THE FOSSIL MAMMAL FAUNA OF THE LANG TRANG CAVES, VIETNAM, COMPARED WITH SOUTHEAST ASIAN FOSSIL AND RECENT MAMMAL FAUNAS : THE GEOGRAPHICAL IMPLICATIONS

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ABSTRACT

The first field collection of the so-called Stegodon-Ailuropoda *fauna of south China and Southeast Asia was made from the Yanjinggou fissure fills of Sichuan Province, China, by Walter Granger in 1922. Before then, knowledge of the fauna was based on collections made from Chinese apothecaries' shops throughout China and Southeast Asia. In 1989 a joint American-Vietnamese team began excavations at Lang Trang Caves, western Thanh Hoa Province, northern Vietnam. That first field season yielded 36 mammalian species of the so-called* Stegodon-Ailuropoda *fauna. Excavations were resumed at the caves in March 1993. Due to the complexities encountered in interpreting the geology and taphonomy of the site during the first field season, a team of six specialists in karst geology, geomorphology, sedimentary petrology, geochronology, vertebrate palaeontology, geoarchaeology and palaeoanthropology was assembled for this research. The purpose of this paper is to compare the fauna recovered from a single sedimentary unit, known as B5, in Cave II at Lang Trang Caves with similar faunas in south China, Indonesia and Malaysia and to discuss the palaeogeographical implications of these.*

THE FOSSIL FAUNA OF LANG TRANG CAVE

The Lang Trang caves are situated about 120 km south west of Hanoi (Figure 1). Different very hard, cemented "breccias" were distinguished in the caves and about 10,000 fossil crowns of teeth, mostly with the roots gnawed, were recovered from these. The gnawing was probably caused by porcupines which bring bones and skulls to their lairs leaving only the tooth crowns. As Cave II, breccia 5, contained most of the fossils, the fossils of this stratum were studied in detail and the species identified are listed in Table 1.

Table 1 shows the number of specimens of each species in breccia 5. *Sus scrofa* is the commonest species, followed by *Muntiacus, Rusa, Acanthion* and *Presbytis/Trachypithecus/Macaca* fossils. The other species are represented by a small number of fossils. All the species except *Stegodon orientalis* and *Elephas namadicus* are extant and live somewhere in Indo-China, Malaysia or Indonesia.

A COMPARISON OF THE FOSSIL FAUNA OF LANG TRANG AND SUMATRA

Padang Caves

Dubois excavated in the Padang Highlands, central Sumatra during 1889-90. Hooijer (1947:253) listed the various sites which he investigated. Most of his material is from three caves: Lida Ayer (Ajer) Cave near Payakumbuh, Sibrambang Cave and the Jambu (Djambu) Cave near Tapisello. Each of these has comparable faunas. De Vos (1983) described the fossil mammal fauna of the Lida Ayer and the Sibrambang Cave and presented their faunal lists. The Lida Ayer Cave is of special interest because the excavation of this was well documented by Dubois in one of his reports. The excavation began on the 15th July 1888 and a report exists in the files of the Dubois collection. The cave is located in a limestone

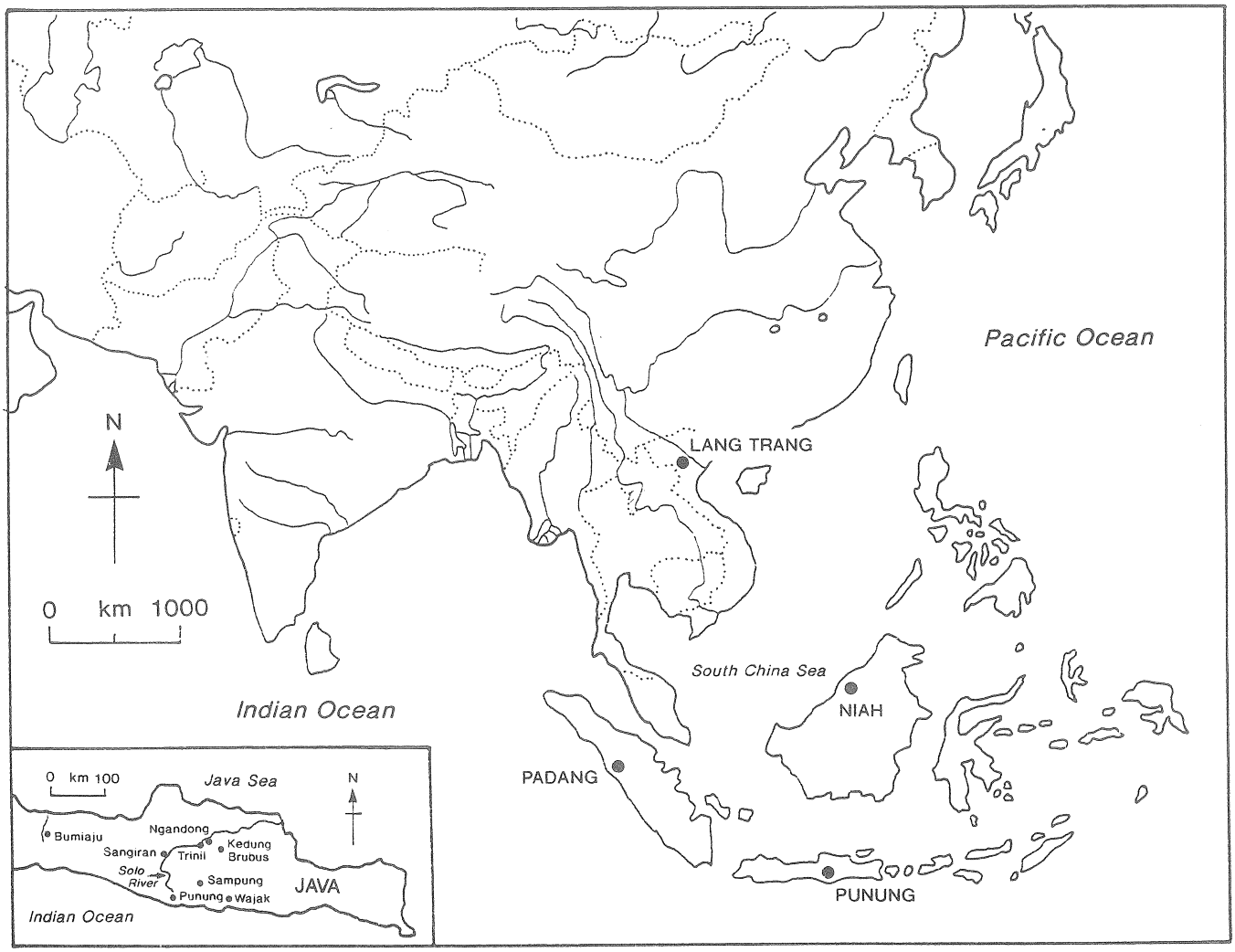

Figure 1: Location of sites mentioned in the text

area south of a village called Situduh Batu. The cave entrance is about 150 m above the river Babuwe. Most of the fossils collected are teeth, with bones rare. Almost all show traces of gnawing, presumably by porcupines, as at Lang Trang, and usually only the tooth crowns are left.

The species which have been identified are :

Pongo pygmaeus : (Hooijer 1948b)
Symphalangus syndactylus : (by Hooijer 1960)
Hylobates sp. : (Hooijer 1960)
Presbytis sp. : (Hooijer 1962)
Trachypithecus cristatus : (Hooijer 1962)
Macaca nemestrina : (Hooijer 1962)
Ursus malayanus : (Hooijer 1948a)
Paradoxurus hermaphroditus : (by J.d.V.)
Cuon javanicus : (by J.d.V.)
Panthera pardus : (by J.d.V)
Panthera tigris : (by J.d.V.)
Felis temmincki : (by J.d.V.)
Arctonyx collaris : (by J.d.V.)
Dicerorhinus sumatrensis : (Hooijer 1946a)
Tapirus indicus : (Hooijer 1947)
Bibos javanicus : (Hooijer 1958)
Bubalus bubalis : (Hooijer 1958)
Capricornis sumatraensis : (Hooijer 1958)
Rusa unicolor : (by J.d.V.)
Muntiacus muntjak : (by J.d.V.)

Table 1. Comparison of the numbers of specimens from Lang Trang (Vietnam) with those from Padang (Sumatra), Punung (Java) and Niah (Malaysia)

Species list	Lang Trang, Vietnam	Lida Ayer, Sumatra	Punung, Java	Niah, Malaysia
Pongo pygmaeus	201	143	199	+
Hylobates sp.	7	a few	41	+
Presbytis / Trachypithecus sp. and *Macaca* sp.	358	16	16	+
Ursus malayanus	2	6	11	+
Ursus thibetanus	33	-	-	-
Ailuropoda melanoleuca	5	-	-	-
Paradoxurus hermaphroditus	11	a few	-	+
Cuon javanicus	1	a few	-	+
Panthera pardus	9	a few	-	+
Panthera tigris	6	a few	15	+
Felis temmincki	6	a few	-	-
Lutra perspicillata	2	-	-	-
Arctonyx collaris	33	a few	-	+
Dicerorhinus sumatrensis	190	22	37	+
Tapirus indicus	18	32	21	+
Bubalus bubalis	33	28	a few	+
Capricornis sumatraensis	23	3	8	+
Rusa unicolor	411	43	12	+
Muntiacus muntjak	481	167	49	+
Sus scrofa	1027	a few hundred	>100	+
Elephas maximus / namadicus	14	8	4	+
Stegodon orientalis	11	-	-	-
Acanthion brachyurus	358	>100	>100	+
Atherurus macrourus	8	-	-	-
Rattus sabanus	2	-	-	-

Sus scrofa : (by J.d.V.)

Sus barbatus : (by J.d.V.)

Elephas maximus : (by Hooijer 1955; but he indicated that the molars were very slender and this suggests that they are actually from *E. namadicus*)

Acanthion brachyurus : (Hooijer 1946b)

Hominids : a semi-shovel shaped right upper central incisor and a left upper molar were identified as *Homo sapiens* : (Hooijer 1948b: 182-187)

Table 1 compares the faunal list from Lang Trang with that of the Sumatran, Javan and Borneo caves. The extinct *Stegodon* is absent from Sumatra but all the other species represented are extant. However, the Cercopithecidae are difficult to identify to the species. *Ursus thibetanus* and *Ailuropoda melanoleuca* were not found in the Sumatran caves while *Bibos javanicus* and *Sus barbatus,* which were not present at Lang Trang, do occur. Otherwise the faunal lists are similar.

Table 1 also indicates that the distributions of the species in the Lang Trang fauna and those of Lida Ayer are comparable. So is the taphonomy : both only contain gnawed teeth. The Sumatran cave faunas are balanced and indicate a connection with the mainland.

Aspartic acid racemization dating (Skelton and de Vos, in preparation) suggests that the Jambu cave material is *c.*60,000-70,000 years old and the Lida Ayer finds are 80,000 years of age.

A COMPARISON OF THE FOSSIL FAUNAS OF LANG TRANG AND PUNUNG (JAVA)

Sondaar (1984) and Leinders *et al.* (1985) proposed a faunal stratigraphy for Java (Figure 2) which is as follows from old to young (see Figure 1 for site locations,

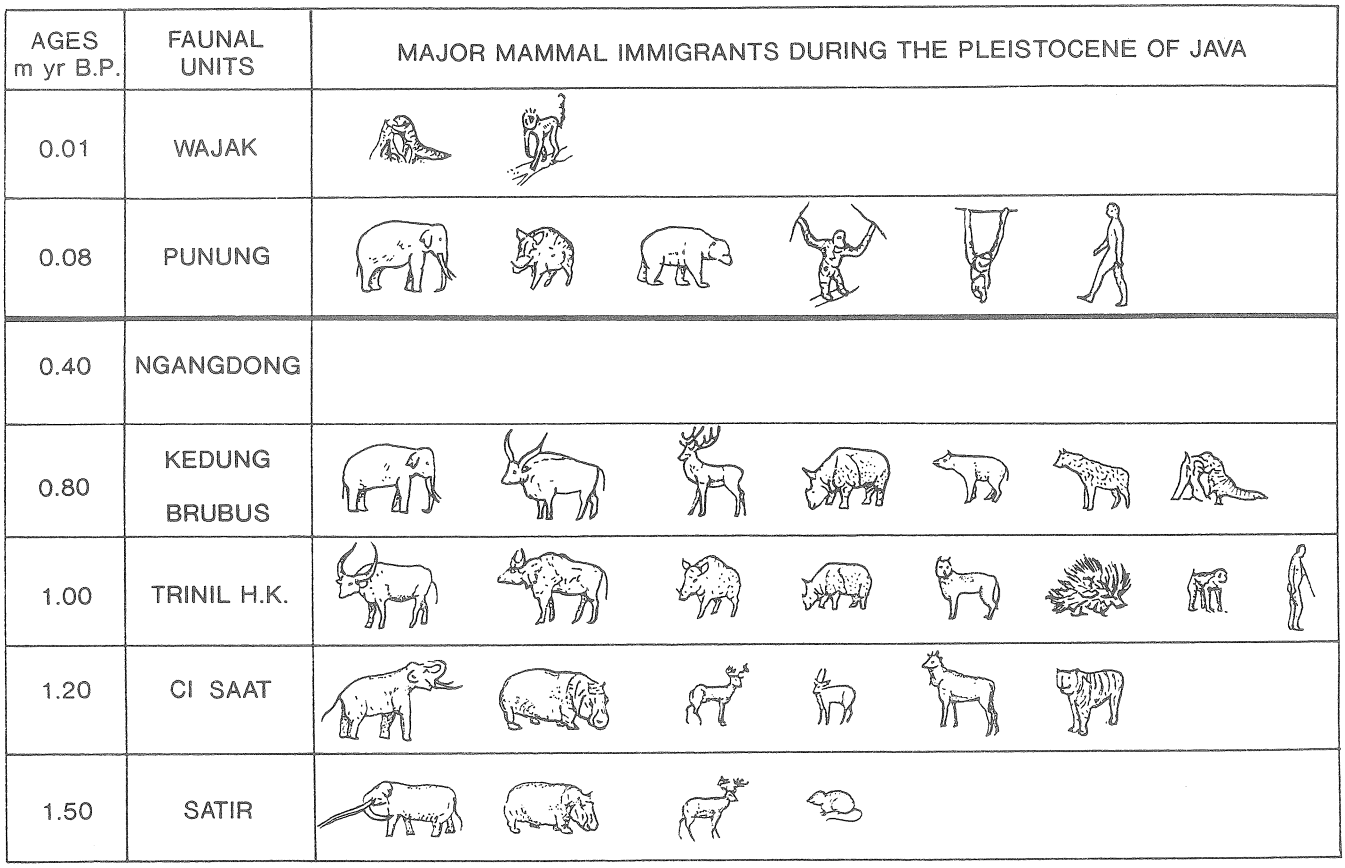

Figure 2: The Javan faunal stratigraphic sequence (after Sondaar 1984 and Leinders et al. *1985)*

and see van den Bergh *et al.* this volume for further details):

The Satir Fauna (dated to *c.*1.5 myr BP). Near Bumiaju this fauna is characterised by species poverty. Only *Mastodon, Hexaprotodon,* cervids and a giant tortoise (*Geochelone*) are known so far from this level. The *Mastodon* and *Hexaprotodon* are archaic and may indicate a relatively old age, while the unbalanced nature of the fauna suggests island conditions. A similar fauna is also present at Sangiran.

The Ci Saat Fauna (dated to around 1.2 myr BP). This fauna is not well known near Bumiaju and Sangiran but remains from *Stegodon, Hexaprotodon* and cervids are common, felids occur, while bovids are rare. The fauna is species poor, which could indicate isolated conditions, but the presence of large felids shows that the mainland could have not been far off.

The Trinil H.K. Fauna (dated to around 1.0 myr BP). This fauna is relatively poor in species although much better balanced than those considered above. It has endemic taxa and large bovids are abundantly represented. The relatively low number of species points to an isolated location and little faunal interchange with the mainland, while the high number of large bovids implies a drier biotope than previously, perhaps an open woodland. This may indicate a glacial period origin.

The Kedung Brubus Fauna (dated to *c.*0.8 myr BP). This contains several new arrivals :*Epileptobos, Tapirus, Elephas, Hyaena* and *Rhinoceros kendengindicus.* The fauna bears a more mainland stamp suggesting that it belongs to a glacial interval of lowered sea level, open woodland, and more faunal interchange with the mainland.

Table 2: Comparison of the Lang Trang fauna with recent and fossil faunas from Indonesia and Mainland Southeast Asia.

Lang Trang Cave fauna,		Borneo		Sumatra		Java		Malay Pen.	Thailand	S. Indo-C.	N. Indo-C.
Vietnam	extinct	fossil	recent	fossil	recent	fossil	recent	recent	recent	recent	recent
Pongo pygmaeus		x	x	x	x	x					
Macaca arctoides								x	x	x	x
M. mulatta									x		x
Presbytis sensu lato (Trachypithecus)		x	x	x	x	x	x	x	x	x	x
Hylobates sp.		x	x	x	x	x	x	x	x	x	x
Ursus malayanus		x	x	x	x	x		x	x	x	x
U. thibetanus									x		x
Ailuropoda melanoleuca											
Arctonyx collaris				x	x	x			x		x
Melogale moschata		x	x				x	x	x	x	
Paguma larvata		x	x	x	x	x	x	x	x	x	x
Paradoxurus hermaphroditus		x	x	x	x	x	x	x	x	x	x
Cuon antiquus (alpinus)	x[1]	(x)		(x)	(x)	(x)	(x)	(x)	(x)	(x)	(x)
Panthera tigris		x		x	x	x	x	x	x	x	x
P. pardus				x		x	x	x	x	x	x
Felis temmincki				x	x	x		x	x	x	x
Elephas namadicus (maximus)	x[2]	(x)	(x)	(x)	(x)	(x)		(x)	(x)		(x)
Stegodon orientalis	x										
Sus scrofa			x	x	x	x	x	x	x	x	x
Rusa unicolor		x	x	x	x	x	x	x	x	x	x
Muntiacus muntjak		x	x	x	x	x	x	x	x	x	x
Bovid											
Capricornis sumatraensis				x	x	x		x	x	x	x
Tapirus sp. (indicus)	x[3]			(x)	(x)			(x)	(x)		
Rhinoceros sinensis (sondaicus)	x[4]	(x)		(x)		(x)	(x)			(x)	
Hystrix subcristata		x	x	x	x	x		x	x	x	x
Atherurus macrourus				x	x	x		x	x	x	x
Rhizomys troglodytes				x	x	x		x	x	x	x
Rattus sabanus		x	x	x	x	x	x	x	x		x

[1] (x) refers to extant *C. alpinus*; Lang Trang species uncertain

[2] (x) refers to extant *E. maximus*; Lang Trang species uncertain

[3] (x) refers to extant *T. indicus*; :Lang Trang species uncertain

[4] (x) refers to extant *R. sondaicus*; Lang Trang species uncertain

The Ngandong Fauna. The faunal list reported in von Koenigswald (1934) has some resemblance to that of Kedung Brubus and an open woodland environment with a drier climate than at present is likely, but more study is necessary.

The Punung Fauna (dated to *c.* 80,000 BP). The Punung fauna is quite different from the preceding Ngandong fauna. The archaic *Stegodon* and *Elephas hysudrindicus* became extinct while *E. maximus / namadicus* might have been a new migrant. The extant species *Sus scrofa* occurs for the first time and the high quantity of *Pongo* remains, also probably a new migrant, as well as *Hylobates* and *Ursus malayanus* is typical of this fauna. The *Pongo* and *Hylobates* fossils suggest a humid forest environment and the total faunal assemblage indicates interglacial conditions.

The Wajak (formerly Wadjak) Fauna (dated to *c.*10,000 BP). This fauna has an open woodland character and

might be considered to be younger in age than the Punung fauna, probably flourishing during a colder period than at present. It lacks *Elephas* and *Tapirus* may have occurred for the last time in Java.

Punung

The Punung fauna is of importance in our comparison. Badoux (1959: 127) noted that Professor von Koenigswald had told him that the "Punung Collection" material originated from two localities, Punung I near Mendolo Kidul and Punung II near Tabuhan. Unfortunately fossils from both sites have been mixed up together but those of Punung I are said to be distinguishable by their comparatively bright greyish colour and those of Punung II by dark brown colouration. This very subjective criterion is unacceptable and the faunal assemblage of both sites is considered here as a whole.

Remarkably most of the tooth roots have been gnawed off and the long bones are missing from the collection. In this respect the finds resemble those from the Sumatran and Lang Trang caves where only small fragments of long bones, which show gnawing marks, have survived.

The fauna is completely different from the archaic older faunas of Java and contains species which still exist in other parts of the Indonesian Archipelago or on the mainland. A reconsideration of the Punung composite fauna by de Vos (1983) concludes that it is uniform in character and of similar composition to faunas from the Sumatran caves excavated by Dubois.

The following species are present (identifications by Badoux 1959 and de Vos 1983) :

Homo sapiens
Pongo pygmaeus
Symphalangus syndactylus
Macaca sp.
Ursus malayanus
Panthera pardus
Panthera tigris
Felis temmincki
Dicerorhinus sumatrensis
Tapirus indicus
Bibos javanicus
Bubalus bubalis
Capricornis sumatraensis
Rusa unicolor
Muntiacus muntjak
Sus scrofa (Sus verrucosus)
Sus barbatus
Elephas maximus
Acanthion brachyurus

Regarding hominids, Badoux (1959) reported two incisors, an upper canine, a lower canine and an upper molar all of which are too small to belong to the orang utan. He also stated that the von Koenigswald collection contained an upper molar from the same locality which may be provisionally assigned to *Homo* (cf. *Pithecanthropus).* This determination was probably given by von Koenigswald (1940) because he thought that the Punung Fauna was a correlate of the Trinal Fauna. However, von Koenigswald (1975) considered the fauna to be post-Trinil and stated that a few isolated teeth indicate the presence of man. De Vos (1985) attributed the finds to *Homo sapiens.*

The Punung Fauna has a recent character and all the faunal elements like *Pongo, Elephas maximus, Capricornis, Sus vittatus, Sus barbatus* and *Ursus* are probably new migrants. More archaic forms like *Stegodon, Elephas hysudrindicus* and *Sus macrognathus* had gone. The large quantity of *Pongo* fossils and the presence of other primates (de Vos 1983) indicates a humid tropical rainforest environment similar to that of the Sumatran and (Table 2) Lang Trang cave faunas.

Table 1 compares the Punung fauna with that from Lang Trang and the Sumatran caves. The species content and the taphonomy of all the faunas is seen to be similar.

A COMPARISON OF THE FOSSIL FAUNAS FROM LANG TRANG AND NIAH CAVE (MALAYSIA)

Medway (1977) presented a complete faunal list for Niah Cave, Sarawak, a site which may be 50,000 years old at its oldest. Apart from domesticated animals (like *Canis familiaris* in the 15-30 cm level and *Sus scrofa* in the 0-61 cm level), *Pongo pygmaeus* occurs down to a level of 259-267 cm and *Hylobates* to 152-183 cm. The latter two species indicate a tropical rainforest environment and the fauna is balanced, suggesting a connection with the mainland. Table 1 compares the fauna of Lang Trang, Sumatra, Java and Niah and reveals clear species similarity, but the taphonomy differs so there are more long bones at Niah.

A COMPARISON OF THE LANG TRANG AND SOUTH CHINA FOSSIL CAVE FAUNAS

The bio-, litho- and chrono-stratigraphy of the south Chinese cave faunas are poorly known. According to de Vos (1984) the fauna is mixed. It is referred to as the *Stegodon-Ailuropoda* fauna. There are many caves with faunal remains but only a few relevant to this paper will be examined in detail.

Liucheng Cave

Kahlke (1961b) reported that the fauna consisted of *Gigantopithecus blacki, Pongo* sp. (*Pongo pygmaeus* according to Aigner 1978), indeterminate primates, *Hystrix* cf. *subcristata, Paguma ? larvata, Cuon* sp., *Ursus* sp. nov. (*U. thibetanus* sp. *kokeni*), *Ailuropoda* sp. nov., *Arctonyx* sp., *Felis* sp., *Hyaena brevirostris* sp. *licenti, Mastodon* sp., *Stegodon preorientalis, Chalicotheriidae* gen. et sp. indet., *Tapirus* sp. (smaller than *Megatapirus*), *Rhinoceros sinensis, Equus yunnannensis, Sus scrofa,* Cervidae gen. et sp. indet., Bovidae gen. et sp. indet., Caprinae gen. et sp. indet.

Hoshangtung Cave

Kahlke (1961a) found the following to be present: *Pongo pygmaeus* sp. *weidenreichi, Macaca* sp., *Hystrix* sp., *Ursus thibetanus* sp. *kokeni, Ailuropoda melanoleuca* sp. *fovealis, Ailurus fulgens, Arctonyx* sp., Canidae indet., *Crocuta crocuta* sp. *ultima, Panthera* cf. *tigris, Panthera* cf. *pardus, Lynx* cf. *lynx, Stegodon* sp., *Palaeoloxodon* (now *Elephas*) cf. *namadicus, Megatapirus* cf. *augustus, Rhinoceros* sp. (probably *R.* sinensis), *Sus* sp., ? *Rusa* sp. I, ? *Rusa* sp. II, *Muntiacus* sp., Caprinae gen. et sp. indet. I, II, Bovidae gen. et sp. nov.

Yanjinggou

The fossils from Yanjinggou in Sichuan came from limestone fissures or pits at the tops of high Palaeozoic ridges which run parallel to the Yangtze River. They were collected by Granger who found the most practical way to obtain fossils from the various pits was to make frequent visits along the top of the ridge and purchase the best specimens found by the native diggers. Matsumoto considered the Sichuan fossils to belong to two distinct faunas, an older or "*Stegodon*- fauna" and a younger fauna from the "clay-loam". According to Granger this was a stratification based upon ecology. However, we consider the suggestion of Matsumoto to be more realistic.

Colbert and Hooijer (1953) reported the composition of the fauna to consist of: *Rhinopithecus roxellanae tingianus, Hylobates (Bunopithecus) sericus, Lepus* sp., *Rhizomys sinensis troglodytes, Hystrix* cf. *subcristata, Cuon javanicus antiquus, Euarctos kokeni (= Ursus thibetanus), Ailuropoda melanoleuca fovealis, Charronia flavigula tyrannus, Arctonyx collaris rostralis, Arctonyx collaris collaris, Viverra zibetha expecta, Crocuta crocuta sinensis, Felis tigris, Felis* sp., *Stegodon orientalis, Palaeoloxodon namadicus, Nestoritherium sinense, Megatapirus augustus, Rhinoceros sinensis, Sus scrofa, Rusa unicolor, Moschus moschiferus pliocon, Muntiacus muntjak margae, Elaphodus cephalophus megalodon, Bubabus bubalus, Bos gaurus grangeri, Capricornis sumatraensis kanjereus* and *Naemorhedus goral.*

The faunal lists of the fossil cave faunas of South China have a number of species in common with those from Lang Trang, Sumatra, Java and Borneo, e.g. *Pongo pygmaeus, Muntiacus* sp., etc.

HOLOCENE AND RECENT MAMMAL FAUNAS FROM JAVA

There are several sites from Java of Holocene age: Sampung, Hoekgrot, Gua Jimbe. Full details are only given here for Wajak.

Wajak Fauna

The type locality, Wajak Cave, was excavated by Dubois. Van Stein Callenfels (1936) reported that it had been quarried away but it was rediscovered by Aziz and de Vos in 1985 (Aziz and de Vos 1989) . The fauna of the cave was reviewed by van den Brink (1982).

As far as hominids are concerned, there is a rather complete skull (Wajak I), skull fragments (Wajak 2), some teeth, and some postcranial skeletal elements. There is general agreement that these belong to *Homo sapiens.*

So the fauna from the site comprises: *Homo sapiens, Presbytis* sp., *Panthera tigris, Rhinoceros sondaicus (?), Tapirus indicus, Muntiacus muntjak, Rusa timorensis, Sus vittatus, Acanthion brachyurus, Manis javanica, Rattus tiomanicus* and *Sciurus notatus.*

Human factors have probably influenced the composition of this Holocene fossil fauna, either by acting as a selective agent or as an influence on the local fauna. This hampers palaeoenvironmental interpretations but all the species present are indicative of a forest environment. However, *Pongo pygmaeus, Ursus malayanus* and *Tapirus indicus* are absent but this kind of fauna still survives in the Malay peninsula, Thailand, South China and North China (Table 2).

DISCUSSION AND CONCLUSION

A comparison is made between the fauna of Lang Trang caves and the fossil and recent faunas of Southeast Asia, the Indonesian Archipelago and Malaysia in Table 2. Based on the data given above, the following conclusions can be reached. The balanced character of the Punung, Sumatran and Borneo faunas suggests that the connection with the mainland became better. During a Late Pleistocene glacial period there was great sea level lowering

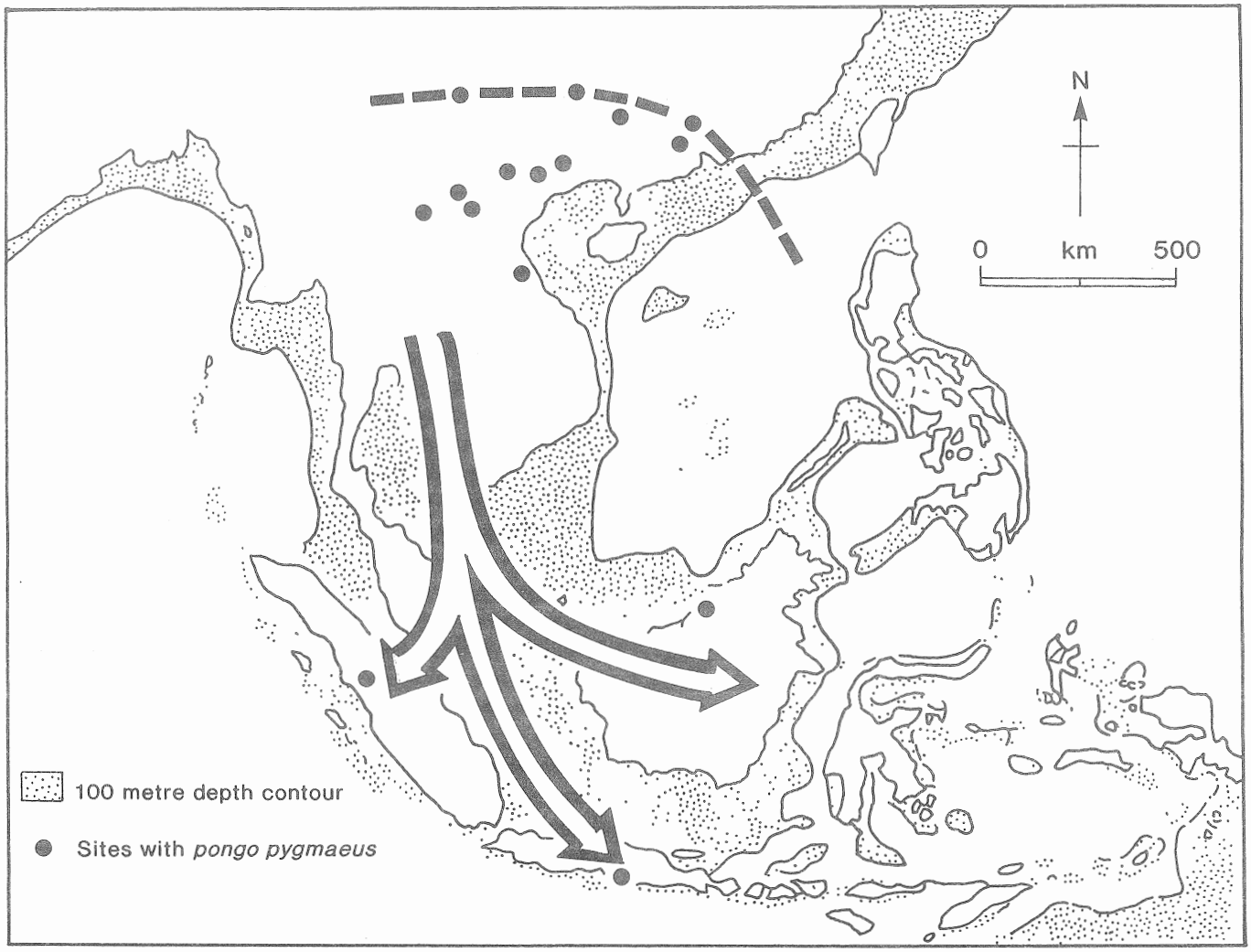

Figure 3: The Sino-Malayan migration route (after Kahlke 1972, with modifications)

(probably the one of 125,000 years ago), the Sunda Shelf became dry and Sumatra, Borneo and Java were connected to the continent. Cooling occurred in northern latitudes and the vegetation and fauna of the mainland moved to the Sunda Shelf. The fauna was a tropical rainforest one probably with *Homo sapiens* from China.

Based on the presence of the Chinese elements in the Indonesian Archipelago, we conclude that the fauna had a Chinese origin, and, for the moment, we can call the migration path the Sino-Malayan route (Figure 3). *Stegodon* became extinct, probably to be replaced by *Elephas,* as did the archaic Javan fauna with *Homo erectus* as well as *Stegodon.* The giant panda remained in China because it was probably better adapted to the cooler climate, the tropical rainforest with *Pongo pygmaeus* moved south and at the peak of the glacial period it reached Java. When the climate in northern latitudes became warmer again the tropical rainforest with *Pongo pygmaeus* moved northwards again. Sea level was rising again and as the tropical rainforest reached Sumatra and Borneo the Sunda Shelf broke up again (probably at the beginning of the Holocene) and the tropical rainforest with its fauna never moved north again. Java became isolated from Borneo first, then from Sumatra, but the connection between Sumatra and Borneo lasted a little longer, which explains the similarities in the fish fauna between west Borneo and Sumatra. Finally Borneo, then Sumatra, became separated from the mainland. Every island has its own pattern of faunal evolution. With time, the fauna of the islands has become impoverished, each

following a different pattern. *Pongo* and *Tapirus* disappeared from Java, while the tiger went from Borneo, and so on.

ACKNOWLEDGEMENT

The Vietnam project is supported by the L.S.B. Leakey Foundation and the Wenner-Gren Foundation.

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