New World Settlement Evidence for a Two-Stage Neolithic Demographic Transition[1]

MATTHEW S. BANDY
Department of Anthropology, University of Oklahoma, 455 W. Lindsey, Dale Hall Tower 521, Norman, OK 73019-0535, U.S.A. (inti@devnull.net). 17 v 05

The adoption of an agricultural village lifeway roughly coincided with a great increase in the absolute number of humans and in the size of human communities. This increase in the growth rate of human populations has been called the "Neolithic demographic transition" (Bocquet-Appel 2002:637). It is one of the fundamental structuring processes of human history, and it is therefore highly relevant to the comparative study of cultural and social evolution at a global scale.

Albert Ammerman and L. Luca Cavalli-Sforza (1971), in their original formulation of the demic diffusion hypothesis, provided a model for the Neolithic demographic transition. In their scenario, the transition to an agricultural economy led to "an increased net reproductive rate, lasting for some generations until a new plateau of population density consonant with the carrying capacity of the land was reached" (p. 687). The transition was therefore, in their view, a two-stage process. In the first stage, reduced mortality and/or increased fertility produced rapid population growth. In the second stage, limitations of the natural environment produced a lower population growth rate. In subsequent publications, Ammerman and Cavalli-Sforza (1984; Ammerman, Cavalli-Sforza, and Wagener 1987) have argued that both the timing of the onset of the Neolithic in Europe and continental-scale genetic distribution patterns are consistent with this model. However, evidence for a two-stage demographic transition has remained indirect. In principle, the observed archaeological and genetic patterns could have been produced by other kinds of historical processes.

Bocquet-Appel (2002) has recently reconstructed population growth rates from standardized age profiles in a sample of Mesolithic and Neolithic cemeteries from Europe and North Africa. Though the results are tentative and suffer from limited sample size, especially for the Mesolithic, Bocquet-Appel reasonably concludes that his data support a two-stage demographic transition coincident with the transition to an agricultural economy. After arranging his data according to chronological distance from the Neolithic diffusion front in such a way that zero represents the beginning of the Neolithic in any given region, he identifies three demographic periods (pp. 644–45). In the first, prior to the transition to agriculture, estimated population growth is stationary or negative. This is a difficult point in the argument, as Bocquet-Appel acknowledges, because of the limited number and distribution of the Mesolithic cemeteries in the sample. In the second period, covering the first roughly 800 years of the Neolithic, the population growth rate increased dramatically, to an average of approximately 1.24% per annum. In the third, the rate of growth decreased somewhat, to an average of 1.16% per annum. The confidence intervals associated with these growth rate estimates are very wide (± 1.07%), and for this reason we should not attempt comparisons of absolute growth rates between world regions. However, the data are sufficient to indicate that the Neolithic demographic transition in Europe was in fact a two-stage process as the demic diffusion model suggests. The rate of population growth increased significantly in the first eight centuries or so of the Neolithic and declined thereafter.

Many questions remain. Perhaps the most important of these concerns the generality of the two-stage demographic transition. Bocquet-Appel suggests that the very high early Neolithic population growth rate reflects an increase in fertility associated with the transition to agriculture. This is reasonable, considering that agriculturalists do in fact have higher average fertility rates than others (Bentley, Jasienska, and Goldberg 1993). Further, direct paleodemographic evidence has recently been published demonstrating a substantial increase in fertility with the beginning of the Neolithic in the Levant (Eshed et al. 2004). He further hypothesizes that population density increased as the Neolithic wore on and that "the promiscuity of humans and animals and the anastomotic process of village populations" (Bocquet-Appel 2002:647) resulted in a disease-related mortality increase and a consequent decline in the rate of population growth. He therefore disagrees with Ammerman and Cavalli-Sforza's original hypothesis that the decline in population growth (the second stage of the two-stage transition) was the result of the population's having reached "the carrying capacity of the land," arguing rather that it resulted from the operation of density-dependent effects in Neolithic village populations. This hypothesis has elsewhere been referred to as "the first epidemiological transition" (Barrett et al. 1998).

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It is important to recognize that none of the factors entering into Bocquet-Appel's hypothetical reconstruction of European Neolithic demographic events are specific to Europe. While every local Neolithic transition is no doubt historically unique, all are characterized by the two essential ingredients of Bocquet-Appel's model: year-round occupation of permanent villages (sedentism) and a substantial degree of dependence on food production for subsistence (agriculture). It is therefore unimportant for this discussion that village life preceded agriculture in some parts of Europe (Zvelebil and Lillie 2000, Zvelebil and Rowley-Conwy 1986) or that crop domestication preceded village life in many parts of the New World (Flannery, Moser, and Maranca 1986, Pearsall 1992, Smith and Cowan 2003). Bocquet-Appel's model should in principle be equally applicable to the Neolithic transitions of the two world regions. In this article I use three archaeological settlement pattern data sets to evaluate the hypothesis that the transition to agricultural village life was associated with a two-stage demographic transition in the New World.

ANALYSIS OF SELECTED SETTLEMENT DATA SETS

In the millennium following the transition to agricultural village life, the hypothesis of a two-stage demographic transition predicts that the earlier half of that millennium will be characterized by relatively high population growth rates and the later half by substantially slower growth. In order to test this hypothesis, I will examine population growth rates during the first millennium of the Formative period of three areas: (1) the Basin of Mexico, (2) the Valley of Oaxaca, and (3) the Titicaca Basin. Before proceeding, however, it remains to address the question of how to monitor population and population growth using archaeological data.

As Bocquet-Appel (2002:637) has observed, there are two broad classes of data that permit direct monitoring of prehistoric population growth rates: bioarchaeological (the age structure of mortuary populations) and archaeological. In this article, I take an archaeological approach to measuring prehistoric population growth not only because it is my area of specialization but also because large, well-analyzed, and well-published mortuary samples of the kind employed by Bocquet-Appel in his analysis are a relative rarity in most of the New World and because settlement archaeology is relatively well-developed in the New World and a number of excellent data sets are available that span the first millennium following the transition to agricultural village life.

There are many archaeological methods for estimating the population of sites. These include site area (Bandy 2001, Feinman et al. 1985, Stanish et al. 1997), combined site area and surface artifact density (Parsons 1971, Sanders 1972), number of structures or rooms (Adler 1992, Hill 1970, de Montmollin 1989), roofed area (Naroll 1962), and measures of refuse accumulation (Gallivan 2002, Varien and Mills 1997, Varien and Potter 1997). All of the data sets employed in the present analysis provide population estimates of all sites for each phase of their occupation. For the present analysis I will use published site population estimates for three regions, all of which are derived from some combination of site area and surface artifact density. However, in order to estimate regional population growth rates it is necessary to derive a measure of regional population that can be monitored over time. I call this measure the "phase population index." The phase population index utilized here will be the simple sum of estimated population for all sites in a region during a given phase.

The most significant complication in the use of the phase population index concerns the problem of site contemporaneity. Sanders (1972:102) expressed the problem in this way:

> Most researchers deal in blocks of time involving hundreds of years. Conceivably in the history of an area, there could have been a period in which settlements were less sedentary and village sites were frequently shifted, followed by a period in which people lived in more stable communities. In this case a simple calculation of the total amount of habitation area or number of ruined houses of the various sites from each period would not give an accurate picture even of the relative population size of the two periods.

The percentage of sites which are occupied simultaneously in a given phase will vary from phase to phase and between different types of sites within a single phase. In stable settlement systems composed of small numbers of relatively large, permanent sites, the phase population index will closely correspond to the actual population of a phase at its maximum. However, in a phase characterized by small sites occupied on a short-term basis the index will significantly overestimate that population. The phase population index as defined here will therefore exaggerate the contribution of small and ephemerally occupied components of a total settlement system relative to sedentary and continuously occupied components. In other words, farmsteads will count for relatively more than villages, town, and cities. It will also tend to exaggerate the population estimates for phases characterized by predominantly transitory settlement vis-à-vis more settled or urban periods.

Two pertinent observations can therefore be made regarding the phase population index. First, as long as the degree of sedentism and site permanence remains about the same between phases the phase population index should vary directly with actual population; it will always be some constant multiple of maximum momentary population for the phase. For the calculation of population growth rates, the accuracy of the phase population index is not as important as its precision. It may yield an entirely incorrect population estimate for each phase, but as long as it does so consistently it is still possible to calculate the population growth rate. Since I am considering here only the first millennium of each sequence, it is possible to say that no dramatic settlement transformations (such as, for example, typically

TABLE 1
Phase Names and Absolute Date Ranges (BCE) for Selected Settlement Data Sets

Basin of Mexico		Valley of Oaxaca		Titicaca Basin	
Early Horizon	1300–800	Tierras Largas	1500–1150	Early Chiripa	1500–1000
First Intermediate 1	800–500	San Jose	1150–850	Middle Chiripa	1000–800
First Intermediate 2	500–200	Guadalupe	850–700	Late Chiripa	800–250
		Rosario	700–500		

accompany episodes of state formation) took place in any of the three areas. Rates of occupation continuity are quite high in all three areas, and the majority of the population resided in large, permanent villages that were often occupied for many centuries and even millennia. Under these conditions the phase population index should yield useful results.

Second, assuming continual settlement expansion and population growth, the phase population index measures population at the end of the phase, the time of maximum momentary population. This assumption holds for all three of the areas to be considered for the first millennium following the transition to agricultural village life. In each case, then, the end of each phase may be considered a point in time for which we have an acceptable regional population estimate.

Considering all of the above, the annual growth rate during a given phase may therefore be calculated using the formula (Hassan 1981:139)

$$r = \frac{1}{T}\ln\frac{P_f}{P_i},$$

where r = annual rate of population change, T = number of years in phase, P_i = phase population index value of previous phase, and P_f = phase population index value of phase. Bocquet-Appel's hypothesis makes two predictions: (1) the transition to agriculture will coincide with a dramatic increase in the rate of population growth and (2) the rate of population growth will decrease significantly sometime in the second half of the first millennium following the transition. A limitation shared by all three areas to be examined is a lack of reliable data on preagricultural population levels or growth rates. At present, it is not possible to calculate a population growth rate for the first phase in each sequence. I will therefore be able to test only the second prediction in each area.

The Basin of Mexico. The Basin of Mexico was the site of perhaps the first really ambitious archaeological settlement-pattern project. Between 1967 and 1973 Jeffrey Parsons and Richard Blanton conducted a pedestrian survey of some 3,500 square kilometers, recording thousands of sites from all time periods of the region's prehistory (Blanton 1972; Parsons 1971, 1976; Parsons et al. 1982; Parsons, Kintigh, and Gregg 1983; Sanders, Parsons, and Santley 1979). A settled agricultural village system is well-documented for the southern Basin of Mexico by the Early Horizon, around 1300 BCE (Blanton et al. 1981, Parsons 1974). In the earlier part of the Preclassic population was very heavily concentrated in the southern parts of the basin, with no substantial occupation of the north until after 500 BCE (Parsons 1974: 91–93).

The early settlement history of the Basin of Mexico is problematic for several reasons (Parsons 1974:91). The primary reason is the recent expansion of Mexico City. Urban sprawl has resulted in the destruction of many sites, among them Tlatilco, probably a major Early Horizon center. In addition, the area surrounding the site of Cuicuilco, also probably a major early center, was covered by a lava flow sometime in the first or second century BCE that obscured the bulk of its associated habitation. It is problematic to estimate population and therefore population growth in the absence of reliable information on the size or density of what were possibly the two most populous settlements in the Basin of Mexico. The Preclassic settlement record of the Basin of Mexico is fundamentally and irremediably incomplete. Nevertheless, the majority of habitation sites do appear to have been preserved and recorded. If a two-stage demographic transition took place, it may be evident in the settlement record.

The phases we are concerned with in this analysis are the Early Horizon and First Intermediate 1–2 phases (Parsons 1974). The absolute date ranges for these phases are given in table 1. Table 2 displays some basic information regarding the settlement system in each phase. I have calculated a phase population estimate for each of the three phases in question and calculated the average annual growth rate during each phase, assuming that the phase population estimate represents the terminal population of the phase. When these data were published (Parsons, Kintigh, and Gregg 1983), high and low population estimates were provided for each site for each phase. I have simply averaged these two numbers to arrive at a population estimate for the occupation. A population index value for each phase (table 2) was calcu-

TABLE 2
Demographic Information by Phase, Basin of Mexico

Phase	Sites	Hectares	Population	Growth Rate (%)
Early Horizon	7	34.4	685	–
First Intermediate	40	297.5	6,314	0.74
Second Intermediate	103	1,152.2	30,790	0.53

lated by summing the population estimates for all occupations pertaining to that phase.

Indeed, the Basin of Mexico data are consistent with the two-stage model (table 2). In the First Intermediate 1 population grew at approximately 0.74% per annum, a very high rate for an agricultural village society without access to antibiotics or modern medicine. In the following First Intermediate 2, after about 500 BCE, the rate of population growth fell to 0.53% annually, still quite a high rate but a considerable drop from the previous phase. Thus, the rate of population growth declined approximately 800 years after the establishment of permanent agricultural villages. This falls precisely into the time frame predicted by Bocquet-Appel's hypothesis.

The Valley of Oaxaca. The Valley of Oaxaca is another New World area that has benefited from archaeological settlement research on a massive scale. By 1985 almost all of this large highland valley, an area of some 2,150 square kilometers, had been archaeologically surveyed (Feinman et al. 1985:333), and these data have been published in their entirety (Blanton et al. 1982, Kowalewski et al. 1989). The present analysis is based on the data published by Kowalewski et al. (1989:appendix 1). These data are somewhat more robust for our present interpretive purposes than the Basin of Mexico data. The Valley of Oaxaca has suffered little from the effects of recent urbanization. The settlement record of this region remains largely intact, and it is probable that no significant pre-Hispanic population concentrations remain unrecorded. A two-stage demographic transition should therefore be readily apparent. As with the Basin of Mexico data, this data set provided high and low population estimates for each occupation of each recorded site. For the present analysis I have simply averaged the two in order to arrive at a population estimate for each site. My phase population estimates (table 3) are the simple sum of the average population estimates for all occupations dating to each phase.

Agricultural village life was well-established in the Valley of Oaxaca by the beginning of the Tierras Largas phase, at 1400 BCE (Flannery 1983, Marcus and Flannery 1996). The following millennium included the Tierras Largas, San José, Guadalupe, and Early Rosario ceramic phases (table 1). Before the Rosario phase, settlement was concentrated in the Etla arm of the valley; the remainder was relatively vacant (Feinman et al. 1985). The Valley of Oaxaca data are consistent with the model of a two-stage demographic transition. Population grew during the San José phase at the rapid rate of 0.60% annually. After about 850 BCE, in the following Guadalupe and Rosario phases population growth fell to almost zero or was even slightly negative.[2] This drop in the growth rate took place approximately 650 years after the transition to agriculture at the beginning of the Tierras Largas phase (fig. 1), exactly as predicted by the model.

TABLE 3
Demographic Information by Phase, Valley of Oaxaca

Phase	Sites	Hectares	Population	Growth Rate (%)
Tierras Largas	24	14.8	325	–
San José	39	104.2	1,937	0.60
Guadalupe	44	95.8	1,782	−0.06
Rosario	83	92.1	1,828	0.01

The Titicaca Basin. The Lake Titicaca Basin of Peru and Bolivia is one of the nuclear areas for village and later state formation South America (Bermann 1990, Janusek 1994, Kolata 1993, Ponce Sangines 1981, Stanish 2003). Permanent agricultural villages appeared in the basin around 1500 BCE, about the same time as in Oaxaca. Though a significant amount of settlement research has taken place in this region in the past 20 years (Albarracín-Jordan 1992, 1996; Albarracín-Jordan and Mathews 1990; Janusek and Kolata 2003; Mathews 1992; Stanish et al. 1997), problems of ceramic chronology have limited the chronological resolution of Formative-period settlement data sets. Lee Steadman's studies (Hastorf et al. 2001, Steadman 1999) of Early and Middle Formative ceramics have only recently made possible the identification and distinction of these early ceramic phases in surface assemblages (see table 1). In 1998–99 I conducted a survey of the Taraco Peninsula, the first survey to employ Steadman's improved chronology (Bandy 2001, 2004). The resulting settlement data set is therefore the only Titicaca Basin settlement data set useful for the present analysis.

The area surveyed was 98 square kilometers, a very small area compared with the Basin of Mexico and Valley of Oaxaca surveys. The density and size of sites pertaining to the earliest ceramic phases were however, very high. An inspection of table 4 will reveal that the Taraco Peninsula, though covering less than 5% of the surface area of the Valley of Oaxaca survey, nevertheless has similar overall population estimates for these early phases. It is important to remember that in both the Basin of Mexico and the Valley of Oaxaca population was highly localized in the earliest ceramic phases. This seems to be a general pattern in early agricultural village societies in many parts of the world. Therefore, having surveyed the Taraco Peninsula is similar to having surveyed the Etla subvalley of Oaxaca or the Chalco/Xoch-

TABLE 4
Demographic Information by Phase, Titicaca Basin

Phase	Sites	Hectares	Population	Growth Rate (%)
Early Chiripa	9	14.2	693	–
Middle Chiripa	23	35.2	1,752	0.46
Late Chiripa	31	65.8	3,507	0.13

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[2] These growth rates differ slightly from the ones published by Feinman and colleagues (1985:346), who report growth rates of 0.59%, −0.03%, and 0.02%. This is because I use a slightly different method of calculating phase population and because I calculate growth from the end of one phase to the end of another while they calculate it between "the temporal midpoints of each phase" (p. 346).

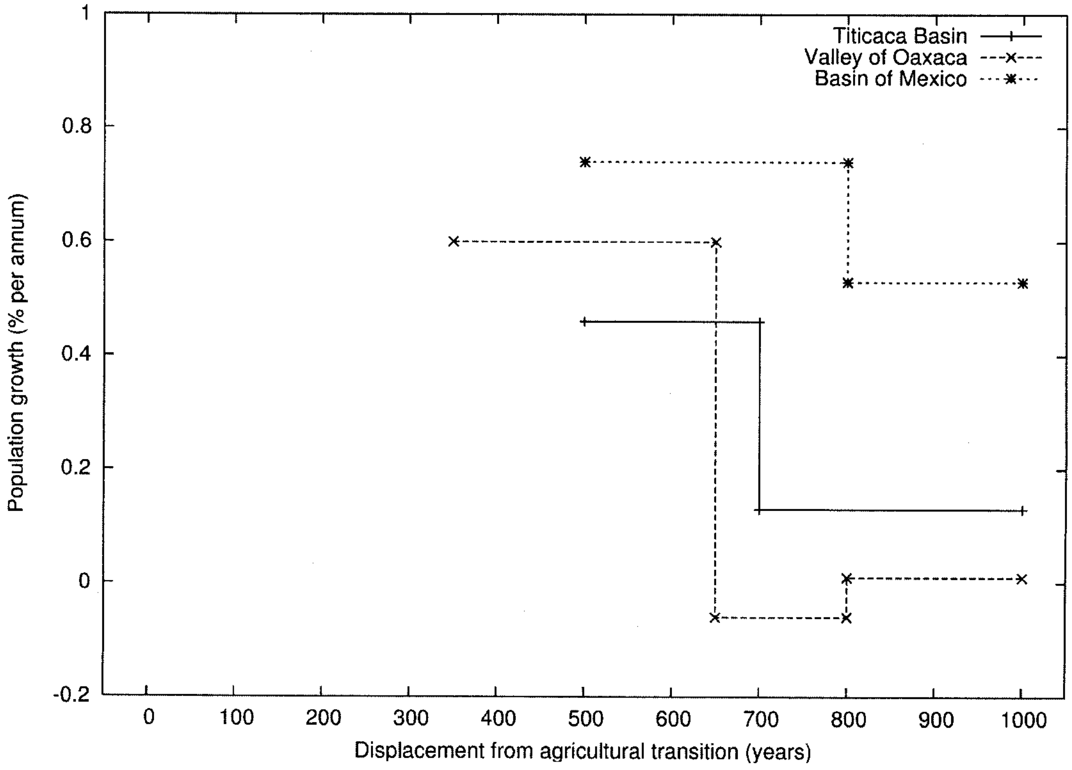

FIG. 1. *Population growth rate in relation to the transition to agriculture.* 0, *the beginning of the Formative period in each area.*

imilco region of the Basin of Mexico; most of the early agricultural village population was located in this relatively small area. This is confirmed by the much lower density of early occupation in the adjacent surveyed areas of the Tiwanaku Valley and the Katari Basin (Albarracín-Jordan 1992, Janusek and Kolata 2003, Mathews 1992).

The Taraco Peninsula data, like those from the Basin of Mexico and the Valley of Oaxaca, are consistent with the two-stage model. Population grew at a relatively rapid rate of 0.46% in the Middle Chiripa phase and dropped to 0.13% during the Late Chiripa phase. This drop in the rate of population growth took place at 800 BCE, approximately 700 years after the transition to agriculture in the southern Titicaca Basin, precisely as predicted by the model.

CONCLUSION

All three of the New World archaeological settlement data sets examined are consistent with Bocquet-Appel's hypothesized two-stage demographic transition. Figure 1 displays the estimated population growth rates of all three areas in reference to the date of the transition to agriculture and village life. In all three cases, an initial very high rate of population growth is followed by a drop in the growth rate that occurs 600–800 years after what in the Old World would be called the Neolithic transition. The profiles for the two better-documented areas (Oaxaca and the Titicaca Basin) are very similar even in their absolute rates of population growth. These results are exactly as predicted by Bocquet-Appel's model, and all of the growth rates in question fall well within the confidence intervals of those reconstructed by Bocquet-Appel (2002:fig. 5) for the European Neolithic.

It is true that the settlement data sets examined here represent relatively small and widely scattered samples and cannot necessarily be considered representative of all New World agricultural village traditions. However, this study is significant for two reasons: first, it has provided positive evidence that Bocquet-Appel's two-stage Neolithic demographic transition took place in the New World Formative as well as the European Neolithic; second, it has done so using an independent class of data. Both European bioarchaeological data and Latin American settlement data suggest that a two-stage demographic transition may be associated with transitions to agricultural village life worldwide.

References Cited

ADLER, M. A. 1992. "The upland survey," in *The Sand Canyon Archaeological Project: A progress report.* Edited by W.

D. Lipe, pp. 11–23. Crow Canyon Archaeological Center Occasional Papers 2.

ALBARACÍN-JORDAN, J. 1992. Prehispanic and early colonial settlement patterns in the Lower Tiwanaku Valley, Bolivia. Ph.D. diss., Southern Methodist University, Dallas, Tex.

———. 1996. *Tiwanaku: Arqueología regional y dinámica segmentaria.* La Paz: Editores Plural.

ALBARRACÍN-JORDAN, J. V., AND J. E. MATHEWS. 1990. *Asentamientos prehispánicos del Valle de Tiwanaku.* Vol. 1. La Paz: Producciones CIMA.

AMMERMAN, A. J., AND L. L. CAVALLI-SFORZA. 1971. Measuring the rate of spread of early farming in Europe. *Man* 6:674–88.

———. 1984. *The Neolithic transition and the genetics of populations in Europe.* Princeton: Princeton University Press.

AMMERMAN, A. J., L. L. CAVALLI-SFORZA, AND D. K. WAGENER. 1987. "Toward the estimation of population growth in Old World prehistory," in *Demographic anthropology: Quantitative approaches.* Edited by E. Zubrow, pp. 27–61. Albuquerque: University of New Mexico Press.

BANDY, M. 2001. Population and history in the ancient Titicaca Basin. Ph.D. diss., University of California, Berkeley, Calif. http://andean.kulture.org/bandy/bandy-dissertation.pdf.

———. 2004. Fissioning, scalar stress, and social evolution in early village societies. *American Anthropologist* 106:322–33.

BARRETT, R., C. W. KUZAWA, T. MC DADE, AND G. J. ARMELAGOS. 1998. Emerging and re-emerging infectious diseases: The third epidemiological transition. *Annual Review of Anthropology* 27:247–71.

BENTLEY, G. R., G. JASIENSKA, AND T. GOLDBERG. 1993. Is the fertility of agriculturalists higher than that of nonagriculturalists? CURRENT ANTHROPOLOGY 34:778–85.

BERMANN, M. 1990. Prehispanic household and empire at Lukurmata, Bolivia. Ph.D. diss., University of Michigan, Ann Arbor, Mich.

BLANTON, R. E. 1972. *Prehispanic settlement patterns of the Ixtapalapa Peninsula region, Mexico.* Department of Anthropology, The Pennsylvania State University, Occasional Papers in Anthropology 6.

BLANTON, R., S. KOWALEWSKI, G. FEINMAN, AND J. APPEL. 1981. *Ancient Mesoamerica: A comparison of change in three regions.* Cambridge: Cambridge University Press.

———. 1982. *Monte Albán's hinterland.* Pt. 1. *The prehispanic settlement patterns of the central and southern parts of the Valley of Oaxaca, Mexico.* Memoirs of the Museum of Anthropology. University of Michigan, 15.

BOCQUET-APPEL, J.-P. 2002. Paleoanthropological traces of a Neolithic demographic transition. CURRENT ANTHROPOLOGY 43: 637–50.

DE MONTMOLLIN, O. 1989. *The archaeology of political structure: Settlement analysis in a Classic Maya polity.* Cambridge: Cambridge University Press.

ESHED, V., A. GOPHER, T. B. GAGE, AND I. HERSHKOVITZ. 2004. Has the transition to agriculture reshaped the demographic structure of prehistoric populations? New evidence from the Levant. *American Journal of Physical Anthropology* 124:315–29.

FEINMAN, G. M., S. A. KOWALEWSKI, L. FINSTEN, R. E. BLANTON, AND L. NICHOLAS. 1985. Long-term demographic change: A perspective from the Valley of Oaxaca, Mexico. *Journal of Field Archaeology* 12:333–62.

FLANNERY, K. 1983. "The Tierras Largas phase and the analytical units of the Early Oaxacan village," in *The cloud people: Divergent evolution of the Zapotec and Mixtec civilizations.* Edited by K. V. Flannery and J. Marcus, pp. 43–45. New York: Academic Press.

FLANNERY. K., C. MOSER, AND S. MARANCA. 1986. "The excavation of Guilá Naquitz," in *Guilá Naquitz: Archaic foraging and early agriculture in Oaxaca, Mexico.* Edited by K. Flannery, pp. 65–95. NewYork: Academic Press.

GALLIVAN, M. D. 2002. Measuring sedentariness and settlement population: Accumulations research in the Middle Atlantic region. *American Antiquity* 67:535–57.

HASSAN, F. 1981. *Demographic archaeology.* New York: Academic Press.

HASTORF, C. A., M. S. BANDY, W. T. WHITEHEAD, AND L. H. STEADMAN. 2001. El período formativo en Chiripa, Bolivia. *Textos Antropológicos* 13(1–2):17–92.

HILL, J. N. 1970. *Broken K Pueblo: Prehistoric social organization in the American Southwest.* University of Arizona Anthropological Papers 18.

JANUSEK, J. 1994. State and local power in a prehispanic Andean polity: Changing patterns of urban residence in Tiwanaku and Lukurmata. Ph.D. diss., University of Chicago, Chicago, Ill.

JANUSEK, J., AND A. KOLATA. 2003. "Prehispanic rural history in the Katari Valley," in *Tiwanaku and its hinterland,* vol. 2, *Urban and rural archaeology.* Edited by A. Kolata, pp. 129–74. Washington, D.C.: Smithsonian Institution Press.

KOLATA, A. 1993. *The Tiwanaku.* Cambridge: Blackwell.

KOWALEWSKI, S. A., G. M. FEINMAN, L. FINSTEN, R. E. BLANTON, AND L. M. NICHOLAS. 1989. *Monte Albán's hinterland.* Pt. 2. *Prehispanic settlement patterns in Tlacolula, Etla, and Ocotlan, the Valley of Oaxaca, Mexico.* Memoirs of the Museum of Anthropology, University of Michigan, 23.

MARCUS, J., AND K. V. FLANNERY. 1996. *Zapotec civilization: How urban society evolved in Mexico's Oaxaca Valley.* London: Thames and Hudson.

MATHEWS, J. 1992. Prehispanic settlement and agriculture in the Middle Tiwanaku Valley, Bolivia. Ph.D. thesis, University of Chicago, Chicago, Ill.

NAROLL, R. 1962. Floor area and settlement population. *American Antiquity* 27:587–89.

PARSONS, J. 1971. *Prehistoric settlement patterns in the Texcoco Region, Mexico.* Memoirs of the Museum of Anthropology, University of Michigan, 3.

———. 1974. The development of prehistoric complex society: A regional perspective from the Valley of Mexico. *Journal of Field Archaeology* 1:81–108.

———. 1976. "Settlement and population history of the Basin of Mexico," in *The Valley of Mexico: Studies in prehispanic ecology and society.* Edited by E. Wolf, pp. 69–100. Albuquerque: University of New Mexico Press.

PARSONS, J. R., E. BRUMFIEL, M. H. PARSONS, AND D. J. WILSON. 1982. *Prehispanic settlement patterns in the southern Valley of Mexico: The Chalco-Xochimilco region.* Memoirs of the Museum of Anthropology, University of Michigan, 14.

PARSONS, J. R., K. W. KINTIGH, AND S. A. GREGG. 1983. *Archaeological settlement pattern data from the Chalco, Xochimilco, Ixtapalapa, Texcoco, and Zumpango Regions, Mexico.* University of Michigan Museum of Anthropology, Technical Reports 14.

PEARSALL, D. 1992. "The origins of plant cultivation in South America," in *The origins of agriculture.* Edited by C. Cowen and P. Watson, pp. 173–205. Washington, D.C.: Smithsonian Institution Press.

PONCE SANGINES, C. 1981. *Tiwanaku: Espacio, tiempo y cultura—Ensayo de síntesis arqueológica.* La Paz: Editorial Los Amigos del Libro.

SANDERS, W. 1972. "Population, agricultural history, and societal evolution in Mesoamerica," in *Population growth: Anthropological implications.* Edited by B. Spooner, pp. 101–53. Cambridge: MIT Press.

SANDERS, W., J. PARSONS, AND R. SANTLEY. 1979. *The Basin of Mexico: Ecological processes in the evolution of a civilization.* New York: Academic Press.

SMITH, B. D., AND C. W. COWAN. 2003. "Domesticated crop plants and the evolution of food production economies in Eastern North America," in *People and plants in ancient Eastern North America.* Edited by P. E. Minnis, pp. 105–25. Washington, D.C.: Smithsonian Institution Press.

STANISH, C. 2003. *Ancient Titicaca: The evolution of complex society in southern Peru and northern Bolivia.* Berkeley: University of California Press.

STANISH, C., E. DE LA VEGA., L. STEADMAN, C. CHÁVEZ JUSTO, K. FRYE, L. ONOFRE MAMANI, M. SEDDON, AND P. CALISAYA CHUQUIMIA. 1997. *Archaeological survey in the Juli-Desaguadero region of Lake Titicaca Basin, Southern Peru.* Chicago: Field Museum of Natural History.

STEADMAN, L. 1999. "The ceramics," in *Early settlement at Chiripa, Bolivia.* Edited by C. Hastorf, pp. 61–72. Berkeley: University of California Archaeological Research Facility.

VARIEN, M. D., AND B. J. MILLS. 1997. Accumulations research: Problems and prospects for estimating site occupation span. *Journal of Archaeological Method and Theory* 4:141–91.

VARIEN, M. D., AND J. N. POTTER. 1997. Unpacking the discard equation: Simulating the accumulation of artifacts in the archaeological record. *American Antiquity* 62:194–213.

ZVELEBIL, M., AND M. LILLIE. 2000. "Transition to agriculture in Eastern Europe," in *Europe's first farmers.* Edited by T. D. Price, pp. 57–92. Cambridge: Cambridge University Press.

ZVELEBIL, M., AND P. ROWLEY-CONWY. 1986. "Foragers and farmers in Atlantic Europe," in *Hunters in transition: Mesolithic societies of temperate Eurasia and their transition to farming.* Edited by M. Zvelebil, pp. 67–93. Cambridge: Cambridge University Press.

New Light on the Earliest Hominid Occupation in East Asia[1]

XING GAO, QI WEI, CHEN SHEN, AND SUSAN KEATES
Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, P.O. Box 643, Beijing 100044, China (gao.xing@ivpp.ac.cn) (Gao and Wei)/*Department of World Cultures, Royal Ontario Museum, Toronto, Ontario M5S 2C6, Canada (chens@rom.on.ca)* (Shen)/*University Village 701H, 601 S. Providence Rd., Columbia, MO 065203, U.S.A. (keates20039@yahoo.co.uk)* (Keates). 18 II 05

The Nihewan Basin in northern China is a major area of archaeological research in East Asia and a prime focus for the search for early hominids. It is located in Hebei Province, about 150 km northwest of the Zhoukoudian Locality 1 *Homo erectus* site near Beijing (fig. 1). The Nihewan is a large extinct lacustrine basin with extensive Pliocene and Pleistocene deposits containing hominid activity sites with associated fossil fauna and stone artifacts. These sites are indicative of the earliest hominid occupation in East Asia at 40° north latitude (Schick et al. 1991, Zhu et al. 2001, Wei 1991, Keates 2000, Shen and Chen 2003). The newly identified site of Goudi, in the eastern Nihewan Basin, where in situ lithic artifacts and fossil fauna have been found associated in Early Pleistocene sediments, has been dated paleomagnetically to about 1.66 million years (Zhu et al. 2004) and therefore represents the earliest hominid occupation in East Asia.

The search for early hominid presence in the Nihewan Basin began in the 1920s, when Pierre Teilhard de Chardin and Emile Licent discovered and studied Pleistocene faunal fossils there (e.g., Barbour, Licent, and Teilhard 1927). In 1935 the Abbé Henri Breuil announced his discovery of a stone "tool," but this find was dismissed as nonartifactual (Breuil 1935, Teilhard de Chardin 1935). The breakthrough in archaeological research in the Nihewan was the identification in 1978 of the Xiaochangliang site, where an assemblage of lithic artifacts in association with faunal remains was excavated from Early Pleistocene sediments (You, Tang, and Li 1978). At the end of the last century, a series of international collaborations between scholars from China, the U.S.A., the U.K., and Canada conducted excavations of Early Pleistocene sites in the Nihewan, including Donggutuo, Feiliang, and Xiaochangliang. These collaborative investigations introduced new approaches to the study of early hominid occupation in northern China, among them the refinement of the paleomagnetic stratigraphic framework in the Nihewan Basin and new methods of lithic analysis including refitting and use-wear analysis (Schick et al. 1991; Keates 2000; Shen and Chen 1999, 2000, 2003; Shen and Wei 2004).

Since the discovery of Xiaochangliang, a number of other sites, including Banshan, Putaoyuan, Guangliang, and Xiantai, have been identified in the same sedimentary layer. In addition, the layers above the Xiaochangliang sediment have yielded Shanshenmiaozui, Donggutuo, Madigou, Huojiadi, and Xujiapo, and one site, Majuangou, has been identified below it (Wei 1997). Goudi was found in the sediments directly below Majuangou (fig. 2). Chinese and American scientists have confirmed that the Xiaochangliang artifact-bearing layer resides in the reversed-polarity magnetozone bounded by the Olduvai and Jaramillo subchrons (Li and Wang 1982, Wei 1991, Yuan et al. 1996), indicating an age ranging between 1.07 and 1.77 million years. The paleomagnetic dating of Goudi by Zhu and colleagues (2001) placed Xiachangliang at 1.36 million years ago. Therefore, on the basis of comparative stratigraphic and paleomagnetic data, we believe that the date of Goudi lies somewhere between 1.36 and 1.66 million years or possibly earlier, given the fact that the Goudi layer is close to the onset of the Olduvai subchron.

DISCOVERY OF THE SITE

The new site was first identified in spring 2001 during an archaeological survey in the Nihewan Basin as part of a research project of the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) of the Chinese Academy of Sciences. The site was named Goudi and excavated during August and September 2001 under the

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