns, see footnote 2; W. Borah, "The Historical Demography of Aboriginal and Colonial Latin America: An Attempt at Perspective," Actas del XXXVII Congreso Internacional de Americanistas (Argentina), in press.

4. The Caribbean Islands, most of Central America, Mexico east and south of the Isthmus of Tehauntepec plus the central Gulf Coast, Amazonia, the Orinoco-Guiana region, the Central Plateau of Brazil, the northern Chaco, and coastal Ecuador-Colombia-Venezuela.

5. For a recent discussion of the impact of epidemic disease in aboriginal America, see A. W. Crosby, "Conquistador y Pestilencia: The First New World Pandemic and the Fall

of the Great Indian Empires," Hispanic American Historical Review, Vol. 47, 1967, pp. 321-337.

6. Borah, see footnote 2, p. 382.

7. Dobyns, see footnote 2, pp. 413-415.

8. W. M. Denevan, Comment on "Estimating Aboriginal American Population," Current Anthropology, Vol. 7, 1966, p. 429.

9. J. L. Phelan, The Kingdom of Quito in the Seventeenth Century (Madison, 1967), p. 47.

10. W. M. Denevan, The Aboriginal Cultural Geography of the Llanos de Mojos of Bolivia, Ibero Americana 48 (Berkeley, 1966), pp. 118-19.

11. W. M. Denevan, "The Aboriginal Population of Western Amazonia in Relation to Habitat and Subsistence," Actas del XXXVII Congreso Internacional de Americanistas (Argentina), in press.

12. J. H. Steward, "The Native Population of South America," Handbook of South American Indians, Vol. 5, Comparative Ethnology, J. H. Steward, ed., Bulletin of the Bureau of American Ethnology 143, pp. 655-668, esp. p. 657.

13. W. Borah, personal communication.

14. C. R. Edwards, Quintana Roo: Mexico's Empty Quarter, Report of Field Work Carried Out under ONR Contract 222 (11) NR 388 067, Dept. of Geography, Univ. of California (Berkeley, 1957), pp. 132, 143.

15. A. Rosenblat, La población indígena y el mestizaje en América, (Buenos Aires, 1954), Vol. 1, pp, 102, 298.

16. C. O. Sauer, The Early Spanish Main (Berkeley, 1966), pp. 65-69.

17. For example, J. H Steward and L. C. Faron, Native Peoples of South America (New York, 1959), pp. 51, 55; Rosenblat, see footnote 15, Vol. 1, p. 101.

18. W. Borah and S. F. Cook, The Aboriginal Population of Central Mexico on the Eve of the Spanish Conquest, Ibero Americana 45 (Berkeley, 1963), pp. 81-82; also see other studies cited therein.

19. Sauer, see footnote 16, p. 65.

20. Steward, see footnote 12. Data is based on Rosenblat and on the Handbook of South American Indians.

21. Dobyns, see footnote 2, p. 415.

22. Denevan, see footnote 10, p. 116.

23. Phelan, see footnote 9, p. 34.

24. Borah and Cook, see footnote 18, pp. 81-82.

25. Critics include A. Rosenblat, La población de América en 1492: Viejos y nuevos cálculos (Mexico, 1967); and W. T. Sanders, Review, American Anthropologist, Vol. 68, 1966, pp. 1298-1299. On the other hand, Dobyns (see

footnote 2, p. 415) has suggested an even larger figure of 30,000,000.

26. O. G. and E. B. Ricketson, Uaxactún, Guatemala, Group E. 1926-1931, Carnegie Inst. Wash. Publ. 477 (Washington, 1937), p. 16.

27. S. G. Morley and G W Brainerd, The Ancient Maya (Stanford, 1956), p. 262.

28. B. Meggers and C. Evans, "The Reconstruction of Settlement in the South American Tropical Forest," Prehistoric Settlement Patterns in the New World, G. R. Willey, ed., Viking Fund Publications in Anthropology 23 (New York, 1956), pp. 156-164.

29. D. W. Lathrap, "Aboriginal Occupation and Changes in River Channel on the Central Ucayali, Peru," American Antiquity Vol. 33, 1968, pp. 62-79.

30. D. W. Lathrap, Yarinacocha: Stratigraphic Excavations in the Peruvian Montaña, unpublished Ph.D. dissertation (Harvard, 1962), Vol. 1, p. 549; W. M. Denevan, "A Cultural-Ecological View of Former Aboriginal Settlement in the Amazon Basin," The Professional Geographer, Vol. 18, 1966, pp. 346-351.

31. G. Reichel-Dolmatoff, Colombia (New York, 1965), pp. 80-81.

32. Denevan, see footnote 11.

33. For example, the Taino agriculture of Hispaniola; see Sauer, footnote 16, pp. 51-58.

34. J. J. Parsons and W. M. Denevan, "Pre-Columbian Ridged Fields," Scientific American, Vol. 217, 1967, pp. 92-100.

35. J. J. Parsons and W. A. Bowen, "Ancient Ridged Fields of the San Jorge Floodplain, Colombia," The Geographical Review, Vol. 56, 1966, pp. 317-343, esp. pp. 342-343.

36. Denevan, see footnote 10, pp. 112-120.

37. William C. Sturtevant, "Taino Agriculture," The Evolution of Horticultural Systems in Native South America: Causes and Consequences, Johannes Wilbert, ed. (Caracas, 1961), pp. 69-82, esp. pp. 72-73.

38. The concept of critical population density for shifting cultivation systems has been well developed for tropical Africa by W. Allen, The African Husbandman (New York, 1965).

39. R. L. Carneiro, "Slash-and-Burn Agriculture: A Closer Look at its Implications for Settlement Patterns," Selected Papers of the Fifth International Congress of Anthropological and Ethnological Sciences (Philadelphia, 1960), pp. 229-234.

40. A. M. Cowgill, "An Agricultural Study of the Southern Maya Lowlands," American Anthropologist, Vol. 64, 1962, pp. 273-286, esp. p. 109.

41. J. A. Hester, Jr., Natural and Cultural Bases of Ancient Maya Subsistence Economy, Unpublished Ph.D. dissertation (U.C.L.A., 1954).

42. R. F. Heizer, "Agriculture and the Theocratic State in Lowland Southeastern Mexico," American Antiquity, Vol. 26, 1960, pp. 215-222; W. T. Sanders, "The Anthropo-Geography of Central Vera Cruz," Revista Mexicana de Estudios Antropológicos, Vol. 13, Nos. 2-3, 1953, pp. 27-78, esp. p. 51.

43. The latest statement of this sort is by W. A. Haviland, who believes that skeletal studies in the Tikal area suggest that a "marked reduction in stature in Late Classic times may be indicative of a situation of nutritional stress" from land failure, and that this "may have had something to do with the collapse of classic Maya civilization" in about 900 A.D.; see "Stature at Tikal, Guatemala: Implications for Ancient Maya Demography and Social Organization," American Antiquity, Vol. 32, 1967, pp. 316-325, esp. p. 316.

44. Cowgill, see footnote 40, p. 110.

45. Steward, see footnote 12, p. 662.

46. Carneiro, see footnote 39, p. 231.

47. A. Leeds, "Yaruro Incipient Tropical Forest Horticulture: Possibilities and Limits," The Evolution of Horticultural Systems in Native South America: Causes and Consequences, Johannes Wilbert, ed. (Caracas, 1961), pp. 13-46, esp. p. 21.

48. Denevan, see footnote 11.

49. C. F. Bennett, Jr., "The Bayano Cuna Indians, Panama: An Ecological Study of Livelihood and Diet," Annals Association of American Geographers, Vol. 52, 1962, pp. 32-50, esp. p. 35.

50. Denevan, see footnote 11.

51. Steward, see footnote 12, p. 664.

52. Denevan, see footnote 11. The above figures are corrections of the original total of 7,600,000 Indians with a density of 2.0 per square mile.

53. The total present Indian population of tropical America is mainly based on Boletín Indigenista, Special Issue, "Guide to the Indian Population of America," Vol. 21, 1961, pp. 169-266; however, it must be kept in mind that there is little consistency in the definition of an Indian. The total population is based on a large number of recent census sources.

54. Sauer, see footnote 16, p. 203.

55. J. Friede, "Demographic Changes in the Mining Community of Muzo after the Plague of 1629," Hispanic American Historical Review, Vol. 47, 1967, pp. 338-343.

56. H. Harvey, Dept. of Anthropology, Univ. of Wisconsin, personal communication.

57. Kroeber, see footnote 1, p. 180; R. L. Carneiro, "On the Relationship Between Size of Population and Complexity of Social Organization," Southwestern Journal of Anthropology, Vol. 23, 1967, pp. 234-243.

58. Lathrap, see footnote 30, Vol. 1, pp. 498-575.

59. Steward and Faron, see footnote 17, pp. 174-251.

60. E. Boserup, The Conditions of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure (Chicago, 1966).

61. P. Gourou, The Tropical World (New York, 1966), Chapter 9. This is a major reason why it is difficult to establish stable colonies of new settlement with permanent agriculture on the fringes of Amazonia.

62. Gourou, see footnote 61, p. 104.

63. Eric Wolf in Sons of the Shaking Earth (Chicago, 1959), p. 78, suggests that the Maya must have had intensive systems of agriculture, even though we have no evidence of it, "which allowed them to maintain stable centers of control."

64. Denevan, see footnote 30.

65. A. Lipschultz, "La despoblación de las Indias después de la conquista," América Indígena, Vol. 26, 1966, pp. 229-247, esp. pp. 234, 239, 242.

66. Dobyns, see footnote 2, p. 415.