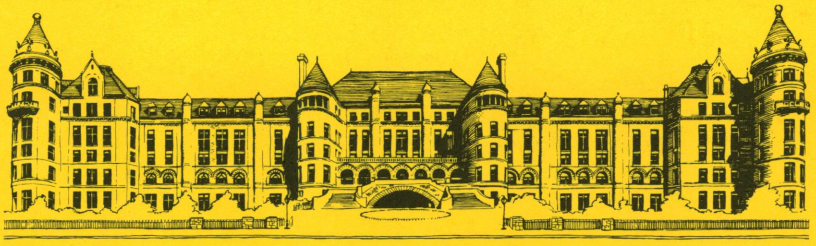

A REVIEW OF THE PLEISTOCENE HOMINOID FAUNA OF THE SOCIALIST REPUBLIC OF VIETNAM (EXCLUDING HYLOBATIDAE)

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A REVIEW OF THE PLEISTOCENE HOMINOID FAUNA OF THE SOCIALIST REPUBLIC OF VIETNAM (EXCLUDING HYLOBATIDAE)

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ABSTRACT

We review the nonhylobatid hominoid fauna currently known from all significant Pleistocene sites in Vietnam. Almost all of the sample examined consists of isolated teeth. In a previous study of material from the cave of Tham Khuyen (Schwartz et al., 1994) we identified, but did not name, a new species of *Pongo* as well as a new genus and species of thick-enameled, nonhominid hominoid. These new taxa are named and characterized in this contribution, as are four new subspecies of *Pongo pygmaeus*. We additionally note sparse evidence for other taxa whose affinities are not determinable on the basis of available specimens. Most large-bodied hominoid fossils from Vietnam are attributable to the genus *Pongo*; at most sites only the species *Pongo pygmaeus* is found. Positive evidence is extremely rare for both *Homo* and *Gigantopithecus* in the Pleistocene of Vietnam.

INTRODUCTION

Over the years some 30 breccia caves have been investigated in the karst landscape of northern Vietnam and found to contain mammal faunas of middle to late Pleistocene age (Kahlke, 1972). At ten sites (fig. 1) such faunas include the remains, almost invariably in the form of isolated teeth, of a variety of large-bodied hominoids. In a previous article we reported that at least five such taxa were apparently represented at the site of Tham Khuyen, which is also apparently the oldest of the breccia caves; in this contribution we broaden our investigation to cover almost all of the Pleistocene sites of Vietnam from which large-bodied hominoids are known. The only hominoid sites from which we were unable to examine specimens are those of Phai Ve and Hang Quyt, from which only a very few isolated teeth have been reported (Kahlke, 1972). All the specimens examined in this study are housed in the collections of the Institute of Archaeology, Hanoi (IAH). In the following discussion we look at each site and its fauna individually, before proceeding to a systematic summary of the Vietnamese Pleistocene hominoid fauna as a whole.

LOCALITIES AND NONHYLOBATID HOMINOID FAUNAS

Tham Khuyen Cave

(figs. 1, 2, 7, 9–11; tables 2, 5–12, 14–16)

We have reported extensively on the large-bodied hominoid fauna from this site elsewhere (Schwartz et al., 1994), and will only briefly review the essentials here.

The cave of Tham Khuyen lies in Binh Gia District of Lang Son Province, close to the frontier with China. Faunally dated to the late middle Pleistocene, some 300–250 kyr B.P., the breccias of Tham Khuyen have yielded the isolated teeth of some five taxa of nonhylobatid hominoids. Early studies (e.g., Cuong, 1984, 1985) had suggested the presence of *Homo* sp., *Gigantopithecus blacki,* and *Pongo pygmaeus* in the extensive sample of isolated teeth. In our more recent study of the material allocated to *Pongo,* we discerned three distinct morphs: the rather uncommon *Pongo pygmaeus*; a much more abundant unnamed species of *Pongo*; and an extremely rare and also unnamed hominoid with no obvious orangutan affinities. Later in this study we will redescribe and name these latter two taxa.

Additionally, we have now had the opportunity to examine closely the specimens originally allocated to *Gigantopithecus* and *Homo.* Five teeth have been ascribed to the former: a lower left canine (TK 65/122), a RI^1 (TK 65/61), and three lower left incisors (TK 65/146, 65/124 and unnumbered). Of these, the canine unquestionably represents *Gigantopithecus.* In addition to the preserved morphology, the wear on this tooth is typical of that genus. The short-crowned upper incisor is unworn and bears a prominent lingual tubercle that extends to the incisal edge. It thus compares well with incisors identified as *Gigantopithecus* from Chinese localities. The lower incisors are all large and moderately

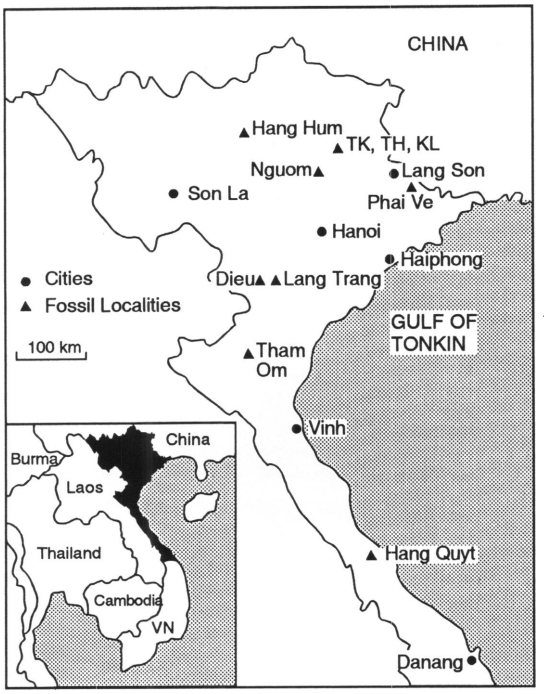

Fig. 1. Map of hominoid sites in Vietnam.

worn; of the three, two might be from *Gigantopithecus* on the basis of size and the possession of a larger lingual heel than is typical of orangutans; the third (TK 65/124) is, however, closer in size and shape to *Pongo*. All three, however, resemble orangutan I_2s in possessing considerable lateral flare. In summary, definitive evidence for *Gigantopithecus* at Tham Khuyen rests on a single canine tooth; the other teeth ascribed to this genus are more uncertainly allocated.

Cuong (1985) mentioned nine hominid teeth from Tham Khuyen, provisionally ascribed to *Homo erectus*. Reevaluation of this sample reveals that only one of these teeth is unequivocally hominid. This is TK 65/167, an upper left canine. It is moderately worn, but preserves the flaring crown morphology, the root shape, and the crown-root relationship that are typical of *Homo sapiens*. The only other tooth in the sample that might plausibly be hominid is a deciduous upper first molar (TK 65/8), which is arguably *Homo*-like in general morphology, for example in having the metacone and protocone quite closely approximated. However, human and orangutan deciduous molars are typically rather similar (Swarts, 1988), and this tooth displays some orangutan-like wrinkling of the occlusal surface. The remaining teeth in the putatively *Homo* sample are upper and lower molars. None of these appears to belong either to *Homo* sp. or to *Pongo pygmaeus*. With their open crowns, rather puffy cusps, and lack of wrinkling, two of them (TK 65/114, lower, and 65/105, upper) most closely resemble the teeth assigned by Schwartz et al. (1994) to the then-unnamed species of *Pongo* described below. They are very small, however, opening up the possibility that these teeth represent females of that species. Two lower molars (TK 65/113 and 118) resemble TK 65/121, a tooth suggested by Schwartz et al. to represent a new type of hominoid not affiliated with the orangutan or hominids, and which is also described below. TK 65/113 is distinctly smaller than 65/118 and 121 (BL breadth 11.37 mm, vs. 12.92 mm and 12.8 mm), again raising the possibility that it represents the female of a size-dimorphic species.

TK 65/50 and 65/53, both upper molars, display features of both orangutan (traces of occlusal wrinkling) and *Homo* (small and rather square in occlusal outline) molars, emphasizing how difficult it can be to discriminate between *Pongo* and *Homo* molars at the small end of the *Pongo* size range.

Tham Hai Cave

(figs. 1, 2)

Immediately adjacent to Tham Khuyen, this cave was excavated toward the end of 1964 by a joint Vietnamese-German (DDR) team. Dating is uncertain, but the site is thought to be approximately contemporaneous with Tham Khuyen. A single tooth was attributed to *Homo erectus* (Cuong, 1985). This is a relatively large upper right molar (BL width 15.41 mm; MD length 13.47 mm), which is heavily worn. It almost certainly belongs to the "Morph 2" category of Schwartz et al. (1994), described below as a new species of *Pongo*.

Keo Leng Cave

(figs. 1, 3; tables 10, 14)

This small cave near Binh Gia in Lang Son Province lies 3 km distant from Tham Khu-

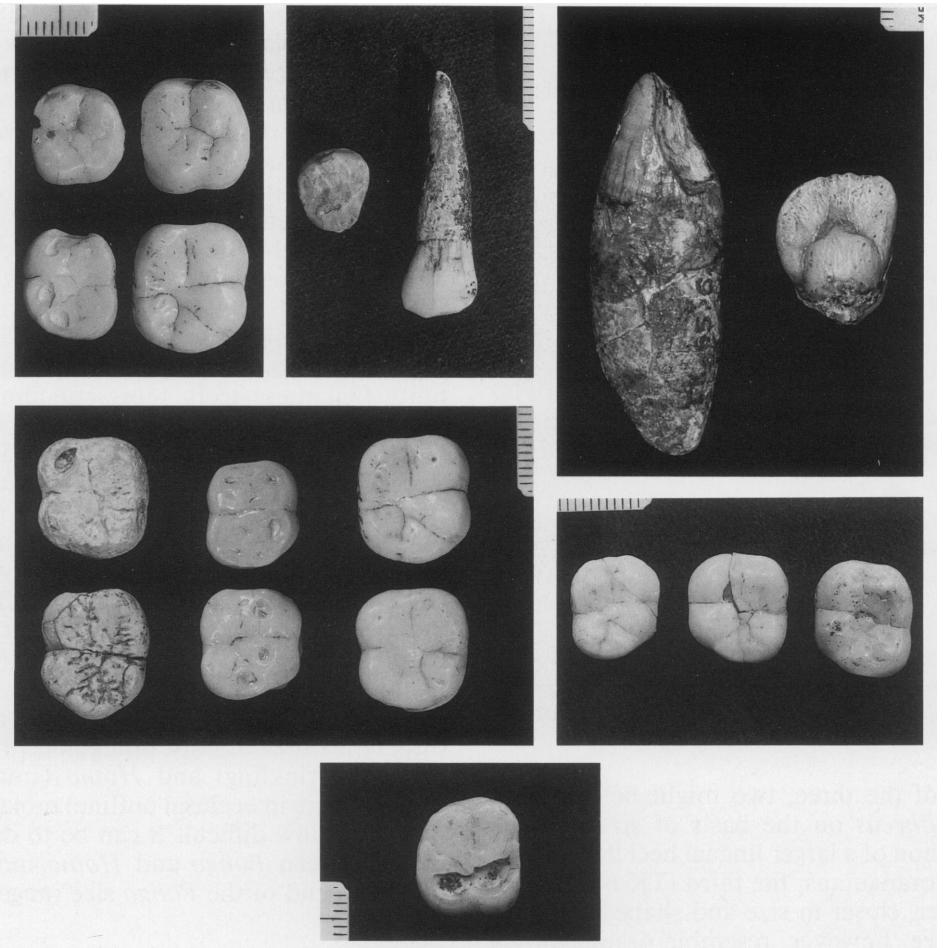

Fig. 2. Hominoid teeth from Tham Khuyen and Tham Hai. **Top row** (left plate, clockwise from top left): upper M1 or M2 (IAH TK 65/105), left upper M1 or M2 (TK/65/192), right lower M1 or 2 (TK 65/123), left lower M1 or M2 (TK 65/114); middle plate, left to right: right upper dm1 (TK 65/8), left upper canine (TK 65/167); right plate (left to right): left lower canine (TK 65/122), right upper central incisor (TK 65/61). **Middle row** (left plate, clockwise from top left): left lower M1 or M2 (TK 65/128), right lower dm2 or M1 (TK 65/52), right lower M1 or M2 (65/123), left lower M1 or M2 (TK 65/130), right lower M1 or M2 (TK 65/44), left lower M1 or M2 (TK 65/149); right plate from left to right: right lower M1 or M2 (TK 65/113), left lower M1 or M2 (TK 65/118), left lower M1 or M2 (TK 65/121). **Bottom**: upper right M1 or M2 (Tham Hai, unnumbered). Scales in mm.

yen and Tham Hai, and was excavated in 1965 by a Vietnamese group. Faunal comparisons suggest an age in the latest Pleistocene for this site, between about 30 and 20 kyr B.P. (Cuong, 1985). Typical forms are *Rhinoceros sinensis* and *Ailuropoda melanoleuca*. Few large hominoids were found, but notable were two mandibular and two maxillary jaw fragments, of *Pongo pygmaeus*, each with two to five teeth. All are badly eroded, but each seems fairly typical of modern orangutans.

Two isolated teeth were allocated by Cuong (1985) to *Homo sapiens*. One, a right lower last premolar (KL 6.o.95), is certainly not typical of *Homo sapiens* although it is not an orangutan tooth either. For the moment, it seems best to regard it as indeterminable. The

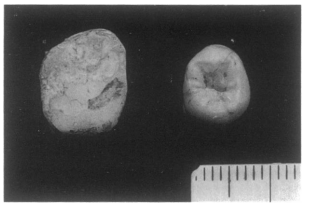

Fig. 3. Hominoid teeth from Keo Leng. **Left**: upper right molar (KL.6.o.90); **right**: lower right P4 (KL.6.o.95). Scale in mm.

other tooth, a right upper molariform (KL 6.o.90), is heavily worn and eroded and must be viewed as undiagnostic.

Hang Hum Cave

(figs. 1, 4, 7, 9–11; tables 7–14, 16)

Solution cavity, now inundated by an artificial lake, in Luc Yen District of Yen Bai Province. The site was exacavated in 1964 by a joint Vietnamese-German (DDR) team (Cuong, 1985), which identified two sedimentary phases: a lower layer with a classic Sino-Malayan fauna considered to date from the beginning of the late Pleistocene, perhaps 140–80 kyr ago, and an upper horizon from the very end of the Pleistocene. Hominoid specimens all appear to come from the older sediments. Approximately 3000 fossils were found, among them specimens identified as *Stegodon orientalis, Neofelis nebulosa, Rhinoceros sinensis, Palaeoloxodon namadicus,* and *Tapirus augustus.*

Primate fossils recovered include those of *Macaca* sp. and *Hylobates* sp., in addition to isolated teeth allocated to *Pongo pygmaeus weidenreichi* and *Homo* sp. Of 60 adult teeth (which are missing some or all of their roots, possibly as the result of porcupine activity) attributed to *Pongo,* all display typical orangutan dental morphology, including enamel wrinkling on the molars and premolars. Some of the lower molars have somewhat rounded buccal edges but, unlike teeth from Tham Khuyen in which all cusps are puffy, these Hang Hum specimens all fall within the range we have observed in modern orangutans. Morphological differences in the canines and premolars, as well as clearly observable size differences, testify to considerable sexual dimorphism in the sample. Tooth wear is typical for modern orangutans, with molar occlusal surfaces worn quite flat. See below for discussion of these teeth.

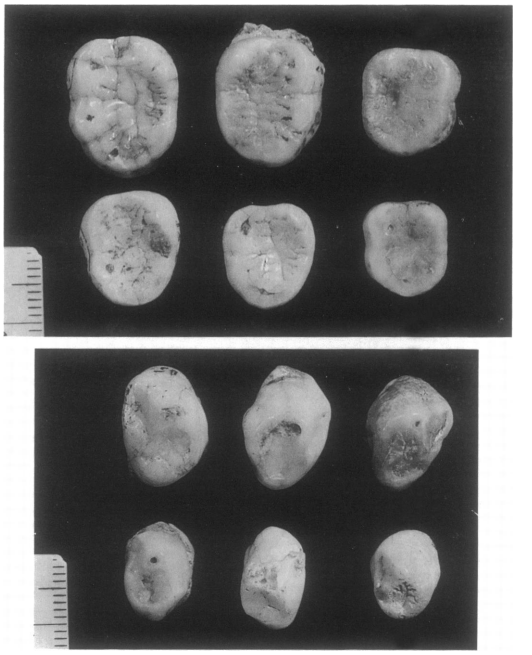

Fig. 4. Hominoid teeth from Lang Trang (left column), Tham Om (middle column), and Hang Hum (right column). **Lang Trang,** from top to bottom: left lower M3 (LT.C2.B5.45), left lower M3 (LT.C2.B5.28), left lower P3 (unnumbered), left lower P3 (unnumbered). **Tham Om,** from top to bottom: right lower M3 (77.TO.9^{b}.v.49), left lower M3 (75.TO.7), right lower P3 (77.TO.ô.13.24), left lower P3 (75.TO.?). **Hang Hum,** from top to bottom: right lower M3 (HH 46), left lower M3 (HH 48), left lower P3 (HH 50), right lower P3 (HH 26). Scales in mm.

Five isolated teeth from Hang Hum were earlier identified as belonging to the genus *Homo* (Cuong, 1992). One (HH 7) is very plausibly a hominid RP^{4}; a LP$_{4}$ (HH 128) is convincingly human also. The other three teeth (two lower molars with illegible catalog numbers and one upper molar, HH 79) are less obviously hominid, but are clearly not *Pongo.* In the absence of more extensive evidence, these teeth should probably continue to be considered hominid, although only by default.

Nguom Rockshelter

(figs. 1, 5; tables 1, 2, 5, 7)

The site is in Bac Thai Province, southeast of the town of Phu Luong. It was located in 1972 by one of us (VTL) and colleagues, and excavated by a Vietnamese group 10 years later. Hoabinhian and more recent cultural layers are underlain at the site by a Son Vian cultural layer, ^{14}C dated to approximately 23 kyr B.P. Only one fossil has been found in the rockshelter, at the deepest level. This is an unusually well-preserved orangutan lower jaw that contains the symphysis and the dentition from a broken left M_1 through the also broken right P_4. The mandible itself is large, robust, and deep at the vertical symphysis; but the canine is tiny, with but a small heel such as is typical of females. The anterior lower premolar is more massive than in the average female orangutan, but the mesial slope is less pronounced than is usual among males. We thus cannot be certain of the sex of the individual.

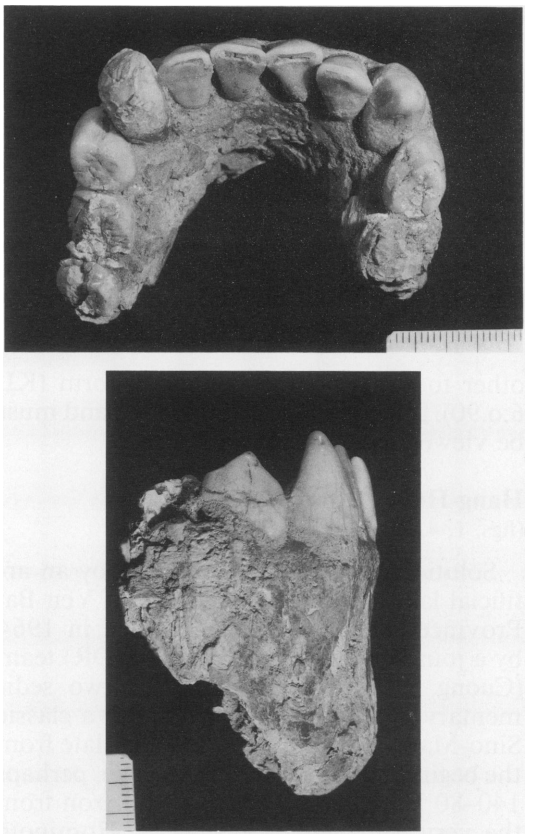

Fig. 5. Anterior portion of mandible of *Pongo* from Nguom (N 116.82). **Top**: occlusal view; **bottom**: lateral view of right side.

Lang Trang Cave

(figs. 1, 4, 6, 9–11; tables 1–3, 5, 7–16)

This large cave in Ba Thuoc District of Thanh Hoa Province was excavated by a joint Vietnamese-American team in 1989 (Ciochon et al., 1990) and 1993. An extensive fossil fauna, mostly very fragmentary, has been recovered; early estimates based on limited evidence suggested a middle Pleistocene date of as much as 500 kyr B.P. (Ciochon et al., 1990). However, analyses of the more recently excavated material suggest that most of the fauna may be considerably younger than this (de Vos et al., MS; Long, MS).

For this report we examined more than 200 isolated teeth of large hominoids (160 of them measurable), all recovered from Block 5 of the Cave 2 breccia. All but one of these teeth (an upper right canine, unnumbered, typical of *Homo sapiens*) are attributable to *Pongo pygmaeus,* although they are very large. Although they tend to be of exceptional size, the only way in which any of these teeth differ from those of extant orangutans is in the shortness of the upper central incisor crowns, and the lack in these same teeth of a well-defined lingual tubercle. As in modern orangutans, there is a marked disparity in size (and in the morphology of the canines and premolars) between males and females. The roots of the teeth tend to be preserved more frequently than is typical of most Vietnamese sites, but traumatic antemortem damage to the occlusal molar enamel is relatively common. Most Vietnamese hominoid sites contain virtually no deciduous teeth, and all adult teeth appear to have erupted by the time the individuals died. However, the Lang Trang sample includes six deciduous teeth and as many as seven unerupted permanent crowns.

Dieu Rockshelter

(figs. 1, 10; tables 7–9, 14)

This site lies in the valley of the Muong Ai River, some 11 km west of the better-known site of Lang Trang, in Ba Thuoc district of

Fig. 6. Upper incisors of *Pongo* from Lang Trang. **Left**: right upper I1 (LT.C2.B5. unnumbered); **right**: left upper I1 (LT.C2.B5. unnumbered). Scale in mm.

Thanh Hoa Province. Initially excavated in 1986 by a Vietnamese group, the site was revisited in 1988, 1989, and 1991 by a joint Vietnamese-Bulgarian team. This group recovered material attributed to *Pongo* at 4.5 m depth, in a level that discontinuously underlies the lowest (Hoabinhian) cultural layer. The associated fauna includes suids and muntjac, and is said to be similar to that from the nearby Lang Trang.

The *Pongo* material from Dieu consists of about 30 isolated teeth, most of which are heavily damaged. Although enamel crenulation is not particularly marked on most cheek teeth, the morphology is typical of extant *Pongo pygmaeus*. Upper central incisors are not complete enough to measure, but were clearly short-crowned. Sexual dimorphism, as in extant orangutans, is reflected in the shape of the premolars.

Tham Om Cave

(figs. 1, 4, 7–11; tables 2, 4, 6–16)

This site, in the Quy Chau District of Nghé An Province, was excavated by a Vietnamese team in early 1977. Red sediments of apparent later middle Pleistocene age (ca. 250–140 kyr B.P., Cuong, 1985) produced most of the mammal fossils and all of the hominoids. Characteristic mammals reportedly include *Stegodon orientalis, Ailuropoda melanoleuca, Rhinoceros sinensis,* and *Tapirus* sp. According to Kha (1977), most of the hominoid fossils were attributable to *Pongo pygmaeus,* but one tooth appeared to be of *Gigantopithecus,* and four were of *Homo.*

Of the 59 teeth allocated to *Pongo pygmaeus,* all but three are typically orangutan in dental morphology. As in extant orangutans, this sample shows strong evidence of sexual dimorphism, in morphology of the canines and premolars as well as in the size of all teeth. Unusually, however, the disparity in size between putative males and females is extreme: males tend to be only slightly smaller than extant male *Pongo pygmaeus,* but the females are very markedly inferior in

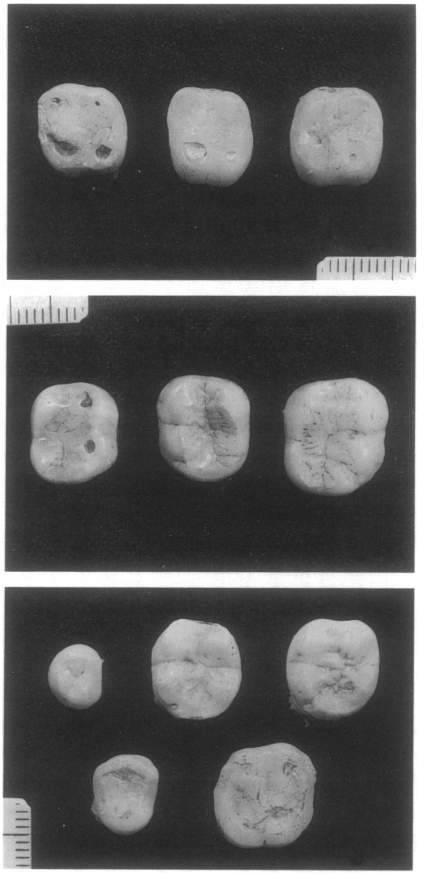

Fig. 7. Hominoid teeth from Tham Khuyen (TK), Tham Om (TO), and Hang Hum (HH). **Top,** from left to right: left upper molar (75.TO.H), left upper molar (TK 65/50), right upper molar (TK 65/53). **Middle,** from left to right: right lower molar (75.TO.22), left lower molar (77.TO.o.7^{b}.v.38), right lower molar (77.TO.v.01.39). **Bottom,** clockwise from upper left: right lower P2 (HH 128), left lower M1 or M2 (HH number illegible), left lower M3 (HH number illegible), right upper molar (HH 79), right upper premolar (HH 7). Scales in mm.

size to typical *P. p. pygmaeus* females. As with the orangutan teeth from Hang Hum and Tham Khuyen, most of the teeth are missing their roots, probably as a result of porcupine activity. Unusually for all sites, however, a large proportion of the molars shows signs of traumatic usage, with a high frequency of broken and chipped cusps (38% of molars display significant antemortem damage of this kind).

As noted, three teeth stand out from the orangutan group. Two of them, a right lower molariform (75.TO.22) and a left lower molariform (77.TO.o.7^{b}.v.38), are similar to orangutan lower molars in complexity of enamel wrinkling and crispness of cusp definition, but differ in having higher crowns, more distinct buccal cusps, larger trigonid basins, and a more narrowly rectangular occlusal outline. These teeth are minimally worn. The tooth from the right side is noticeably larger than that from the left. The third distinctive tooth, a lower right molariform (77.TO.v.01.39), lacks a trigonid basin and bears a shallow, smooth, and broad talonid. This thick-enameled tooth is somewhat worn, but faint traces of wrinkling are distinguishable in its enamel. It might be a last deciduous molar, but is more probably an adult tooth of some non-orangutanlike but also nonhuman hominoid.

The single upper right central incisor (unnumbered) that has been attributed to *Gigantopithecus* by Kha (1977) is greatly worn, which makes any definitive identification impossible. However, the tooth was clearly a very large one (worn B/L breadth: 14.5 mm; worn M/D length: 16.35 mm), and its considerable buccolingual width is consistent with Kha's attribution.

Fig. 8. Hominoid teeth from Tham Om. **Top** (clockwise from upper left): left upper molar (75.TO.H2), left upper molar (77.TO.o.13.H5), left lower dm1 (TO unnumbered), left upper molar (75.TO.H3). **Bottom,** left to right: right upper P4 (77.TO.o.13.45), left upper P4 (75.TO.11). Scales in mm.

Four identifiable Tham Om hominoid teeth

TABLE 1
Summary Statistics of Lower Central Incisors

	n	Mean	SD	CV
I_1—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	9	9.80	0.72	7.35
P. p. pygmaeus (Hooijer, 1948)	12	9.10	0.77	8.46
P. p. pygmaeus male (Swindler, 1976)	7	10.10	1.36	—
P. p. pygmaeus female (Swindler, 1976)	8	9.40	0.80	—
Nguom	2	10.30	0.14	1.37
Lang Trang	2	9.64	0.66	6.83
I_1—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	56	10.20	1.09	10.69
P. p. pygmaeus (Hooijer, 1948)	51	9.50	0.90	9.47
P. p. pygmaeus male (Swindler, 1976)	6	9.70	1.02	—
P. p. pygmaeus female (Swindler, 1976)	9	8.50	0.38	—
Nguom	2	9.01	0.05	0.55
Lang Trang	2	9.14	1.05	11.45

TABLE 2
Summary Statistics of Lower Lateral Incisors

	n	Mean	SD	CV
I_2—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	112	9.70	0.80	8.25
P. p. pygmaeus (Hooijer, 1948)	17	8.90	0.71	7.98
P. p. pygmaeus male (Swindler, 1976)	7	11.00	1.37	—
P. p. pygmaeus female (Swindler, 1976)	9	9.70	0.78	—
Nguom	2	10.61	0.02	0.20
Lang Trang	7	11.20	1.24	11.03
Tham Khuyen	2	11.15	0.21	1.90
Tham Om	3	10.40	0.51	4.86
I_2—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	137	10.90	1.10	10.09
P. p. pygmaeus (Hooijer, 1948)	48	9.90	0.97	9.80
P. p. pygmaeus male (Swindler, 1976)	6	9.70	0.66	—
P. p. pygmaeus female (Swindler, 1976)	9	8.40	0.58	—
Nguom	2	9.24	0.40	4.36
Lang Trang	7	9.47	0.93	9.78
Tham Khuyen	2	8.08	0.32	3.94
Tham Om	3	8.92	0.65	7.27

have been identified as hominid: three adult upper molars and one deciduous lower first molar. The slightly worn deciduous tooth (unnumbered), with a B/L width of 9.67 mm and M/D length of 10.94 mm, is, however, more *Pongo*- than *Homo*-like. The tooth is bulky, the crests are very thick, and the anterior basin is subequal in size to the posterior one. The remaining three molars are all quite heavily worn, which contributes to the difficulty of identifying them. However, all show at least slight traces of wrinkling. On balance, it seems likely that all three teeth are attributable to *Pongo*; the alternative attribution, to *Homo,* seems less convincing. It is fair to note, however, that the similarity between these teeth and those of *Homo* is striking—and the more striking the more worn they are. But in the context of this substantial sample of *Pongo* it is most plausible to see them as falling at one end of the *Pongo* range of variation. This observation underlines the similarity in basic structure between orangutan molars and those of more macrodont

TABLE 3
Summary Statistics of Upper Central Incisors

	n	Mean	SD	CV
I^1—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	27	14.90	1.46	9.79
P. p. pygmaeus (Hooijer, 1948)	5	14.00	1.13	8.07
P. p. pygmaeus male (Swindler, 1976)	6	13.40	1.76	—
P. p. pygmaeus female (Swindler, 1976)	9	12.40	0.77	—
Lang Trang	5	13.07	0.76	5.79
I^1—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	23	12.70	0.93	7.32
P. p. pygmaeus (Hooijer, 1948)	23	12.50	1.24	9.92
P. p. pygmaeus male (Swindler, 1976)	4	14.70	0.96	—
P. p. pygmaeus female (Swindler, 1976)	4	13.80	1.04	—
Lang Trang	5	14.55	0.78	5.35

TABLE 4
Summary Statistics of Upper Lateral Incisors

	n	Mean	SD	CV
I^2—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	44	9.60	0.86	8.96
P. p. pygmaeus (Hooijer, 1948)	27	8.60	0.82	9.53
P. p. pygmaeus male (Swindler, 1976)	4	8.40	0.28	—
P. p. pygmaeus female (Swindler, 1976)	5	8.30	0.74	—
Tham Om	2	7.91	0.08	0.98
I^2—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	29	9.60	0.90	9.38
P. p. pygmaeus (Hooijer, 1948)	32	8.70	1.00	11.49
P. p. pygmaeus male (Swindler, 1976)	4	8.80	0.73	—
P. p. pygmaeus female (Swindler, 1976)	4	8.40	0.25	—
Tham Om	2	8.09	0.30	3.67

Homo; had these three teeth been discovered in isolation, it would have been difficult to contest their initial allocation to *Homo*.

SYSTEMATICS

The preceding brief review of the fossil large-bodied hominoid fauna of Vietnam indicates that there is a greater diversity of taxa represented than the conventional allocation of all specimens to *Pongo pygmaeus, Homo* sp., and *Gigantopithecus blacki* would imply (cf. Schwartz et al., 1994). Indeed, there is evidence in this suite of material for one new genus, for one new species of *Pongo*, and for at least four new subspecies of *Pongo pyg-*

TABLE 5
Summary Statistics of Lower Canines

	n	Mean	SD	CV
Lower C—B/L				
P. p. palaeosumatrensis male (Hooijer, 1948)	49	14.30	1.58	11.05
P. p. palaeosumatrensis female (Hooijer, 1948)	47	9.90	0.86	8.69
P. p. pygmaeus male (Hooijer, 1948)	21	12.90	1.03	7.98
P. p. pygmaeus female (Hooijer, 1948)	22	9.10	1.05	11.54
P. p. pygmaeus male (Swindler, 1976)	3	14.80	0.59	—
P. p. pygmaeus female (Swindler, 1976)	6	11.90	1.13	—
P. p. weidenreichi female (Holotype)	1	11.00	—	—
Nguom	2	15.10	0.40	2.67
Lang Trang	2	14.60	7.18	49.18
Tham Khuyen	3	12.47	0.90	7.23
Lower C—M/D				
P. p. palaeosumatrensis male (Hooijer, 1948)	40	17.10	1.65	9.65
P. p. palaeosumatrensis female (Hooijer, 1948)	42	13.30	1.10	8.27
P. p. pygmaeus male (Hooijer, 1948)	16	15.70	1.10	7.01
P. p. pygmaeus female (Hooijer, 1948)	23	12.30	1.09	8.86
P. p. pygmaeus male (Swindler, 1976)	3	12.00	1.07	—
P. p. pygmaeus female (Swindler, 1976)	3	9.70	2.55	—
P. p. weidenreichi female (Holotype)	1	14.20	—	—
Nguom	2	10.11	0.50	4.97
Lang Trang	2	14.40	1.64	11.39
Tham Khuyen	3	17.07	1.21	7.06

TABLE 6
Summary Statistics of Upper Canines

	n	Mean	SD	CV
Upper C—B/L				
P. p. palaeosumatrensis male (Hooijer, 1948)	18	15.20	1.79	1.18
P. p. palaeosumatrensis female (Hooijer, 1948)	28	11.00	0.89	8.09
P. p. pygmaeus male (Hooijer, 1948)	19	14.30	1.08	7.55
P. p. pygmaeus female (Hooijer, 1948)	23	10.30	0.91	8.83
P. p. pygmaeus male (Swindler, 1976)	4	13.20	1.89	—
P. p. pygmaeus female (Swindler, 1976)	5	10.80	0.49	—
Tham Om[a]	4	8.80	1.49	16.96
Tham Khuyen	2	17.95	0.07	0.39
Upper C–M/D				
P. p. palaeosumatrensis male (Hooijer, 1948)	21	20.90	1.74	8.33
P. p. palaeosumatrensis female (Hooijer, 1948)	35	14.10	1.12	7.94
P. p. pygmaeus male (Hooijer, 1948)	17	18.30	1.82	9.95
P. p. pygmaeus female (Hooijer, 1948)	23	12.90	0.86	6.67
P. p. pygmaeus male (Swindler, 1976)	4	16.40	2.08	—
P. p. pygmaeus female (Swindler, 1976)	4	12.50	1.56	—
Tham Om[a]	4	12.21	2.42	19.81
Tham Khuyen	2	18.43	1.73	9.40

[a] Tham Om sample contains two deciduous teeth.

TABLE 7
Summary Statistics of Lower Anterior Premolars

	n	Mean	SD	CV
P_3—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	266	10.60	1.21	11.42
P. p. pygmaeus (Hooijer, 1948)	47	9.80	1.06	10.82
P. p. pygmaeus male (Swindler, 1976)	8	11.00	1.80	—
P. p. pygmaeus female (Swindler, 1976)	7	9.30	0.55	—
Nguom	2	14.20	0.34	2.39
Dieu	2	10.25	0.38	3.73
Hang Hum	6	10.37	1.11	10.71
Lang Trang	18	10.38	0.77	7.44
Tham Khuyen (*P. hooijeri*)	10	10.98	1.00	9.09
Tham Om	7	10.61	1.04	9.80
P_3—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	236	15.90	1.79	11.26
P. p. pygmaeus (Hooijer, 1948)	46	15.00	1.91	12.73
P. p. pygmaeus male (Swindler, 1976)	7	15.60	2.10	—
P. p. pygmaeus female (Swindler, 1976)	7	13.80	1.01	—
Nguom	2	10.59	0.64	6.08
Dieu	2	15.65	2.12	13.56
Hang Hum	6	16.12	1.91	11.86
Lang Trang	18	15.31	1.17	7.63
Tham Khuyen (*P. hooijeri*)	8	17.02	1.89	11.07
Tham Om	7	15.88	1.07	6.72

TABLE 8
Summary Statistics of Lower Posterior Premolars

	n	Mean	SD	CV
P_4—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	265	10.10	1.49	14.75
P. p. pygmaeus (Hooijer, 1948)	46	10.40	0.87	8.37
P. p. pygmaeus male (Swindler, 1976)	8	11.90	1.21	—
P. p. pygmaeus female (Swindler, 1976)	6	10.40	0.53	—
Dieu	2	11.39	1.22	10.68
Hang Hum	11	11.40	0.45	3.97
Lang Trang	17	15.33	1.24	8.08
Tham Khuyen (*P. hooijeri*)	3	12.57	0.14	1.10
Tham Om	5	12.46	1.01	8.08
P_4—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	263	13.40	1.19	8.88
P. p. pygmaeus (Hooijer, 1948)	46	12.90	1.33	10.31
P. p. pygmaeus male (Swindler, 1976)	7	11.30	0.80	—
P. p. pygmaeus female (Swindler, 1976)	7	10.50	0.80	—
Dieu	2	13.34	0.33	2.44
Hang Hum	11	11.91	0.51	4.28
Lang Trang	17	11.02	0.99	8.98
Tham Khuyen (*P. hooijeri*)	3	13.90	1.41	10.15
Tham Om	5	13.52	0.70	5.20

TABLE 9
Summary Statistics of Upper Anterior Premolars

	n	Mean	SD	CV
P^3—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	169	13.70	1.43	10.44
P. p. pygmaeus (Hooijer, 1948)	47	13.00	1.30	10.00
P. p. pygmaeus male (Swindler, 1976)	7	13.20	1.00	—
P. p. pygmaeus female (Swindler, 1976)	6	11.80	0.72	—
Dieu	2	13.61	0.46	3.38
Hang Hum	4	13.90	0.75	5.37
Lang Trang	17	13.48	0.86	6.40
Tham Khuyen (*P. hooijeri*)	5	14.24	0.60	4.21
Tham Om	3	12.85	0.42	3.30
P^3—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	192	10.60	0.94	8.87
P. p. pygmaeus (Hooijer, 1948)	40	10.10	0.91	9.01
P. p. pygmaeus male (Swindler, 1976)	6	10.30	1.03	—
P. p. pygmaeus female (Swindler, 1976)	8	9.60	0.94	—
Dieu	2	12.50	1.20	9.62
Hang Hum	4	10.60	0.93	8.76
Lang Trang	17	11.33	0.73	6.45
Tham Khuyen (*P. hooijeri*)	5	12.32	0.82	6.64
Tham Om	3	11.55	1.60	13.86

TABLE 10
Summary Statistics of Upper Posterior Premolars

	n	Mean	SD	CV
P^4—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	265	13.70	1.31	9.56
P. p. pygmaeus (Hooijer, 1948)	50	12.70	1.18	9.29
P. p. pygmaeus male (Swindler, 1976)	7	13.30	0.89	—
P. p. pygmaeus female (Swindler, 1976)	8	12.10	0.64	—
Keo Leng	2	14.82	0.47	3.15
Hang Hum	3	14.84	1.10	7.40
Lang Trang	17	15.33	1.24	8.08
Tham Khuyen	2	12.37	0.96	7.77
Tham Khuyen (*P. hooijeri*)	3	14.08	1.15	8.14
Tham Om	3	14.41	0.86	5.98
P^4—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	275	10.00	0.87	8.70
P. p. pygmaeus (Hooijer, 1948)	39	9.40	0.84	8.94
P. p. pygmaeus male (Swindler, 1976)	7	10.00	0.75	—
P. p. pygmaeus female (Swindler, 1976)	8	9.30	0.77	—
Keo Leng	2	10.84	0.17	1.57
Hang Hum	3	9.99	0.62	6.22
Lang Trang	17	11.02	0.99	8.98
Tham Khuyen	2	9.97	0.26	2.63
Tham Khuyen (*P. hooijeri*)	3	10.88	1.54	14.17
Tham Om	3	10.90	0.66	6.09

TABLE 11
Summary Statistics of Lower First Molars

	n	Mean	SD	CV
M_1—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	195	12.30	0.86	6.99
P. p. pygmaeus (Hooijer, 1948)	59	11.60	0.92	7.93
P. p. pygmaeus male (Swindler, 1976)	7	?	?	—
P. p. pygmaeus female (Swindler, 1976)	10	?	?	—
Hang Hum	10	12.17	0.77	6.31
Lang Trang	15	13.30	0.76	5.68
Tham Khuyen M_1/M_2	5	13.91	1.05	7.56
Tham Khuyen M_1/M_2 (*P. hooijeri*)	2	14.93	0.11	0.71
Tham Khuyen M_1/M_2 (*Langsonia*)	5	12.33	0.76	6.12
Tham Om	8	13.87	1.27	9.18
Tham Om M_1/M_2	3	11.90	1.16	9.77
M_1—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	204	14.20	0.98	6.90
P. p. pygmaeus (Hooijer, 1948)	51	13.10	1.05	8.02
P. p. pygmaeus male (Swindler, 1976)	8	13.40	0.68	—
P. p. pygmaeus female (Swindler, 1976)	10	11.40	2.68	—
Hang Hum	10	13.19	0.37	2.76
Lang Trang	15	15.43	0.98	6.38
Tham Khuyen M_1/M_2	5	15.85	1.43	9.00
Tham Khuyen M_1/M_2 (*P. hooijeri*)	2	16.48	0.62	3.78
Tham Khuyen M_1/M_2 (*Langsonia*)	5	13.96	0.56	4.02
Tham Om	8	15.92	1.26	7.92
Tham Om M_1/M_2	3	13.65	1.15	8.40

TABLE 12
Summary Statistics of Lower Second Molars

	n	Mean	SD	CV
M_2—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	222	14.00	1.08	7.71
P. p. pygmaeus (Hooijer, 1948)	48	12.70	1.18	9.29
P. p. pygmaeus male (Swindler, 1976)	8	?	?	—
P. p. pygmaeus female (Swindler, 1976)	8	?	?	—
Hang Hum	3	13.44	1.34	9.94
Lang Trang[a]	7	12.33	1.72	13.95
Tham Khuyen M_1/M_2	5	13.91	1.05	7.56
Tham Khuyen M_1/M_2 (*P. hooijeri*)	2	14.93	0.11	0.71
Tham Khuyen M_1/M_2 (Langsonia)	5	12.33	0.76	6.12
Tham Om	3	13.02	1.06	8.17
Tham Om M_1/M_2	3	11.90	1.16	9.77
M_2—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	217	15.40	1.24	8.05
P. p. pygmaeus (Hooijer, 1948)	47	13.60	1.42	10.44
P. p. pygmaeus male (Swindler, 1976)	8	14.20	0.59	—
P. p. pygmaeus female (Swindler, 1976)	8	13.30	0.58	—
Hang Hum	3	14.59	0.87	5.93
Lang Trang*	7	14.57	1.70	11.67
Tham Khuyen M_1/M_2	5	15.85	1.43	9.00
Tham Khuyen M_1/M_2 (*P. hooijeri*)	2	16.48	0.62	3.78
Tham Khuyen M_1/M_2 (*Langsonia*)	5	13.96	0.56	4.02
Tham Om	3	15.34	1.08	7.02
Tham Om M_1/M_2	3	13.65	1.15	8.40

[a] Lang Trang sample also contains four deciduous teeth.

TABLE 13
Summary Statistics of Lower Third Molars

	n	Mean	SD	CV
M_3—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	207	12.90	1.25	9.69
P. p. pygmaeus (Hooijer, 1948)	44	12.30	1.29	10.49
P. p. pygmaeus male (Swindler, 1976)	5	?	?	—
P. p. pygmaeus female (Swindler, 1976)	5	?	?	—
Hang Hum	4	11.70	0.80	6.80
Lang Trang	12	15.12	0.99	6.57
Tham Om	9	13.68	1.11	8.12
M_3—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	208	14.50	1.42	9.79
P. p. pygmaeus (Hooijer, 1948)	39	13.60	1.71	12.57
P. p. pygmaeus male (Swindler, 1976)	5	13.50	1.82	—
P. p. pygmaeus female (Swindler, 1976)	4	12.90	0.79	—
Hang Hum	4	13.45	0.72	5.37
Lang Trang	12	17.84	1.14	6.40
Tham Om	9	15.91	1.40	8.77

TABLE 14
Summary Statistics of Upper First Molars

	n	Mean	SD	CV
M^1—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	330	13.50	0.95	7.04
P. p. pygmaeus (Hooijer, 1948)	64	13.10	0.95	7.25
P. p. pygmaeus male (Swindler, 1976)	7	?	?	—
P. p. pygmaeus female (Swindler, 1976)	10	?	?	—
Dieu	3	14.28	0.70	4.90
Keo Leng	2	13.58	0.00	0.00
Hang Hum	2	12.48	0.54	4.31
Lang Trang	19	14.93	1.10	7.35
Tham Khuyen (*P. hooijeri*)	7	14.78	0.24	4.22
Tham Om	3	15.12	1.02	6.74
Tham Om M^1/M^2	3	12.37	0.58	4.70
M^1—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	330	12.70	0.92	7.24
P. p. pygmaeus (Hooijer, 1948)	59	12.20	1.07	8.77
P. p. pygmaeus male (Swindler, 1976)	7	12.80	0.81	—
P. p. pygmaeus female (Swindler, 1976)	10	11.90	0.75	—
Dieu	3	12.78	0.28	2.18
Keo Leng	2	13.84	1.10	7.92
Hang Hum	2	12.22	0.47	3.82
Lang Trang	19	14.09	1.17	8.29
Tham Khuyen (*P. hooijeri*)	7	13.57	0.90	6.64
Tham Om	3	14.71	0.39	2.62
Tham Om M^1/M^2	3	11.87	0.26	2.23

TABLE 15
Summary Statistics of Upper Second Molars

	n	Mean	SD	CV
M^2—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	340	15.30	1.36	8.89
P. p. pygmaeus (Hooijer, 1948)	51	13.90	1.27	9.14
P. p. pygmaeus male (Swindler, 1976)	7	?	?	—
P. p. pygmaeus female (Swindler, 1976)	9	?	?	—
Lang Trang[a]	11	15.00	1.46	9.76
Tham Khuyen	2	15.61	0.77	4.94
Tham Khuyen (*P. hooijeri*)	3	14.98	0.16	1.07
Tham Om	4	16.05	1.57	9.79
Tham Om M^1/M^2	3	12.37	0.58	4.70
M^2—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	349	13.80	1.16	8.41
P. p. pygmaeus (Hooijer, 1948)	46	12.20	1.27	10.41
P. p. pygmaeus male (Swindler, 1976)	7	12.70	0.55	—
P. p. pygmaeus female (Swindler, 1976)	9	12.10	0.79	—
Lang Trang[a]	11	15.03	2.01	13.40
Tham Khuyen	2	14.55	1.27	8.75
Tham Khuyen (*P. hooijeri*)	3	14.04	0.22	1.59
Tham Om	4	15.59	1.10	7.07
Tham Om M^1/M^2	3	11.87	0.26	2.23

[a] Lang Trang sample also contains two deciduous teeth.

TABLE 16
Summary Statistics of Upper Third Molars

	n	Mean	SD	CV
M^3—B/L				
P. p. palaeosumatrensis (Hooijer, 1948)	227	13.70	1.45	10.58
P. p. pygmaeus (Hooijer, 1948)	45	13.20	1.30	9.85
P. p. pygmaeus male (Swindler, 1976)	3	?	?	—
P. p. pygmaeus female (Swindler, 1976)	4–5	?	?	—
Hang Hum	4	14.03	1.27	9.03
Lang Trang	11	15.60	1.68	10.76
Tham Khuyen	4	13.80	1.28	9.29
Tham Om	4	15.33	1.13	7.39
M^3—M/D				
P. p. palaeosumatrensis (Hooijer, 1948)	227	11.90	1.19	10.00
P. p. pygmaeus (Hooijer, 1948)	43	11.60	1.48	12.76
P. p. pygmaeus male (Swindler, 1976)	4	12.40	0.42	—
P. p. pygmaeus female (Swindler, 1976)	5	11.50	0.46	—
Hang Hum	3	11.72	0.58	4.93
Lang Trang	11	14.40	1.65	11.48
Tham Khuyen	4	11.75	0.55	4.68
Tham Om	4	14.84	1.02	6.84

maeus. In addition, there are hints that other undescribed taxa are present, notably at Tham Om, although current evidence is too sparse to allow them to be adequately characterized. In this section we formally describe the new taxa for which evidence appears to be compelling. We recognize that subspecies determination in the fossil record is often a questionable process; but given that Hooijer's (1948) subspecific division of the subfossil orangutan faunas of Sumatra and China has been favorably viewed for almost half a century, and that distinct, site-limited orangutan morphs are clearly recognizable in our Vietnamese sample, we conclude that it is most useful as well as most practicable to extend Hooijer's practice here.

ORDER PRIMATES

SUBORDER ANTHROPOIDEA

SUPERFAMILY HOMINOIDEA

FAMILY INCERTAE SEDIS

Langsonia, new genus

TYPE SPECIES: *Langsonia liquidens*, new species.

INCLUDED SPECIES: Type only.

DISTRIBUTION: Currently known only from Tham Khuyen Cave, Lang Son Province, Vietnam.

DIAGNOSIS: As for type species.

DISCUSSION: See under type species.

ETYMOLOGY: Named for the province of Vietnam where first found.

Langsonia liquidens, new species

HOLOTYPE: IAH (Institute of Archaeology, Hanoi) TK 65/44, right M_1 (fig. 2).

TYPE LOCALITY: Cave of Tham Khuyen, near Binh Gia, Lang Son Province, Vietnam (fig. 1).

DISTRIBUTION: Type locality only. Middle Pleistocene.

HYPODIGM: Type plus IAH TK 65/52, right dm_2 or M_1; TK 65/113, right M_1 or M_2; TK 65/118, left M_1 or M_2; TK 65/121, left M_1 or M_2.

ETYMOLOGY: *L. liquis, dens*; oblique-toothed, to denote the unusual conformation of the posterior edge of the lower molars.

DESCRIPTION AND DIAGNOSIS: Known only from isolated lower molars; these are thick-enameled and in the midrange of size for fossil and living Hominoidea. High-crowned, with expanded occlusal surfaces and large trigonid. Differs from all other known living and fossil hominoids in the combination of

the following characters: Protoconid, hypoconid, and hypoconulid are of equal height and much lower than the buccal cusps. Entoconid much reduced in length and metaconid greatly expanded mesiodistally. Hypoconulid partly coalesced with entoconid, expanding the tooth distally and producing an obliquely oriented posterior molar margin.

DISCUSSION: The lower molars of *Langsonia liquidens* are smaller than those of most of the other Vietnamese hominoids, and differ from them all morphologically. Indeed, they are distinct in morphology from the homologous teeth of any fossil or living hominoid with which we are familiar, thus making it difficult at this time to make any allocation to family or subfamily. Certain small upper molars from Tham Khuyen (e.g., TK 65/50 and 65/53) are distinctive from other hominoid upper molars in the sample from this site, and may also represent *L. liquidens.* However, in the absence of associated dentitions, it is impossible to state with any confidence that they do.

FAMILY PONGIDAE

Genus ***Pongo*** Lacépède, 1799

Pongo hooijeri, new species

HOLOTYPE: IAH TK 65/123, left M_2 (fig. 2).

TYPE LOCALITY: Tham Khuyen Cave, near Binh Gia, Lang Son Province, Vietnam (fig. 1).

DISTRIBUTION: Type locality, plus the neighboring Tham Hai Cave. Middle Pleistocene.

HYPODIGM: Isolated teeth only. From Tham Khuyen Cave, by element: TK 65/46, 138, 142, 142a, 143 (canines); TK 65/3, 11, 37, 39, 58, 107, 135, 148, 156, 162 (upper premolars); TK 65/1, 2, 4, 5, 6, 9, 12, 36, 47, 150, 155, 161, 197, 1152 (lower premolars); TK 65/13, 34a, 45, 51, 57, 79, 112, 119, 136, 137, 150, 159 (upper molars); TK 65/123, 125, 130 (lower molars). From Tham Hai Cave: one upper right molar, unnumbered.

ETYMOLOGY: In honor of the late Dr. Dirk Albert Hooijer, distinguished paleontologist and monographer of the Pleistocene pongid fauna of southeastern Asia.

DESCRIPTION AND DIAGNOSIS: Larger than most subspecies of fossil and living *Pongo pygmaeus* (see figs. 9–11), but differs from all known populations of *P. pygmaeus* in lacking significant crenulation on the occlusal surfaces of the molars and upper premolars, and on the basins of the lower premolars. Incisors are not known. Molar cusp disposition similar to that of *P. pygmaeus,* but the cusps themselves are puffier and more rounded occlusally as well as on their external slopes. The occlusal surfaces are thus more poorly defined, and the occlusal basins are more constricted.

DISCUSSION: The characters of the molars listed above distinguish these teeth very markedly from those of *Pongo pygmaeus,* and give them a very distinctive "gestalt." While it does appear that this new form belongs in the same general clade as the extant orangutan, it is by no means clear on the basis of current evidence that the two are very closely related. Pending better material, we feel a conservative interpretation is most appropriate, and have thus allocated this dentally distinctive primate to its own species of *Pongo.* It may well turn out, however, that the relationship between the two species is more distant than this implies, and it is possible that a separate generic designation for *hooijeri* will ultimately be warranted.

Pongo pygmaeus (Linnaeus, 1760)

Pongo pygmaeus ciochoni, new subspecies

HOLOTYPE: Isolated M_3, IAH LT93.C2.B5.28 (fig. 4).

TYPE LOCALITY: Cave of Lang Trang, Ba Thuoc District of Thanh Hoa Province, Vietnam (fig. 1).

DISTRIBUTION: Type locality only. Late Pleistocene.

HYPODIGM: Type plus 5 I^1, 1 I^2, 2 I_1, 6 I_2, 3 C, 17 P^3, 18 P_3, 17 P^4, 20 P_4, 19 M^1, 15 M_1, 9 M^2, 3 M_2, 11 M^3, 11 M_3, 2 dm_2, most cataloged under the single locality designation IAH LT93.C2.B5.

ETYMOLOGY: To honor Dr. Russell Ciochon, pioneer in collaborative research between Vietnam and the United States, and excavator of Lang Trang Cave.

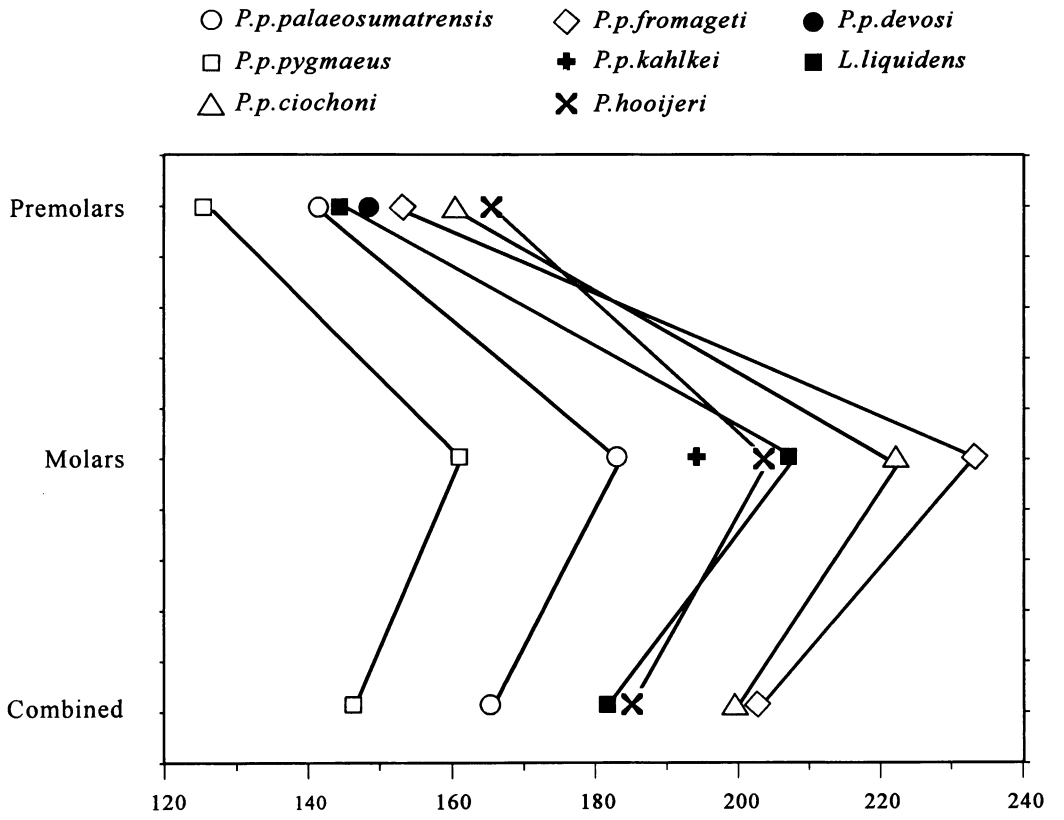

Fig. 9. Line chart of maxillary dental robusticity averages.

DESCRIPTION AND DIAGNOSIS: Generally similar in dental morphology to most other fossil and living populations of *Pongo pygmaeus,* except that upper central incisor crowns are low, lacking lingual tubercles and/or pillars, as in *P. p. palaeosumatrensis* (see fig. 6). Exceeded in upper molar size only by *P. pygmaeus* from Tham Om, and in lower molars only by *pygmaeus* from Tham Khuyen. Has the largest upper premolars known for any orangutan, although the lower premolars are smaller than those from Tham Om (see figs. 9–11).

Pongo pygmaeus devosi, new subspecies

HOLOTYPE: IAH HH 48, left M_3 (fig. 4).

TYPE LOCALITY: Cave of Hang Hum, Luc Yen District, Yen Bai Province, Vietnam (fig. 1).

DISTRIBUTION: Type locality only. Late Pleistocene.

HYPODIGM: Type plus IAH HH 22, 58, 59 (incisors); HH 49 (canine); HH 1, 3, 3a, 4, 10, 51, 54 (upper premolars); HH 5, 6, 7, 8, 9, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 50 (lower premolars); HH 15, 16, 17, 18, 35, 38, 52, 53 (upper molars); HH 11, 18, 19, 20, 21, 36, 37, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 55, 57 (lower molars).

ETYMOLOGY: To honor Dr. John de Vos, for his studies of the fauna of southeastern Asia and particularly the subfossil fauna of Lang Trang Cave.

DESCRIPTION AND DIAGNOSIS: Larger in size than living *Pongo pygmaeus,* but significantly smaller than all other subfossil orangutans in lower molar size. However, it exceeds the forms from Sumatra and Dieu Rockshelter in lower premolar size, and the Sumatran and Chinese forms in upper premolar size (data from upper molars are lacking).

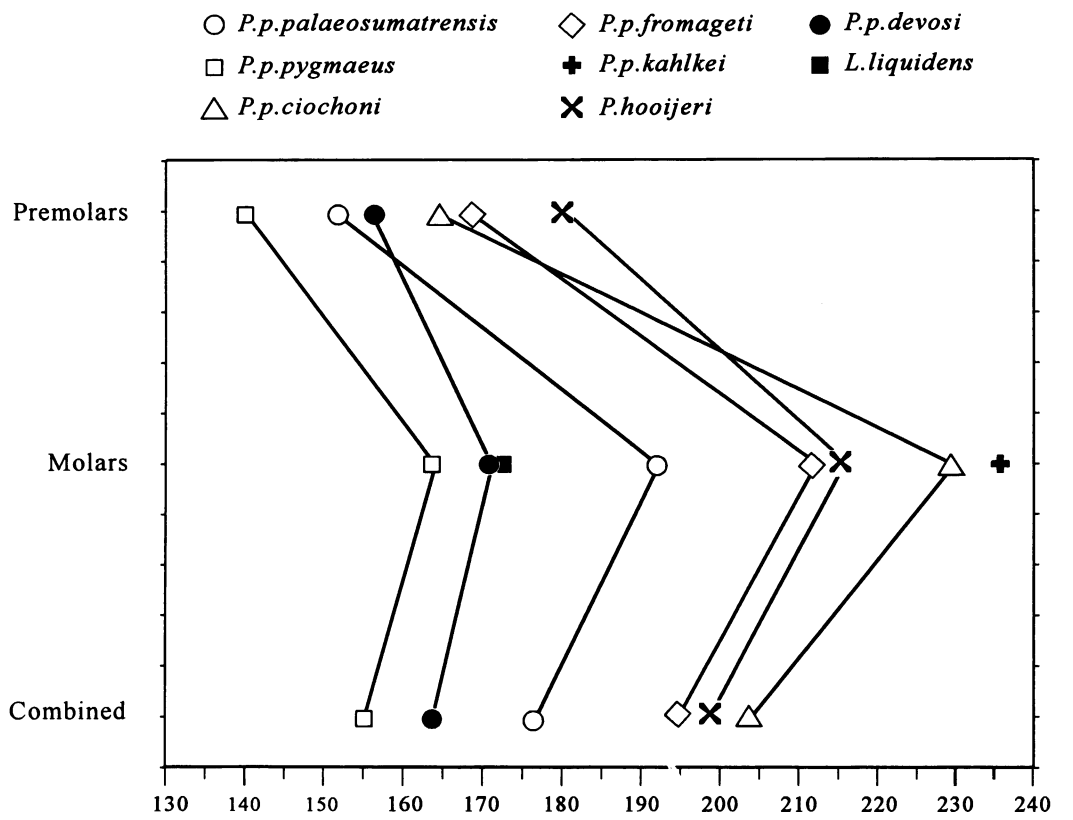

Fig. 10. Line chart of mandibular dental robusticity averages.

Pongo pygmaeus kahlkei,
new subspecies

HOLOTYPE: IAH TK 65/149, left M_1 or M_2 (fig. 2).

TYPE LOCALITY: Cave of Tham Khuyen, near Binh Gia, Lang Son Province, Vietnam (fig. 1).

DISTRIBUTION: Type locality only. Middle Pleistocene.

HYPODIGM: Isolated teeth only (fig. 2). Holotype plus TK 65/137, 139 (incisors); 118 (canine); 45, 107 (upper premolars); 10, 34B, 40, 56, 152, 158, 164 (upper molars); 41, 128, 131, 134, 149 (lower molars); 151 (dm_2).

ETYMOLOGY: In honor of Dr. H. D. Kahlke, distinguished paleontologist and excavator of many caves in Vietnam.

DESCRIPTION AND DIAGNOSIS: Lower incisors short-crowned; otherwise similar in morphology to those of other subspecies of *Pongo pygmaeus,* extinct and extant. Possesses the largest lower molars known from any subspecies, but upper molars are intermediate in size between the largest and smallest subspecies (see figs. 9–11).

Pongo pygmaeus fromageti,
new subspecies

HOLOTYPE: IAH 75.TO.7, left M_3 (fig. 4).

TYPE LOCALITY: Cave of Tham Om, Quy Chau District, Nghé An Province, Vietnam (fig. 1).

DISTRIBUTION: Type locality only. Later Middle Pleistocene.

HYPODIGM: Isolated teeth only. Holotype plus 77.TO.14, 77.TO.001.12 (upper incisors); 75.TO.2 (lower incisor); 75.TO.? (upper deciduous canine); 75.TO.3, 77.TO.96. v.44 (upper canines); 75.TO.6, 75.TO.10, 75.TO.11?, 77.TO.11, 77.TO.12.5, 77.TO. ?13.45 (upper premolars); 75.TO.4, 75.TO.7?, 75.TO.8, 75.TO.9, 75.TO.12, 77.TO.8.25,

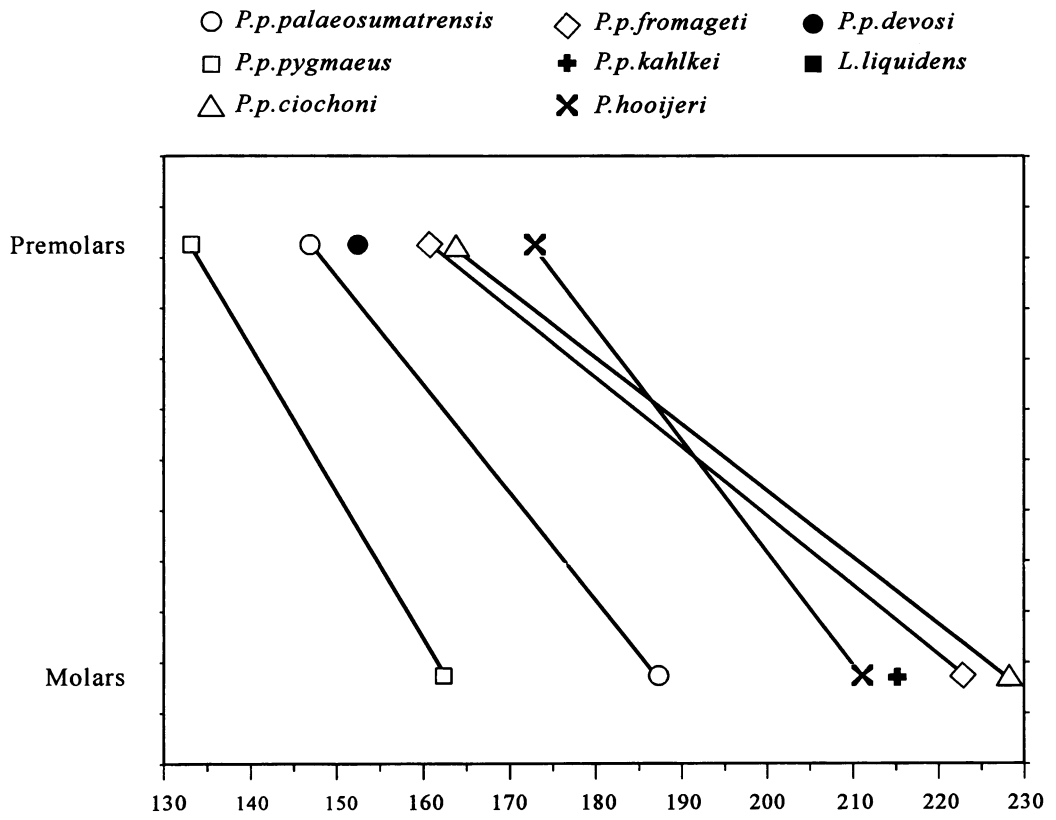

Fig. 11. Line chart of dental robusticity averages, maxillary and mandibular teeth combined.

77.TO.9.v.47, 77.TO.10a.23, 77.TO.12.26, 77.TO.13.24, 77.TO.46, 77.TO.96.v.48 (lower premolars); 75.TO.18, 77.TO.8, 77.TO.12, 77.TO.13.8, 77.TO.o.9^{b}.Tv.17, 77.TO.o.9^{b}.v.70, 77.TO.o.10.A.20, 77.TO.o.13.11, 77.TO.o.13.18, 77.TO.o.13.19, 77.TO.o.13.21 (upper molars); 75.TO.12, 75.TO.14, 75.TO.16, 75.TO.17, 75.TO.19, 75.TO.20, 77.TO.9.30, 77.TO.9A.31, 77.TO.19.27, 77.TO.o.8.38, 77.TO.o.13.33, 77.TO.o.13.35, 77.TO.o.13.76, 77.TO.o.14.28, 77.TO.o.19.29, 77.TO.o.19.34, 77.TO.o.6^{b}.v.37, 77.TO.9^{b}.v.49 (lower molars). Plus other isolated teeth with undecipherable numbers.

ETYMOLOGY: In honor of Dr. J. Fromaget, an early pioneer in the study of cave breccia faunas in southeastern Asia.

DESCRIPTION AND DIAGNOSIS: Similar in tooth morphology to other fossil subspecies of *Pongo pygmaeus,* but larger than all in its maxillary molars (see figs. 9–11). Exceeded in upper premolar size only by the Lang Trang subspecies, but in lower molar size by the forms from both Lang Trang and Tham Khuyen. In the lower premolars, larger than the Lang Trang form (data are lacking for Tham Khuyen).

DISCUSSION: Each of the Vietnamese cave sites considered here appears to contain remains from only a single, morphologically homogeneous, population of orangutans, *Pongo pygmaeus.* Metric variation at each site seems to be adequately explained by sexual dimorphism. However, size variation among sites is enormous. In analyzing this intersite variation, we modified the approach employed by Hooijer (1948) in his study of subfossil orangutan teeth from southern China and Sumatra. Hooijer used crown area (length times breadth) to derive a "robustic-

ity index" for each tooth, and plotted his site samples against each other and against samples of extant *Pongo*. In this way he established that the subfossil orangs from Sumatra (which he assigned to the subspecies *P. p. palaeosumatrensis*) were larger than extant orangs from the same region, and that the sparse material from China (which he called *P. p. weidenreichi*) was larger yet.

Having less confidence than Hooijer in our ability to distinguish consistently between first and second molars with any certainty, we were reluctant to generate robusticity indices for each premolar and molar. We therefore combined each tooth class for robusticity analysis, and did likewise with Hooijer's measurements. As can be seen from figures 9–11, we were able to replicate Hooijer's results, which discriminate between extant orangutans and the samples from Sumatra and southern China. We then expanded this analysis to include the orangs from each Vietnamese site for which dental measurements were available. Our results (figs. 9–11) showed that the Vietnamese samples were as distinct from one another as Hooijer's were, and that each was also distinct from the Sumatran and southern Chinese samples. As noted above, we thus felt justified in establishing subspecific distinctions, as done by Hooijer.

What is most remarkable is the scale of size differences between the largest and smallest orangutan populations studied. All of the extinct orangutan populations are considerably larger in size than any extant population recorded, and the variation in size between the smallest and the largest extinct populations exceeds anything with which we are familiar in any extant ape species. There is also distinct variation in the size proportions of the various tooth classes. For example, the orangutans of Tham Om are the largest of all in upper molar size, but are smaller than those from Lang Trang in upper premolar size. Similarly, those from Hang Hum are smaller than all other extinct orangutans in lower molar size, but are larger than the Sumatran form in lower premolar size.

On the unique basis of isolated teeth that show close morphological affinities to those of extant orangutans, it is probably not useful to argue that yet more species of orangutan are represented in northern Vietnam, or even in southeastern Asia and Indonesia as a whole. However, it should be borne in mind that the size variation reported here in the overall sample of what we are calling *Pongo pygmaeus* does amply exceed that normally expected among subspecies of the same species.

DISCUSSION AND CONCLUSIONS

Prior to the research reported by Schwartz et al. (1994) it had been believed that all fossils of large-bodied hominoids from Vietnam could be subsumed within the three species *Pongo pygmaeus, Homo* sp., and *Gigantopithecus blacki*. Reappraisal by these authors of specimens from Tham Khuyen Cave made it apparent that at least two additional distinctive morphs existed in that assemblage. These have been named here as a new genus and species of hominoid, *Langsonia liquidens,* and a new species of *Pongo, P. hooijeri*. In this study, we have broadened our assessment to cover large-bodied hominoid specimens from all significant Pleistocene sites in Vietnam. The result has been to reveal yet more diversity among those fossils previously identified as orangutans or hominids.

For example, in the sample of isolated teeth from Tham Om, there are some teeth that do not fit comfortably in any existing taxon, including those named in this paper. Two lower molars (77.TO.o.7^{b}.v.38 [fig. 7] and 75.TO.39), although orangutanlike in degree of enamel crenulation, are less so in having more restricted occlusal basins and being more narrowly rectangular in occlusal outline. Even more singular are a lower molar (77.TO.v.01.39; fig. 7) and an upper molar (75.TO.H; fig. 7), which are smaller than associated orangutan material and which are distinctly non-orangutanlike in morphology (in contrast to the small specimens from Hang Hum). Beyond noting that these are small, thick-enameled, nonhominid hominoid teeth, on current evidence we are unable to determine their affinities.

The cave of Hang Hum has also yielded three teeth whose affinities we are unable to resolve with certainty, although we have considered them "default hominids" above. Two are lower left molars, and unfortunately bear illegible catalog numbers; one is an upper

molar, HH 79 (fig. 7). These teeth were initially identified as *Homo sapiens,* but their large size places them outside the range of our own species. The two lower molars compare most closely in size and morphology with those of *Homo erectus* from Zhoukoudian. The third tooth is too worn to permit similar comparison. If the lower molars are indeed those of *Homo erectus,* this would suggest a remarkably late survival of this species in Vietnam. Additionally, two premolar teeth from Hang Hum (HH 7 and 128; fig. 7) are distinctly those of *Homo sapiens.* Additional material is needed to resolve the questions raised by these specimens; it is thus particularly unfortunate that, subsequent to its initial excavation, the Hang Hum site has been inundated by an artificial lake.

Tham Khuyen has also yielded specimens that are difficult to interpret. Two upper molars (TK 65/50 and 53; fig. 7) are distinct in both size and morphology from the *Pongo pygmaeus kahlkei* and *Pongo hooijeri* specimens identified at this site. In general size and shape, they most closely resemble the upper molar from Tham Om (75.TO.H; fig. 7) characterized above as belonging to a small, thick-enameled, nonhominid hominoid of uncertain affinities.

Apart from the adjacent cave of Tham Hai, from which only a single tooth (fig. 2) is known, Tham Khuyen is the only site to have yielded fossils of *Pongo hooijeri.* This species is, moreover, far more abundant at Tham Khuyen than is any other hominoid including *Pongo pygmaeus,* subspecies of which compose almost the entire hominoid fauna at all other sites. Tham Khuyen is also the only site in Vietnam to yield definitive—if very sparse—evidence of *Gigantopithecus blacki* (fig. 2). Only one other Vietnamese site, Tham Om, contains even presumptive evidence of *G. blacki,* in the form of a single excessively worn upper incisor. If the Tham Om specimen indeed represents *G. blacki,* it is a rather remarkable outlying occurrence: the species is otherwise only known from China and from Tham Khuyen, immediately adjacent to the Chinese border. Tham Om, on the other hand, lying some 350 km to the southeast of Tham Khuyen, is the most southerly of the important Vietnamese hominoid sites.

Pongo pygmaeus is without question the most ubiquitous and most abundantly represented hominoid in the current record of the Vietnamese Pleistocene. It is the only hominoid that occurs at all significant cave and rockshelter sites, and it is frequently the only one. However, the Vietnamese fossil populations vary greatly among sites, the total variation greatly exceeding that seen among extant orangutans. Up to the present, most hominoid systematists have recognized four subspecies of *Pongo pygmaeus* in extant and fossil faunas. These are:

1. *Pongo pygmaeus pygmaeus* (Linnaeus, 1760), for the extant orangutans of Borneo.
2. *Pongo p. abelii* (Lesson, 1827), for the extant orangutans of Sumatra.
3. *Pongo p. palaeosumatrensis* Hooijer, 1948, for isolated Pleistocene fossil teeth from sites in Sumatra that are larger than those of *P. p. abelii.*
4. *Pongo p. weidenreichi* Hooijer, 1948, for isolated Pleistocene fossil teeth from southern China that are yet larger than those of *P. p. palaeosumatrensis.*

In our recent review of the hominoids from Tham Khuyen (Schwartz et al., 1994), we noted that the isolated teeth of *Pongo pygmaeus* from that site appeared to fall within the size range quoted for the large subspecies *P. p. weidenreichi* by Hooijer (1948). The more detailed analysis reported here (figs. 9–11) strongly suggests, however, that the teeth of the Tham Khuyen orangutans are metrically distinct from those of *P. p. weidenreichi.* Further, each of the various Vietnamese sites with a statistically analyzable sample contains a homogeneous and distinctive orangutan population that is most appropriately distinguished at least at the subspecific level. We thus recognize four new subspecies of *P. pygmaeus* here: *P. p. ciochoni* (Lang Trang), *P. p. devosi* (Hang Hum), *P. p. fromageti* (Tham Om), and *P. p. kahlkei* (Tham Khuyen). These subspecies populations are distinguished both by size and by dental proportions.

At all Vietnamese sites males and females can be discriminated on the basis of canine and/or premolar morphology (see fig. 4 in

TABLE 17
Ranked, Unpaired, Two-Sample *t*-Test of Sexual Dimorphism in Lang Trang, Tham Om, and Hang Hum Samples

Rank	Sample-Meas.	Prob.	Male		Female		Chance (%) from same population
			Mean	*n*	Mean	*n*	
1	LT 1 P4-B/L	.0001	12.80	14	11.10	7	0.01
2	LT 1 P4-M/D	.0001	14.21	14	11.82	7	0.01
3	LT 1 P3-M/D	.0001	16.05	11	14.14	7	0.01
4	LT u M1-B/L	.0001	14.75	12	12.84	6	0.01
5	LT u P3-B/L	.0001	14.26	7	12.71	6	0.01
6	TO 1 M3-M/D	.0001	16.80	6	14.15	3	0.01
7	LT u M3-M/D	.0002	15.47	7	12.54	4	0.02
8	LT u M1-B/L	.0003	15.56	12	13.83	6	0.03
9	TO 1 M3-B/L	.0004	14.37	6	12.32	3	0.04
10	LT u M3-B/L	.0006	16.65	7	13.77	4	0.06
11	LT u P3-M/D	.0009	11.90	7	10.64	6	0.09
12	LT u M2-B/L	.0021	16.30	5	14.46	4	0.21
13	TO 1 M1-M/D	.0048	16.72	5	14.60	3	0.48
14	LT u P4-M/D	.0059	11.30	14	9.70	3	0.59
15	LT u P4-B/L	.0131	15.66	14	13.81	3	1.31
16	LT 1 M3-M/D	.0142	18.18	10	16.17	2	1.42
17	LT 1 M1-M/D	.0162	16.39	4	15.02	10	1.62
18	TO 1 M1-B/L	.0175	14.61	5	12.64	3	1.75
19	TO 1 P4-M/D	.0186	14.00	3	12.80	2	1.86
20	LT 1 M1-B/L	.0188	14.01	4	12.98	10	1.88
21	LT 1 M3-B/L	.0190	15.41	10	13.72	2	1.90
22	LT 1 I2-B/L	.0206	12.02	4	10.10	3	2.06
23	LT u M2-M/D	.0223	16.70	5	14.14	4	2.23
24	LT 1 I2-M/D	.0299	10.06	4	8.67	3	2.99
25	LT 1 P3-B/L	.0342	10.68	11	9.90	7	3.42
26	HH 1 P4-M/D	.1505	12.41	3	11.63	2	15.05
27	HH 1 P4-B/L	.2384	11.78	3	11.24	2	23.84
28	TO 1 P4-B/L	.2440	12.93	3	11.76	2	24.40

Schwartz et al. 1994; fig. 4, this paper), just as they can among extant orangutans. Only in the Lang Trang and Tham Om samples, however, is sexual dimorphism also expressed metrically (table 17), as it is among both living orangutan species (cf. Swindler, 1976; Swindler and Olshan, 1988).

In summary, the ensemble of Vietnamese Pleistocene sites reveals a much greater diversity of large-bodied hominoid taxa than was previously suspected, despite the fact that only isolated teeth have yet been recovered at almost all sites. At least four genera are represented: *Pongo, Langsonia, Homo,* and *Gigantopithecus.* Within *Pongo,* we are able to recognize two distinctive species: *P. pygmaeus* and *P. hooijeri.* The latter is effectively known from only a single site in the northernmost part of the country. This site, Tham Khuyen, appears to be the earliest locality yet investigated, and *P. hooijeri* is by far the most abundant hominoid there, while *P. pygmaeus* is relatively rare. At all the later sites, in contrast, *P. pygmaeus* is either the sole hominoid or close to it. The range in size of the orangutan fossils at these sites is such that, in addition to the two previously described fossil subspecies of *P. pygmaeus,* we are able to recognize four new ones.

At all sites, fossils of both *Homo* and *Gigantopithecus* are extremely rare. *Homo* is found in at least three Vietnamese sites, but only at Hang Hum, where the four putative *Homo* teeth are hard to interpret (see above), is it represented by more than one or two teeth. *Gigantopithecus* is rarer still, definitive evidence coming only from a single tooth found at Tham Khuyen. If a very badly worn

tooth from the more southerly site of Tham Om does not represent *Gigantopithecus blacki,* we can conclude that the southern limit of distribution of this hominoid broadly coincided with the modern border between China and Vietnam. Given the extreme rarity of *P. p. weidenreichi* specimens from southern Chinese sites, it also seems possible that the prehistoric northern limit of orangutan distribution on the Asian mainland lay not far distant from this modern border. Finally, we note the existence in the Pleistocene of Vietnam of sparse evidence for a small hominoid with thick-enameled teeth, of uncertain affinity, and for a possible additional variant of *Pongo.*

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