tyryl cyclic AMP may also be more effective in promoting elongation because it is less susceptible to phosphodiesterase activity (*6*) and thus may attain a higher intracellular concentration. This possibility is at present under investigation.

Axonal elongation is directly dependent on microtubule formation (*5*). This elongation occurs in the presence of inhibitors of protein synthesis (*7*), which suggests an intracellular subunit pool. We therefore believe that cyclic AMP and its dibutyryl derivative stimulate axonal elongation by initiating tubule assembly from a preexisting pool. Support for this hypothesis comes from the recent work of Gillespie (*8*), who has shown that cyclic AMP stimulates microtubule assembly in several rat tissues.

Another agent known to stimulate axonal elongation in similar cultures is nerve growth factor (NGF) (*9*). Using the techniques described above, we have begun to compare the growth-promoting activities of cyclic AMP with those of NGF. We have some evidence that leads us to the interesting possibility that NGF acts through cyclic AMP stimulation of microtubule assembly as a "second messenger system."

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Prehistory of the Formosan Uplands

Abstract: *Recent archeological surveys in the central mountain ranges of Formosa show human occupation of considerable antiquity. The pattern of ecological adaptation which dichotomizes Southeast Asia characterized prehistoric Formosan settlement.*

The cultural ecology of aboriginal Formosa shows the adaptive dichotomy between uplands and plains that is typical of Southeast Asia. The time depth of this pattern of adaptation was suggested by the results of archeological survey and trial excavations made in the high central mountain range of Nant'ou District (see Fig. 1). Shallow terrace formations along the slopes of the mountains which rise precipitously from the Ch'en Yu Lan River are dotted with surface concentrations of chipped, flat, stone "hoes" and eroded potsherds. In addition, the chipped stone hoes were found thinly scattered over the slopes for miles around. Three small excavations were made in the area of the five hamlets that compose the village of Tungp'u (altitude 1000 m). The density of artifacts suggests that these areas of concentrated debris were centers of occupation, although no indications of houses were discovered. One charcoal sample has been submitted for analysis; it derives from the upper portion of the occupation layer, which is about 95 cm thick. This sample (GX-1538) was dated by carbon-14 at 1165 ± 110 years ago (A.D. 785 ± 110).

The stone artifacts are made of locally derived material, mostly slate. They are all chipped along the lateral edges and some show use-polish on the flat surfaces. Several are notched at the butt end. The hoes are thin in section and average 15 cm in length. No other type of stone artifact was discovered.

The pottery is homogeneous in color and composition; it is all a low-fired brown ware with sparse, fine grit inclusions in the paste. Almost all the pottery has textured surfaces achieved during manufacture by beating the clay with carved wooden paddles. Check-stamping predominates, but some triangular and herringbone patterns occur. Less frequent were designs produced by use of the cord-wrapped paddle (see Fig. 2). Although no reconstructions are possible, rim sherds indicate that the most common shape of vessel was a wide-mouthed jar of medium size.

The function of the stone tools is suggested by the horticultural practices of the contemporary settlers in the region, linguistically identified as Bunun and Tsou. The primary working implement is a short-handled hoe with which the very steep slopes are carved into narrow terraces, protected from soil runoff by stone embankments set into the hillside. Millet and sweet potatoes are grown on these terraces after the natural vegetation has been burned off. The people in the villages today easily identify the stone hoes as tools used by their "ancestors."

The aboriginal groups living in the central mountains have a population density of less than 83 per square mile (32 per square kilometer) (*1*). The settlement pattern appears to vary in relation to altitudinal zones: the Bunun, who inhabit the zone above 1000 m (30 percent live above 1500 m) live in small hamlets of dispersed homesteads, while the Tsou, over half of whom live below 1000 m, have centralized villages with satellite hamlets. The Atayal, distributed in the same zones, have occupied the high river valleys, where small dispersed villages tend to have alliances within each drainage system. The subsistence diet consists of cultivated millet and tubers and some fruits, augmented by birds and small game. Recently abandoned village sites indicate a good deal of small-scale movement, while the annual routine of each family also involves migration through a considerable territory.

Observation of widespread archeological remains in the Tungp'u region suggests the antiquity of this adaptive pattern. This is reinforced by the radiocarbon date which verifies settlement of the uplands well before the Chinese migrated to the west Formosan plain. We can hypothesize that at an early, but as yet unknown, date, a people with a fully established upland style of life had covered the central mountain ranges with a thin blanket of population. They engaged in cultivation of millet and tubers and exploited the diversified natural resources of the environment. The dispersed settlement pattern was a function of their subsistence technology. There is no reason to postulate a prior existence on the plains which would have been characterized by an entirely different lifestyle. What is not yet understood is the prehistoric relationship between the hill peoples and the rice-agriculturalists of the lowlands. The extent of symbiosis or even transhumance is still to be investigated.

The apparent congruence between prehistoric and ethnographic data cited above suggests a way out of the dilemma of "explaining" the extraordinary aboriginal cultural and linguistic diversity found in Formosa. Ethnologists, linguists, archeologists, and even physical anthropologists have, over the last 70 years, devised schemata for classifying this diversity in comprehensible categories.

Without exception, these devices rely on the recognition and description of isolated traits. The ethnologists have seized on characteristics ranging from type of marriage system, house styles, and origin myths to the presence or absence of wood carving and facial tattooing (*2*). Linguists have measured lexical distance between the languages of aboriginal Formosa (which are all Austronesian) and have proposed systems of classification which contain from three major groups to over 20 (*3*). Attempts have been made to equate lexical and cultural trait clusters and distributions with the anthropological designation "tribe," although the latter term is itself undefined in the Formosan or Chinese context.

The archeologist has extended this method by naming prehistoric remains (usually pottery) as "cultures," and using the approach of ethnogenesis, even searching for clues to "tribal" origins in the ancient ceramics (*4*). The physical anthropologist has also used the "trait" notion, suggesting that skin color, average body height, and relative ability to taste phenylthiocarbamide can be used as criteria descriptive of "tribes" (*5*). In addition to violating reasonable concepts of culture, or perhaps as a result, it has been necessary for these investigators to invoke waves of populations, migrating to Formosa, variously from southwestern China, the southeastern coast of Asia, the region of the central plains in northern China, the Philippines, and Indochina. These migrations are then used to explain the cultural diversity found in Formosa.

Another difficulty is presented by the grossly disparate descriptions of aboriginal conditions given by the Dutch colonists of the early 17th century and those written by the Chinese settlers who arrived in great number during the 18th century. The Dutch have left accounts of aboriginal groups living in the central mountain ranges and on the western coastal plain. Their interest in the mountain people was stimulated by an active trade in deerskins, brought down from the hills by the hunters. Where the Dutch noted cultural diversity, the Chinese tended to lump all aboriginals into one population, emphasizing the notion that the aborigines were *pushed* out of the plain and into the mountains by the swelling agricultural population emigrating from the mainland (*6*).

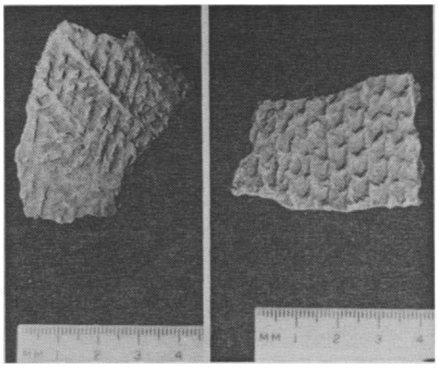

Fig. 2. Textured pottery sherds from Tungp'u.

A serious problem raised by these early documents and all anthropological studies thus far is the lack of correspondence between systems of classifying and naming aboriginal groups. The fluidity of categories reflected in this research results in part from the biases of the "classifiers," but more importantly indicates what is likely to be the historical reality: considerable shifting and melting of boundaries between ethnic units. This conclusion is supported by new evidence for a prehistoric time depth that would allow for internal differentiation and indigenous culture change apart from external pressures. This time depth is lengthened by the discovery in a cave site on the eastern coast of Formosa (Chang P'in) of a flake-tool industry in a preceramic context. The earliest known occupation of the island has been extended by this discovery to an anticipated horizon of at least 10,000 years (*7*).

A further hypothesis can be drawn from the preliminary survey of upland prehistory and the ethnographic material. The Formosan evidence seems to reflect conditions where linguistic groupings did not necessarily corre-

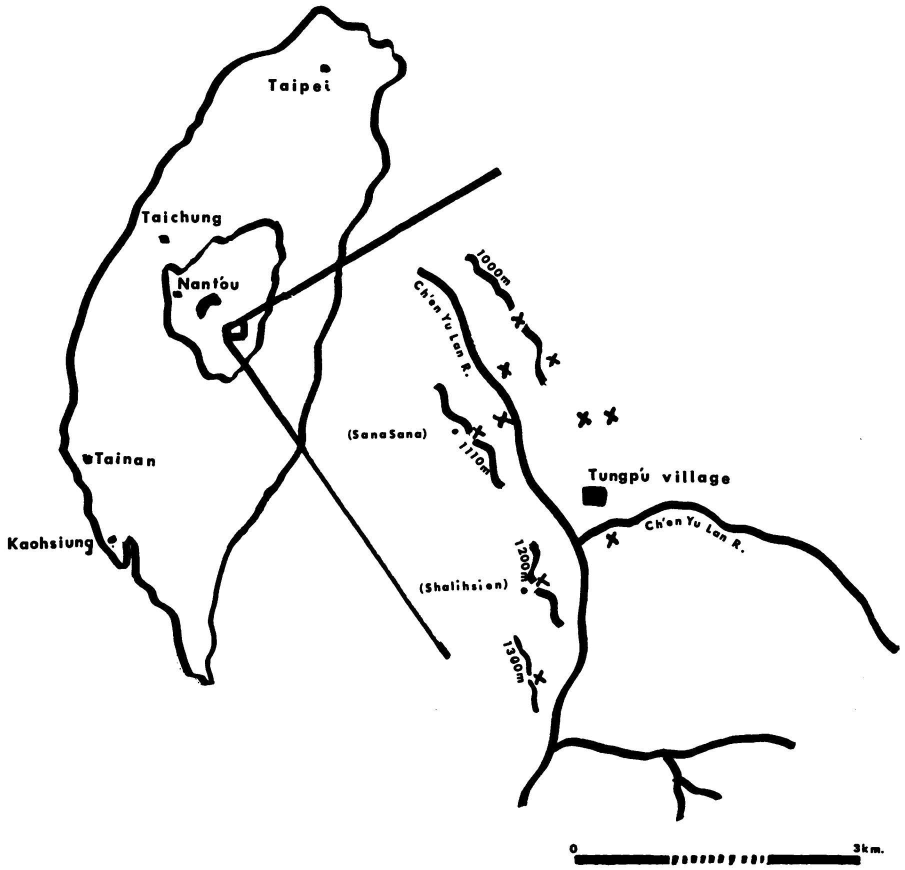

Fig. 1. Map of the Tungp'u area with sites of archeological remains indicated.

spond to societal organization but were crosscut by patterns of ecological adaptation. The notion of "tribe" is not useful either in ethnohistory or prehistory, since it is the classificatory device of outsiders (for example, Han Chinese or Dutch) and does not accurately describe the aboriginal scene at the time of contact, nor does it allow for the indigenous culture contact and change which took place.

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DNA of Rous Sarcoma Virus: Its Nature and Significance

Abstract. *Purified preparations of Rous sarcoma virus (an avian tumor virus with an RNA genome) contain small amounts of double-stranded DNA. This DNA cannot be hybridized to viral RNA, but will reanneal completely with the DNA of avian cells. Extensive substitution of bromodeoxyuridine for thymidine in "viral" DNA does not photosensitize the biological activity of the virus. These observations indicate that the DNA associated with Rous sarcoma virus is derived from the DNA of the avian host cell, and is probably devoid of any function in the life cycle of the virus.*

The principal nucleic acids of the RNA tumor viruses (oncornaviruses) are a 70*S* single-stranded RNA (the putative viral genome) and two forms of low-molecular-weight RNA (*1*). Recently, however, small amounts of DNA have also been found in purified preparations of avian (*2, 3*) and murine (*4*) oncornaviruses. This observation is of interest in view of the substantial body of evidence indicating that DNA is essential to both the replication of oncornaviruses and the induction of cellular transformation by these viruses (*5*). We now describe experiments designed to ascertain the source and significance of the DNA associated with virions of the Schmidt-Ruppin strain of Rous sarcoma virus (RSV).

Virus was propagated in secondary cultures of chick embryo fibroblasts, labeled with [^{3}H]thymidine (14 c/mmole), [^{14}C]uridine (55 mc/mmole), or [^{32}P]orthophosphate (all from Schwarz/Mann), and purified as described (*2, 6*). Nucleic acids were extracted from purified virus with sodium dodecyl sulfate and pronase (*7*), then fractionated by elution from hydroxyapatite (*8*). DNA comprises approximately 0.5 to 1.0 percent of the total nucleic acids obtained from RSV in this manner. Similar results were obtained with phenol extraction, although the recovery of nucleic acids was reduced (*2*).

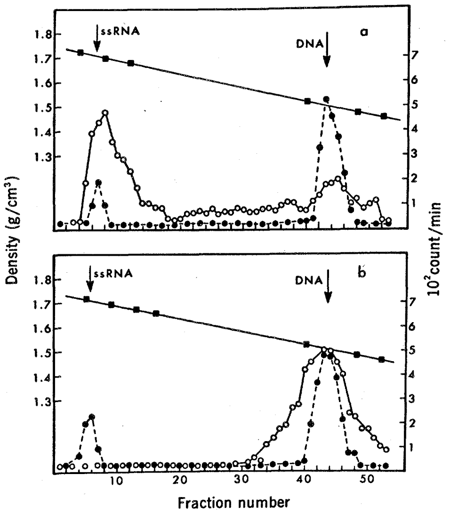

Fig. 1. Hybridization of DNA with RSV RNA. Denatured DNA (<0.1 μg) was incubated with 5 μg of 70*S* RSV RNA in 0.4 ml of annealing solution (*11*) for 24 hours at 37°C. The nucleic acids were then analyzed by equilibrium centrifugation in Cs_2SO_4 (*11*). *Escherichia coli* RNA and lambda phage DNA both labeled with ^{32}P served as density markers. (a) Virus-specific DNA synthesized by RNA-directed DNA polymerase. ^{3}H-Labeled DNA was synthesized with the virion-associated polymerase of RSV (*7, 9*), and single-stranded DNA was isolated from the reaction product as described (*8*). This DNA is entirely complementary to RSV 70*S* RNA, and consequently can be extensively hybridized to viral RNA as illustrated here and reported (*11*). ●—●, ^{32}P, count/min; ○—○, ^{3}H, count/min; ssRNA, single-stranded RNA marker; DNA, DNA marker. (b) Virion DNA. ^{3}H-Labeled DNA was extracted from purified RSV, denatured with NaOH, and incubated with 70*S* RSV RNA as described above. The amount of virion DNA (< 0.1 μg) was estimated on the basis of the specific activity of DNA extracted from the cells used to produce the labeled virus. ●—●, ^{32}P, count/min; ○—○, ^{3}H, count/min; ■, density, g/cm^3.

The DNA extracted from purified RSV is double helical, as judged by its elution from hydroxyapatite (data not shown). The standards for this analysis were the single-stranded DNA of fd bacteriophage and the double-stranded DNA of avian cells [see (*8*) for details of the procedure and its standardization]. The RSV DNA is completely denatured to the single chain form when boiled in 3 m*M* EDTA for 10 minutes or when treated with 0.4*N* NaOH at 37°C for 1 hour (unpublished observation). These data indicate that virion DNA is composed of double-stranded molecules with no propensity to "snap back" after denaturation.

Virions of oncornaviruses contain an RNA-directed DNA polymerase (*9*) which transcribes the viral RNA genome into double-helical DNA (*8, 10*). It is conceivable that virion DNA represents the product of such transcription occurring within the virion. We tested this possibility by examining the ability of denatured virion DNA to anneal with 70*S* RSV RNA, purified by rate-zonal centrifugation in density gradients of sucrose (*6*). The annealed nucleic acids were analyzed by equilibrium centrifugation in Cs_2SO_4 (*11*). As a control, single-stranded DNA synthesized in vitro by the RNA-directed DNA polymerase of RSV (*7, 8*) was reacted with a large excess of 70*S* viral RNA (Fig. 1a). Virtually all of the DNA hybridizes with viral RNA, and consequently bands at approximately the same density as single-stranded RNA. The nature and specificity of these hybrid structures have been recorded (*11*). No hybrids are formed when denatured virion DNA is reacted with 70*S* viral RNA (Fig. 1b). The breadth of the band of virion DNA is due to its low molecular weight [about 100,000 to 500,000; (*2*)] compared to that of the lambda bacteriophage DNA marker (about 30×10^6).

Failure of the virion DNA to hybridize with viral RNA under the