HOABINHIAN MACROBOTANICAL REMAINS FROM ARCHAEOLOGICAL SITES IN VIETNAM: INDICATORS OF CLIMATE CHANGES FROM THE LATE PLEISTOCENE TO THE EARLY HOLOCENE

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Keywords: Vietnam, Hoabinhian, macrobotanical remains, climate change, *Canarium*

ABSTRACT

This paper discusses the plant remains excavated from the Hoabinhian sites of Xom Trai (18,000-16,000 BP), Con Moong (12,500-8,500 BP), Dong Cang (11,000-10,000 BP) and Mai Da Dieu (19,500-8000 BP). Almost all the charred plant remains have been dated directly, except at Dong Cang, where the dates of the plant remains were based on C-14 dates of mollusk shells in equivalent layers. Nut shell fragments of Juglans (walnut), Castanopsis and Canarium are the main vegetable food remains in Hoabinhian sites in Vietnam from 20,000 to 8000 BP. The periods of cave exploitation overlap in the total Hoabinhian chronology and represent a long period of climate change from a cold climate at the LGM to a warmer climate in the early Holocene.

INTRODUCTION

Chester Gorman's (1970) excavation at Spirit Cave (Thailand) in the 1960s greatly influenced the author of this paper. The first test excavation to follow Gorman's dry sieving method in Vietnam was carried out in the Hoabinhian cave of Xom Trai (Lac Son, Hoa Binh) in August 1982 (Nguyen *et al.* 1982). Here I collected, for the first time in Vietnam, many hundreds of dry and charred prehistoric plant remains. In 1986-87 I came back from Germany to Xom Trai cave and excavated 6 square meters and also visited Con Moong cave and conducted a test excavation with the same sieving method. One year later, in the winter of 1987-88, a Vietnamese-Bulgarian team excavated at the cave of Dong Cang and collected more charred nut fragments. Dr. Dang Huu Luu let me study this collection in Hanoi. In 1988, Dang Huu Luu and his Bulgarian colleagues also collected charcoal samples from the excavation in Mai Da Dieu and sent them to the Berlin C-14 Laboratory. Studying these samples, I recognized that they were charred fragments of *Juglans*-like and *Canarium* nuts.

The plant remains of Dong Cang are stored at the Institute of Archaeology in Hanoi. The rest of the Xom Trai, Con Moong and Mai Da Dieu materials are stored at the Center for Southeast Asian Prehistory in Hanoi.

After the excavation season 1986-87, the plant collections from Xom Trai and Con Moong were studied by botanist Dr Nguyen Nghia Thin and his student Tran Thi Thuong at the National University of Hanoi. In 1988, Professor Douglas Yen of the Australian National University in Canberra agreed to study these Vietnamese Hoabinhian plant remains. From Germany, I sent 25 samples from Xom Trai and Con Moong to Canberra.

Some other plant remains recovered from Hoabinhian sites have also been documented. These include:

1. Seeds of *Celtis* from My Te cave, cemented in a sediment block together with *Melania* snail shells and animal long bones, excavated by M. Colani (see Viet 2000 for this sample and all listed below).
2. Seeds of *Celtis* from Nguom rock shelter, collected by Ngo The Phong and Vu The Long from a small test excavation in 1987.
3. Seeds of *Celtis* from Sung Sam cave, collected by Nguyen Viet from a test excavation in 1987.
4. Fruit stone fragments of *Canarium* sp. from Hang Doi, excavated by Bui Vinh and Nguyen Gia Doi in 1990.
5. Nut shell fragments of *Canarium* sp. from Hang Muoi, test excavated by Nguyen Viet in 1987.
6. *Juglans*-like nut shell fragments from Lang Vanh, test excavated by Nguyen Viet in 1987.
7. *Juglans*-like nut shell fragments from Du Sang rock-shelter, excavated by Nguyen Viet in 2004.

METHODS OF COLLECTION AND IDENTIFICATION

The main method for collecting the dry and charred plant remains at the mentioned sites was dry sieving. All sediments excavated from Con Moong and Xom Trai during the 1982 and 1986-87 seasons were sieved with four sizes of mesh: 1 mm, 2 mm, 5 mm and 10 mm. The plant materials from the 2 mm sieve were examined microscopically.

The identifiable items were confirmed by Nguyen Nghia Thin (National University of Hanoi), Douglas Yen (Australian National University in Canberra) and researchers at the East Berlin Tierpark. The charred nut

shell fragments of *Canarium, Aleurites, Quercus* and *Castanopsis,* and the *Juglans*-like nutt shells, were identified by examining their cross-sections under a microscope. The fragments of *Canarium* and Q*uercus/Castanopsis* from Con Moong and the charred *Juglans*-like nut shells were used as materials for direct C14 dating.

The plant remains from Xom Trai

This collection came mainly from the excavations of 1982 and 1986 and from the last survey in 2004 (Fig. 2). It contains 128 dried items and 324 charred items (about 30 items per cubic meter of excavated cultural sediment). Almost all the charred fragments belong to nut shells very similar to *Juglans* (walnut). Because of the incompleteness of the samples it is not possible to identify them to species level. However, they dominate the assemblage as the main vegetable food remains in all cultural layers at Xom Trai

Almost all the small charred *Juglans*-like nut shells were used for C-14 dating after they were identified microscopically according to cross-section. Only the complete nuts and big shell fragments were documented. The radiocarbon dates range from 18,400 to 16,000 BP. Unfortunately, more than two meters of the upper sediments from Xom Trai were removed by local farmers to fertilize their gardens and rice fields. But during or after the Neolithic a group of rice growing people seem to have appeared at Xom Trai, perhaps from the coastal plains somewhere near Ninh Binh and Thanh Hoa (maybe via the lower Buoi river). Hundreds of dry and charred rice grains excavated from the upper layers are dated to 780 years ago, although this date probably does not represent the earliest rice in the region (Table 1).

Table 1. Charred plant remains excavated in Xom Trai cave in 1982 and 1986.

Species	C14 uncal. BP	no. fragments	%
oc cho (*Juglans*-like)	18,400-16,000	466	86
oc cho (*Juglans*-like)	18,400-16,000	1072	82

The plant remains from Con Moong

This collection comes from the test excavation in 1987. It contains 18 dried items and 855 charred items (about 300 items per cubic meter of excavated cultural sediment). The charred plant items are clearly separated into two groups by depth. *Canarium* dominated to a depth of 160 cm, and *Castanopsis* from 160 cm to 250 cm. The C-14 dating of Con Moong is based on three types of material: charred plant remains, shells of the land snail *Cyclophorus* sp., and shells of the freshwater snail *Melania* sp. The results show similar ages for stratigraphically equivalent samples of the land snails and charred plant remains, while the freshwater snails are on average about 500 years older. The Hoabinhian occupation here began c.13,000 BP and ended c.8000 BP (Table 2).

Table 2. Charred and dry plant remains excavated in Con Moong cave in 1987.

Species	locations in site	C14 uncal. BP	no. fragments	%
soi de (Quercus/ Castanopsis)	B3a-B1a	12,000-10,000	ca 3500	98
trau (Aleurites)	B2ab-B1ab	11,000-10,000	14	0.5
tram (*Canarium)*	A4b-A1	10,500-8,000	1019	98

The plant remains from Dong Cang

The Vietnamese - Bulgarian excavation team also used dry sieving to collect materials from Hoabinhian sediments in Dong Cang cave. However, because the sieve mesh size was large, the plant remains are either complete or relatively large fragments. The collection which Dr. Dang Huu Luu permitted me to examine contained only 130 items. The C-14 dates for Dong Cang were determined by a Polish laboratory from bones and freshwater snail shells. The most likely dates for the Dong Cang Hoabinhian occupation are from 11,000-10,000 BP (Table 3).

Table 3. Charred and dry plant remains excavated in Dong Cang cave in 1987.

Species	locations in site	C14 uncal. BP	no. fragments	%
oc cho (Juglans-like)	Layer 2/3	11,000 - 10,000	7	5
soi de (Quercus/ Castanopsis)	Layer 2	11,000 - 10,000	64	49
tram (*Canarium)*	layer 2	11,000 - 10,000	4 complete specimens	0.3

The plant remains from Mai Da Dieu

This collection originated from charcoal samples brought by Prof. Pham Huy Thong to the Berlin C-14 laboratory in 1988, where I was a research fellow from 1984 to 1989. While studying this sample prior to dating, I recognized that they included *Juglans*-like material later dated to 19,500 BP (46 charred items from a depth of 320 cm), and *Canarium* later dated to 8,000-7,000 BP (32 charred items from a depth of 180 cm). Only a small number of these samples could be preserved because of the destructive nature of the dating process. The three dates for the Mai Da Dieu Hoabinhian occupation obtained from the charred plant remains represent two quite different floras (Table 4).

Table 4. Charred and dry plant remains excavated from Mai Da Dieu.

Species	locations in site	C14 uncal. BP	no. fragments	%
oc cho (*Juglans*-like)	H1-320cm	19,400	46	100
tram (*Canarium)*	180-140 cm	9,000-7,000	52	100

DISCUSSION: CLIMATE CHANGES BETWEEN 20,000 AND 8000 BP

Table 1 presents material from the Late Pleistocene in Xom Trai Cave, before 15,000 BP, when there was a dominance of *Juglans*-like and *Celtis* remains. The *Juglans*-like remains are oldest in Mai Da Dieu at 19,500 BP, and highly abundant from 18,000-16,000 BP at Xom Trai and Lang Vanh. The youngest samples of *Juglans*-like material were found in Dong Cang at about 11,000 BP (Table 3). This plant exists presently in Vietnam only at an altitude of 1200–3000 m above sea level, while during the LGM, about 18,000 BP, this plant was endemic at an altitude of only 100 m above sea level. The average temperature during the LGM in northern Vietnam must have been about 5-7^{o} C cooler than current conditions.

From other sources, many researchers think that during the LGM period, the climate in Vietnam, as well as Southeast Asia generally, was drier than today. However, our field study of the freshwater snail *Melania* sp. shows that they live in fast running streams under the influence of heavy rainfall. There are large numbers of freshwater snail shells as food remains in Xom Trai and Lang Vanh (about 40,000 shells per cubic meter of excavated sediment). A stone-lined circular hearth perimeter was also discovered in the 18,000 BP layer in Xom Trai cave, situated away from the cave opening, in a location offering protection from the wind. That suggests that the LGM habitat at Xom Trai may have been quite cool. The presence of turtles (tortoises) and rodent bones in the faunal remains excavated from the LGM layers in Xom Trai, Lang Vanh and Du Sang caves also suggests that the *Juglans/Quercus* flora provided a rich food source for such animals (Table 5).

Table 5. Charred and dry plant remains excavated from Lang Vanh (1987) and Hang Doi (1988).

Name of plant	locations	C14 uncal. BP	no. fragments	%
oc cho (*Juglans*-like)	Lang Vanh (70cm)	16,700	1	100
tram (*Canarium)*	Hang Doi	11,000-10,000	6 complete specimens	100

In the case of Con Moong, the charred *Quercus/Castanopsis* remains dominated in layers B1a-b, B2 and B3 (12,000-10,500 BP), while in the lowest layers (B4 and B5, 13,000-12,000 BP), only the dry fruit stones of *Celtis* were found. *Celtis* is the major plant represented in the Nguom sediments, which have evidence for a dry and cold climate between 24,000 and 19,500 BP. However, we also found *Celtis* remains in Sung Sam and in the Con Moong upper layers at 11,000-10,000 BP, so this plant may not be a good indicator of climate change owing to its broad environmental tolerance. *Castanopsis* remains occurred also in Dong Cang at 11,000 BP.

In Dong Cang and Con Moong, shells of the crab *Ranguna* have been found in large numbers in layers dating 12,000 to 9,000 BP, suggesting high rainfall at this time, and corresponding to the increased numbers of land and freshwater snails *Cyclophorus/Melania*, as well as the increase in *Castanopsis* and *Canarium* macroremains.

The oldest *Canarium* remains were discovered in Dong Cang and Hang Doi at about 11,000 BP, similar in age to those from Spirit Cave, northwest Thailand (Tables 3 and 5). At Con Moong, the earliest charred fragment of *Canarium* was found in layer B1a, but *Canarium* became dominant only in layer A4b, about 9500 BP. At Mai Da Dieu, *Canarium* remains were found in the middle and upper layers dating to about 8000 BP. *Canarium* continues to grow today in the same locations as these caves and represents an important Holocene food plant of the Hoabinhian.

CONCLUSIONS

Botanists Birks and Birks (2000) have recently argued for the importance of plant macrofossils in vegetation reconstruction. The applications of sieving and flotation in excavations in northern Vietnam have enabled us to collect plant macrofossils. These represent humanly exploited flora, almost all food plants, and are relatively *in situ* compared to plants represented by pollens with wide distributions. A comparative collection of samples of modern species is necessary for the identification of these archaeological remains.

The changing climate from 20,000 to 8500 BP in Vietnam did not vary much from the general global situation. The climate was clearly colder during the LGM, with most exploited plant foods coming from the evergreen *Juglans* forest. As the climate became warmer during the terminal Pleistocene, *Quercus/Castanopsis* forest replaced the *Juglans* forest. However, we have not yet found evidence for a dry climate during that time, since it was seemingly always moist in the Muong Vang Valley where Xom Trai cave is located. Therefore, *Juglans*-like macrobotanical remains appear to be the best indicators for the LGM in Vietnam, whereas *Canarium* is the best indicator for the terminal Pleistocene and early Holocene boundary phase at about 11-10,000 BP.

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