Fig. 1 (left). Swamp plants form an extensive floating mat around the margins of Lake Kumphawapi. This image, looking toward the lake proper, shows one of the open channels maintained by local villagers who use the lake's resources.

Fig. 2 (top). Two long-tail canoes were procured from obliging local fisherman by the Monash team and lashed together to provide a stable platform for coring.

Pollen Grains in Sands of Time
Lake Sediments Contribute to the Archaeology of Thailand

by Dan Penny

Over the past 30 years or so, a genteel battle has raged over the prehistory of northeast Thailand. Despite a long history of international archaeological research in the area, little has been resolved since the earthshaking discovery that bronze technology was known in Southeast Asia at least 1000 years earlier than traditionally thought. Research conducted by the University of Pennsylvania Museum, particularly in regard to the site of Ban Chiang, has been a focus of this debate.

As past special editions of *Expedition* (1976 and 1982) devoted to Ban Chiang research show, many types of investigation are necessarily involved in modern archaeology. One important aspect of research into the human past is the reconstruction of ancient environments and particularly the impact of humans on these environments over time. Indeed, the reconstruction of human interaction with the natural environment is playing a key role in the most recent skirmish over Thai prehistory, on the nature and origins of agriculture in the Ban Chiang region.

My own small part in this drama began in 1993. Blissfully unaware of the simmering controversies surrounding Ban Chiang and related sites, I began an investigation into the environmental history of the region as part of my doctoral research at Monash University in Melbourne, Australia. It was my intention to investigate patterns of vegetation change by analyzing the pollen content of sediments that have slowly accumulated in settings such as lakes and swamps. This science is known as palynology or, more specifically, palaeo- ("ancient") palynology. Using this approach, I hoped to be able to reconstruct ancient environments in northeast Thailand and determine how prehistoric people in the Ban Chiang region interacted with their environment. It is possible, for example, for the palynologist to infer how climate has changed through time, when agriculture may have appeared in an area, and potentially what kind of agriculture may have been practiced. In many parts of the world palynologists have been able to identify the microscopic remains of crop plants or agricultural weeds associated with them. While it is not always possible to obtain such direct evidence of agriculture, other indications, such as the modification or disturbance of tropical forests, may provide insight into the economies of ancient populations.

Fig. 3. Map of mainland Southeast Asia. Lake Kumphawapi is about 30 kilometers southwest of the archaeological site of Ban Chiang, Thailand.
Map by Ardeth Abrams

The Cores

Unlike archaeologists, palynologists are seldom rewarded with heart-stopping discoveries in the field. In stark contrast to the discovery of a human burial, for example, we are unlikely to uncover any evidence that can be seen with the naked eye. The fieldwork is also less glamorous. I worked in swamps and lakes in the Udon Thani and Sakon Nakhon provinces of northeast Thailand, collecting around fifteen sediment cores. The largest of the sites was a freshwater lake called Lake Kumphawapi, some 30 kilometers to the southwest of Ban Chiang (Figs. 1–3).

During each field season I was stationed in the town of Kumphawapi at the southern edge of the lake. I spent long days working with my wife, Jo, my supervisor, Dr. John Grindrod, and the extremely affable and slightly bemused local assistant, Somkit Nimanin (who, I'm sure, thought we were all mad), hammering core tubes into the lake bottom.

My study material also included a sediment core extracted from Lake Kumphawapi by the University of Pennsylvania Museum's Thailand Palaeoenvironmental Project team (Fig. 4). This project, led by Drs. Joyce White and Lisa Kealhofer, represents a focus for the overlapping interests of the University of Pennsylvania and Monash University research teams, and has been the basis of strong collaborative links between the two institutions.

Once the cores were transported to the laboratories at Monash University in Melbourne, Australia, the real work began. By chemically treating the lake mud, it is possible to concentrate microscopic pollen grains preserved within the sediment. By taking a series of samples down through the sediment column (Fig. 5), changes

Fig. 4. Lisa Kealhofer, co-director of the Museum's Thailand Palaeoenvironment Project, coring at Lake Kumphawapi. The pollen data from this core were analyzed by the author and used to create Figure 6.
Photo by Joyce C. White

in the abundance of these pollen grains over time can be measured. From this, the impact that humans may have had on the vegetation and the broader environment can be reconstructed.

Patterns in the Vegetation

Around three hundred samples and an estimated 125,000 pollen grains later, a striking pattern of vegetation change began to emerge. Prior to the height of the last glacial period (20–40,000 years ago), northeast Thailand would have looked very different than it does today. My research indicated the presence of a forest dominated by Pine and Oak instead of the modern tropical deciduous forests. As the global

Fig. 5. The core from Lake Kumphawapi extracted by the Thailand Palaeoenvironment Project is here cut open and a sample of the sediment is being removed. The series of samples from the core, which was 6.18 meters in length, were sent to Australia for analysis by the author.
Photo by Joyce C. White

climate became cooler and drier at the height of the glacial period (around 18,000 years ago), conditions became so dry in northeast Thailand that many lakes and swamps dried out. As a result, the plant fossils that normally preserve in these wet environments were destroyed, and no pollen information was recovered on the vegetation of the time. However, when conditions improved (about 10,000 years ago), Lake Kumphawapi began to fill, and the plant fossils that were preserved in the lake sediment from this time indicate that the vegetation surrounding the lake had changed markedly. Due to increased monsoon rainfall during the early part of the Holocene epoch (10–6000 years ago), these forests were more diverse than their predecessors, and had clear similarities with modern Thai forests.

Yet around 6500 years ago, something remarkable happened to the burgeoning tropical forests of northeast Thailand. Many tree species decreased in abundance, while others disappeared from the pollen record altogether (Fig. 6). This striking forest decline is coincident with a substantial increase in the amount of microscopic charcoal particles preserved in the lake mud, a crude indication of fire in the lake catchment. The regional climate at the time of this episode was wet and warm relative to modern conditions, and there is no evidence to indicate a sudden change in climate to drier conditions

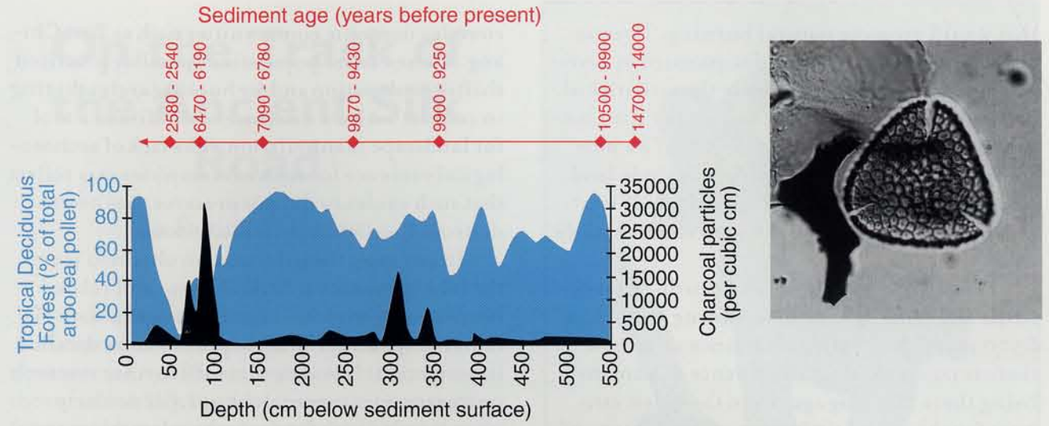

Fig. 6 a,b. (a) Summary pollen diagram of core seen in Figure 5, showing the relative abundance of broadleaf monsoon forest (blue graph) in association with the abundance of microscopic charcoal particles (black). The decline in forest pollen from around 6500 years BP is associated with a massive increase in sedimentary charcoal, perhaps indicative of widespread burning in the Kumphawapi catchment. The chronology (red line) is based on the calibration of radiocarbon ages to calendar years. (b) Photomicrograph of pollen grain of *Hydrocera trifolia* (Balsaminaceae), a swamp herb.

Fig. 7. Fire is used as a tool in both hunting and gathering and in agriculture, even in northeast Thailand today. Here a field near Ban Chiang has been burned to help clear plant detritus during the dry season, in order to prepare for the next planting season. The cause of the evidence for intensive use of fire in the Lake Kumphawapi core beginning about 6500 years ago is a topic of scholarly debate.
Photo by Joyce C. White

that would promote natural burning. The patterns of vegetation change documented at Kumphawapi may, therefore, reflect the activities of prehistoric human populations rather than natural environmental change (Fig. 7). The possibility that those activities might include land clearance for some form of agriculture is less certain, and has become the subject of scholarly debate.

The possibility of humans disturbing forests in the Ban Chiang region beginning around 6500 years ago is intriguing, since up to now there is no archaeological evidence of humans living there this long ago. Even the oldest estimate for the initial settlement of Ban Chiang of between five and six thousand years ago, an estimate which some would argue is far too generous, post-dates the evidence for forest disturbance by at least one thousand years! The evidence for significant forest disturbance through burning led me to formulate a hypothesis that human populations existed in northeast Thailand prior to the development of permanent, relatively complex domestic communities such as Ban Chiang. These earlier populations possibly practiced shifting cultivation and/or hunting and gathering in concert with an intensive use of fire as a tool for landscape manipulation. The lack of archaeological evidence for such communities may reflect that such evidence did not preserve, has been destroyed, or is simply yet to be found.

In any case, the information obtained from the lake sediments at Kumphawapi and related sites—natural archives of environmental data—is tantalizing and certainly worthy of more detailed investigation. It may be that with further research into past environmental change, particularly when coupled with future archaeological investigations, the missing evidence required to test the hypothesis I have proposed will emerge.

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