MARITIME ADAPTIVE STRATEGIES IN POST-PLEISTOCENE SOUTHEAST ASIA: AN ETHNOARCHAEOLOGICAL MODEL FOR THE NATURE AND DISTRIBUTION OF ARCHAEOLOGICAL SITES

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ABSTRACT

Throughout Southeast Asia, evidence of Holocene human occupation can be recovered from most beaches, strands and estuaries. Yet interpretation of such coastal sites has hitherto been limited. Was usage the same everywhere? What social structures enabled survival of such widespread and fragmented communities? Epistemologically, how can evidence of this maritime mode of adaptation be retrieved?

In this paper the authors describe an evolutionary palimpsest of sites in the Phuket region of Thailand, ranging from seasonal fishing camps through long-term base camps where "sea peoples" congregate annually during the monsoon season. Over time these base camps are modified to accommodate increased populations, but eventually a camp's carrying capacity is reached and the community splinters and moves to new but always pretested sites, following well-established dendritic sea paths linking the widely spaced econiches.

The authors develop and evaluate archaeological methodologies designed to retrieve information about the nature of sites and the degrees to which they have been exploited to the limits of their carrying capacity. Shell and other midden deposits, in particular, are critically examined for their usefulness in conveying this type of information and compared with archaeological deposits for their explanatory value.

INTRODUCTION

Ethnoarchaeology is a methodology which has considerable potential to address the epistemological concerns of archaeological research. This is especially true when time and space discontinuities, which so often seriously limit the validity of the analogies drawn, can be controlled and when it is possible to collect comparative data over a long enough span of time to observe the formation and transformation of what will become the archaeological remains of the future.

The aim of the ethnoarchaeological work which we have undertaken is to model how subsistence strategies based on specialisation in marine resources evolved in the tropical island environment of Southeast Asia and developed into some of the unique cultures of the region. Fifteen years ago, we began our ethnographic and archaeological research on islands off the west coast of south Thailand. Over a 3-year period in the early 1980s, we studied a series of 15 sites and have updated our initial research by periodic return visits at intervals over the past 10 years.

To frame our research, we had recourse to mathematical models of spatial behaviour including "nearest neighbour analysis" and "catastrophe theory" (Postle 1980; Zeenan 1977) as well as theories borrowed from biogeography, which we will explain more fully later in this paper. We also found we had to develop and test how effectively archaeological recovery techniques can identify and interpret remains of human activity in the sandy matrix of beach sites in coastal Southeast Asia where archaeological deposits are constantly being reorganised or erased by the tides, monsoon rains and centuries of repeated human maintenance of the sites.

THE PHUKET STUDY AREA

Our research focused on the group of islands off the west coast of peninsular south Thailand, known collectively as the "Phuket Group." The Phuket Island Group has

yielded evidence which suggests occupation by people who, over the past several millennia, have increasingly specialised in exploiting the maritime resources of the area. Linked by geology, flora and fauna, as well as by material culture to the surrounding islands in the Andaman Sea, the Straits of Malacca and to Sumatra, as well as to sites on the peninsula of Thailand, the Phuket Group exhibits a wide ecological diversification. An autochthonous population of maritime hunter-gatherers exists to this day on the coasts and in the waters of the area and it is this continued presence and the opportunity for ethnoarchaeological research into the persistence of maritime adaptations which drew us to the area, as much as the wide range and large number of archaeological sites one finds throughout this island group.

Although we have ethnographic data ranging from the Burmese to the Malay border, the study area for the archaeological investigations of our project extends from Takuapa, in Phangnga Province, south to Ko Phi Phi Island in the province of Krabi. This area contains a concentration of archaeological sites located in habitats characteristic of the entire range of econiches occupied by maritime hunter-gatherers throughout the Southeast Asian archipelago for the past several thousand years (Anderson 1989: 111).

Demography of the Chaw Lay

The subjects of the ethnoarchaeological portion of our study are an indigenous population of maritime hunter-gatherers referred to in past literature as "sea nomads" or "gypsies." Traditionally, they live a peripatetic existence travelling by boat over an area extending from Burma as least as far south as the Riau-Lingga islands beyond Singapore, and ranging sometimes through the Indonesian archipelago to reach the Sulu Sea in the southern Philippines (Sopher 1977: 54-5).

Elsewhere (Engelhardt 1989: 136-9; Rogers 1992: 29-32), we have reported extensively on the ethnography of these people. Here we will limit our comments to noting that they speak dialects related to Malay (Hogan 1972). Within our study area, three sub-dialects are encountered: Moken, spoken from southern Burma south to Phuket; Moklen, spoken from Phangnga south to Phuket; and Urok Lawoi, spoken from Phuket south along the coast of Malaysia to Riau and Lingga. This linguistic variation is a reflection of very recent regional isolation and not of any material or socio-cultural divergence which we have found to be statistically significant over time. However, the ready linguistic mutability of the people is symptomatic of biogeographic principles at work which have, over time, determined the distribution of people over the econiches available in this particular environment. In order to study the evolution of this distribution pattern and because the central island of Phuket is, and has been for some time, the meeting point and common ceremonial centre for the three dialect groups, we did a major portion of our research at this node and at satellite camp sites on nearby islands associated with Phuket base settlements (Figure 1).

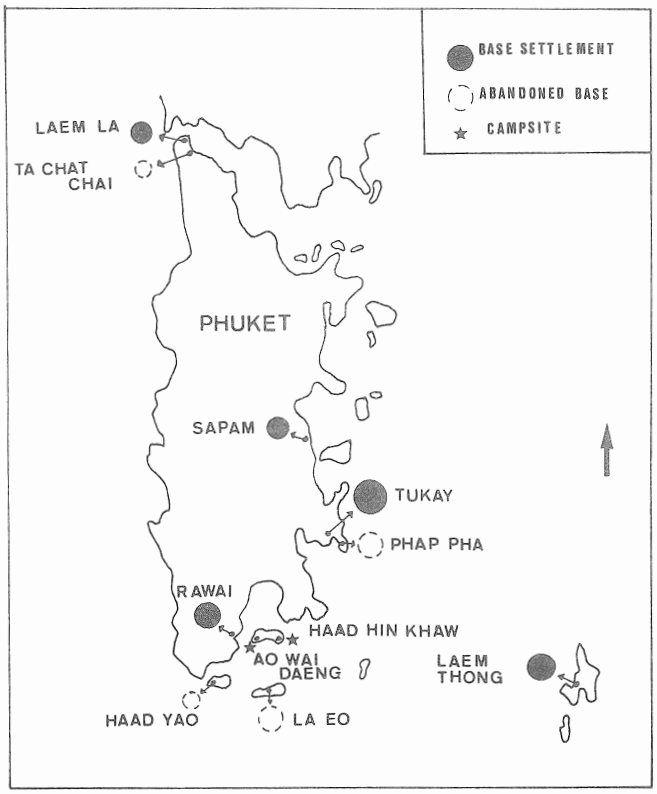

Figure 1: Map of the Phuket study area showing all sites; the size of the dot represents the relative size of the population.

The people in question refer to themselves either by the dialect they speak or, collectively in the southern Thai vernacular as "Chaw Lay." Although unscientific, we also use this collective term to break the misconception that these people are transhumant nomads, a notion that the terms "sea nomad" or "sea gypsy" perpetuate.

In 1981, there were approximately 4500 Chaw Lay living along the coast of Phangnga, Phuket and Krabi provinces, in more than 46 groups and settlements ranging in size from 2 to more than 820 people. Of these, about 1600 lived on Phuket Island itself and on the nearby islands; mostly in the 5 main settlements of Rawai, Tukay, Sapam and Laem La on Phuket and Laem

Tong on Ko Phi Phi. At the time of our original field research, there were other major groups living on Ko Surin in the north; along the Takuapa coast and on Ko Lanta and Ko Adang in the south.

The Chaw Lay are maritime hunter-gatherers, or more accurately fishermen-cum-strandloopers who specialise in the exploitation of marine resources. Fish is the basic food resource and major source of protein in the Chaw Lay diet. Its capture, preparation and consumption provides the impetus for social organisation and the inspiration for the bulk of the culture's material culture and technology. Because fish are a mobile resource, the Chaw Lay concentration on fishing requires them to maintain a mobile way of life with a compact and easily transportable material culture and social attitudes which encourage the spirit of adventure, group cooperation and an outgoing hospitable attitude to other nomadic groups they may meet on the foraging expeditions and upon whom they may have to depend for food and shelter. Fishing is the preferred occupation of all Chaw Lay. Our studies of the communities' patterns of energy expenditure show that Chaw Lay men spend 35% of *all* their time and 85% of all their *working* time out fishing. They fish primarily during the day, using hook-and-line or woven traps and return at night to their homes to sleep. On long fishing trips they will stop and spend the night at any of the many other Chaw Lay campsites near where they are fishing.

THE GEOGRAPHIC ENVIRONMENT OF MARITIME HUNTER-GATHERERS

The Thai peninsula and its offshore islands are the southern extension of a mountain range which extends northward along the Thailand-Burma border until it meets the Himalayan massif. The predominant structural trend in this part of the peninsula is roughly north-south, parallel to the mountain range. The significance of this is that natural biogeographic movement is channelled north-south along the coast; while the choice to move laterally across the Isthmus of Kra has presented technological and organisation obstacles to human groups since prehistoric times (Stargardt 1983: 3-8).

Immediately west of the peninsula lies the Andaman Sea basin. The shallow basin's inner shelf and Mergui Terrace in the eastern part of the basin are bordered on the western margin by a submarine continental slope which extends from the northern end of Sumatra to the Gulf of Martaban. The Phuket Group conforms broadly to a distinct continental slope environment whose characteristics of an abundant, diverse and stable biomass have made such regions primary target areas for prehistoric as well as more recent human exploitation.

The Phuket, Phangnga and Krabi Seas are the result of flooding of old river valleys. In Pleistocene times, the sea level was maybe as much as 130 metres lower than it is now as water was trapped in ice flows. What is now the Sea of Phuket was the mouth of the Phangnga River with the Krabi River delta feeding just to the south. As the ice melted, the delta was drowned with a maximum reached sometime between 12,000 and 7000 B.P. Since that time there has been a minor drop in the sea level.

The sea level changes at the end of the Pleistocene which resulted in the flooding of the Sunda Shelf made the Southeast Asian archipelago environmentally unique among the world's major culture areas (Chappell and Thom 1977: 281-4). One important effect of this flooding was to give Southeast Asia the world's longest total amount of coastline relative to surface area. The correspondingly high ratio of sea to land is responsible for a higher degree of climatic homogeneity than in other areas of comparable size, while the land masses of Sumatra, Java, Borneo, Luzon and the other large islands of the archipelago act as breakwaters between the Pacific and Indian oceans, thus making for ordinarily calm seas.

Other major effects of the late Pleistocene flooding were the creation of wide estuaries, increased sedimentation and the formation of extensive mudflats and swamps. These accentuated the already broken-up character of the region by sub-dividing the remaining land masses into small segregated units — islands or the ecological equivalent thereof on the region's many coasts. The region, therefore, is well-suited to be the testing ground for models of human evolution based on theories of island biogeography.

Indeed, what is remarkable from the archaeological point of view, is that virtually all of these silted-in, newly-formed coastal areas show early evidence of human habitation. It appears that as soon as mature econiches evolved, they were occupied and exploited by humans ranging over an area corresponding to the flooded continental shelf, from Mergui in Burma, along the west coast of the Thai and Malaysian peninsula, south to the islands of Singapore.

The Phuket Group is obviously only one part of a large network of maritime exploitation based on the entire area. The understanding of the possibilities of successful adaptation to maritime environments depends on an approach which does not treat isolated sites but instead takes into consideration that any of the islands is only part of a much larger interlocking network linked together by the waterways between them. The distinctive

maritime-oriented lifestyle of the peripatetic fishermen-cum-strandloopers of the Southeast Asian archipelago must thus be understood in its relationship to the area's environment and how humans have spaced themselves throughout this environment in order to best exploit its natural resources.

The Biologic Environment

If we look at the Chaw Lay's chosen environment from their own sea-focused perspective (Figure 1), we see a region of biotically-rich tropical seas, punctuated throughout by innumerable islands and coves which provide shelter from storms, fresh water and a year-round supply of shellfish, as well as fruits, vegetables and building materials from the strand forest complex. Coupled with this geographical pattern is a wide-spread, intermixed and diverse biota characteristic of both tropical and marine environments. Together, these have provided humans with staging areas everywhere throughout the archipelago from which to base exploitation of the abundant marine resources.

That the Chaw Lay have utilised these sites is confirmed by archaeological evidence we have uncovered of a Chaw Lay-like occupation pattern everywhere throughout the region's coasts; and verified by our Chaw Lay informants statements that they are a people who live on *all* islands, a statement which is confirmed by our studies of present-day site exploitation patterns among the various sub-groups.

The beaches which are the landfalls necessary to the Chaw Lay subsistence strategy are low formations, rarely more than 3 to 5 metres above sea level and composed of sedimentary material or weathered bits of shell and coral. These beaches range in size from diminutive pockets enclosed within a narrow gap between projecting headlands of harder rock to long miles of only slightly concave beaches. Behind the smaller beaches the land rises quickly. Behind the larger beaches, the land is usually low, flat and flooded at high tide and/or during the monsoon season. Small streams break through the beaches, usually at either end and act as drains. Sometimes these low lagoon areas are bordered by mangrove or nipa palms which take advantage of the protection afforded by the beach to colonise the still waters behind. Occasionally, where the shore has been continuously prograding there can be a second older, beach ridge, several hundred feet inland parallel to the present beach. This second beach, too, forms part of the preferred Chaw lay habitat.

Just beyond the line reached by the high tide, the special vegetation complex usually called "beach" or "strand forest" begins. Plants growing within this complex have developed organs tolerant of salt spray, are capable of growing in seasonally dry and nutritionally deficient sands and have seeds and fruits capable of dispersal by sea currents. The coconut is, of course, the most conspicuous plant of this complex and the one most extensively used by the Chaw Lay. While the total number of species occupying this economic is relatively small when compared to the tropical rain forest, their typically well-developed storage systems makes them particularly useful to humans. Also important to the wandering Chaw Lay is the fact that the same vegetable complex is present at virtually every beach in the area, thus making this portion of their resource base extremely predictable.

The second major coastal niche inhabited by the Chaw Lay is composed of mangrove swamps and adjacent mudflats. Mudflats are features resulting from alluvial deposition and the partial redistribution of sediment by the action of currents. They are found along the shores of shallow seas covering the continental platform in places where wave action is gentle and where much material is brought down by streams and deposited. Islands, separated by shallow straits from coasts, may also provide protection from ocean swells and permit the formation of deltaic mud flats. These widespread flat deposits of mud are periodically covered with salt water and then exposed again as the tide ebbs and flows. Streams and channels connecting with the sea, occupy shallow depressions in the mudflats, but only imperfectly drain the area. Most of these areas experience a tidal range of two meters or more and thus large expanses of mud will often be exposed. The characteristics of these mudflats are uniform throughout most of Southeast Asia and impose special biotic conditions to which only a few species have been able to adapt. These conditions include immersion in salt water, poor aeration and waterlogged viscous texture to the soil (Dyer 1979).

When the favourable conditions of a protected shoreline and the lack of a strong tidal current exist, the mangrove forest complex is able to colonise these mudflat areas. The mangrove formation is characterised by a relatively small number of plant species arranged in bands parallel to the coast. Along the Thai coast *Rhizophora* and *Avicennia* are the two most common genera, although the large mangrove trees of the genus *Bruguiera* were formerly abundant and used by the Chaw Lay to make their boats. Now most have been cut down for their salt-and-rot resistant wood and other species are fast following as the demand for charcoal made from the mangrove woods increases. A mangrove-cousin, *Nipa fruticans*, should also be mentioned here because of its eco-

nomic importance in providing fruit sugar, starch and above all thatch material for the Chaw Lay. Animal life on the shallow mud flats and in the mangrove seems to be predominantly marine in origin, for there are few representatives of terrestrial fauna. Shellfish and crustaceans, however, are plentiful as are some reptilian species. Crab, shrimp and mollusc are particularly important food resources for the Chaw Lay from the mangroves.

The sea itself forms the third and most important environmental zone exploited by the Chaw Lay. In the Andaman Sea, the abundance of diatomaceous phytoplankton which form the basic food supply of marine fish coupled with the year-round warmth of water and moderate salinity provide an environment which has traditionally provided the Chaw Lay with abundant fish resources. The fauna of this area is an extremely diverse, unspecialised one with representatives occupying all the available marine econiches. There is a great variety of fish available and it is a true generalisation to say that all species are caught and, with the exception a very few poisonous varieties, are eaten by the Chaw Lay. In addition to fish there are crayfish, sea cucumbers or slugs, ray, squid and an enormous range of mollusc.

Although fish is the most important economic resource for the Chaw Lay, it is not the bottom line of their subsistence base. Access to shellfish, particularly oysters, is the most vital aspect of Chaw lay subsistence. Even during times of the year when fishing is impossible, shellfish collecting continues to be an activity in which every member of the community can participate with minimal energy expenditure. During our field research we recovered 146 different species of molluscs from Chaw Lay archaeological sites, while our native informants could recognise every fish and shellfish species shown them in a compendium of known species.

MOBILITY AND SPACING

At each site therefore, the Chaw Lay, as predicted, exploit all available ecological niches: the deep sea, the coral reefs, the intertidal mudflat, the area washed by breaking waves, the rocky outcrops exposed at low time, the shallow waters, the sandy beach deposit, the lagoon area behind the beach, hill areas behind the lagoon, river estuaries and canals and the mangrove swamps. At any one time, the area actively exploited by one group of Chaw Lay will comprise many such "vertical transects", each composed of most if not all of these ecological mini-zones (Figure 2). The "catchment area" of each Chaw Lay group, therefore, includes a much larger area than their habitation site. It is the carrying capacity of each catchment area that, in part, determines the spacing of Chaw Lay groups throughout the potential econiches.

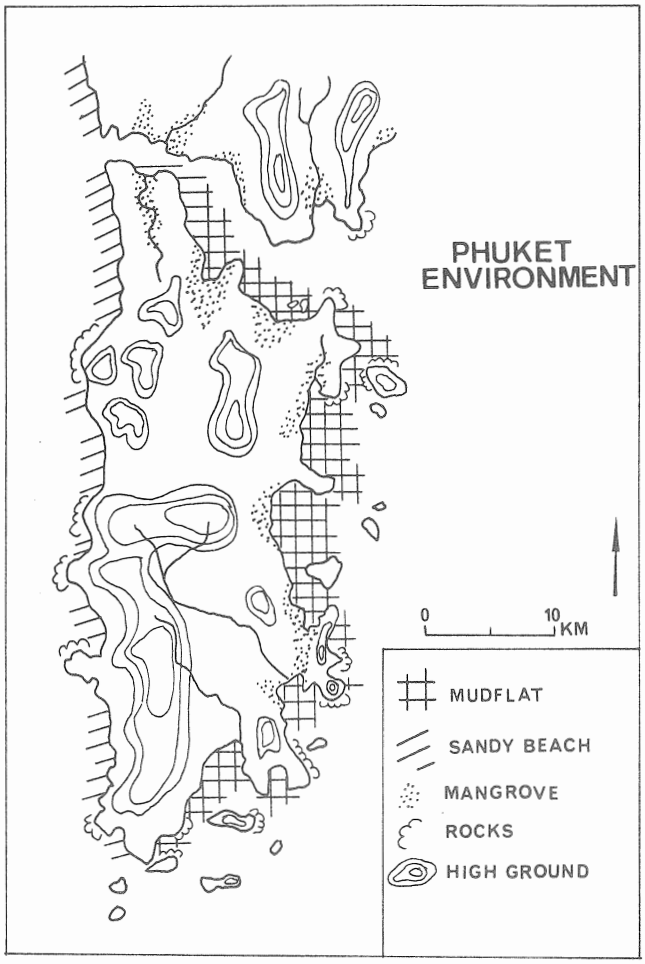

Figure 2: Map of Phuket showing the major ecological zones.

In terms of maintaining human population densities, resource diversity is as important as resource density (Yesner 1980, 1984). Coastal areas tend to have a larger number of ecological niches crowded into the same area than do non-coastal areas. Because of this, in addition to the other geographic and climatic factors discussed above, coastal areas tend to exhibit higher species diversity. The more species exploited, the more stable is the entire resource pattern. Another major effect of this high species diversity on human populations is that if the biomass of one food resource is low, alternatives are available to buffer the population. Another important consideration in the exploitation of this econiche is that marine resources are more stable through time because of longer food chains and are therefore more predictable.

Predation higher on the food chain is also more efficient in terms of energy resources gained. Therefore, Chaw Lay by strategic preference pursue larger species of fish. These tend to be solitary wanderers in the sea and therefore a too heavy concentration of fishermen in any one area reduces the economic validity of the expedition. On the broad level, this influences spacing of Chaw Lay groups throughout the archipelago and in part accounts for their widespread distribution but sparse population concentration in any one area.

Biogeographical theory also provides other explanatory models for understanding the widespread distribution and spacing of the Chaw Lay throughout the available econiches and across time. As we will show later in this paper, biogeography provides a basis for understanding the splintering of Chaw Lay groups in response to carrying capacity overload and their colonisation of other, often temporary, satellite camps. Applying the concept of "filtering" we can also understand how and why certain satellite camps drop in and out of the network, depending upon factors such as (i) their position along dendritic networks linking the satellites with base camps; (ii) the absolute size of the satellite site; (iii) the critical level of population which the base camp can support; and (iv) the degree to which the base camp's carrying capacity has been over-reached and its resources exhausted.

TOOLKIT AND ARCHAEOLOGICAL ARTIFACTS

To exploit this coastal/marine econiche, the only specialised technology developed by the Chaw Lay involves boats for mobility and fishing gear and submersible traps for the capture of mobile aquatic resources. The rest of the material culture assemblage utilised by the Chaw Lay to exploit their biologic environment is limited, "filtered" to suit a constantly mobile lifestyle where numerous possessions would be a burden. Items are multi-purpose, small and easily transportable, with an emphasis on shared communal implements where possible.

In a previous paper (Engelhardt and Rogers n.d.), we have analysed in detail the tools and materials used in Chaw Lay subsistence activities and charted their ethnoarchaeological journey through use in an activity, re-use, storage, re-cycling and finally to discard. Our analysis of the documentation of this cycle, both above ground ethnographically and the by-products of it as they are retrievable from the archaeological record, demonstrates that, with the single important exception of utilised stone, virtually *no* Chaw Lay artifact remains intact in the archaeological record or associated with their original activity locus. The archaeological evidence we do find which is indicative of various activities consists of surface alterations to "activity areas" and the secondary deposits of debris which have resulted from activity area maintenance. The material culture remains found in these deposits consist of only the tiniest fragments, re-used and recycled until they are so fragmentary as to be impractical to manipulate and therefore beyond use.

Model of Maritime Adaptation

The implications of this maritime adapted pattern are profound. Leaving aside, for the moment, the constraints imposed on the material culture assemblage by a mobile subsistence strategy, we have found that what we see archaeologically is a reflection of the evolution of spatial patterning of the people as they move, in kaleidoscope fashion, about their environment in order to best exploit the various, often mobile, resources of the econiche in which they specialise.

Each Chaw Lay site is used in a continuous but intermittent fashion in both a regular and erratic manner. This seemingly contradictory situation is a result of the varied patterns of econiche use. A site, or a portion of a site, may be used as a base camp by one Chaw Lay group, while several small and transient groups may use portions of the site for temporary occupation. In the same time span, a family group may use the econiche for water and vegetable collection, but not for residence, as they stay on their boats and move on. The pattern is further complicated by aspects of seasonality and the occasional need for a site to be temporarily under-utilised while its resources are regenerated.

The Chaw Lay's conceptual organisation and use of space for social and economic subsistence activities is what determines the spatial patterning of archaeological remains at ground and below-ground levels. The complex patterning creates on the sandy matrix of the beach sites what can best be described as a palimpsest: a multiple overlay of partly visible lines of "text", each one imperfectly erased but remaining in a shadowy form. The concept of a palimpsest seems particularly applicable for intermittently occupied coastal sites, from which the evidence of human use is regularly removed by both climatic phenomenon such as the annual monsoon and by the action of the inhabitants themselves through regular maintenance of activity areas and scavenging of abandoned sites.

Can this difficult record of maritime adapted lifeways be disentangled? Is the archaeological information too partial and too obscured to be interpreted? In this paper, we propose a model of maritime adaptation, founded in ethnoarchaeological methodology, which we believe

clarifies the spatial arrangements seen in the archaeological record of each site as well as the distribution of archaeological sites throughout our study area. Our aim is to provide a model which will decode the palimpsest and explicate the complex evolution of a system of ecological checks and balances which has enabled sustained exploitation of the coasts and island of the Southeast Asian archipelago since the end of the Pleistocene era.

METHODOLOGY

To develop our model we examined the ethnographic and archaeological patterning at 4 levels of socio-economic organisation:

i) temporary seasonal camp sites, forming the basic unit, or building blocks, of Chaw Lay colonisation of a site;
ii) base settlements of longer term occupancy, functioning in a sustained manner well within a site's carrying capacity;
iii) communities at the point of collapse from over-exploitation of the environmental resources of a site's catchment area; and
iv) abandoned occupation areas, past the point of collapse now in a state of environmental regeneration and used only for intermittent scavenging.

The archaeological "transforms" (Engelhardt and Rogers n.d.; Schiffer 1976) which we examined in particular included those which have been shown by our previous ethnoarchaeological study to be those which enter the archaeological record and are retrievable. These are (a) ground evidence of structures; (b) compacted surfaces with and without inclusions; and (c) debris depositions (Meehan 1982: 112-8). Repeated partial erasure of these three variables form the traces we see in the Chaw Lay archaeological palimpsest.

Level 1 — Temporary Camp Sites: Haad Hin Khaw, Ao Wai Daeng and Haad Yao

The least complex level at which Chaw Lay spatial patterning was studied was at the simplest level of the temporary campsite. One example of this is a site called Haad Hin Khaw (Figure 3) on the island Ko Lon. Ko Lon is a large island to the southwest of Phuket. The site of Haad Hin Khaw is a small beach on the southeast corner of the island. Foothills rise at either end, while behind the raised beach a deep lagoon area extends some distance back. Fresh water is available from steep streams at either end of the beach. Haad Hin Khaw is a very small temporary encampment with a long history of intermittent use.

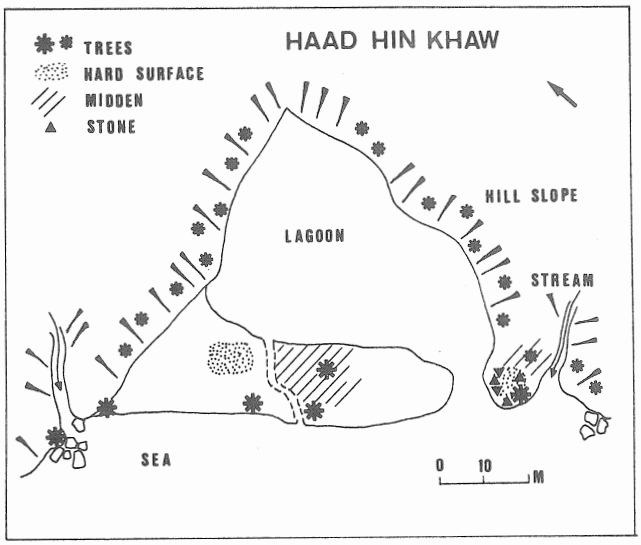

Figure 3: Map of the temporary campsite at Haad Hin Khaw, on the island of Ko Lon.

this gully, were remains of a midden deposit consisting primarily of shell. At the far east end of the site, there is a flat and compacted activity area at the foot of a tree. With it were 5 fire-charred stones, shell fragments and a midden deposit to the rear. By analogy and with the confirmation of informants, we have interpreted this peripheral area to be a multi-purpose food-processing activity area, while the compacted area in the centre of the site can be understood as an area of communal domestic and social activity.

This small site represents the basic unit of Chaw Lay occupation; a single boat group on the move during the non-monsoon season and stopping for a short period to occupy and exploit the econiche. The boat group would live aboard but build or occupy a makeshift house on the beach on a temporary basis. The size of Haad Hin Khaw prevents it from ever supporting more than this minimal usage.

A larger site, however, presents the potential for this minimal stage to expand into a more long-term and complex occupation. We see a step towards this at the site Ao Wai Daeng, another site on Ko Lon (Figure 4). This is a larger but shallow beach on the southwest of the island. Ao Wai Daeng offers enough space for multiple boat units to temporarily occupy it, leaving 3 or 4 areas of activity surfaces, a path along the front of the beach and midden deposits. Our ethnographic study confirmed that the site is still used as an oyster gathering camp.

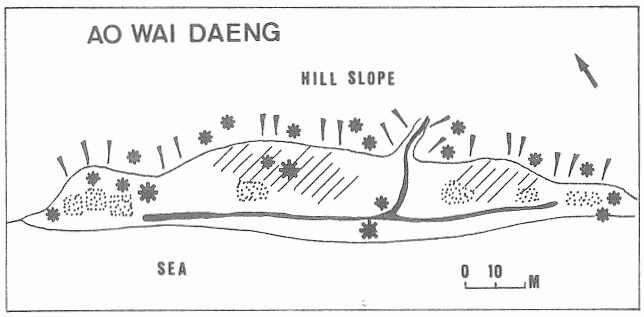

Figure 4: Map of Ao Wai Daeng, Ko Lon, an expanded campsite.

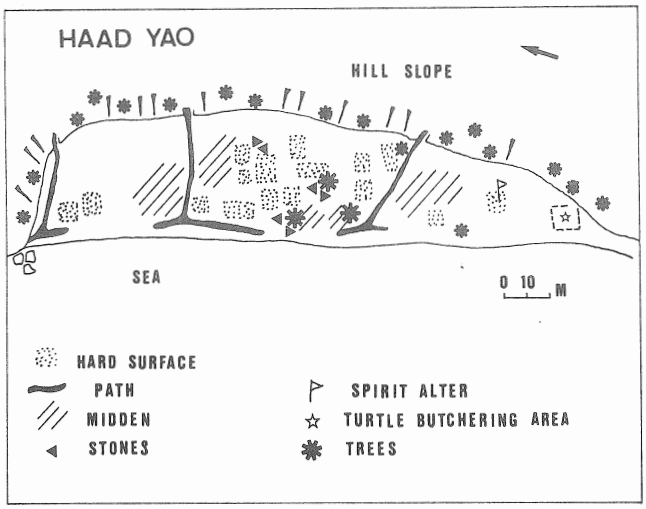

Figure 5 Map of a minimal, permanent base settlement at Haad Yao, on the island of Ko Bon.

When the econiche is larger still and richer, we see a movement beyond a temporary campsite, towards the minimal requirements for permanent base site habitation. This is visible at the site of Haad Yao on Ko Bon, southwest of Phuket (Figure 5). Haad Yao, on the island's west coast, is 350 meters long with steep hills behind and rocky outcrops at each end. A stream enters the beach at its north end. Here we see 9 or 10 activity/habitation surfaces clustered at the north end of the beach, extensive shell midden deposits and a central open activity area under a large shade tree. At the opposite end of the beach are a spirit house area and a turtle butchering area. The scale here is larger and the range of activity areas wider. Until approximately 70 years ago Haad Yao was a base camp supporting a substantial population. However over the years the sea eroded away one-third of the beach's depth and people relocated to other sites, mostly to a near-by emerging base camp at Rawai. No longer environmentally capable of supporting base site habitation, Haad Yao reverted to a camp site used in the same manner as Haad Hin Khaw and Ao Wai Daeng.

Level 2 — Base Settlements: Tukay

The next level of organisational complexity at which Chaw Lay spatial patterning was studied was at the level of a functioning site in a state of sustainable environmental homeostasis, serving as a base settlement, with continual year-round occupancy. Although several sites at this level were studied, the example we will discuss here is the settlement at Tukay, a site on the former island of Ko Sirei which recently has become linked to the main Phuket Island by sedimentation and mangrove colonisation (Figure 6). Tukay is located on a raised tombola beach, with mangrove lagoon behind and scrub-covered hills at both ends. As with all Chaw Lay communities, the primary and virtually only, economic activities are fishing and shellfish collection.

From geographical analysis of this and similar sites, it is possible to abstract patterns of optimal spatial organisation of a Chaw Lay base settlement in terms of the layout of structures, activity areas and deposition. Analysis of a series of village maps made consecutively over several years shows that communal, multi-purpose spaces are located towards the front of the site, with groups of houses clustered behind and to the sides. Behind these house clusters, towards the back of the site, are areas where occasional, casual, unstructured, or unsocial activities take place. At the extreme rear of the site are the areas where the village deposits its discard. The layout of this constructed environment of structures, activity areas and depositions, reflects and in turn influences, the Chaw Lay social environment. The arrangement of houses is based on a series of loose, irregular, adjacent semi-ovals, elongated to maximise the length of the beach. As the individual Chaw Lay and family units or even groups of units move from settlement to settlement the arrangements of houses at a particular village will alter. The houses themselves may be dismantled, packed on to a boat and removed, or moved to another section of the village and occupied by a different residential unit. This endlessly fluctuating situation never ceases, however, to reflect the communal sense of Chaw Lay life and the patterning of the social environment.

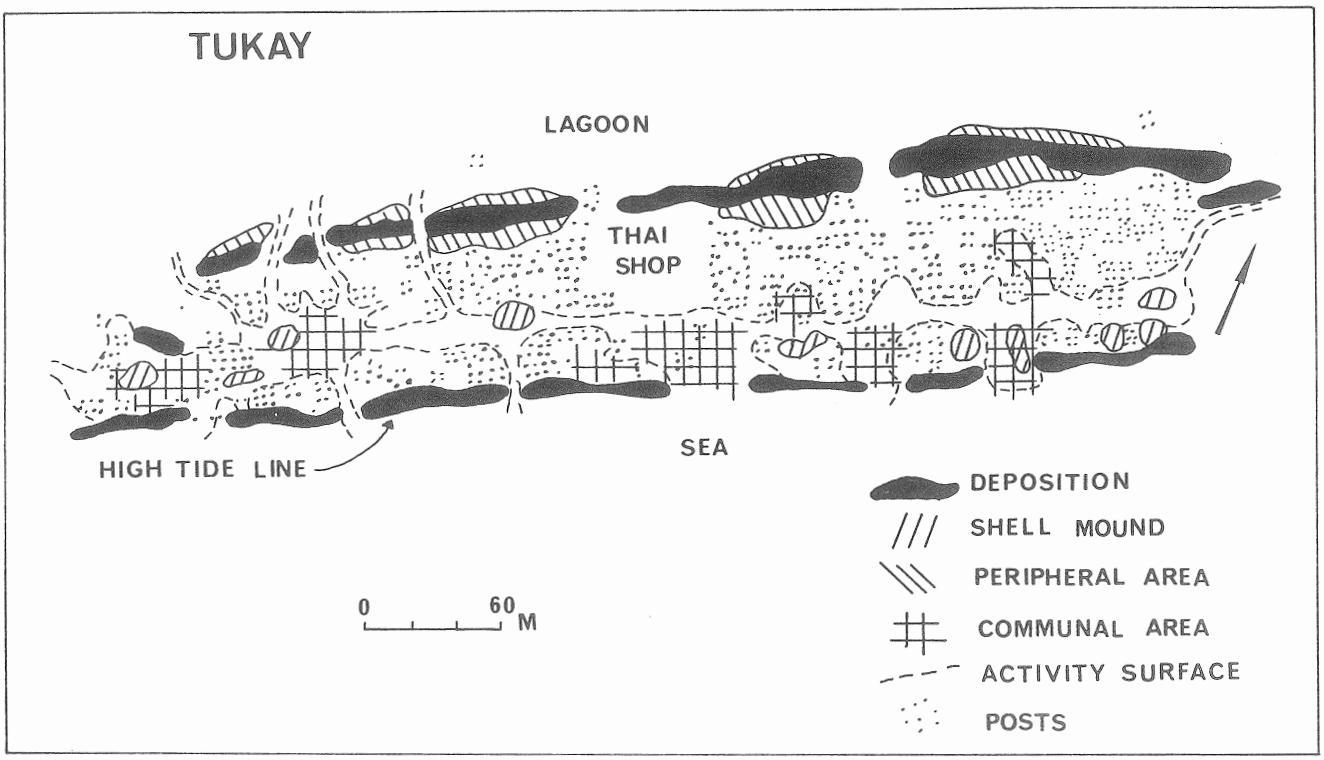

Figure 6: Map of the base settlement at Tukay, Phuket Island.

The open, interstitial areas created by this structural patterning are areas used by the Chaw Lay as the location for communal economic and social activities. At Tukay, a pattern of activity area use was documented showing that certain locations were the focus of a variety of activities in combination. The large open areas around which structures are loosely grouped, are the location of a wide range of communal activities requiring open space and often including a large socialising element. Peripheral areas are the location of activities which generate large quantities of waste.

Briefly, the pattern of deposition at Tukay is a band of virtually continuous shell mound along the front of the site, acting as a breakwater and interrupted only by the occasional access path to the intertidal area. At the back of the site is another continuous band of midden consisting of mixed material, but still primarily shell, extending irregularly into the mangrove. Within the habitation area atop the raised beach, there are smaller deposits of shell, usually of a single species, around trees or in areas where habitation ovals back on to one another. In general, it can be said that depositions tend towards the periphery of the site as they increase in size and permanence. Under conditions of ecological homeostasis debris accumulations inside the village are temporary, not allowed to grow to a large size, are limited by burning, containment and, eventually, re-deposition at the periphery.

Ethnographically we know that Tukay is a site which has experienced sustained growth for more than 100 years and is still enjoying this long-term prosperity. The spatial patterning of structures, activity areas and depositions -- which will become the future archaeological markers of the site -- confirm that the site has not yet reached its carrying capacity. This ecological homeostasis is the result of a balance which the Chaw Lay of Tukay have so far been able to maintain in the maritime-adapted system.

At Tukay, as at all Chaw Lay sites, there is the need to balance the relationship between the extraction of resources from the environment and the time needed for these resources to replenish, either through re-growth (e.g. shellfish) or in-migration (e.g. fish). This, in large

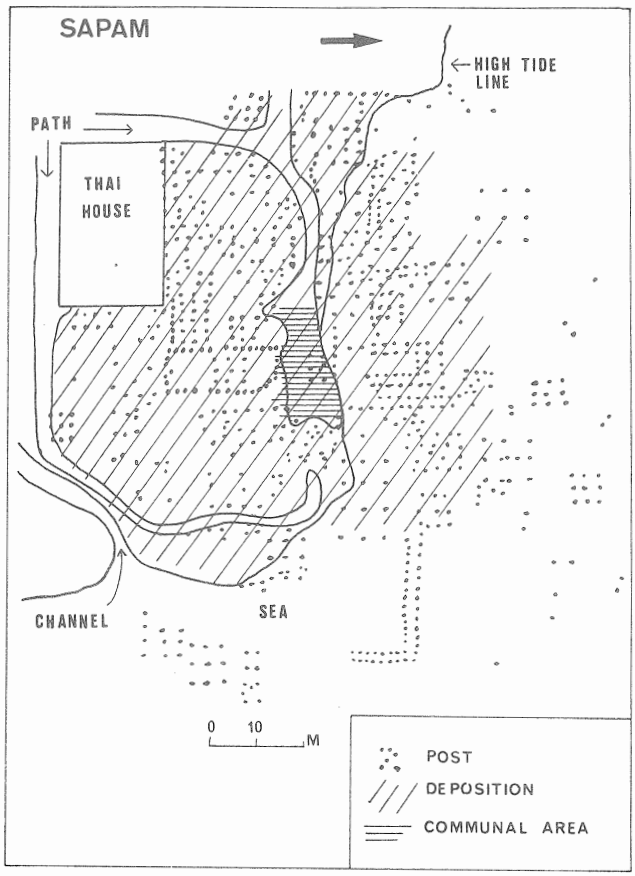

Figure 7: Map of Sapam, Phuket Island, a base settlement in stress at the limit of its carrying capacity.

part has to do with the absolute carrying capacity of the site and explains the Chaw Lay preference for larger sites, but more importantly for sites with the most extensive range of ecozones within the site's catchment area.

As a by-product of human habitation, sites, during the early stages of occupation, become more inviting environments for oysters, crabs and other scavengers with considerable economic potential for humans. The Chaw Lay also attempt to control a site's ecological balance through mechanisms which regulate the population of a site and its network of satellites and associated fishing camps, especially at times of the year vital for resource regeneration. Population is kept at optimum seasonal levels through constant movements of people to and from temporary fishing camps, while the population of the base settlement is regulated by permanent migration to other settlements where there may be more potential for growth in a still under-exploited econiche.

Level Three — Collapse: Sapam

The site of Sapam (Figure 7) is situated on a small channel leading from estuary mudflats west into a tidal lagoon and is partially located directly over the intertidal mudflats. The primary economic activity is shellfish gathering from the nearby mudflats and mangroves. Sapam represents a Chaw Lay settlement in crisis: the econiche has been over-populated and over-exploited. In spatial terms this environmental overload has resulted in a loss of the basic Chaw Lay cultural sense of space and grouping, which we can see clearly when we look at the way in which patterning has eroded and segregation has been lost, in comparison to Tukay.

As population pressure intensifies and the environment degrades, the density of structures increases to the point where almost every available space is occupied by a post. This is a diagnostic indicator that the balance between houses and communal areas has broken down and the Chaw Lay sense of meaningful segregation of space has been lost. Sapam at the time of our study was in this precise state. Figure 7 shows the density of habitation and the break-down of patterns of spatial organisation of structures across the site.

This breakdown in structural patterning results in a concomitant loss of the positioning and segregation of activity areas. In Sapam it has become impossible to identify segregated areas of communal activity, as the open areas required are filled with structures and midden deposit. Similarly, messy and unsocial activities which ideally would be relegated to the unoccupied fringes of a site, at Sapam have to take place within the settlement between houses, as all peripheral area has been filled with structures.

Viewed archaeologically, the entire site of Sapam is a mixed shell midden, containing activity and household deposition. It shows that when a site is limited in space and reaching a state of environmental overload, the depositions will grow to occupy all available space. Discrete mounds, middens, peripheral and tidal deposits all merge and the distinction between primary and secondary deposition becomes blurred.

The Removal Response

When a Chaw Lay settlement grows to the point that it is covered with indiscriminate midden and filled with structures to the point where segregation of structures, activity and depositions is lost, this is the indication that the site's carrying capacity has been exceeded. Its re-

sources have been so over-exploited that an accelerating downward spiral towards ecological collapse has been engineered by its inhabitants (Rambo 1985).

Sapam is a community experiencing stress near to this terminal point of collapse. The econiche has "filled up" beyond its carrying capacity. Continued exploitation only accelerates the process of degradation creating a situation where increasing amounts of energy must be expended by the community in order to maintain itself at the minimal acceptable growth coefficient. That this was indeed happening at Sapam was confirmed by our studies of the time spent by the population in subsistence activities. At Sapam, men and women both spent approximately 65% of their time in activities related to subsistence extraction (primarily shellfish collecting as fishing from Sapam was no longer possible due to depletion of resources), compared to 35% at Tukay. This means that virtually all the waking hours of the Sapam population was spent looking for food.

Catastrophe theory provides us with a model to explain what happens when, over time, the time (and therefore the energy) devoted to subsistence activities increases to the point where the energy expended approaches (or even becomes greater than) the resultant energy extracted from the environment. Additional energy inputs come to have increasingly negligible effect on output. Such a system is not sustainable in the long term and radical or "catastrophic" change is to be expected.

The Chaw Lay, when faced with stress of this kind, react with a "catastrophic jump" which we have called the "Removal Response", which constitutes their primary problem-solving strategy. As a first reaction to an untenable situation created by exceeding the carrying capacity of a site, the affected Chaw Lay community will attempt to establish a new equilibrium through the out-migration of individuals or small splinter groups. This may give the site a temporary reprieve. Sapam, at the time of our study, was in such a state.

But once fishing is abandoned as an economically productive activity, the pressure on the shellfish resources of a site soon becomes unsustainable. If shellfish, which is the basic subsistence resource, is also stressed to the point where it too is in a spiral of decline, the site eventually will become uninhabitable. Now the entire community must migrate elsewhere, allowing the site time for the very slow process of ecological regeneration.

Individually or in groups, the Chaw Lay community packs up and relocates to other sites. Some may go to other base settlements. Others will splinter from the main group with some individuals or smaller boat groups migrating further to a series of temporary camp sites, eventually attempting to establish a new base settlement at a suitable, unoccupied location. These movements plug into the already-established fishing and migratory networks. Structured in long dendrites following the biogeographic chains linking the island and coastal econiches, these links create and reaffirm the interchangeability of sites over the study area and pattern the relationships between them.

Indeed, it is the wide distribution of interchangeable econiches and the disbursed availability of marine resources throughout them that permit a change of location as the most basic reaction to stress in the system. The Removal Response is basic, because it does not necessitate a change in means, forces, or relations of production. But it is not simple, because the varying size (and therefore carrying capacity) makes each potential econiche dissimilar and requiring of a unique exploitation strategy. Many may already be occupied and more or less capable of absorbing additional numbers. Others will be in varying states of regeneration. A complex splintering and regrouping of communities under stress is therefore a necessity.

Within the technological repertoire of the Chaw Lay, the necessary means of transportation — boats — together with the concomitant structuring of social relations so as to insure a boat has the minimum necessary crew, has already been long evolved to cope with the economic exploitation of the econiche. Therefore the culture has in it both the technological and organisation ability to more the entire community, or a splinter thereof, to a different place with minimal disruption of the overall social structure.

SYSTEM EVOLUTION OF MARITIME ADAPTATION

This cycle of population pressure resulting in over-exploitation and site abandonment occurs constantly in the Chaw Lay system. As sites become endangered and near collapse, the Chaw Lay respond first by individual spin-off, splintering of small (boat) groups to other sites. This allows an expansion of the population into other available econiches in the network.

Eventually, however, a local area network will fill up, with all available econiches either occupied or abandoned to the regenerative state. When this happens, there is a discontinuity in the system and a major shift in group focus occurs. One base settlement site is abandoned and a new centre comes to the fore. The re-organised system then continues its growth, but the shift away from no-longer-inhabitable sites inevitably results in isolation of

parts of the network from each other. Biogeographical theory predicts that over time, through an interaction of the "founder effect" with the extinction curve of abandoned sites, certain groups may find themselves so cut off from the network of potential econiches that they can no longer continue to maintain their minimum growth coefficient. Culture change may then result through, for example, integration with other communities with different modes of production, such as neighbouring farmers; or through the adoption of new technologies such as commercial net fishing; or, when stressed to the limit of its existence, a community may use its maritime technology for violence in the form of piracy (Collins 1965: 211-9).

Our research has shown that until about 2000 years ago the maritime hunter-gathering mode of production enjoyed a long phase of increased specialisation and expansion. However, with the rise of commercial trading in Southeast Asia over the past 2000 years, competition for similar econiches has limited the number of free sites available for further expansion. The Chaw Lay — and other maritime hunter-gatherers of Southeast Asia — now face a chronic and acute shortage of suitable econiches, with large stretches of the dendritic chains removed from the network, either temporarily or permanently as a result of both over-exploitation and occupation by competing groups. The still available niches grow smaller, more densely concentrated and further separated from other groups, divided by the sterile interstices that have fallen out of the network. In the end, the adaptive mode may fail and we have the situation we see today, of a culture heading for extinction. The awareness of the importance of understanding such an process in the evolution of human cultures, was one of the overwhelming reasons which led us to our ethnoarchaeological study the Chaw Lay as one of the last remaining groups of maritime hunter-gatherers.

In archaeological terms, we see evidence for the evolution of this system in the distribution of sites. It explains the fact that virtually every coastal econiche in Southeast Asia is an archaeological site. The biogeographical concept of filtering helps to understand how increasing isolation affects the limited artifact assemblages found at archaeological sites through the progressive reduction of types and the growth of localised local variations.

Level 4 — Abandonment: Phap Pha

A test programme was designed to evaluate our hypotheses concerning the archaeological patterns created by the Chaw Lay's maritime mode of adaptation both at specific sites and as patterned throughout the wider environment. Archaeological methodology was employed at several abandoned Chaw Lay sites, in an attempt to reconstruct a map of their original, living form. This reconstruction was then evaluated for the degree to which it fit our expectations based on the ethnoarchaeologically derived model.

One of these sites is Phap Pha, which will serve as our example for this archaeological test. Phap Pha is a sandy, raised beach between two headlands, separated from the mainland of Phuket by a mangrove swamp. The site is bordered on both long sides by the sea. We know from provincial administrative records that the south-facing beach was densely settled during the height of the Chaw Lay occupation. The site was occupied for more tha 90 years and was abandoned in approximately 1960, 20 years before our study commenced.

The site of Phap Pha was investigated using archaeological techniques including the excavation of micro-layers of sandy soil using straight bristle brushes, a technique we like to refer to as "archaeological dermabrasion" which conveys the correct sense of peeling the thinnest layers off of the ground surface in order to reveal the remains of the partially-erased layers of the palimpsest below. Thus we were able to reconstruct from the archaeological record of Phap Pha, the evolution of Chaw Lay spatial patterning visible ethnographically at sites such as Tukay and Sapam. The patterns of structural remains, activity areas and deposition were analysed to reconstruct a map of Pha Pha's spatial organisation when it was the site of a living community.

The archaeological map of Phap Pha (Figure 8) shows the large number of habitation and activity surfaces: 62 flat, hardened surfaces fill the site, pressed into sand, sediment and shell midden. Compacted paths run along the front of the site and back towards the low area and hillslope. Spaces which, by analogy, can be interpreted as originally open communal activity areas occur at several places along the front of the site and under large tamarind trees at the rear of the site. However, these areas, like all of the site, are now covered in virtually continuous shell deposit. The site has large quantities of shell, lying in a complex arrangement of overlapping non-segregated mounds, lengthwise across the site. A number of activity areas atop these middens were associated with shell fragments, utilised stones artifacts and evidence of fires. These can be interpreted as food processing areas.

Peripheral activity areas were also identified at the far west end of the site. Deposition remains revealed these to be a turtle-butchering area in the brush at the edge of the site and an ancestral spirit-house area on the hill nearby.

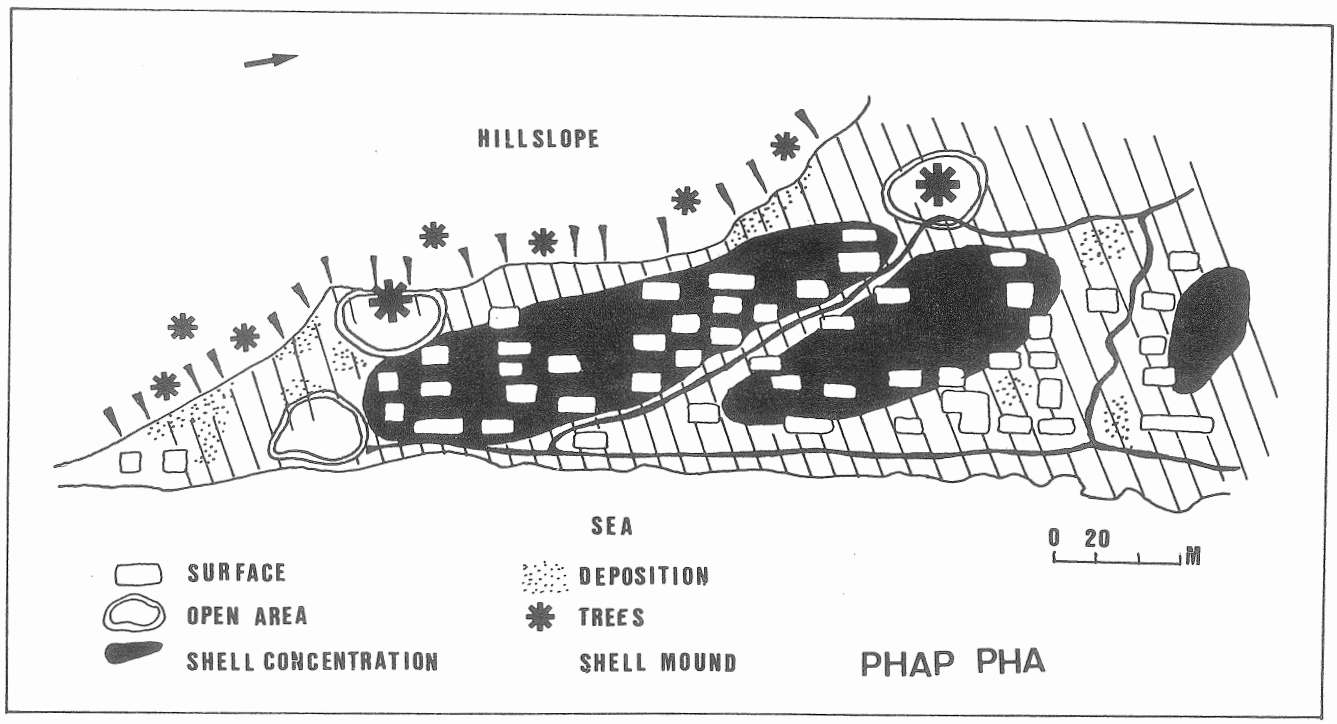

Figure 8 : rchaeological map of the abandoned site of Phap Pha, Phuket Island.

This interpretation was confirmed by informants who formerly lived at the site.

Secondary middens were found in concentration along the back of the site, where the contour of the raised beach dips at the base of the hill slope. The other form of midden at this site is built up at the base of trees.

We know that Phap Pha was abandoned due to what the Chaw Lay themselves say was overcrowding or what we would term the exceeding of the site's environmental carrying capacity. This map therefore represents a users' definition of site collapse, in an unacceptably over-exploited econiche. Phap Pha is an archaeological representation of Sapam.

When the collapse stage is reached the essential elements of Chaw Lay patterning, their balance and integrity is lost and a site becomes untenable for habitation. Faced with this stress, the Chaw Lay of Phap Pha resorted to the Removal Response.

As predicted, the abandonment of Phap Pha did not constitute an immediate and total depopulation. On the contrary, a complex interplay of movements and changes occurred along an extended time frame. We are fortunate to have a detailed ethnographic account of the evacuation of Phap Pha reconstructed from a number of informants who participated in the movements described below. When Phap Pha was a growing site its inhabitants were closely connected to satellite sites at Laem Thong on Ko Phi Phi and at La Eo on Ko He, frequently moving between sites and sharing ceremonial events. As Phap Pha began to reach saturation and a crisis point, individuals and small splinter groups began to migrate out to other sites: to then-satellite camps at Rawai, Tukay and Sapam and to other base camps, in particular to La Eo. After a period of approximately 30 years, however, due to the rapid influx of people from Phap Pha, the carrying capacity of La Eo, which is a smaller site and contains fewer ecozones than Phap Pha, was also exceeded. People began the same process of withdrawal as was still in progress at Phap Pha. They moved again to small temporary camps like those on Ko Bon and Ko Lon, to larger and expanding sites such as Tukay and Rawai and in particular to Laem Thong on Ko Phi Phi. This failure at La Eo was quickly followed by the final collapse and total abandonment of Phap Pha. The majority of the remaining population on Phap Pha moved to nearby Tukay, but a considerable number migrated to Laem Thong and

Rawai. This influx of inhabitants resulted in the consolidation of both of these sites as new permanent base settlements.

The movements described here represent a 100-year segment of a continuing process. At the present time, the sites of Laem Thong and Rawai are both experiencing out-migration. Many of the inhabitants of these sites are moving to Tukay, which our more recent follow-up studies have shown now to be fast approaching a level of unacceptable density.

Abandoned sites, such as Phap Pha and La Eo, do not drop entirely out of the system, however. They are conceptually redefined by their Chaw Lay users as sites-at-rest, usable only briefly by small numbers for minimal exploitation at widely spaced intervals. They re-enter the network first as sites for scavenging artifacts; then as temporary fishing camps.

ARCHAEOLOGICAL SITE CLASSIFICATION

At any given moment in time, the Chaw Lay world is a network of temporary seasonal fishing camps; newly-settled base camps; established and growing permanent settlements with an associated constellation of satellite sites; mature communities in a state of homeostasis with out-migration offsetting in-migration and a ecological balance maintained in equilibrium; communities in carrying capacity crisis experiencing net population loss through out-migration; and abandoned sites which have dropped out of the network.

The question arises: When we find a site archaeologically, how do we know which kind of site it is? Which level of organisation and carrying capacity does it represents? We cannot automatically assume that a site seen in the archaeological context is either a seasonal camp or a abandoned base settlement because, aside from any external, political reason why a site may be abandoned at an intermediate state, we have seen that a site may become so isolated from the rest of the network that they no longer are viable parts of the system, regardless of the level of organisation it has achieved. There is also the possibility that at any given site, the stratigraphic palimpsest if carefully read and decoded will show the developmental sequence through which the site passed as it evolved from one level of organisation to another, or, as it moved in and out of various networks over the long passage of time.

Our research has shown that it is possible to formulate a series of guidelines for identifying and categorising coastal and island archaeological sites or stratigraphic levels thereof, according to their carrying capacity equilibrium, level of organisation and role in the network of a maritime-adapted subsistence strategy.

The prehistoric carrying capacity of a site must first be evaluated to assess its size and resource diversity which place limits on the level to which a site may develop. We have found that species variety together with the changing average size of shellfish remains provide the most reliable indicative data in this regard.

The degree to which a site is "filled up" is another indicator of its development and extent to which its carrying capacity has been exploited or over-exploited. We have found that one reliable measure of this is the density of postholes, particularly in the centre of a site. This central area is the area which, by ethnographic analogy, we have found to be the last to be filled in by either structures or depositions, as it is reserved as an open to serve diverse communal activities.

In a 10-meter square positioned dead-centre of the ethnographic sites we investigated, the differences in post density were strikingly diagnostic of the degree to which a site is "filled up":

Haad Hin Khaw (camp site)	0 posts
Ao Wai Daeng (camp site)	0 posts
Haad Yao (camp site)	0 posts
Baan Sak (camp site)	0 posts
Laem La (satellite site)	0 posts
Tukay (mature site)	0 posts
Laem Thong (mature site)	1 post
Rawai (mature site)	1 post
Sapam (collapsing site)	49 posts

At Sapam this represents a virtually total absence of open communal space which is a requisite of successful socio-economic functioning of a Chaw Lay community.

With careful excavation, evidence of postholes are sometimes recoverable even in a matrix of sand and mud. We recorded and studied the way in which postholes were dug, how posts rotted *in situ* or were removed for recycling and how postholes subsequently filled up with sediment and were partially erased to become shadows on the archaeological palimpsest of the site. This study enabled us to then identify and retrieve posthole evidence at archaeological sites and to use the data to reconstruct the original built environments. There reconstructions were then assessed by our informants and confirmed as broadly accurate.

There is no doubt, however, that the retrieval of evidence of postholes from sandy beach or mangrove mud-flat sites is difficult. Because it is a form of data that suffers badly from erasure, its retrieval will always be only

fers badly from erasure, its retrieval will always be only partial. It was only after two years of constant field work with continual reference back to ethnographic observation and experimental study of soil mechanics that we were able to recognise the archaeological remains of former postholes (and other structural evidence such as rainwater drip lines from thatched roofs.) Our work at Ko He, where we did recover posthole evidence points to interesting correlations in this regard between what remains in the archaeological record from the ethnographic reality. Even with the most careful excavation techniques, only a fraction of the original number of postholes will be recoverable. However and this is where the study of density in ethnographic sites is so revealing, because the Chaw Lay spatial template calls for open communal areas in site centre, evidence of any posts in these central areas in archaeological sites is a positive indicator that the site had reached a state of terminal over-crowding.

The percentage of a site's area covered in deposition and the degree to which deposition loses its spatial segregation from structures, activity areas and other depositions is also diagnostic and, being easier to measure, is perhaps a more useful archaeological indicator. At the relatively newly-established site of Laem La only about 20% of the site area is occupied by deposition and there is virtually no overlap of the deposition with other features of the site. In contrast, more or less all of Sapam is covered with deposition and segregation is absent. Sites, with percentage areas of deposition, are as follows:

Ethnographic Sites	
Baan Sak	10 %
Laem Thong	15 %
Laem La	20 %
Rawai	30 %
Tukay	35 %
Sapam	99 %
Archaeological Sites	
Haad Hin Khaw	15 %
Haad Yao	35 %
Ao Wai Daeng	30 %
La Eo (Ko He)	60 %
Phap Pha	90 %

Another indicator of developmental level is the spatial distribution of utilised stone at a site. At temporary camp sites, there are few or no stones found associated with activity areas, structures or depositions. At developed base settlements such as Tukay, stones occur frequently, but segregated in storage clusters and in strong association with structures (Figure 9). At abandoned sites such as Phap Pha and La Eo on Ko He, this segregation and clustering is lacking; stones are found in random

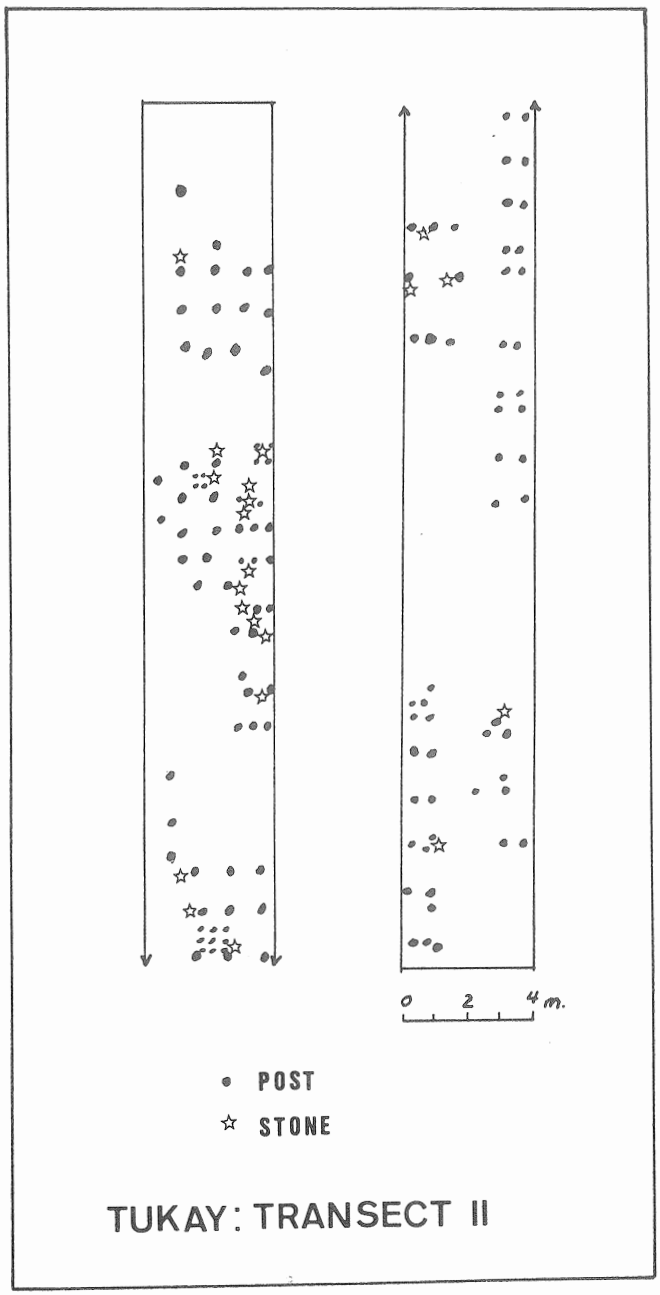

Figure 9: A transect through the base settlement of Tukay illustrating the strong spatial association between stones and posts.

scatter throughout the deposition which covers these sites.

The archaeological palimpsest of every site is an interplay of all these and other factors including environmental and geographical factors such as (a) site size, (b) econiche diversity and (c) shellfish density. Time and space factors such as (d) the location of "nearest neighbour" sites and (e) the time span elapsed since the last occupation also are important variables, interacting with the (f) density and (g) segregation of the archaeological features we have discussed above — evidence of structures; compacted surfaces; debris deposition and stone artifacts.

CONCLUSION

The archaeological evidence found at coastal and estuarine sites in Southeast Asia has often been dismissed as confusing, partial and an incoherent scatter of data made unreadable (and almost unretrievable) by post-depositional environmental factors. Viewed in the conventional terms applied to cultures that remain permanently in one place and accumulate layers of deposit, or to transhumant groups which move in regular patterns between sites, the data remains incoherent. There is a clear need for a model of site spacing and archaeological composition based on mobility. The model we have suggested above seems a sufficient explanation of the distribution of sites and populations in the Southeast Asian coastal environment and for the interpretation of the archaeological remains found at these sites. We hope it will serve as a useful tool for the interpretation of the palimpsest of sand, mud, fish bone, shell and sea.

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