

# Ecological Context and the Prehistory of the West Central Taiwan Coast

*Received 25 September 1978*

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**T**HIS PAPER is the result of a year's participation in the Choshui-Tatu River Valleys Interdisciplinary Research Project (Chang 1974*a*, 1974*b*, 1977). The author excavated at three sites, all situated near the coast, and the results of those excavations have been reported elsewhere (Dewar 1977*a*, 1977*b*). This paper provides a general, simplified description of the palaeoecology of the Choshui-Tatu study area. The palaeoecological characterization has as its main goal the attempt to define the important characteristics of the home of the neolithic settlers of this area and becomes the basis for a discussion of the local developmental sequence.

## THE GEOGRAPHICAL AND ECOLOGICAL SETTING

In 1590, when a Portuguese ship caught sight of a lush green hillside rising up out of the South China Sea, the sailors aboard named it *Ilha Formosa*, 'the beautiful island'. The island of Formosa, the present province of Taiwan, is located about 160 km east of the coast of southeastern mainland China, about 480 km north of Luzon, the northernmost main island of the Philippine archipelago, and about 100 km south from Kyushu, Japan. The island is over 35,900 sq km in area. Approximately 386 km in length and aligned roughly north-south, Formosa is 158 km wide at its broadest point. Thus, no place on the island is more than 80 km, or about 50 miles, as the crow flies, from the ocean (Hsieh 1964).

This leaf-shaped island is dominated geographically by the spine of mountains which runs north-south from one end to the other. The mountains include 48 peaks of more than 3000 m and essentially divide the island into three north-south strips: the western coastal plains and hills, the central mountain spine, and the narrow hills and valleys of the extremely sharply graded eastern coast.

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The island lies between latitudes 22° and 24° N; the Tropic of Cancer thus passes across the island near the midpoint from north to south. Awash in the warm Japanese Current, and insulated, to a degree, from continental climates of East Asia by the Straits of Taiwan, the island enjoys a partially tropical, partially subtropical climate in areas of low elevation. Formosa receives two monsoons a year, a winter monsoon from the northeast and a summer monsoon from the southwest. The latitudinal gradient is only about 0.8°C of mean annual temperature per degree of latitude; thus the mean annual temperature of Keelung in the north is, at 21.8°C, only 2.3°C cooler than that at Heng-chun, at the southern end of the island (Hsieh 1964: 47). However, the monsoons concentrate the rainfall at the north and south ends of the island in different seasons, and the presence of the mountain spine provides rainshadow conditions which vary seasonally. While some areas along the mountain spine receive more than 4 m of rain per annum, those at the southern end receive more than half of the local rainfall during the summer, while those at the northern end receive more than half of the annual rain during the winter. The east coast of the island receives more rain than the west coast, and there is an altitudinal gradient as well, with rainfall increasing as one travels from the low western plains to the foothills and then the mountains.

While rainfall and temperature vary throughout the island, the agriculture practiced in the area of lower elevation utilizes both tropical and subtropical crops. Currently, the major crops are rice (*Oryza sativa* L.), sugarcane (*Saccharum officinarum* L.), banana (*Musa sapientum* L.), pineapple (*Ananas comosus* [L.] Merr.), tea (*Camellia sinensis* [L.] Kuntze), sweet potato (*Ipomea batatas* [L.] Lam. (*B. edulis* Choisy)), citrus fruits (*Citrus* spp.), and manioc (*Manihot esculentus* Crantz). In addition, minor crops include a variety of legumes, vegetables, fruits, and minor grains as well as tobacco (Hsieh 1964: 265–275).

The agriculture practiced by the aboriginal population of the island was dependent upon a different set of crops (Segawa 1953; Ch'en 1968: 19–23). Universal, or nearly so among the groups of Formosan aborigines, was the cultivation of foxtail millet (*Setaria italica* [L.] Beauv.), sweet potato, taro (*Colocasia esculenta* [L.] Schott.), banana, ginger (*Zingiber officinale* Rosc.), ramie (*Boehmeria frutescens* Thumb. var. *concolor* [Makino] Nakai), sugarcane, bottle gourd (*Lagenaria siceraria* [Molina] Standley.), Job's-tears (*Coix lachyma* L. var. *frumentacea* Mak.), peanuts (*Arachis hypogea* L.), tobacco (*Nicotiana tabacum* L.), and the greater yam (*Dioscorea alata* L.).

The crop inventories of the Formosan aborigines were not, however, limited to these crops nor without variability between the tribal groups. Ch'en (1968: 19) lists altogether eight grain crops grown by the aborigines on Taiwan. In addition to foxtail millet and Job's-tears, these were: (a) sorghum (*Holcus sorghum* L. var. *japonicum* Honda); (b) broom corn millet (*Panicum miliaceum* L.); (c) barn millet (*Eleusine coracana* [L.] Gaertn.); (d) maize (*Zea mays* L.); (e) rice; (f) goosefoot (*Chenopodium* spp.). All these grains were grown by at least three of the seven tribal groups and all the tribal groups cultivated at least four of the eight grains (with the sole exception of the Yami, who grow only one grain crop—foxtail millet). Similarly, while Ch'en lists 50 "main crops of the Formosan aborigines" (1968: 19ff.), no one group cultivated more than 32 of these. The minimum number recorded was 18 (among the Yami). Of these 50 crops, only seven were cultivated uniquely by one

group. Thus, it is clear that while there were some crops that were shared by *all* of the tribal groups reported, there was also much between-group variability in terms of the individual crop inventories. This pattern of diversity can probably be projected back into at least the recent past, since Ch'en excluded from this list 18 recently introduced crops (Ch'en 1968: 22-23). Such diversity in crop inventories must, in part, be the result of varying edaphic conditions, although other factors are likely to be responsible as well.

#### THE STUDY AREA

The Choshui and Tatu River Valleys are located approximately midway, from north to south, on the western side of Taiwan (see Fig. 1). The Choshui River is the longest river in Taiwan, 170 km, and drains the largest river basin on the island. It rises in the central mountain spine at a location over 3000 m in elevation. The

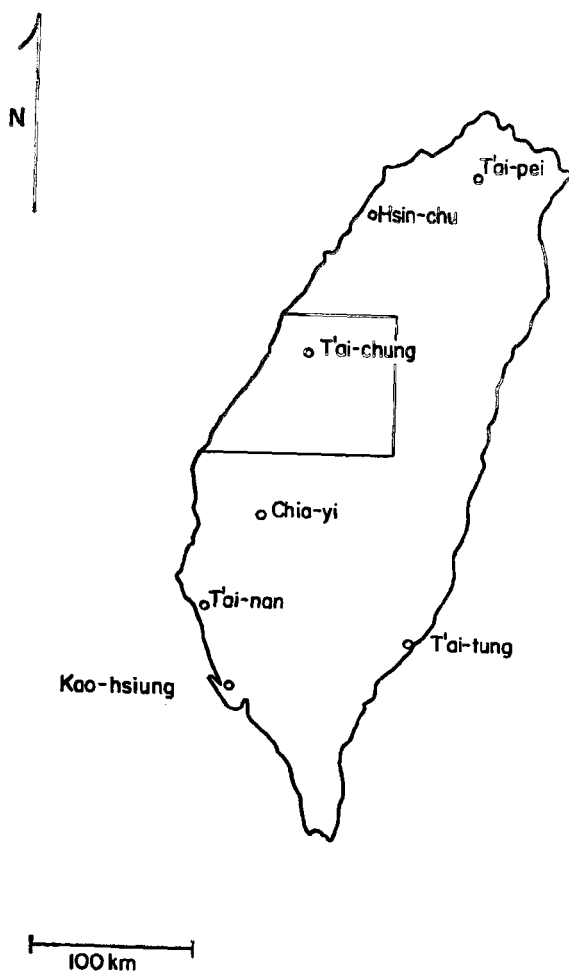


Fig. 1 The Island of Formosa.

Tatu River is located to the immediate north of the Choshui, from its source in the mountains to its outlet into the Straits of Taiwan.

The lower courses of both rivers form the T'ai-chung Basin. The total drainage system of these two rivers is over 5200 sq km.

Within the Choshui and Tatu drainage systems are a large variety of ecological zones, well differentiated in terms of climate, biota, and geomorphology. In this area are mountains (including Yü Shan, or Mt. Morrison, the highest peak on Taiwan at approximately 4000 m) located in the interior on the eastern side of the drainage systems, as well as the low coastal plains of the west. Between lie basins, terraces, and hills dissected by the branching courses of the two parallel rivers (Ch'en 1959-1961, 1966; Lin 1964). The temperature range is broad, for while there is little variation due to latitudinal differences, there is a drop of 0.48-0.96°C annual mean temperature for every increase in altitude of 100 m. There is also a wide range of rainfall, from areas averaging approximately 1 m of rainfall per year to others averaging more than 2.5 m at higher elevations (Wang 1967; Hsieh 1964). The area's biota is naturally varied as well, with high-altitude arctic forests and tropical-subtropical areas in lower elevations (Liu and Liu 1957; Liang 1966).

For descriptive purposes, the Choshui-Tatu Valley system can be divided into six separate zones: (1) the coastal plains and the T'ai-chung Basin; (2) the coastal hills of Ta-tu-shan in the north and Pa-kua-shan in the south; (3) the remainder of the basin terraces surrounding the T'ai-chung Basin; (4) the river terraces of the middle courses of the rivers; (5) the highland basins, including the P'u-li Basin and Jih-yueh-t'an (Sun-Moon Lake); and (6) the mountains (see Fig. 2).

### *The Coastal Plains*

The coastal plains and the floor of the T'ai-chung Basin are extremely low, flat areas separated from the Straits of Taiwan by only a low, sandy ridge. At the present time, they are used almost exclusively for rice pondfields or residences. The farmers are able to grow two rice crops per annum, although the second crop is usually less productive, due in part to the high winds which accompany the typhoon season of late summer and fall. Where water for irrigation is sufficient, rice productivity was recently the highest in Taiwan (Hsieh 1964: 278).

The coastal plains in this region are very similar to the coastal plains along the length of the western shoreline of Taiwan. The composition of this coastline is primarily a mixture of sand, clay, and gravel. The coastline as described by Hsieh (1964: 27) is "straight, monotonous and flat, [and] as a result the coast lacks harbors." Eustatic change in sea level and tectonic motion have alternatively flooded and exposed the Straits of Taiwan during the Pleistocene and Holocene: "the Quaternary Period in Taiwan was an age of rhythmic movements of transgressions and regressions of sea waters and fluctuations of shorelines" (Lin 1963: 210). Since no archaeological sites have been uncovered on the coastal plains of the study area which predate the site of Ying-p'u (radiocarbon dated to approximately 1000 B.C.; see Chang 1969: 275), there is evidence that the last seawater transgression was of comparatively recent age.

The most noteworthy resources which would have been plentiful in the past along the margins of the coast are saltwater molluscs. Shellmound sites are common

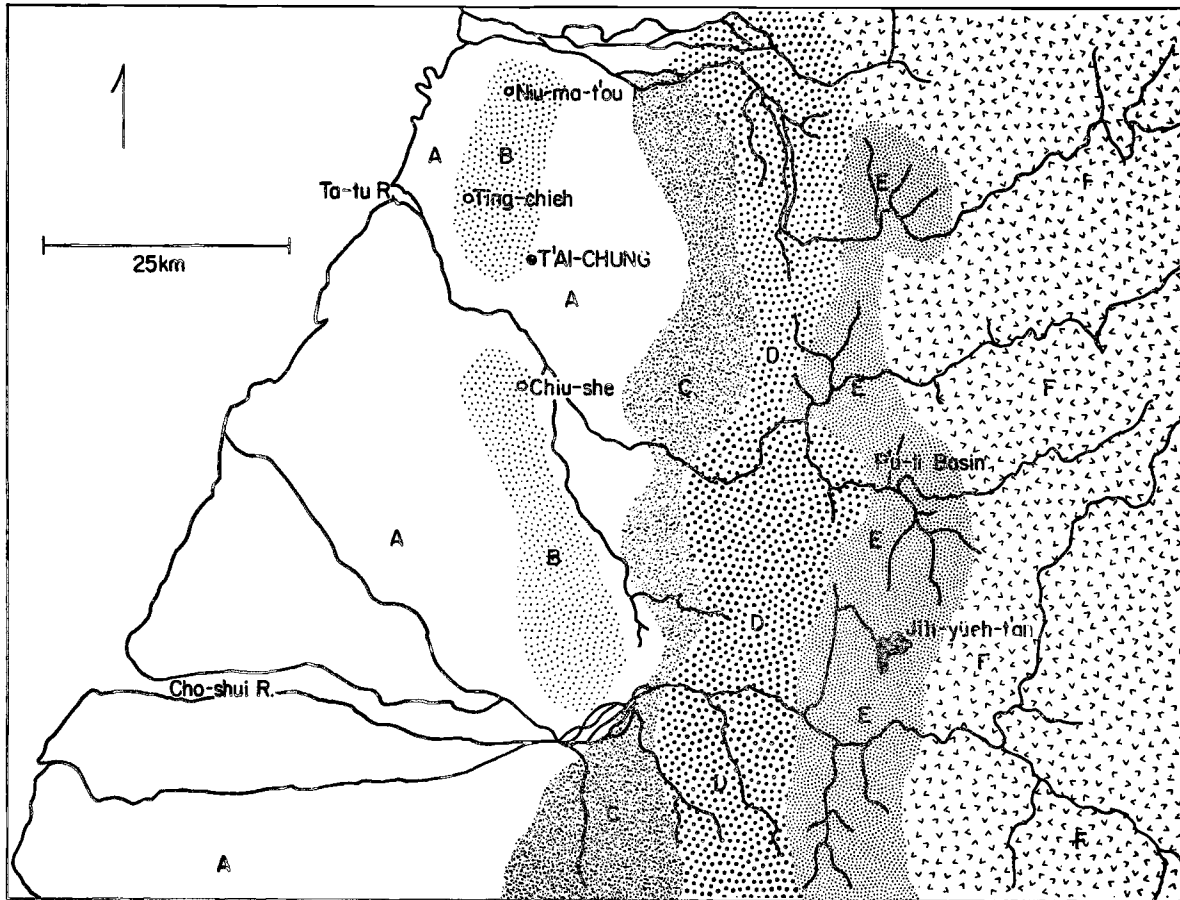


Fig. 2 The Study Area. *A* = the coastal plains; *B* = the coastal hills; *C* = the inland basin terraces; *D* = the river terraces; *E* = the highland basins; *F* = the mountains.

throughout the length of the west coast (Lin 1961, 1964; Kokubu 1962). In the study area, however, no shellmounds are known until comparatively late (Proto-historic Phase, 700–1200 A.D.; see Chang 1974b: 274). Other plant and animal resources (including terrestrial, littoral, and marine forms) would have fluctuated with the transgressions and regressions. It is interesting that pollen samples from the site of Niu-ma-t'ou (Huang et al. n.d.: 22) located on the western slope of the Ta-tu-shan hill, near the coastal plain, may give evidence of a freshwater association. At a period when the bulk of the coastal plains were considerably more moist than at present, the course of the Tatu River may have produced an area of less salinity near the inland margin of the coastal plains.

The T'ai-chung Basin today is ecologically similar to the coastal plains. Outside the residential and industrial areas of T'ai-chung and the surrounding towns, the land is primarily devoted to rice pondfields. During the Quarternary, the basin was probably flooded most of the time. Chang (1974b) reports that the geomorphological investigations of the Choshui-Tatu Project indicate that the basin was originally separated from the Straits of Taiwan (and the flooded coastal plains) by a continuous coastal hill at the location of the modern Ta-tu-shan and Pa-kua-shan tablelands. At this time, the basin would have been flooded by the fresh waters of the Tatu River flowing in from the east. At some time during the later Pleistocene, the modern gap between the Ta-tu-shan and Pa-kua-shan tablelands opened, and the basin became first a lagoon of the Straits and then, finally, was drained. While the evidence seems to suggest that the Pa-kua-shan and Ta-tu-shan tablelands were separated well before the earliest known occupations of the region, it is at present impossible to date accurately the sequence of events starting with the opening of the basin to the Straits and culminating in the draining of the basin. It is also difficult to identify, for any specific period, whether the basin was filled with fresh, brackish, or salt water. A complicating factor is the tectonic origin of the basin. Hsieh reports (1964: 37), on the basis of a survey for the Chinese Petroleum Corporation, that the sediments deposited by the Tatu River and its tributaries extend to a depth "far below 1000 feet." While the basin has not been the scene of recent uplift, the coastal plains are continuing to rise (Hsieh 1964: 38ff.). Although sites are known for the basin floor (especially Ts'ao-hsieh-tun) earlier than for the coastal plain, the paucity of archaeological remains from any but the highest portions of the basin floor (Ts'ao-hsieh-tun is located at about 90 m above sea level, near the entrance of the Tatu River into the basin) suggest that it was not suitable for habitation until fairly late in the Holocene. The stratigraphy at Ts'ao-hsieh-tun itself is indicative of rapid changes in the basin floor. The cultural remains are scattered through 2 m of alluvium, from a depth of 370 cm to 170 cm. A single radiocarbon date from 260 cm gave an indication of 4000 years B.P. (Tsang n.d., 1977; Chang 1974b: 271). While the length of occupation at this locality cannot be exactly determined, all the early materials recovered were from a single phase (for which Ts'ao-hsieh-tun is the type site) tentatively identified as approximately 500 years in duration by Chang (1974b: 272).

Huang et al. have described the pollen recovered from soil samples taken from the Ts'ao-hsieh-tun site and report that the indications are for local association of "*Alnus-Magnoliaceae-Pinus/Acer-Phyllanthus*" with a subassociation of "Grass-Cyperaceae - *Nymphaea* - Juncaceae - Compositae - *Chenopodium* / Convolvulaceae -

Euphorbiaceae-*Eriocaulon*-Menispermaceae-Orchidaceae-Amaranthaceae" (Huang et al. n.d.: 24). These interpretations are based upon an analysis of all pollen fossils recovered. Of the total of 5265 palynomorphs recovered, however, only 197, or approximately 3.7 percent, were from samples deeper than 170 cm (Huang et al. n.d.: 9). Culturally, no materials 170 cm or less in depth were identified as belonging to the Ts'ao-hsieh-tun Phase. The materials recovered from more shallow layers are all attributed to the modern or protohistoric periods (Tsang 1977, n.d.).

Soil samples from one other site in this zone, Shih-pa-chang, were submitted for palynological analysis. The pollen recovered from the four Shih-pa-chang samples, however, only amounted to 98 grains (total palynomorphs totaled only 132). Further, only 44 of the pollen grains were from samples associated with the archaeological stratum (Huang et al. n.d.: 2). As a result, Huang and colleagues report only a "*Nymphaea*/Juncaceae-Grass subassociation" (p. 24). This sub-association of aquatic and terrestrial pioneer species can tell us little about the prehistoric environment.

The association reported by Huang and colleagues for Ts'ao-hsieh-tun describes a climate more temperate than today, if treated literally, since of the tree genera reported only *Phyllanthus* is characteristic of the low-elevation tropical forests of the region today. All the others (*Alnus*, *Pinus*, *Acer*) are typical of the more temperate forests of higher altitudes, more than 600 m above sea level (Liu and Liu 1957: 3-25). The report of *Nymphaea* and other aquatic forms attests to the presence of shallow areas of fresh water nearby. The pollen profile, however, does not represent a balanced sample from all the excavation layers but is very heavily weighted toward more recent samples. The discrepancy between the association reported for this site and Liu's description of the lower-elevation modern forests is probably best explained with reference to the highly manmade environment which surrounds the site at present. Most level ground is flooded for rice paddies, and the few patches of natural vegetation are very strongly weighted toward early succession species.

### *The Coastal Hills*

The coastal hills, the Ta-tu-shan tableland, and the Pa-kua-shan tableland lie parallel to the coast, at a distance of approximately 4 to 6 km, and rise in elevation to more than 100 m. Each of these hills is comparatively flat at the summit, and 2 to 4 km in breadth. The T'ai-chung Basin lies to the east, at a lower elevation, and is drained principally by the Tatu River, which passes through the gate formed by the south end of the Ta-tu-shan tableland and the north end of the Pa-kua-shan tableland. The climate of the western coast is among the driest in all Taiwan, with the city of T'ai-chung receiving approximately 1.78 m of rainfall per annum (Hsieh 1964: 53). The agricultural potential of the hillsides and summits of the coastal hills is limited by the availability of water. Most of the area of the western-facing slopes is unfarmed, although in areas close to settlements limited fields of sweet potatoes, peanuts, and sugarcane are maintained. At the summit of the Ta-tu-shan tableland, some fields of sugarcane are cultivated, and along the eastern edge of the Pa-kua-shan tableland modern irrigation facilities permit the culture of some fruit trees, ginger, taro, and pineapples. While 1.8 m/annum of rain would support, in most circumstances, a far greater range of crops, the geologic structure of the coastal

hills does not permit the retention of water at depths available to farmers. The bulk of the rain is concentrated (150 out of 178 cm/annum) in the months of April through September. The area of T'ai-chung is one of the sunniest in all of Taiwan, with an average of only 127.2 rainy days/annum (over a 49-year period). Dividing the monthly average rainfall by the average number of rainy days per month (see Table 1) gives some indication of the average amount of rainfall per rainy day. The concentration of rain in the summer months and the intensity with which it falls (almost 1 inch per rainy day in June) has produced extensive erosion, especially along the westward slope of the hills, carving large gulleys susceptible to flash flooding, and requiring major flood control measures. While some of the water is absorbed into the laterite and gravel matrix of the hills, it rapidly sinks to levels near sea level, where springs, including some of very high flow, distribute water to the plains. The vegetation covering the uncultivated portions of the coastal hills is mostly low scrub forest, in many areas dominated by *Acacia confusa* which is grown and harvested for charcoal by the Chinese population.

TABLE 1. AVERAGE RAINFALL AND RAINY DAYS PER MONTH FOR T'AI-CHUNG\*

	JAN.	FEB.	MARCH.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Rain (cm)	3.28	6.78	11.4	13.0	22.8	37.1	29.5	33.8	13.9	2.18	1.78	2.56
Days	7.6	10.1	12.7	11.1	13.0	16.6	16.0	17.3	8.5	3.4	4.7	6.2
Rain/rain day (cm/day)	.43	.67	.89	1.17	1.75	2.23	1.84	1.95	1.63	.64	.38	.41

\* Data from C. M. Hsieh 1964.

The coastal hills are geologically recent, identified by Hsieh (1964: 12) as Pleistocene clay and sand formations. The major component of these formations is "a coarse-textured, poorly sorted gravel with considerable admixture of silt and fine sand" (Hsieh 1964: 81). The soil which rests atop this clay gravel structure is primarily lateritic, poor in nutrients, and dark red in color. The surface soil is a grayish brown clayey loam, presumably resulting from cultivation and rarely more than a meter in depth.

Huang and colleagues also analyzed pollen and spores present in a series of soil samples from the site of Niu-ma-t'ou (Locus D). This site is located along the western slope of the Ta-tu-shan tableland at elevations ranging from approximately 25 to 80 m above sea level. Huang and colleagues reported an "*Acacia/Alnus-Pinus* association" with a "*Nymphaea-Chenopodium-Compositae-Grass/Cyperaceae-Juncaceae* subassociation (n.d.: 24). The woody plants (*Acacia*, *Alnus*, *Pinus*) are not associated with the low-elevation tropical forest (Liu and Liu 1957). Their abundance in the sample here may either represent (a) local microenvironmental conditions which prevented the achievement of the normal climax vegetation, or (b) the result of frequent disturbance producing a pollen sample more heavily weighted toward early succession or pioneer species. The *Nymphaea* and *Juncaceae* suggest the presence of fresh water or freshwater marshes in the vicinity, and the *Chenopodium*, *Compositae*, *Cyperaceae*, and grass pollen can be described as a weed flora with the



possible inclusion of some crops. This represents further evidence for frequent clearance or disturbance in the immediate vicinity of the site.

As previously, the pollen samples were lumped together for vegetational analysis and diachronic changes were not reported. The sample was again heavily weighted toward the more recent layers. Of the total of 786 woody dicotyledon pollen grains, 731 were from the shallowest sample (35 cm). The shallowest five samples account for 88.8 percent of the total pollen grains recovered. Recently, the site was cleared of vegetation for extensive periods to facilitate the defense of the military position at the crest of the hill and at present is strongly dominated by *Acacia confusa*. The sharp decline in the pollen grains recovered as the depth of the sample increases may also suggest that at the lower depths the original distribution is masked by the effects of differential preservation of the pollen of different species. The pollen recovered from Niu-ma-t'ou thus tentatively suggests an area characterized by subclimax vegetation, possibly the result of frequent clearance, or the result of local microenvironmental conditions. We are at present unable to separate the effects of these two alternatives. Similarly, we are unable to determine the time depth of these conditions.

#### *The Inland Basin Terraces*

The remaining terraces which surround the T'ai-chung Basin differ radically in ecological terms from the Ta-tu-shan and Pa-kua-shan tablelands. Geomorphologically, they share with the tablelands the function of limiting the T'ai-chung Basin, but they are otherwise easily distinguished.

Geologically, the inland basin terraces are well differentiated from the tablelands, differing in both age and composition. The entire western slope of the mountain spine of Taiwan is characterized by Tertiary shale and sandstone formations (Hsieh 1964: 12-13) in contrast to the younger clay and sand formations of the tablelands. Associated with this are soil and hydrographic differences. In many areas, the shale and sandstone formations are capped by red and yellow soils, the result of both laterization and podzolization. The shale and sandstone formations are less permeable than the tablelands (Hsieh 1964: 86-90).

Today, the inland terraces are utilized for a variety of crops including rice (where paddy construction is possible and where water sources are available), banana groves, and various fruits and vegetables. The general appearance of the area is quite different from the coastal tablelands, because the uncultivated regions of the inland terraces are covered with a vegetation altogether more lush than that of the coastal hills, including extensive stands of bamboo forest.

In the past, before extensive changes in the vegetation resulted from the activities of humans, these inland terraces were probably covered with tropical forest. In west central Taiwan, such a forest would likely include (Liu and Liu 1957) such trees as *Bischoffia javanica* Bl., *Phyllanthus reticulatus* Poir., *Tetrapanax payrifolium* (Hook.) K. Koch, *Schefflera octophyllum* Harms., *Zelkova formosana* Hay, and many other tropical broad-leafed evergreens. It is difficult to predict what the fauna associated with climax tropical forest in this area would have been; it is likely to have been rather sparse, however, with the exception of some arboreal forms, especially avian, since in general tropical forests are characterized by relatively low mammalian biomass.

*The River Terraces*

Ascending the rivers from the T'ai-chung Basin, one travels through the next three zones, the river terraces of the middle courses of the rivers, the highland basins, and finally into the mountains. Precise delineations of these three zones is difficult, but the shifts which occur are important. The forests change from tropical evergreen to subtropical evergreen to temperate deciduous to temperate evergreen to the final transition to the high-altitude arctic conditions. The river terrace zone can be arbitrarily defined as the terraces and surrounding hills along the river courses between the river's entry into the T'ai-chung Basin and its exit from the highland basins. The middle course of the Tatu River leaves the P'u-li Basin at approximately 400 m elevation and enters the T'ai-chung Basin at an elevation of approximately 100 m.

Along the middle courses of the river, the land forms are distinctive, due to the extraordinarily variable, and frequently very swift, river flow. All major streams above the T'ai-chung Basin have carved very wide beds, often several hundred meters wide, well strewn with cobbles. Except in times of rain, the rivers passing through these beds may be no more than 5 to 10 percent of the breadth of their graveled beds. Rising on either side are a number of river terraces of modern and ancient age. The higher terraces of the middle course of the Tatu River, according to Chang's description of the geomorphological history of the region (1974a: 42-44), were formed between about 10,000 and 20,000 years ago, as the result of the draining of the water formerly flooding the highland basins.

The river terraces are situated at the base of hills, which rapidly increase in elevation as one moves away from the stream beds. Often, even in areas where the river bed is less than 200 m above sea level, hills 2 to 3 km distant rise to nearly 1000 m. Thus, the river terrace zone presents different problems and resources than the three previous zones.

The principal difference is directly related to the geomorphology. Associated with the altitudinal gradient is a gradient in terms of floral and faunal association. Associated variation in slope, ground water, and exposure contributes in producing a high degree of ecological diversity in the terrestrial communities over very small distances. Hsieh reports that the basic Plio-Pleistocene sandstone and shale formations in this region may exceed half a mile in thickness. His description of the characteristic topography suits the area near the site of P'ing-lin (Tsang 1977, n.d.) in the river terrace zone especially well: "As a result of weathering and erosion this formation creates a very rugged, often pinnacle-shaped topography which glows like flame as it reflects the evening sun" (Hsieh 1964: 12).

There is an increase in rainfall associated with increase in altitude and proximity to the mountains. As a result, the river terrace zone receives more rainfall annually than the three previously discussed zones. An estimation from Hsieh's fig. 10 (1964: 49) suggests that rainfall in this zone averages between 2 and 2.5 m per annum.

The basic plant associations of this zone are often described as dependent upon altitude (Liu and Liu 1957: 3-12; Ch'en 1968: 2, citing Okuda and Nomura 1935 and Segawa 1953; Hsieh 1964: 103-105). This is an especially common circumstance in tropical areas distinguished by rapid changes in elevation over short

distances. In such areas, it is often difficult to draw distinct lines between plant communities, since individual plant species have different edaphic requirements and will have different distributions. Thus, in the three descriptions just cited, the elevational boundaries between major plant communities are all defined differently. For example, Liu and Liu (1957: 3) describe the tropical forest as extending up to 600 m; Ch'en (1968: 2) places this boundary at 800 m; Hsieh implies a boundary (1964: 105) intermediate to these. In each case, the authors suggest that differing reference plants were used in the determination of the boundaries between communities (although the description by Liu and Liu is by far the most complete). One further problem is that a great deal of the area of this zone has been subject to recent clearing and is not presently covered with climax vegetation.

In the river terrace zone, the altitude varies from about 100 m above sea level, where the Tatu River enters the T'ai-chung Basin, to over 1000 m. Following the description of the flora by Liu and Liu, one would expect that in the past there would be two important strata of plant association: from the river level to about 600 m above sea level a tropical flora and from 600 to 1600 m a subtropical flora (Liu and Liu 1957: 8). Typical of forests between 600 and 1200 m are such forms as *Ficus septica* Burm., *Trema orientalis* Bl., *Cinnamomum* spp., *Mallotus philippensis* (Lam.) Nuell. Arg., *Ardisia lentiginosa* Ker., *Ficus formosana* Hay., *Smilax lanceaefolia* Hoxb., *Alocasia macrorrhiza* Schott., and *Musa formosana* Hay. (Liu and Liu 1957: 6-7).

Soil samples from one site in this zone were submitted for playnological analysis. This site is Ta-ch'iu-yüan (Huang et al. n.d.), excavated by Shuzo Koyama (Koyama 1977). A total of 7215 palynomorphs were recovered from 11 samples. The site is located near the eastern boundary of the river terrace zone, in the Choshui River Valley. Koyama describes the environs of the site as a "small alluvial plain" extending southward from the south bank of the Chin-sui River. In the immediate vicinity are rice paddy fields, but the test pit was located in a banana field. As at the other sites, the palynological data were discussed without reference to diachronic change. The five shallowest samples, described as recent or modern (Huang et al. n.d.: 2) contained 86.4 percent of the total number of playnomorphs recovered (6234 of 7215). Thus, the sample is quite heavily biased toward more recent conditions. Huang and colleagues describe the association revealed by the recovered palynomorphs as a "Magnoliaceae/*Pinus-Alnus* association" and "Grass-*Nymphaea-Chenopodium*/Compositae-Cyperaceae-*Eriocaulon* subassociation" (n.d.: 24). This is not dissimilar to the pollen rain to be expected from a site located near the boundary between the tropical and subtropical zones, close to a river and modern agricultural fields, including paddies.

The hills surrounding the river terraces were probably not only more diverse in flora than the lower elevation zones, but may well have had a more diverse and productive fauna. Ch'en Ch'i-lu (1968: 34) lists 11 species as the most common game hunted by aborigines in Formosa. These are: (a) deer (*Cervus unicolor swinhoii* [Sclater]); (b) Formosan muntjac (*Muntiacus reevesii micrurus* [Sclater]); (c) wild boar (*Sus scopa taiwanus* [Swinhoe]); (d) Formosan bear (*Selenarctos tibetanus formosanus* [Swinhoe]); (e) leopard-cat (*Felis bengalis* Keer); (f) Formosan gem-faced civet (*Paguma larvata taiwana* Swinhoe); (g) Formosan rock macaque (*Macaca*

*cyclopis* Swinhoe); (h) Formosan pangolin (*Manis pentadactyla* Linnaeus); (i) Formosan bamboo partridge (*Bambusicola thoracica sonorivox* Gould); (j) Formosan ring-necked pheasant (*Phasianus colchicus formosanus* Elliot); (k) Swinhoe's blue pheasant (*Lophura swinhoii* [Gould]). Ch'en<sup>1</sup> states that the most important of these is the deer, that the bear and the leopard-cat were mainly hunted for their pelts and that hunting the monkeys was taboo in some tribes and directed at gathering monkey bones for Chinese herbalists in other tribes.

There is no authoritative treatment of the modern or ancient distribution of these game species. Disregarding the macaque, the leopard-cat, and the bear (none of which seemed to serve as a major food resource) the remaining eight species can be divided into three groups: the birds, the cervids, and a residual group (the boar, the civet, and the pangolin). The cervids were probably wide-ranging animals found in many of the microenvironments. The pheasants and partridges were probably most frequently found in open forest or areas of second growth. The residual group is composed of animals likely to have been primarily forest dwelling and solitary, such as civet and pangolin, or living in small groups, such as boar (cf. Walker 1975).

Even without detailed information on distribution, it seems unlikely that any one particular microenvironment would have had a monopoly on hunting potential. To be able to predict the supply of game available to hunters at any particular time in the past, we will need not only information on the natural distribution of the prey species, but also the effect of human settlement and hunting on the species abundance and distribution. For example, it has been recently suggested that field system margins support a greater biomass of some prey than undisturbed conditions in a basically similar forest of Luzon (Peterson 1977; Peterson and Peterson 1977).

The streams would have provided one other source of animal protein: aquatic fauna. Excluding freshwater invertebrates, for which there is as yet no evidence of consumption, the rivers provided fish for the aborigines in modern times. Curiously, while "net sinkers" are commonly reported from Formosan archaeological contexts, Ch'en (1968: 42) reports that with the exception of the Yami, the coastal Ami, and the Thao of Jih-yueh-t'an (Sun-Moon Lake), "fishing is of little importance" for Formosan aborigines. He reports, however, that the Budai Rukai utilized eight different methods of fishing in small creeks, including the use of nets, hooks, fish poison, fish traps, and arrows (Ch'en 1968: 43). The use of fish poison seems to have been particularly widespread and often cited (Hanetori 1902; Matsuyama 1902; Aoki 1931; Karikome 1935; Ogawa 1931; Furuno 1942; all cited in Ch'en 1968: 42f.).

Better information is available on the distribution of fish in west central Taiwan than of terrestrial and arboreal fauna. Liang (1966: 41-56) lists 19 species of fish found today in the freshwater streams and rivers of Nan-t'ou Hsien. These fish, however, are not evenly distributed, or present in all waters. The list also includes species (as *Cirrhina molitorella* [Cuvier and Valenciennes]) not native to Taiwan, but imported by Chinese immigrants, as well as some without economic value (e.g., *Rhodeus ocellatus* [Kner], *Formosania lacustre* [Steindachner]) or primarily distributed in artificial environments (as the rice pondfield fish *Cobitis taenia* Linnaeus).

*The Highland Basins*

Ascending further up the rivers, one reaches a series of highland basins arranged in a line approximately northeast-southwest. There are altogether 15 basins. The elevation of the basin floors is reported to vary between 38 and 780 m and the basins range in size from less than 2 sq km to the 125 sq km of the P'u-li Basin. All these basins were formed by crustal movement and were the sites of ancient lakes (Hsieh 1964: 38). At the present time, only the Jih-yueh-t'an Basin preserves its lake. Jih-yueh-t'an (Sun-Moon Lake) is also the highest of the basins. Chang (1974*b*), summarizing work during the first year of the Choshui-Tatu Project, suggests that during the Pleistocene at least four other basins were still flooded (P'u-li, T'ou-she, T'ung-kuei, and Yü-ch'ih). As a result of a combination of factors, including differential age of the draining of the basins, local topography, elevation, and size, the basin floors are not all uniformly flat (Hsieh 1964: 38). However, even the "most deeply and widely dissected basin in the group," P'u-li, with basin floor elevations ranging from about 380 to about 500 m, presents a wholly different vista from the surrounding areas. While the topography and environment of the hills and mountains surrounding the basins differ little from those of the hills and mountains flanking the river terraces, the relatively flat floors of the basins provide a striking contrast. For example, the P'u-li Basin is the site of a modern irrigation system of broad extent (Hsieh n.d.). The climate at the basin floors is determined in part by their elevation, as is the case throughout the region, and also in part by the topography. The P'u-li Basin, for example, with an elevation of the basin floor ranging from 380 to 500 m, would be expected to have a flora nearly transitional from tropical to subtropical. The surrounding hills, however, protect the basin from strong winter winds. Many people in T'ai-chung claim that their local climate is the finest climate in all Taiwan, but for the sole exception, they usually add, of P'u-li.

With the exception of the flooded basins, it is unlikely that the highland basins differed substantially from areas of like altitude nearby in the river terrace zone, except in terms of flatness of topography. The flora and fauna would not have contrasted strongly with that encountered in areas of like elevation, although strong contrasts between the basin floors and the surrounding hills would have been present, mirroring similar contrasts in the river terrace zone.

The flooded basins, however, must have presented a rather different set of resources than those encountered anywhere else. In particular, the fish of these mountain lakes were probably quite different than those found in the streams and rivers, and the still waters of a lake may have been a much more productive microenvironmental zone for the prehistoric occupants to exploit. According to current evidence, both geological and archaeological, the Jih-yueh-t'an Basin was the only basin flooded at the time of human occupation of this region (Chang 1974*b*). It is interesting to note that the only noncoastal aborigine group which relied extensively upon fishing (Ch'en 1968: 42ff.) were the Thao, who lived on the shores of Jih-yueh-t'an. The fishing techniques of the Thao, which were quite varied (Li 1957), included the use of floating artificial islands upon which fish traps were set.

The fish of Jih-yueh-t'an are also distinct from those of the surrounding rivers. Liang (1966: 41-56) lists 20 species of fish for the lake, 14 of which seem to be

found nowhere else. He lists *Erythrocutler aokii* (Oshima) as the economically most important fish of Jih-yueh-t'an.

The highland basins have also been the site of several recent palynological studies. Tsukada (1966, 1967) has reported the results of palynological analysis of a lake core from Jih-yueh-t'an. Huang (n.d.) has recently reported the results of the analysis of a pollen core from Wai-chia-tao-ken, in the Yü-ch'ih Basin, southwest of P'u-li, and about 150 to 200 m higher in elevation than P'u-li (n.d.: 2). Finally, Chung and colleagues have analyzed palynological samples recovered from four archaeological sites in the P'u-li Basin (1973). Tsukada's analysis has suggested (Tsukada 1966, 1967; Chang 1967, 1969, 1974b) two important interpretations. The first is that commencing about 8000 years B.P., there was a climatic optimum, bringing an annual temperature 2 to 3°C higher than present conditions, and continuing until about 3000 years ago. The second is that Tsukada found strong evidence in his pollen core for two important discontinuities in the nature of the pollen rain during the last 15,000 years. From about 14,000 to 12,000 years ago, there is evidence for the destruction of the forests surrounding the lake by burning and the persistence of second-growth pollen in the core sample. At about 4200 B.P., there is a "steep increase in grass pollen . . . which suggests intensified agricultural activities" (Chang 1969: 193).

The results from the Wai-chia-tao-ken core, however, do not strongly substantiate these conclusions. Specifically, at that location no evidence was found for deforestation or for grassland formation (Huang n.d.: 16). It should be pointed out that Huang and Tsukada differed in their methods of analysis: Tsukada relied upon indicator species and Huang upon species association (Huang n.d.: 15-16).

The pollen core at Wai-chia-tao-ken was originally intended to serve as a reference for the interpretation of the pollen and spores recovered from archaeological sites in the P'u-li Basin (Chung et al. 1973; Huang n.d.: 2). The Wai-chia-tao-ken profile, however, proved of little use in the interpretation of events in the P'u-li Basin, since none of the events of modern times which were apparent in the P'u-li samples was referable to similar events in the Wai-chia-tao-ken profile. Chung and colleagues reported two pollen zones from the P'u-li sites, Zone A and Zone B. Zone B is further subdivided into three subzones, B<sub>1</sub>, B<sub>2</sub>, and B<sub>3</sub>, from most recent to most ancient. Zone A was considered to represent the period of about 1500 years ago until the present and was distinguished from Zone B generally by the evidence of deforestation and cultivation of crops (indicated by *Ipomea* spp. and cereal pollen; see Chung et al. 1973: 188). Zones B<sub>1</sub> and B<sub>3</sub> each were dominated by nontree pollen (shrubs and herbs) "such as Convolvulaceae, Plantaginaceae, Compositae, Cyperaceae, Gramineae, and Chenopodiaceae." Zone B<sub>2</sub> was distinguished by a higher relative concentration of pollen of Pinaceae, Taxodiaceae, and Betulaceae, all principally arboreal groups.

These four pollen associations were dated by reference to a single radiocarbon date from the Wai-chia-tao-ken profile of about 25,000 B.P. at a depth of 8.4 m (Chung et al. 1973: 188). The dates given, about 1500 B.P. to the present for Zone A, about 2000 B.P. for B<sub>1</sub>, 3000 B.P. for B<sub>2</sub>, and 4000 B.P. for B<sub>3</sub>, must be regarded as highly tentative. Similarly, the conclusion that anthropogenic deforestation began in the P'u-li region "at least before 5000 B.P. and after 15,000 B.P." (Chung et al. 1973: 189) is a speculative one. Of more importance for our purposes

is the conclusion reached by the authors that the climate in the P'u-li Basin is classifiable as subtropical throughout the periods represented by Zones A and B (Chung et al. 1973: fig. 8, 190).

### *The Mountains*

East of the highland basins the elevations continue to increase. In some cases, the effective slope is very great. For example, peaks of over 3000 m are found within 15 to 20 km of Jih-yueh-t'an. The highest point on Formosa, Yü-Shan, is located in the southwest corner of Nan-t'ou Hsien with an elevation of 3997 m.

Climatically, the mountain area is the most diverse, for it varies from the warm temperate climate of the river valleys as they empty into the highland basins to the treeless arctic conditions found above 3900 m on Yü-Shan (Liu and Liu 1957: 12). The climatic diversity is not only the result of the increase in elevation, but also due to local geomorphological diversity, reflecting complex processes and a long period of erosion (Hsieh 1964: 30).

The mountain area is thus one of high diversity in climate and relief. At present, it is also the home of many of the less acculturated Formosan aborigines (Ch'en 1968: 8). While very few villages located above 2000 m were reported by Kano in 1938 (cited in Ch'en 1968: 16ff. and Hsieh 1964: 129-131), 52.8 percent of the Tsou and 44.9 percent of the Atayal populations lived in settlements above 1000 m in elevation. For Taiwan as a whole (not considering the Yami of Lan Yü), 23.1 percent of the aboriginal population lived in settlements above 1000 m in elevation at the time of Kano's work. A further 25.9 percent lived in settlements located between 500 and 1000 m. During precontact times, the proportion of the aboriginal population living at such high altitudes would surely have been much lower, although the population density in the mountains need not have been absolutely lower. The relative shift to higher-elevation settlements is demonstrated by the lack of any aboriginal settlements below 50 m on the main island of Formosa in 1938.

The mountain area not only serves as a refuge for the aborigines, it also provides a refuge for fauna which must once have had a wider distribution. For example, Liang (1966: 6) reports that the Formosan bear is presently limited to Yü-Shan.

Areas which were not immediately adjacent to settlements in prehistoric or historic times need not have been economically unimportant. This point is emphasized in the studies included in a recent study of prehistoric Mesoamerican villages (Flannery 1976). In his description of hunting practices, Ch'en (1968: 33-39) implies that hunting parties often traveled some distance from their permanent settlements. Further, he reports the practice of surround hunting by groups of men, with either dogs or fire used as an agent to drive game toward the waiting hunters. Such hunts were probably not frequently conducted in the immediate vicinity of villages. While the impact of techniques such as these on the faunal population is not presently clear, it seems likely that the area devoted to hunting must have been extensive.

Ch'en provides descriptions of two practices among the Budai Rukai which substantiate indirectly the importance of hunting in areas at a distance from the settlements. He reports that hunting grounds were owned by chiefs (1968: 35) whose permission was required before hunting could commence. Thus, hunting

and hunting areas were under a form of political control. Ch'en also reports (1968: 36ff.) that the Budai Rukai strictly observe omens encountered on the way to the hunting grounds, notably "the crying sounds, and the manner or direction of flight of some kinds of birds." If the omens were sufficiently negative, a hunting trip would be canceled. One of Ch'en's informants reported that his father waited more than half a month to start such a trip and finally gave up his plans (1968: 36). Such careful attention to omens must have had the effect of reducing the number of hunting trips significantly, and thus of controlling the number of animals removed. This represents a form of cultural control of the hunting areas, and probably had the effect of preventing some overhunting.

While it is difficult to project back into prehistory the practice of similar controls on overhunting, this may be taken as evidence that hunting was frequently at substantial distances from the settlements, and that the exploitation of these "unoccupied" regions was neither haphazard nor unimportant.

### *Summary*

The Choshui-Tatu River Valleys have been described in terms of six zones: the coastal plains, the coastal hills, the inland basin terraces, the river terraces, the highland basins, and the mountains. Within each of these zones is a variety of microenvironments, and differing resources which may have played a role in the prehistoric economies. The six zones were not defined by rigorous application of rules derived from ecological associations, as an ecologist might do in describing environmental microzonation. Instead, each area has been viewed in terms of the geomorphological and ecological features it exhibits, and stress has been laid upon the ecological variety within and contiguous to these areas.

Three potential sources of information with regard to the recent climatological history of this region have been considered: the Jih-yueh-t'an and Wai-chia-tao-ken pollen cores and the pollen samples from archaeological sites throughout the area. Considered collectively, they suggest that the climatological changes which occurred during the Holocene have been minor, and provide little evidence of any shifts great enough to have required substantial alterations in human economic practices. This conclusion is tentative and subject to alteration as more detailed evidence becomes available. Much more substantial problems surround the general question of the nature of anthropogenic modifications of the regional ecology. Profound modifications are easy to observe at the present, but no strong evidence is available to allow chronological treatment of these processes.

### THE COASTAL REGION IN PREHISTORY

Three periods of development are evident in the prehistory of the coastal region of the study area of the Choshui-Tatu Project. The first of these I call the period of Hillside Settlement; the second, the Ying-p'u Settlement period; and the third, the Shellmound period. These three periods on the coast will first be characterized and then the culture-historical relationships evident with other regions within west central Taiwan will be considered. Finally, I will discuss the possible reasons for the pattern of development observed.



The coastal region, as I use it here, refers to the coastal plains, the floor of the T'ai-chung Basin, and the Pa-kua-shan and Ta-tu-shan tablelands (Zones 1 and 2 earlier). The terraces which surround the the T'ai-chung Basin (Inland Basin Terrace Zone) were probably culturally a part of this region at the earliest times, but not by the time of the Shellmound period. Specifically, this region is characterized by four main features: the Straits; the low areas of the coast, which were certainly flooded marshes at various times in the past; the coastal hills; and the freshwater marshes and braided river channels running through the T'ai-chung Basin. The terraces to the east are rather different, in part because the water supply is greater and more constant. The archaeological evidence supports the view that the coastal region has had a somewhat separate development, although certainly not due to isolation, from the regions to the east. One might also point to the high degree of cultural, ethnic, and linguistic diversity among the P'ing-p'u, or Plains tribes aborigines, who inhabited the coastal region before the arrival of large numbers of Chinese immigrants in the seventeenth century (Y. Chang 1965; C. Liu 1958; Ferrell 1969). Diversity at that time does not prove the existence of diversity millennia earlier and no such claim is offered, but it does suggest the possibility.

#### *Hillside Settlement*

The sites of Niu-ma-t'ou and Ting-chieh (Dewar 1977*a*, 1977*b*, P. Liu 1955) are each representative of the Hillside Settlement period, and the earlier occupations at Chuang-hou-ts'un and Lung-ch'uan-ts'un (Sun n.d.), among excavated sites, are assignable to this period as well. All these sites are located on the western slope of Ta-tu-shan tableland, facing the Straits of Taiwan some 4 to 6 km away. The following reconstructed palaeogeographic situation can be tentatively proposed. As the modern coastal plains were flooded, at least partially, during the period of Hillside Settlement, the settlements could probably be described as located on the middle of the western hillsides, with dry hill and summit above them, and wetter lands below, marsh or swamp littoral nearby, and the Straits at a further distance. The precise nature of the surrounding communities is difficult to reconstruct. In the report of the fossil pollen recovered from Niu-ma-t'ou (Huang et al. n.d.), a freshwater marsh at the base of the hill is suggested. As discussed earlier, however, at this time there is no basis for a confident characterization of microenvironmental features on the basis of that pollen analysis.

The hypothesized ecologic location of these sites can be described in terms of four microzones, in bands parallel to the coast: (a) the Straits themselves, saltwater below the low-water mark; (b) the littoral, often up to 4 km in breadth, where the Tatu River flowed into the Straits, possibly of varying (spatially and temporally) degrees of salinity and vegetational cover; (c) the lower slopes of the coastal hills; (d) the upper slopes and summits of the tablelands. Most interestingly, residents of sites near the south end of the Ta-tu-shan tableland and residents of the northern end of the Pa-kua-shan tableland would have had several km of land travel to reach other ecologic microzones, if the T'ai-chung Basin were flooded, as it probably was during a large part of the time before 1000 B.C.

The components from recently excavated sites (Dewar 1977*a*, 1977*b*) which were assignable to this first settlement period are the Early Plainware and Cord-Marked

Ware settlements from Ting-chieh and Levels I, II, and III from Niu-ma-t'ou. These components are assignable in Chang's terminology to the Ts'ao-hsieh-tun Phase and a possible, and unnamed, earlier phase denoted by the presence of TPK elements (Chang 1974b: 271, 1977). In Chang's summary of Formosan prehistory (1969: 203), these levels would be referred to as NMT Fine Cord-Marked. It is probably best to reserve the use of "Ts'ao-hsieh-tun Phase" for reference to the group of settlements and cultures throughout central Taiwan at this period. As such, it replaces "NMT Fine Cord-Marked." The coastal region Hillside Settlement period is best regarded as a regional focus of this phase.

The single most important criterion in the assignment of occupation levels to the Ts'ao-hsieh-tun Phase is the presence of the characteristic red paste pottery, often Cord-marked. Further, an examination of the ceramics from Ting-chieh and Niu-ma-t'ou reveals a similarity of form, paste, and quality so great that it is my conviction that separating the red paste pottery of Ting-chieh from that of Niu-ma-t'ou would be impossible without information as to provenience.

The pottery of levels of Niu-ma-t'ou (NMT) and Ting-chieh (TC) can be correlated as follows: NMT Level I = TC Level Ia (approximately); NMT Level II = TC Level Ib; NMT Level III = TC Level Ic (see Dewar 1977a, 1977b). These can be termed Early, Middle, and Late Hillside Settlement periods, respectively. It is likely (Dewar 1977a: 232) that TC Level Ia is slightly later in time than the beginnings of NMT Level I.

The pottery of the Early Hillside settlement is only slightly different from the pottery of the Middle Hillside settlement. The distinctive characteristics of the early period are those referred to as "Ta-p'en-k'eng elements" by Chang (1974b, 1977). It should be pointed out that there is little or no reason to assign this level to a "Ta-p'en-k'eng Corded Ware Culture." The Early Hillside should be regarded as the earliest known period of occupation along the coastal hills, and differs in no other important fashion yet known from the immediately succeeding period.

The pottery of the Middle Hillside settlement is that previously known as NMT Fine Cord-Marked (Chang 1969). For the characteristics of this ware, the reader is referred to the site reports mentioned earlier and to the report of the earlier work at Niu-ma-t'ou (P. Liu 1955).

As reported in P. Liu (1955: 71-72), there is an apparent change in the frequency of cordmarking through time, with the shallower deposits of red paste ceramics displaying less frequent cordmarking. The trend to a decrease in the frequency of cordmarking through time at the Hillside Settlement sites should not be regarded as evidence of a new cultural phase. In the terminology of Chang (1974b, 1977), the latest period of the Ts'ao-hsieh-tun Phase along the coast is characterized by a decrease in the percentage of cord-marked sherds. This plain red pottery, however, is in other respects largely indistinguishable from the ceramics of the Middle Hillside settlement. During the Middle Hillside settlement at Niu-ma-t'ou, approximately 32 percent of the red paste sherds were plain, and at Ting-chieh the figure is 56 percent, while during the Late Hillside settlement the respective figures are 55 percent and 69 percent. Thus, the change is best viewed as incremental. A similar examination of the changes of frequency of rim modes strongly supports this conclusion. This situation contrasts strongly with that of the interior. There, the basically cord-marked red ceramic Ts'ao-hsieh-tun Phase is often succeeded by

a phase, designated 'Ta-ch'iu-yuan, characterized by a thick, coarse, plain red pottery, often heavily tempered with grit (Chang 1974b: 271-272; Koyama 1977). The plain red ware of the coast does not seem similar enough to be classed with this coarse ware, and thus, the 'Ta-ch'iu-yuan Phase of the interior has not been identified on the coast.

While changes in pottery styles throughout the Hillside Settlement period are easily demonstrated, the evidence of other aspects of life of the inhabitants is so sparse as to prevent the detection of meaningful change. The lithic assemblages for this period from Niu-ma-t'ou and Ting-chieh are small, in marked contrast to ceramic assemblages. It is apparent from the limited sample, however, that the main activity in the vicinity of these sites was agricultural. The virtual absence of hunting tools or evidence of gathering along the littoral stand in marked contrast to the number of presumed hoes, harvesting knives, adzes, and axes. No quantification of the energy or time spent upon these various activities is possible without direct evidence of the consumption patterns, and the preservation conditions (no organic material, except pollen, was recovered) at these coastal sites prevent that. It is unclear whether the littoral resources were used at all in this period, for no shell was recovered from the sites, although littoral resources include much more than molluscs (e.g., animal and plant species limited to the littoral), and the absence of shells in the occupational debris could be explained in other ways (e.g., if the shells were discarded at the littoral, and only the edible portions brought to the occupation site).

Even if littoral resources were utilized, agriculture was, certainly, the basis of the economy. Further, the site locations may suggest some of the characteristics of the agronomic system. The summit of the tablelands, apparently unoccupied throughout this period, presents little opportunity for the agriculturalist. Among the problems to be faced is the lack of surface water. Settlement seems only to have been situated near the bottom of the hill where springs and other sources provided water to drink. The settlements were placed near the break of the hill, where one finds the division between the hillside ecozone and the coastal plain. Probably then, as now, there was a gradual increase in the moisture content of the soil as one moves off the hill and onto the flats. Were the sea level higher or the land lower during the period of occupation, then it is possible that the flats would have been covered with brackish water. However, there would still have been a strip of land below the occupations which would have been moister than the hill above. No matter the precise distance to the sea, the hillside site would have provided a range of locations for fields, all on western slopes, characterized by an increase in aridity with altitude.

While it has been conjectured that paddy field agriculture may have been introduced in this area about the time of the Hillside Settlements (Lin 1966), it seems more probable that the main field type would have been swidden. All the Formosan aborigines swiddened in the recent past (Ch'en 1968; Segawa 1953; Ferrell 1969), and even today very few plant rice in paddies (Ch'en 1968: 322). There is no ethnohistorical documentation for any aboriginal rice paddy construction before the period of Chinese settlement, although on Lan Yu Island (Botel Tobago, Kotosho) the Yami maintain flooded fields for taro (Kano and Segawa 1956). At the present time, in the vicinity of Ting-chieh, the hill slopes are terraced to the altitude permitted by the availability of water for paddy. This is no more than

50 m above sea level. Above that, only a small proportion of the land is utilized, either as drained fields for sweet potatoes, peanuts, taro or sugarcane, or as wood lots, for the production of charcoal.

Given the edaphic conditions, it is likely that the agriculture of this area has always exhibited a layered aspect. The Yami, while almost certainly not the descendants of the Hillside settlers, are useful as a source of ethnographic analogy. One probable major difference between the Yami and the Hillside settlers' subsistence patterns is that the Yami are great fishermen and dependent upon many littoral resources (Kano and Segawa 1956). With reference to the agricultural sphere, however, there is little necessary difference between the Yami and the projected system of the Hillside settlers. Most crops of the Yami are found throughout the Formosan aborigines' systems: millet, taro, yams, sweet potatoes, sugarcane, and bananas, among others. All these, save the sweet potatoes, are likely to have had a long history in Taiwan. What is striking about the Yami agricultural system is the diversity of field types and the utilization of different fields for different crops. Thus, the coastal flats are used for permanently flooded fields of taro, well-drained patches near the settlements are planted with sugarcane, swiddens of different forms are prepared at varying elevations for the grain and other tubers. It seems quite likely that the Hillside settlers also had a diversity of field types, with different associated crop regimes. At present, however, only conjectures can be made as to what form those fields would have had, and what the specific crop associations might have been.

#### *Ying-p'u Settlement*

Succeeding the period of Hillside Settlement is the Ying-p'u Settlement period, named after the famous site located on the coastal plain southwest of the southern end of the Ta-tu-shan tableland. This site, excavated by Japanese scholars in the 1940s and later by the Yale-Taita expedition, under the direction of Professor Sung Wen-shun of the National Taiwan University, is well known for the black pottery uncovered there (Kanaseki and Kokubu 1949, 1953; Chang 1969). Throughout the Choshui-Tatu Project area and probably at different times in different locations, the red pottery which characterized the initial period of settlement was replaced by dark grey or black pottery. This replacement was accompanied by a great increase in the number of known sites, as well as apparent changes in the nature of the settlement locations and other characteristics. All three of the sites excavated by the author have deposits attributable to this period. The Ying-p'u materials from Ting-chieh and Niu-ma-t'ou, however, are limited in quantity and suggestive of a short occupation early in the period, while the material from Chiu-she is Ying-p'u period throughout, and undoubtedly later than the Niu-ma-t'ou and Ting-chieh materials. The site of Chuang-hou-ts'un, to the northeast of Niu-ma-t'ou, on the northern edge of the Ta-tu-shan tableland, facing the Ta-chia River, appears to represent the same situation as at Niu-ma-t'ou and Ting-chieh, with evidence of a short settlement during the Ying-p'u after a longer settlement during the Hillside Settlement period (Sun n.d.).

In Chang's 1969 summary of Taiwan prehistory, the initial appearance of the black or grey pottery in central Taiwan was described as the Ying-p'u Horizon. The cultural phase in which the black or dark grey pottery first became important

in central Taiwan is now referred to as the Ta-ma-lin Phase, after the type site in the P'u-li Basin (Stamps 1977; Shih 1953; C. Liu 1956). I have chosen to use Chang's (1974*b*, 1977) phase terminology for the description of areawide phenomena, and have chosen a separate term (Ying-p'u Settlement period) for the coastal focus. While it risks ambiguity to use the term "Ying-p'u" for a coastal focus (since the earlier usage referred to a horizon of broader area), the site of Ying-p'u remains the type site of the area and thus the usage is warranted.

Of the five important sites assigned to this period, three (Ting-chieh, Niu-ma-t'ou, and Chuang-hou-ts'un) are situated at the site of an earlier Hillside Settlement. Chiu-she is sited at a somewhat similar location as the previous three. It is located on the first terrace overlooking the T'ai-chung Basin on the northeastern side of the Pa-kua-shan tableland. The fifth site, Ying-p'u, is located on the coastal plains, southwest of the southern end of the Ta-tu-shan tableland and near the northeast bank of the Tatu River. The occupations of this period at Ting-chieh, Niu-ma-t'ou, and probably at Chuang-hou-ts'un are brief, however, while the occupation at Ying-p'u is much more extensive and possibly of longer duration. The length of occupation at Chiu-she is probably intermediate, shading toward the shorter end (Dewar 1977*a*: 100). The single most striking change from the preceding period is the location of a site on the coastal plain. At this period of time, the local sea level was not greatly different from the present. The inhabitants were no longer required to live along the slopes of the coastal hills. A plausible interpretation of the deposits at Niu-ma-t'ou, Ting-chieh, and Chuang-hou-ts'un is that they represent occupations that were abandoned in preference for lower-elevation localities. At Ting-chieh, there is some evidence that areas immediately below those chosen for excavation may have had a higher proportion of ceramics of the Ying-p'u period of age than the excavated areas. Excavation at these lower areas was not feasible, and it is also possible that the informal surface collections may have been biased by recent erosion of Ying-p'u material from higher on the hill. A similar move to lower elevations in the immediate vicinity is also likely at Niu-ma-t'ou.

The ecological situation of the occupations of Ting-chieh, Niu-ma-t'ou, and Chuang-hou-ts'un would have changed little from the preceding period, except that the Straits would have been located at a greater distance and the area of the coastal plain increased. The site of Ying-p'u, located at a distance of approximately 1 km from the Ta-tu-shan tableland, most likely was primarily dependent upon the coastal plain, the river, and its banks for support (with the littoral resources, and those of the hills, at a greater distance). The site of Chiu-she differs from the rest, for it is located on the east slope, facing the T'ai-chung Basin and not the Straits. At the foot of the terrace upon which Chiu-she sits is the present location of the braided channel of the Tatu River. The site is thus very near the low, wet plains of the basin, the course of the river and the drier Pa-kua-shan tableland at its back, to the west.

The defining feature of these occupations is the predominance of dark grey or black pottery. The pottery from Ying-p'u is characterized by a predominantly fine paste black pottery, often decorated by linearly arranged incisions and punctations and occasionally painted (Kanaseki and Kokubu 1949, 1953). Extremely similar sherds have been found at Niu-ma-t'ou and in smaller numbers at Ting-chieh, although none was painted. At Chiu-she, one sherd, incised and punctated in

Ying-p'u style, was found in the deepest level of the site. All the other ceramics at Chiu-she were undecorated and were made of grey paste. It should be pointed out that grey undecorated sherds were also present at Ting-chieh and Niu-ma-t'ou, but these more resembled the red paste sherds also uncovered there than the undecorated grey sherds of Chiu-she. In fact, at neither Niu-ma-t'ou nor at Ting-chieh were any deposits containing only black and dark grey paste ceramics excavated. In each case, the levels with the highest concentrations of black pottery also contained an even greater quantity of very late Hillside red paste pottery.

On the basis of the ceramics and site locations, these five sites can tentatively be assigned to three temporally successive categories:

- a. Transitional—Niu-ma-t'ou, Ting-chieh
- b. Classic—Ying-p'u
- c. Late—Chiu-she

The assignment of Chuang-hou-ts'un is likely to be either in (a) or (c). The site of Ying-p'u has been dated with three radiocarbon determinations which firmly place it between 1000 B.C. and 300 B.C. (Chang 1969: 206). The site at Chuang-hou-ts'un has had one radiocarbon date of about 100 B.C. (Chang 1974b: 273). The dating of the deposits at Ting-chieh and Niu-ma-t'ou is not clear but may be close to that of Ying-p'u; thus the foregoing classification may reflect relationships other than merely chronological.

The stone tools associated with the occupation levels for the Ying-p'u Settlement period do not fundamentally differ from those of the preceding period. Thus, there is little evidence of any major shift in the economy of the occupants from the Hillside Settlement period. It is likely, however, that the shift in residence location effected changes in other aspects of the cultures. At the present time, it is impossible to explain the shift satisfactorily. It is interesting to note, however, that the two main changes from the Hillside period, site location and ceramic style, may not have occurred at the same time. Both Niu-ma-t'ou and Ting-chieh stratigraphies can be interpreted plausibly as showing evidence of a period of change in ceramic styles, including a gradual, not abrupt, replacement of the red paste wares by dark grey, followed by an abandonment of the excavated portions of the sites.

A change of residence location of a largely agricultural group may imply a parallel shift in the nature of field locations. (In this case, we have no other resources which we can identify on archaeological grounds as relevant.) It is likely, given the distance of the Ta-tu-shan slopes from Ying-p'u, that at this time the fields themselves were moved out onto the coastal plain. If the earlier period were characterized by a diversity of field types due to diverse edaphic conditions and crop regimes, then the location of a larger number of fields on the moister and more level plain would be likely to result in a change both of the types of crops which were most frequently grown and in the yields of each crop. Plausibly, there would be an increase in the proportion of crops requiring the most water, and a possible decrease in crops preferring more well-drained soils.

Husks excavated at Ying-p'u have been identified as rice (Chang 1969: 206). The significance of this discovery is uncertain. Rice was an aboriginal crop on Formosa, although by no means the dominant staple. Further, rice seems to have

only been grown in swiddens before the period of Chinese immigration. The assumption that the shift from the hillsides to the plain was due to the use of the newly drained, moister coastal plain for wet rice agriculture has yet to be supported. Given that the first evidence for rice paddy construction does not predate the first major Chinese emigration to Taiwan in the seventeenth century A.D., the hypothesis seems less than probable. Following a line of reasoning similar to Gorman's (1977), and in view of the well-established evidence for rice agriculture on the mainland at least during the fourth millennium B.C., I feel that the Ying-p'u rice husks must be regarded as the earliest known *archaeologically* for central Taiwan, but cannot be used to date the first appearance of rice on the island.

An alternative suggestion would be that the site location was purposely chosen to maintain close proximity to the shoreline of the Straits of Taiwan. Thus, as the shoreline retreated, so the settlement locations followed. Until direct evidence of the importance of the littoral area for the Ying-p'u settlers is available, such a hypothesis is also not supportable.

A third set of hypotheses is based on the premise that the occupants of the villages of the Hillside Settlement period and those of the villages of the Ying-p'u period were not genetically related. Sufficient skeletal evidence available to test this hypothesis directly, to the best of my knowledge, does not exist (see, however, Sung and Chang 1954). Further, if the occupants of the final levels of Niu-ma-t'ou and Ting-chieh are included in the Ying-p'u Settlement population, this indirect evidence suggests a transition in the human populations, just as there seemed to be in the assemblages.

#### *Shellmound Settlement*

The appearance of village sites with large mollusc shellmounds marks the start of the third period of settlement along the coast. Two such sites were recently excavated by Sun (n.d.). These are Lung-chuan-ts'un and San-chiao, which are located between Niu-ma-t'ou and Ting-chieh. Similar sites have long been known from the coastal region, the most important of which are the shellmounds at Fan-tzu-yuan (Shih and Sung 1956; Sung 1962) and Pa-kua-shan (Kanaseki and Kokubu 1953).

In Chang's description (1974b, 1977) of the cultural phases of the Choshui-Tatu study area, these sites are classed under the term *Protohistoric*. In his previous summary (1969), they were classed as representatives of the Fan-tzu-yuan Horizon. In both accounts, these terms refer to cultural phenomena occurring throughout the central Formosan area. On the coast, sites of this phase are most readily identified by the presence of shellmounds; in the interior, while the extensive shellmounds are absent, many characteristics of the ceramic and stone tool assemblages are very similar to their coastal counterparts.

While the location of the Shellmound Settlement sites is not dissimilar from the preceding period, the use of large quantities of shellfish gives active voice to an orientation both to the littoral and to the importance of shellfish gathering as a subsistence activity. Similarly, the excavators of the Yuan-li Shellmound reported the remains of several species of wild animals, including deer, monkey, and wild boar, as well as the dog (*Canis familiaris*; Su 1959, quoted in Chang 1969: 207), again providing more evidence of hunting and gathering activity than has been

recovered from earlier sites in this area. There is little reason to doubt that the shellmounds document the intensive use of sea mollusca for the first time, but it is by no means certain that there was an increase in the importance of hunting and gathering in this settlement period. While such a shift is a reasonable possibility, quantification of this problem seems especially difficult because of the totally inhospitable preservation conditions uncovered in many of the earlier Hillside and Ying-p'u Settlement period sites.

#### THE COASTAL REGION AND THE INTERIOR

Origins are a constant concern of archaeologists, and the origins of the earliest settlers in a region attract especial attention. While a Pleistocene occupation has been uncovered on the east coast of Formosa at the site of Pa-hsien-tung (Sung 1969), no cultural material of similar age is known from the rest of the island. A human parietal, however, dated well into the Pleistocene, has been recovered in T'ai-nan Hsien (Chang, personal communication). The earliest sites known for the central Taiwan area are Ts'ao-hsieh-tun Phase. At several of these sites (P'ing-lin IV, Niu-ma-t'ou, Chuang-hou-ts'un, Lung-chuan-ts'un, Ting-chieh, and possibly Tung-chiao; Chang 1974b: 271), some recovered sherds have been identified as similar in style to those found in association with the Corded-Ware Culture stratum at Ta-p'en-k'eng in northern Taiwan (Chang 1969: 164-171). At Niu-ma-t'ou, the earliest material recovered was distinguished stratigraphically and typologically from the succeeding Level II material. The Level II material, assigned by me to Middle Hillside, can be considered as representative of the classical Ts'ao-hsieh-tun Phase. The most striking of the TPK-style sherds occurred in the underlying Early Hillside settlement level. A comparison of the somewhat meager Early Hillside assemblage with that of the overlying assemblage, however, led me to argue that this material was *not* of the Ta-p'en-k'eng Corded-Ware Culture, but that its closest cultural affinities were with the Ts'ao-hsieh-tun Phase materials. Thus, the material has been classified as belonging to the earliest part of the Ts'ao-hsieh-tun Phase, not as a distinct earlier cultural phase.

The origins of these earliest coastal settlers are not readily identified. While the culture is clearly distinct from the northern TPK Corded-Ware Culture, a relationship with it seems to be indicated by the presence of very distinctive TPK Corded-Ware traits, most especially the incised, ridged rims. While for neither the TPK Corded-Ware Culture nor the Early Hillside settlers of Niu-ma-t'ou is more than the general form of the ecologic and economic conditions of life perceivable, there is little reason to believe now that they are necessarily very different from each other. Further, there is one other excavated example of an apparently near-contemporaneous Corded-Ware Culture site, that of Feng-pi-t'ou, on Taiwan's southwest coast (Chang 1969: 53-59). In 1969, Chang described the earliest cord-marked pottery sites from the southwest and the northwest of Taiwan as regional clusters of the same culture, distinguished by some stylistic traits (Chang 1969: 217). In a chronological chart (Chang 1969: 216) he indicated the presence of the Corded-Ware Culture at all areas along the west coast, with the exception of the central region, which he marked with a question mark, correctly perceiving the later date of the Fine Red Cord-Marked ceramics.



The materials excavated from the Early Hillside settlement at Niu-ma-t'ou and the recovery of similar material at other Ts'ao-hsieh-tun Phase sites tend to replace that question mark with a certainty: The earliest ceramic assemblages in all well-known regions of the west coast share stylistic affinities, and hold forth the possibility of descent from a common parent culture. Many questions remain. It is perhaps significant that at both Ta-p'en-k'eng and Feng-pi-t'ou there was a distinct gap between the Corded-Ware Culture deposits and the overlying materials, while at Niu-ma-t'ou the earliest materials clearly grade into, and may not be distinct from, the Ts'ao-hsieh-tun Phase. It may suggest the Early Hillside component is later than the Corded-Ware Culture occupations at Feng-pi-t'ou and Ta-p'en-k'eng. It is not now possible to identify either Ta-p'en-k'eng or Feng-pi-t'ou as the earliest ceramic site of Taiwan, and the location of any conjectured parent culture to TPK Corded Ware, FPT Corded Ware, and NMT Early Hillside is at present indeterminable.

An alternate possibility exists, however, to explain the similarities of the NMT Early Hillside materials and those of the Corded-Ware Culture at the north and south ends of the island. The similarities may be the result of a diffusion of ceramic styles and technology from the Corded-Ware Culture to another, resulting in the NMT Early Hillside. In this case, there need be no single parent culture, but the origins of the Early Hillside materials are then unknown, for there is no site now known which may represent the culture receiving the diffusion of the Corded-Ware Culture ceramic styles. The possibility exists that there may have actually been an occupation of the west central region by the Corded-Ware Culture itself, as suggested by the chronological chart in Sung and Lien (1975). To date, however, no evidence of any such occupation is available.

One hypothesis concerning the history of the Corded-Ware Culture can be discarded. It has been widely proposed that the discontinuity in the Jih-yueh-t'an (Sun-Moon Lake) pollen core at about 9000 B.C. was due to the agricultural activities of people associated with the Corded-Ware Culture. The failure to find any evidence of an occupation of any culture in this region at such an early date suggests strongly that the discontinuity must be explained in another fashion (Dewar 1977a; Stamps 1977: 279-281).

The three sites we have been discussing (Ta-p'en-k'eng, Feng-pi-t'ou, and Niu-ma-t'ou) are all located near the coast, and while this may have some significance, it is also true that one other major Corded-Ware Culture site has been excavated, and it is not located on the coast. This is the site of Yuan-shan, located in the T'ai-pei Basin (Chang 1969: 211). Thus, the possibility exists that the distribution of known Corded-Ware Culture and related (as at Niu-ma-t'ou) sites is only an artifact of sampling. In the central region in particular, while Niu-ma-t'ou is the best documented case, the appearance of TPK-like elements in the pottery at two noncoastal sites (P'ing-lin IV, Tung-chiao; see Chang 1974b: 271), and our inability to accurately place the sites in a chronological framework, require some caution in this generalization. One possibility is that the presence of this tradition along the coast may give evidence of the routes of communication among the three areas. While the areas intermediate between the southwest coast and the project area and the northwest and the project area are very poorly known archaeologically, environmental conditions in each of those areas may have made them less attractive

to early settlers. The area to the north of the project area, especially near Hsinchu, has a much more narrow coastal plain than either the project area or the north-western region near the T'ai-pei Basin. While the topography of the area intermediate to the Choshui-Tatu region and the southwest is not as distinctive, it should be noted that both of these areas were until recently of less agricultural potential than any of the areas in the vicinity of Feng-pi-t'ou, Niu-ma-t'ou, or Ta-p'en-k'eng (see Hsieh 1964: 275-280). These latter three areas are among the most productive rice areas in Taiwan, while the area in the vicinity of Hsinchu is given to mixed farming on the hills, and the plain near Chia-yi was principally devoted to sugarcane until the recent construction of irrigation facilities, due to the presence of an especially long dry season. While it could be argued that the environmental conditions necessary for the production of rice may have little to do with the conditions most suitable or attractive to early agriculturalists, the association may well be nonrandom.

The absolute chronological positions of the Corded-Ware Culture and the NMT Level I Early Ts'ao-hsieh-tun are for the moment unclear. One radiocarbon date is available for the Corded-Ware Culture in the southwestern area ( $5480 \pm 55$  B.P. (Chang 1973: 525)), and the site of Ts'ao-hsieh-tun itself has a single radiocarbon date of 4000 B.P. (both 5568 half-life; Chang 1974b: 271) from a layer probably postdating Level I at Niu-ma-t'ou. Similarly, dates from Feng-pi-t'ou and Ta-p'en-k'eng (Chang 1969: 265) from the overlying occupations suggest a date for the Corded-Ware Culture "... [antedating] by a considerable interval ... 2500 B.C." (Chang 1969: 217). The date from Ts'ao-hsieh-tun suggests that the Ts'ao-hsieh-tun Phase may have a starting date of near 2500 B.C., and the dates for Level I material from Niu-ma-t'ou should closely approximate that. If so, the material from both Feng-pi-t'ou and Ta-p'en-k'eng will still be the earliest.

There is, however, little doubt that the occupations along the coast labeled Middle Hillside Settlement period are local developments out of the Early Hillside Settlement period. The reported presence of diagnostic TPK-style sherds at the majority of Ts'ao-hsieh-tun Phase sites and the nature of the stratigraphic relationship between Levels I and II at Niu-ma-t'ou make other interpretations implausible. During the Middle Hillside period, the locations of Ts'ao-hsieh-tun Phase sites included the coastal hillsides and also the lower river terraces and the inland perimeter of the T'ai-chung Basin. While the ecological conditions in the vicinity of these more inland sites were certainly different from those along the coastal hills, the importance of this factor is uncertain. Different resources would be located at different distances from sites in each area, but the most important measure of ecological difference would quantify only the differences in relative ease of access to those resources most important to the inhabitants. Without a detailed understanding of the nature of those resources (which might include fresh water, land of certain slope, soil, moisture and/or exposure, microzones where important plant resources were located, etc.) utilized and essential to settlement, measuring the degree of ecological difference is, as a practical matter, impossible.

At Ts'ao-hsieh-tun itself, there is one striking difference. Of all the sites excavated for the phase, this is the only site which is not located on a hillside terrace or slope. Instead, Ts'ao-hsieh-tun is located on the floor of the T'ai-chung Basin, albeit at a present elevation (90 m above sea level) even higher than the coastal sites'

current elevations (Tsang 1977). The processes which transformed the T'ai-chung Basin from a small bay into a drained basin during the Holocene, however, are complex and very poorly dated. As a result, the precise extent of flooding at the time of the occupation of Ts'ao-hsieh-tun is unknown. Ts'ao-hsieh-tun is also the only well-excavated site of its phase in which the early diagnostic TPK-style sherds were not reported (Chang 1974*b*: 271). It may well have been settled later than the other excavated Ts'ao-hsieh-tun Phase sites (it should be noted that the presence of TPK-style sherds in surface collections probably biased the choice of sites of this phase for excavation). It is possible that at the time of first Ts'ao-hsieh-tun Phase settlement (Early Hillside on the coast) the basin was still uninhabitable. After an elapse of years, the draining basin allowed for settlement at areas close to the eastern perimeter, as at Ts'ao-hsieh-tun itself. If this is the case, then the process which resulted in the changes of settlement location between the Hillside and Ying-p'u Settlement periods along the coast may have begun earlier, during the Ts'ao-hsieh-tun Phase (at about the time of the Middle Hillside), but at locations away from the coast.

The Late Hillside Settlement period along the coastal terraces derives from the Middle Hillside, and is, in fact, little distinguished from it. The ceramics are distinguished from those of the Middle Hillside by the presence of more plain than cord-marked sherds, and by an increase in the number of dark grey sherds. The plain sherds are *not* identical with those common to the Ta-ch'iu-yuan Phase sites, principally located in the interior, although they are probably contemporary. It seems possible that the fashion for plain vessels may have come from the interior, but other characteristics of the ceramics, including color, paste, and rim modes, are both little changed from the Middle Hillside and quite distinct from the ceramics of Ta-ch'iu-yuan Phase sites.

As Chang notes (1974*b*: 272), the Ta-ch'iu-yuan Phase was a time of expansion of populations into higher elevations in the interior. Along the coast there was also an increase of the number of occupations. However, the ceramics of the coastal sites, assigned to Later Hillside, are little different than those of the preceding period, and distinct from the ceramics of the interior. This is the first indication of the development of partially independent cultural traditions within the Choshui-Tatu River Valleys. At present, there are insufficient data to explain this satisfactorily (but see the following).

During the Ta-ma-lin Phase, the diversity of settlement locations continued to increase. The number of sites encountered in surveys also increases. In the coastal region, the Ying-p'u Settlement period is noted for the occupation of locations on the lowlying coastal plain (as at Ying-p'u itself) and the abandonment of some of the hillside settlements (as at Niu-ma-t'ou and Ting-chieh). The Ta-ma-lin Phase, throughout the study area, is the time of the virtually complete transition to black or dark grey ceramics. Along with the apparent increase in the number of settlements in this period, there is a further expansion of the area over which these settlements were located (Chang 1974*b*: 272-273). As the diversity of the ecological zones in which settlements were located increased, there was a parallel increase in the variety of tools recovered from the sites.

Before we speculate on the explanation of this horizon, the degree of contrast present in these sites should be examined. Perhaps the most important sites of this

phase are those at Ying-p'u and at Ta-ma-lin, in the P'u-li Basin. Both of these have long been considered as characteristic of the phase, and at each location a very similar black pottery was recovered (Chang 1969: 205-206; Stamps 1977). The tool assemblages are quite different and are discussed below. The conclusion that the differences between tool kits represent differing patterns of economic activity seems inescapable.

At Ying-p'u, the following types of tools are reported by Chang (1969: 206): "rectangular adzes, chipped and polished knives, and a few other types of implements." At Chiu-she, the lithic inventory consisted entirely of tools likely to serve in the clearing and maintenance of fields (adzes, axes, hoes), woodworking, and the harvesting of fields, with the sole exception of two possible net sinkers. At Ting-chieh in the Level II Ta-ma-lin Phase component and at Niu-ma-t'ou in the contemporary Level IV component, the tool inventories are almost completely devoted to agricultural pursuits, with the exception of two net sinkers at Ting-chieh and a single projectile point at Niu-ma-t'ou.

By contrast, the artifact assemblages from the P'u-li Basin sites included (Stamps 1977; Shih 1953; C. Liu 1956) net sinkers (in much larger numbers), *ko* halberds, and arrow points, as well as stone hoes, reaping knives, and adzes. In the nearby Jih-yueh-t'an (Sun-Moon Lake) Basin, Liu and Liu (1957) reported a similarly varied tool kit, collected at 13 localities, all presumably assignable to the Ta-ma-lin Phase. These tool kits included substantial evidence of hunting as well as agricultural pursuits.

It is interesting to note that these differences are not simply the result of differences in settlement location and concomitant ecological variation, but reflect as well developmental changes which occurred through time. The assemblages of the preceding Ta-ch'iu-yuan Phase, located along the middle courses of the rivers, and presumably those ancestral to the occupants of the middle stream course and highland basins of the Ta-ma-lin Phase, do not show a tool type distribution similar to that of the Ta-ma-lin assemblages. "The limit of the red pottery cultural expansion was in the area between Shui-li and Chi-chi in the Choshui River valley system where the TCY [Ta-ch'iu-yuan] site is located" (Koyama 1977: 358). At this site, the overwhelming proportion of tools recovered were clearly agricultural in use. Koyama summarized his findings as follows: "A community consisted of about 60 people forming a fairly sedentary village with agricultural fields close to the village. Hunting by bow and arrow was not a dominant subsistence effort. Fishing was also a minimal activity in this stage" (Koyama n.d.: 4-5).

In the immediate vicinity of Ta-ch'iu-yuan is located the site of Tung-chiao, where components of both Ta-ch'iu-yuan and Ta-ma-lin phases have long been known. One interpretation for the distribution of sites in this area, and the differences in tool kits between the red pottery sites and the black pottery sites, has proposed not a temporal ordering, but rather envisions a contemporary occupation of the area by two distinct ethnic groups with different ecological requirements (Treistman 1972). Good evidence of contemporary occupation is unavailable, and the most parsimonious explanation suggests a temporal sequence here as elsewhere in the central Formosan area. On the other hand, ethnic or linguistic homogeneity is unlikely to have characterized this area in the last two thousand years, at least, and

recent work, especially that of Jean Treloggen Peterson (1977), may suggest a degree of *a priori* likelihood to Treistman's hypothesis.

In the P'u-li Basin, the earliest sites encountered, described by Stamps (1977) as of the Shui-wa-ku period, have lithic inventories nearly identical to those of the succeeding Ta-ma-lin period. The only additions to the lithic assemblage during Ta-ma-lin times were a few new arrow point variations (Stamps 1977: 275). This led to the conclusion that the "subsistence pattern" of the two periods was similar. However, the black paste pottery similar to Ying-p'u, for which the site of Ta-ma-lin has long been known, is not dominant in the assemblage until the Ta-ma-lin period. Thus, if any changes or developments in subsistence techniques were necessary before occupation of the highland basins was possible, these changes occurred before the dominance of the Ying-p'u type of pottery in the ceramic assemblage. Similarly, the increase in the area of occupation might be said to represent the necessity of more arable land due to regional population increase (as perhaps measured by the increase in the number of known sites for the Ta-ma-lin Phase). If so, then the demographic impetus was also felt in the highland basin area before the major shift in the ceramics.

The Ta-ma-lin Phase on the coast (Ying-p'u Settlement period) gives little evidence of any major shift in economic base from the preceding settlement period, except with reference to site location. The evidence from Niu-ma-t'ou and Ting-chieh points not to a population replacement at the end of the Hillside Settlement period, but rather to a transition in ceramic style and site locational characteristics. While it is clear that the ecologic determinants of settlement in the highland basin regions and along the coast are quite different, in each area it can be stated that the transition from the previous phase occurred in steps, with settlement changes preceding ceramic changes in the highlands and the reverse along the coast. This argues against population replacement or changes in ethnic group as *the* cause of the shift to the Ta-ma-lin Phase.

The site of Ying-p'u has three radiocarbon dates:  $2970 \pm 80$  B.P.,  $2810 \pm 100$  B.P., and  $2250 \pm 60$  B.P., corresponding to a range about 1020 to 300 B.C. (Chang 1969: 265). The nine radiocarbon dates from sites in the P'u-li Basin break into two clusters: (a)  $3282 \pm 100$  B.P.,  $3207 \pm 96$  B.P., and  $2994 \pm 90$  B.P.; (b)  $2381 \pm 71$  B.P.,  $2197 \pm 66$  B.P.,  $2104 \pm 63$  B.P.,  $1846 \pm 55$  B.P.,  $1837 \pm 55$  B.P., and  $1783 \pm 53$  B.P. (Chang 1974b: 273; Stamps 1977). The first cluster (approximately 1350 to 1050 B.C.) is associated with the Shui-wa-ku period. One date from the second cluster (431 B.C.) was also associated with Shui-wa-ku materials. The remainder of the second cluster of dates (c. 250 B.C. to 200 A.D.) are from the site of Ta-ma-lin and are associated with the Ta-ma-lin period of the P'u-li Basin. Stamps suggests that the period of major influence from the coast became apparent about 247 B.C. Thus, the initial settlement of the P'u-li Basin (Shui-wa-ku period) occurred slightly earlier than the earliest date for Ying-p'u settlement. Contact between the highlands and the coast (demonstrated by the ceramics) follows almost a millennium later.

As a cultural phase, the Protohistoric is defined principally by chronology. It is the period of time, perhaps a millennium in length, during which the distribution of Formosan aborigines developed toward the pattern present at the onset of significant Chinese emigration in the seventeenth century (Kano 1946, 1952;

Miyamoto 1956; Chang 1959, 1964, 1969: 240–247). Useful analysis of this period of time requires, first, an excellent understanding of the distribution of the various ethnic groups (see Chang 1964: 199; Treistman 1973; Kano 1952 for cautionary statements in this regard), and second, the excavation and analysis of sufficient sites of this period, and especially the later portions of it, to allow the referencing of ethnohistoric and archaeological data. Failing these requirements, discussions of the interregional relationships during this period must be limited save for the fact that this period must represent a continuation of the trend toward increasing local diversity. At the close of this period, the first visitors to the west central coast encountered about a half dozen different languages and associated ethnic groups (Ferrell 1969*b*: 159). The Chinese and Dutch records have been summarized and codified especially well for the west central coastal region (Y. Chang 1965; C. Liu 1958; Ferrell 1969*b*), but these data postdate a period of change for the aborigines, since the first contact with the Dutch and Chinese had already occurred. No archaeological sites yet excavated in this area give good evidence of transition into the Protohistoric period. Archaeological remains can probably be identified with an aboriginal group in only one location in the region (Shih and Sung 1956).

#### CONCLUSIONS

The earliest known occupation of the Choshui-Tatu Project area is clearly related to the earliest occupations known in Taiwan—those of the Corded-Ware Culture. At the beginning of recorded history in Formosa, roughly the seventeenth century, this area was, as all of Taiwan, a home for several ethnolinguistically distinct groups. The explanation of the development of this ethnic diversity, however, is still beyond our capacities. No explanation which is simply a function of ecological diversity will serve, for the patterns of resource distributions are far from simple in this area (and, especially in the case of mammals and birds, poorly known). As a simple example, an attempt to contrast coastal and highland basin settlements of the Ta-ma-lin Phase as “coastal farmers” versus “highland hunter-farmers” can be called into question by the fact that the best collection of land mammal faunal remains in the region comes from a Protohistoric Phase coastal shellmound.

The Jih-yueh-t'an (Sun-Moon Lake) pollen core which led to speculations about human occupation in this area more than 10,000 years ago must now be viewed as partially unsupported by more recent work, and the resulting speculations as probably unfounded.

#### ACKNOWLEDGMENTS

This research was supported in part by a Dissertation Improvement Grant (GS-38474) from the National Science Foundation (Program for the Social Sciences). During field research, the author was a research assistant in the Institute of History and Philology, Academia Sinica. The useful results of this research are to be attributed to those in Taiwan and in the United States who so graciously assisted me. Among others: Professors Yih-yüan Li, Wen-hsun Sung, Ch'u-hsun Kao, Kwang-chih Chang, Harry Merrick, and Irving Rouse, as well as Chen-hua Tsang, Shih-ch'ang Lo, Ch'uan-k'un Ho, Shih-ch'ang Huang, Pao-kang Sun, and Chao-mei Lien.

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