

The Niah Excavations and an Assessment of the Impact of Early Man on Mammals in Borneo

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IN 1961, drawing evidence from such identifications and analyses of mammalian remains from the Niah excavations as were then available, Tom Harrisson (1961a) concluded that "man has . . . been influencing the fauna in more than a casual way for thousands of years." Developing this idea in a contribution to the *Malayan Nature Journal* (1961b), he wrote:

Several major impressions so far received from this side of the cave work may be briefly stated here.

1. The Upper Pleistocene (archaeologically late Palaeolithic) fauna is very much more similar in general to present day than has often been supposed. Most species are the same, except for those clearly hunted to extinction as indicated below.

2. *But* many examples of existing species at deep (=old) Niah levels tend to run *larger* than any living examples. Some of those may deserve subspecific distinction.

3. On the other hand, there have been some surprising *changes* in the *quantitative components* of the local fauna—including even the bats living *in* the caves (some forms very common in the past are now scarce or locally absent and vice-versa).

4. At least three and probably four large animals all stated to occur in Dayak folklore and still found in Malaya are now proved in Borneo from stone-age levels at Niah.

5. Other large animals found abundantly as stone-age food do not now normally occur within hundreds of miles of Niah—notably orang-utans.

6. Below 50,000 years the fauna is still overwhelmingly akin to modern with one tremendous exception—a Giant Pangolin hitherto only known from the Middle Pleistocene fossil beds of Java (a single specimen) and at Niah represented by true, non-fossil bone.

It will be clear that the last four of the above conditions could each be attributed to human influence; while the second, size change, could also be in some cases due partly to constant hunting out of larger forms by man. Indeed, as the Niah story unfolds, in this and in many other ways one feels that man began to *exercise major and often decimating influences on the local fauna very long ago*.

In what has, sadly, proved to be his last review for local readers of the results of his palaeontological work in Borneo (Harrisson 1973), he did not revive discussion of this idea, although his remarks (p. 394) show that he considered the problem still open.

Other palaeontologists working in different parts of the world have also attributed to man a significant role in the late Pleistocene or early Holocene extinction of animal species—particularly of the gigantic types (either absolutely large, or large by comparison with modern relatives) collectively termed the Pleistocene “megafauna.” Martin (1967) attributed the first formulation of this idea to A. R. Wallace, in *The World of Life* (1911). Although controversy is not lacking—see, for instance, Hester (1967) for an alternative opinion—man is now often accepted as a critical contributive factor in the progressive decline that occurred in late- and post-glacial Europe and northern Asia, and in the abrupt elimination of the megafauna that took place in North America about 11,000 years ago (Kurten 1972). For Africa the argument is less secure. There, a phase of extinction occurred at the close of the Middle Pleistocene but not subsequently, so that the extant large mammal fauna of the savanna regions today is essentially identical with that of the late Pleistocene.

Reduction in body-size has also been attributed by other authors to the effects of hunting by man. Again, alternative arguments have been proposed, of which adaptation to a warmer climate has commonly been favored; see Edwards (1967) for a review.

Against this background, it seems useful to reexamine the applicability of such arguments to Borneo, drawing on the additional evidence accumulated since 1961 as a result of continued work on the animal remains recovered at Niah. Were Tom Harrisson alive, this paper (or its draft) might have benefited from his critical appraisal. As it stands, “Ditepuk tangan sebelah tidak akan berbunyi”—so says the Malay proverbialist. In this instance, I can only hope that my one-handed clap will at least blow a puff of wind in the right direction.

THE NIAH CAVE EXCAVATION

The site of the excavation discussed in the following pages is the Main or West mouth (=Kuala Besar) of the Great Cave (known locally as Gua Subis) at Niah, Sarawak, 113° 47' E, 3° 49' N. The excavation area is divisible into a frequentation zone (or “occupation sector”; B. Harrisson 1967) 6250 sq ft in area and a “cemetery”

5000 sq ft in area. Tom Harrisson and Michael W. F. Tweedie dug the first trial trench (designated "A") in the center of the frequentation zone in 1954 (Harrison 1957, 1959a: 571). Work resumed in 1957, and in that and the following year the bulk of the frequentation deposit was removed. Later work, continuing into the 1960s, concentrated on peripheral zones (particularly the Neolithic cemetery) and on the lower levels of the frequentation deposit, which was followed down to 144 inches in depth from the original surface.

At the time of his death, Tom Harrisson had published neither a detailed account of the fieldwork nor a stratigraphic plan of this site. All trenches were excavated in layers parallel to their original surfaces, but without access to the daybooks it is, unfortunately, impossible to reconstruct even an outline stratigraphy or to make sense of the system of trench prefixes. He had, however, obtained samples for C-14 age determination from the middle and lower middle levels of the center of the frequentation zone. Aspects of the method of dating may be susceptible to criticism, but there can be no doubt that the values obtained form an internally consistent series compatible with an orderly increase of age with depth (Table 1).

TABLE 1. DATES COMPUTED FROM C-14 AGES OBTAINED FOR SAMPLES FROM THE FREQUENTATION ZONE OF THE WEST MOUTH, SUBIS CAVE, NIAH, PUBLISHED BY TOM HARRISSON (1958, 1959b, 1967)

SAMPLE NUMBER (GRO)	APPROXIMATE DEPTH (INCHES)	TRENCH PREFIX	ORIGIN DATE (B.C.)	COMMENT
1905	n.s.*	W/2	502 ± 70	Described as "charcoal 'seal' subsurface" (Harrison 1958) and "ash layer" (Harrison 1959b).
1960	12	"Subsidiary"	2082 ± 70	Not the "main deposit" (Harrison 1959b).
n.s.	(Outer edge of frequentation)		8160 ± 310 9080 ± 280	Converted from B.P., dates given by Harrison (1967).
1159	48	E/1	17,613 ± 190	"Upper and middle band of 'flake and blade' levels" (Harrison 1958).
1158	72	E/1	30,673 ± 700	"Lower band of above" (Harrison 1958).
1339	(96-)100	E/E	37,643 ± 1000	Originally published as "c. 100 inches" (Harrison 1958), later modified (Harrison 1959b).
1338	100	n.s.	39,543 ± 1000	"Slightly to one side" of 1339 (Harrison 1959b).

* n.s. denotes information not stated in original sources.

In his writings on the topic, Tom Harrisson habitually equated depth directly with age on a uniform scale throughout this excavation, and discussed results in terms of extrapolated C-14 dates. Justification for this approach can only be based

on the stratigraphy, about which he of course had information as yet unobtainable by other investigators. At this stage, we can only make inferences from the details that have been published.

Some reports have denoted the existence of localized stratigraphic disturbance. For instance, at one stage Tom Harrisson (1959a) interpreted features of a peripheral part of the West mouth site as signs of a "pit dwelling" excavated in the contemporary cave floor. In later writings, however, he did not elaborate this apparently interesting topic, and my impression is that he had second thoughts. At the time of the excavation, a detached and inexperienced observer, I personally doubted the correctness of the interpretation. There is, however, no doubt—as the meticulous work of Barbara Harrisson (1967) has shown—that there had been at least 33 interments of human remains in the frequentation zone of the West mouth (2 extended burials, 15 flexed, 4 seated, and 12 burials of mutilated bodies or body parts, plus two sites of deposited or buried cremation residues). The depth of the burials (measured from the upper surface of the bones) varied from near-surface to 50 inches, with the exception of one instance at 106 inches. In no case was the existence of a pit or grave recognized during excavation (B. Harrisson 1967). Inevitably, animal remains and other objects recovered from the disturbed soil above and around burials were mixed with material from other parts of the trench concerned, and cannot retrospectively be separated.

Still, the seriousness of the consequent stratigraphical anomalies should not be overemphasized. Many burials were peripheral in position (see B. Harrisson 1967: Fig. 2) and the volume of cave soil involved was small in relation to the total dimensions of the frequentation deposit. Moreover, certain other clear stratigraphic features—for example, an "ash seal" and a layer of "sterile pink-and-white soil" (Harrisson 1959a)—imply an absence of gross disturbance. Chemical analysis of soil samples from trench EW/2 showed progressive changes in pH, nitrogen, and organic carbon in relation to depth, compatible with steady decomposition and mineralization of organic materials (Sutton 1960), and by inference incompatible with severe disruption of the original stratification. Separate analyses of samples from A/2, E/B3, and E also showed progressive changes with depth, although comparisons between trenches were anomalous (Sabels 1966). Tabulations of artifacts by depth have given correlations that appear to apply broadly through the whole frequentation deposit. Cumulatively, there is thus adequate evidence that in the main the original stratification had been preserved, at least in central sectors of this deposit. It is therefore reasonable to accept a general correlation of depth and age as a basis for interpretations.

The geomorphological history contributed by Wall (1967) implies that the cave has been exposed throughout the last (Würm) glaciation. If the C-14 dates are accepted (and I see no reason to doubt their general indications), the time-span of this excavation evidently extends back to the first period of maximum glaciation during the Würm. Since productive cave soil continued in places as much as 44 inches below the deepest C-14 sample, it is likely that the initial (basal) stratum is much older. Even assuming no greater compression at greater depth (i.e., no change in the average age/depth ratio below 100 inches), the indicated age of the basal (144 inches) layer is at least approximately 60,000 years. This approaches the approximate date of the commencement of the Würm glaciation (Kurten 1972).

From levels of undoubted Würmian age upward there are clear indications of the presence of man. Below the oldest C-14 samples, a human cranium identified as *Homo sapiens* of a negritoid type (Brothwell 1960) was found at 106–110 inches, and a left astragalus of modern type at 102–105 inches (Hooijer 1963). There were also unassociated artifacts found at comparable depths: a stone flake at 110 inches (Harrisson 1959a) and a bone tool at 117 inches (Harrisson and Medway 1962).

The artifacts from other levels demonstrate progressive cultural development. Cataloguing of the stone tools unfortunately is unfinished (Harrisson 1973: 396). We are obliged to try to draw a coherent picture from successive impressions and analyses published by Tom Harrisson. The deepest were flakes and “chopper tools,” which he consistently classed as Palaeolithic. On different occasions he proposed different subdivisions; a late paper on the topic (Harrisson 1970) seems to envisage two successive flake cultures. These were followed by “Mesolithic” types, consisting of worked flakes and edge-ground pebbles or cores. Since he preferred to deal in terms of inferred C-14 ages, it is impossible to discover from his writings the depth at which the replacement occurred in different trenches. His earlier papers imply that the transition lay at about 48 inches in the central sector. The upper limit of Mesolithic tools again is not specified, but evidently lay in superficial levels (the top 12 inches) where were also found true polished Neolithic stone tools and some metal-age artifacts.

In my own field, it is noteworthy that the distribution of Mesolithic stone tools apparently coincided with certain distinctive artifacts of mammal bone or teeth: fragments of pigs’ tusks ground to give a sharp edge, “simple points” of bone (plausibly identified as projectile tips) and bone “gouges” of uncertain function (Harrisson and Medway 1962). Evidently the Mesolithic culture made greater use than the Palaeolithic of parts of the mammal skeleton as a source material, and manufactured a greater variety of tools to meet specific purposes.

The remains of domesticated mammals, that is, dog (Medway 1977b), pig (Medway 1978), and goat (Medway 1963), were found only in superficial levels and must therefore be associated exclusively with Neolithic or later cultures.

From this résumé, it will be clear that by far the greater part of the frequentation deposit (i.e., below the most superficial levels) was formed over a chronological period of 40,000 years or more during which local man did not advance beyond a comparatively primitive existence. New tools and new practices were introduced with the advent of Mesolithic culture, but at all times, lacking domestic animals, man presumably depended for meat on hunting, fishing, and the collection of other animal products of his environment, including aquatic mollusks.

Because the West mouth opens onto a cliff (some 100 ft above the valley bottom, involving at the present day a straight climb of at least 60 ft; see Jee 1959), Tom Harrisson assumed that no large animals other than flying or scansorial types, or natural cavernicoles, could enter the cave, and hence that all remains of such animals owe their presence in the archaeological deposit to the intervention of man. Over so long a period of exposure, it is inevitable that weathering and erosion have altered the local topography of the cave mouth. Yet the dispersed and fragmented nature of the skeletal parts of mammals, and the presence of charred pieces among them, provide confirmation that these are indeed midden remains. A disproportionately high representation of juveniles among the orang-utan remains was interpreted

by Hooijer (1960*b*) as proof that they were killed by man, rather than dying natural deaths in the cave. Whether or not the cliff has always existed in its present form and height, I see no reason to doubt that the remains of noncavernicolous mammals found do indeed provide a sample of the quarry of the primitive men who visited this cave mouth at Niah.

All mammal species identified from the excavation are listed in Table 2, which assembles records previously scattered through the pages of the *Sarawak Museum Journal*. The fullness of the list is a tribute to the work of the specialists to whom Tom Harrisson sent selected material. There is still much that could be learned from further examination of the bone, particularly of the post-cranial material. Such quantitative assessments as can be made on present information are relatively crude.

THE WÜRMIAN ENVIRONMENT

During the period covered by the Palaeolithic and Mesolithic cultural eras in Borneo, effects of the climatic changes associated with the Würm glaciations were felt throughout the world. In Borneo temperatures at certain times were lowered sufficiently to allow the formation of a permanent ice-cap and glaciers on the summit of Mt. Kinabalu (Jacobson 1970; Koopmans and Stauffer 1967). The last phase of this local ice-age apparently persisted until less than 10,000 years ago; for Kinabalu, a deglaciation date of 7210 ± 120 B.C. has been given (Hope and Peterson 1976).

During glacial maxima, the freezing of a vast amount of the world's surface water caused a general lowering of sea level. Such recessions of the sea would have placed Niah cave in an inland position, much farther from the coast than it is at present. Elsewhere in the world, recessions of the order of 400 ft have been deduced. Perhaps because of up-warping of the crust, the extent of withdrawal may have been less in the Sunda region. Off the east coast of Malaya, a lowering of 219 ft during the youngest recession has been established by Biswas (1973), C-14 dated at $11,170 \pm 150$ B.P., with older Pleistocene recessions varying from about 150–200 ft. In the final postglacial phase from about 10,000 years ago the sea again advanced, ultimately reaching 5–15 ft above its present level about 4000 years ago (Wall 1967), since which time it has once more receded.

The earlier period was not however consistently icy. Glacial phases of the Würm were interrupted by at least one mild interstadial, during which there is evidence of a worldwide resurgence of sea levels. Although in the north temperate zone the sea apparently did not reach even its present level, at Niah this may have been exceeded. Evidence comes from beds of marine oyster shells found *in situ* in three places (Harrison 1960), including the Gan Kira mouth of Subis cave. Samples from Gan Kira yielded a C-14 age of $37,500 \pm 2,400$ years (Harrison 1972: 387–388). This mouth opens at about the level of the Subis-Tanggap floodplain, established to be 26 ft above present sea level by Jee (1959). If the C-14 age is not spurious (e.g., through accidental contamination) then the evidence indicates a sea level sufficiently elevated to convert the Subis limestone outcrop into an island (but not necessarily high enough to submerge the West mouth frequentation site) at a date not far outside the limits given for the interstadial in a regional context, 30,000–26,000 B.P. (Hope and Peterson 1976).

TABLE 2. MAMMAL SPECIES IDENTIFIED AMONG ARCHAEOLOGICAL REMAINS FROM THE WEST MOUTH, SUBIS CAVE, NIAH

IDENTIFICATION	DEEPEST LEVEL (INCHES)	REFERENCE
INSECTIVORA		
Moonrat, <i>Echinosorex gymnurus</i>	0-24	Medway (1958a)
Lesser Gymnure, <i>Hylomys suillus</i>	93-96	Medway (1963)
White-toothed Shrew, <i>Crocidura cf. fuliginosa</i>	144	Medway (1960c), Cranbrook (1963)
(Lesser) Treeshrew, <i>Tupaia cf. minor</i>	84-87	Medway (1963)
CHIROPTERA		
Flying Fox, <i>Pteropus cf. vampyrus</i>	0-12	Medway (1963)
Geoffroy's Rousette, <i>Rousettus amplexicaudatus</i> ¹	108-111	Aldridge & Cranbrook (1963)
Rousette indet., <i>Rousettus</i> sp. ²	108	Aldridge & Cranbrook (1963)
Cave Fruit Bat, <i>Eonycteris spelaea</i> ¹	99-102	Cranbrook (1966)
Trefoil Horseshoe Bat, <i>Rhinolophus trifolius</i>	117	Aldridge & Cranbrook (1963)
Borneo Horseshoe Bat, <i>R. borneensis</i> ¹	105	Aldridge & Cranbrook (1963)
Diadem Roundleaf Horseshoe Bat, <i>Hipposideros diadema</i> ¹	96-108	Aldridge & Cranbrook (1963)
Cantor's Roundleaf Horseshoe Bat, <i>H. galeritus</i> ¹	117-120	Cranbrook (1963)
Bent-winged Bat, <i>Miniopterus cf. tristis</i> ³	96-99	Aldridge & Cranbrook (1963)
Bent-winged Bat, <i>M. cf. blepotis</i> ³	126-129	Aldridge & Cranbrook (1963)
Bent-winged Bat, <i>M. australis</i> ¹	81-93	Aldridge & Cranbrook (1963)
Wrinkled-lipped Bat, <i>Tadarida plicata</i>	114-117	Cranbrook (1966)
Hairless Bat, <i>Cheiromeles torquatus</i>	106-108	Cranbrook (1966)
DERMOPTERA		
Flying Lemur, <i>Cynocephalus variegatus</i>	24-36	Medway (1958a)
PRIMATES		
Slow Loris, <i>Nycticebus coucang</i>	0-12	Medway (1958a)
Leaf monkeys, <i>Presbytis</i> sp. (<i>melalophos</i> gp.)	120-123	Hooijer (1962)
Silvered Leaf Monkey, <i>P. cristata</i>	48-60	Hooijer (1962)
Long-tailed Macaque, <i>Macaca fascicularis</i>	99-102	Hooijer (1962)
Pig-tailed Macaque, <i>M. nemestrina</i>	96-99	Hooijer (1962)
Gibbon, <i>Hylobates cf. muelleri</i>	60-72	Medway (1958a)
Orang-utan, <i>Pongo pygmaeus</i>	102-105	Hooijer (1960b, 1963)
PHOLIDOTA		
Giant Pangolin, <i>Manis palaeojavanica</i>	104-110 ⁴	Hooijer (1960a)
Malay Pangolin, <i>M. javanica</i>	114-117	Hooijer (1963)
RODENTIA		
Giant Squirrel, <i>Ratufa affinis</i>	48-60	Medway (1958a)
Prevost's Squirrel, <i>Callosciurus prevostii</i>	24-36	Medway (1958a)
Low's Squirrel, <i>Sundasciurus lowii</i>	90-93	Medway (1963)
Tufted Ground Squirrel, <i>Rheithrosciurus macrotis</i>	60-72	Medway (1958a)
Mueller's Rat, <i>Rattus muelleri</i>	99	Medway (1964)
Long-tailed Giant Rat, <i>R. sabanus</i>	100	Medway (1964)
Porcupine, <i>Hystrix</i> or <i>Thecurus</i> sp.	132-144	Medway (1958a)
Long-tailed Porcupine, <i>Trichys lipura</i>	24-36	Medway (1958a)

TABLE 2. (Cont'd)

IDENTIFICATION	DEEPEST LEVEL (INCHES)	REFERENCE
CARNIVORA		
Domestic Dog, <i>Canis familiaris</i>	6-12	Clutton-Brock (1959), Medway (1977b)
Sun Bear, <i>Helarctos malayanus</i>	60-72	Medway (1958a)
Malay Weasel, <i>Mustela nudipes</i>	48-60	Medway (1958a)
Ferret Badger, <i>Melogale orientalis</i>	54-60	Medway (1958a)
Hairy-nosed Otter, <i>Lutra sumatrana</i>	69-72	Medway (1958a)
Oriental Small-clawed Otter, <i>Amblonyx cinerea</i>	36-48	Medway (1958a)
Malay Civet, <i>Viverra zangara</i>	0-12	Medway (1958a)
Bearcat, <i>Arctictis binturong</i>	66-72	Medway (1958a)
Banded Palm Civet, <i>Hemigalus derbyanus</i>	24-48	Medway (1958a)
Mongoose, <i>Herpestes</i> sp.	24-36	Medway (1958a)
Tiger, <i>Panthera tigris</i>	6-12	Hooijer (1963)
Clouded Leopard, <i>Neofelis nebulosa</i>	0-24	Medway (1958a)
Leopard Cat, <i>Felis bengalensis</i>	78-81	Hooijer (1963)
PERISSODACTYLA		
Malayan Tapir, <i>Tapirus indicus</i> ⁵	84-87	Medway (1960a), Hooijer (1963)
Sumatran Rhinoceros, <i>Didermoceros sumatrensis</i>	60-72	Medway (1965)
ARTIODACTYLA		
Bearded Pig, <i>Sus barbatus</i>	106-110	Hooijer (1963), Medway (1978)
Domestic Pig, <i>S. scrofa</i> dom.	0-24	Medway (in prep.)
Large Mouse-deer, <i>Tragulus napu</i>	96-102	Hooijer (1963)
Small Mouse-deer, <i>T. javanicus</i>	0-24	Medway (1958a)
Barking Deer, <i>Muntiacus muntjak</i>	48-60	Medway (1959b)
Sambhur, <i>Cervus unicolor</i>	84-96	Medway (1959b)
Banteng (or Buffalo) <i>Bos javanicus</i> (or <i>B. bubalis</i>) ⁶	96-102	Hooijer (1963)
Goat, <i>Capra hircus</i>	0-6	Medway (1963)

¹ Recorded in this cave in modern times (Medway 1958b; Harrison 1966)

² A smaller species than *R. amplexicaudatus*.

³ By inference from species of *Miniopterus* in Borneo today (Medway 1977a), it is possible that the taxon identified as "cf. *tristis*" is in fact *M. (schreibersii) blepotis*, and that identified as "cf. *blepotis*" is *M. medius*.

⁴ Not found at more superficial depths.

⁵ A foot-bone identified as elephant by Koenigswald (1958) proved to be attributable to the Malayan Tapir. Yet in 1976, a molar of the Indian Elephant was acquired at Niah by the Sarawak Museum. The vendor said that this tooth had been found in a cave by his deceased grandfather. The circumstances of its origin are not now verifiable but, potentially, the specimen proves the presence of elephant at Niah at some past period.

⁶ Buffalo was positively identified by Koenigswald (1958), but the specimen—like all others found so far—was shown to be indeterminate (Medway 1959b). Only the Banteng occurs wild in Borneo today (Medway 1977a) and the archaeological evidence is insufficient to prove that the Buffalo was also present in the past.

During this interstadial, the climate may have been broadly similar to that prevailing today. During glacial phases, it is likely that the average air and sea temperatures were some 5–6°C lower (Biswas 1973), corresponding to an annual mean at Niah of 20–22°C. Winds in general would have been stronger, but precipitation as little as half of present averages, with most rain falling during the southwest monsoon, and the northeast monsoon tending to be dry (Petersen 1968).

MAN VERSUS MAMMALS

The role of man in the control of animal numbers is very varied. Since he is dietically and behaviorally versatile, even at a Palaeolithic cultural level it is unlikely that man would concentrate exclusively on a single member species among the variety of potential prey shown to be present. Given a limited quarry population into which immigration was prevented (e.g., a land mammal on an island), it is conceivable that the depredations of a sufficiently numerous and effective group of primitive human hunters could exceed the birth rate of the prey and ultimately lead to its extermination. In addition, prey whose habits lead to a clumped distribution (e.g., obligatorily cave-roosting bats) may be both easy to hunt and unduly susceptible to hunting pressure if the relevant resource (caves, in the case of bats) is in restricted supply. In general, however—even today, when the introduction of firearms has completely altered the relationship of hunter and quarry—the effects of man on most terrestrial mammal populations operate in an indirect fashion through activities other than overt predation.

Man may indirectly affect an animal population by introducing competitor species, or new predators, or new varieties of parasites or pathogens (including micro-organisms). But the most important single factor is undoubtedly the destruction of habitat. In a diverse community of wild mammals, interspecific competition is minimized by the variety of ecological adaptations. As a consequence, many species are specialized for particular niches in the total environment and alteration or degradation of their natural habitats has profound effects.

The highly specialized mammals (e.g., obligate forest-dwellers) are more susceptible than generalized types. Other species-specific characters which will affect a mammal's response to predation or other deleterious factors, and its power of recuperation, include the reproductive rate. This in turn is dependent on the duration of the gestation period, normal numbers of conceptuses, and breeding periodicity. Because their reproductive rates are low—associated with late attainment of sexual maturity, long gestation, few young per birth, and long intervals between breeding attempts—large mammals (i.e., the megafauna) are usually more susceptible to detrimental conditions (natural or artificial) than are small mammals.

The extent to which these processes have (or are likely to have) operated in Borneo can now be considered in the light of results from the Niah West mouth excavation. Clearly, the effects of man as a direct predator will be related to his choice of food sources. Tom Harrisson suggested that human predation might have affected the composition of the bat fauna in Niah cave. Certainly, remains of cavernicolous animals (in which bats predominate) abound in the West mouth deposit at all levels, and relative frequencies of the bat species identified in selected samples have indicated changes at various past times in the community occupying

the cave. All parts of the bat skeleton are represented, and some pieces are charred. From examination of the remains, however, it is impossible to decide whether or not the bats concerned had been eaten. Many (if not all) must represent bats that died naturally, rotted where they fell, and so became part of the accumulated cave deposit in some cases charred by subsequent bonfires on the spot where they lay.

In support of Tom Harrisson's suggestion, it is certainly plausible that early man sought bats or swiftlets as food, as indeed does modern man at Niah. On the other hand, this particular cave, by virtue of its huge mouths and great internal height, presents unusually severe problems to a hunter unless armed with a shotgun. As I have personally witnessed in many parts of the Indo-Pacific region, a man who wants to obtain a reasonable return for his effort seeks a tunnel-like cave with a narrow entrance in which the passing flight-stream is concentrated. Under such conditions a small bat colony can be extirpated with the most simple equipment. Subis cave at Niah, however, contains such an expanse of effectively safe roosting space and provides so few opportunities for harvesting the emergent flight-streams that I do not believe predation by man with only primitive aids (i.e., without shotguns) could have more than a trivial effect.

We have shown (Harrisson and Medway 1959) that some of the bat species at present occupying the cave can, by erosive effects, themselves alter the physical state of their roost-sites. Over long periods of time, cumulative results of the bats' presence could in this manner render a particular site unsuitable for continued use. All bats, moreover, feed outside the cave and are thus susceptible to environmental changes affecting the abundance of their food sources (plant or animal). I conclude that ecological factors such as these are much more likely to account for past changes in number or composition of the bat fauna of this cave than is human predation.

The remains of noncavernicolous mammals from the excavation clearly demonstrate that the Bearded Pig was consistently the most important mammalian quarry species. Bones and teeth of this pig occur abundantly at all levels (Medway 1978). The amount of material involved has been too great to quantify precisely, and counts have accordingly been confined to single selected elements of the skeleton. Thus, among the animal bone excavated from the central zone in 1954-58, I found 228 ankle-bones (astragalus) of pig. For comparison, in the same sample I found 13 heel-bones (calcaneum) of Orang-utan, and 148 heel-bones (calcaneum) of monkeys of at least three, and possibly more, species.

Other medium or large mammals were represented on so much smaller a scale that it has been possible to count not merely single bones but all identifiable parts of the entire skeleton. Results, from the same or a slightly larger sample, are as follows: Malayan Tapir, 12 pieces (Medway 1960*a*); Sumatran Rhinoceros, 15 pieces (Medway 1965); Large Mouse-deer, 10 pieces; Barking Deer, 14 pieces; Sambhur, 18 pieces; wild cattle, 22 pieces (Medway 1960*b*). The Tiger has been recognized by a single tooth from a very young animal (Hooijer 1963), and the Indian Elephant, although probably available (see note to Table 2), was unrepresented.

In the upper (i.e., younger) levels, there was an increase in diversity of noncavernicolous mammals. A notable change was the rather abrupt increase in the relative frequency of arboreal mammals (i.e., monkeys and tree squirrels) above the 48-inch level (Medway 1959*b*). This can be associated with the advent of Mesolithic

technology, with its greater use of bone as a source material, in particular for the manufacture of projectile tips (above). Nonetheless, comparative counts of tarsal bones show that pigs, individually, continued to be taken in greater numbers than any other single species, and in quantity pig-flesh must have remained the preponderant meat.

It is clear that, at all times, pre-Neolithic man at Niah selected prey from a wide variety of mammals but concentrated principally on middle-sized species which, in modern times, are common and conspicuous members of the forest community. There is no evidence whatsoever that these particular quarry populations were depleted by persistent hunting. Other mammals were taken in very much smaller quantity. Spread over the time-span involved, the loss to wild populations represented by these remains is clearly trivial by comparison with total numbers and the natural turnover.

At this point, we may also consider the relative evidence for hunting versus natural causes of the postglacial decline in average size. This has been documented for several Southeast Asian mammalian species, including examples from Niah. I find strong support for a natural explanation in two contrasting instances. Firstly, the mammal most hunted, the Bearded Pig, shows no such change over the full time-scale of the West mouth excavation (Medway 1978). Secondly, two species for which statistically significant changes of this nature have been demonstrated are Mueller's Rat and the Long-tailed Giant Rat (Medway 1964). Both rats are poorly represented in the archaeological remains and were evidently not important food resources. Moreover, both are widespread and abundant in forest habitat and—even if occasionally caught—trapping by man cannot possibly have had a significant effect upon their populations.

Having concluded that the results from Niah provide no indication of excessive hunting pressure by early man, it is necessary to examine alternative ways in which his presence might have affected population levels of contemporary mammals.

There is no evidence that early man introduced any alien, potentially competitive or predatory mammal into Borneo. For instance, although elsewhere in the world the dog may have been domesticated as long as 12,000 years ago, there is no archaeological evidence of its presence in Borneo before the Neolithic period (Medway 1977*b*). There is no wild canid in Borneo (as there is in other parts of the Sunda region), but this apparently vacant niche has not been filled by feral domestic dogs. Other domestic animals are also all derived from progenitors not indigenous to Borneo. As noted above, none appear at Niah before Neolithic or later levels, and again no species has established itself in a feral state.

It is very difficult to test for the introduction of a parasite or disease in a period long past. For such an organism (without mutation) to have a severe effect, it must be brought into an area where it was formerly absent and where, through lack of previous contact, a susceptible host population has neither inherited nor acquired immunity. Since early man at Niah had no domestic animals, it would have been necessary that he himself carry the parasite or disease. It would also be necessary that he should be able to cross an obstacle that acted as a barrier to movement of the susceptible alternative mammalian host.

The sea provides such an obstacle to large land mammals. But the evidence from Niah indicates that Palaeolithic man was equally strictly confined to land. I deduce

this point from the absence of a detectable stratum of marine remains corresponding in age to the interstadial inundation and isolation of the Subis outcrop that is indicated by the Gan Kira oyster bed (see above). If man had continued to frequent the cave at this time, he would certainly have left evidence in the form of marine mollusk shells, crab claws, fish bones, etc. These remains would be expected at 90–96 inches. In fact, marine or estuarine shellfish were totally absent from sample trenches between 96 and 120 inches (Medway 1960*b*), and at higher levels became abundant (in comparison with freshwater species) only above 24 inches depth. In a sector of trench "A" excavated in 2-inch layers, saltwater mollusks reached peak concentration between 4 and 14 inches (Medway 1960*d*). By extrapolation from C-14 dates, the influx of estuarine shellfish can be correlated with the postglacial rise in sea level, before which this rich source of food was evidently too distant or otherwise unavailable to the human cave visitors. If the Subis limestone was indeed an island during a Würmian interstadial, contemporaneous man was clearly incapable of reaching it. By inference, he would have been equally incapable of crossing a stretch of sea sufficiently wide to serve as a barrier to the migration of other large mammals.

The total impact of man in Borneo in other ways (e.g., habitat alteration) is difficult to assess, but will have depended on his population density. It is probably rash to make firm deductions from the scanty evidence, but a few comparisons may be instructive.

In this cave mouth the average rates of accumulation of the deposit (=midden remains + other spontaneously occurring organic and inorganic materials) between successive rounded C-14 dates have been as follows: 0–20,000 years B.P., 2.4 inches per 1000 years; 20,000–31,000 B.P., 2.2 inches per 1000 years; 31,000–40,000 B.P., 3.1 inches per 1000 years. Assuming increased compression at lower levels, these figures may indicate a slightly greater intensity of frequentation in Palaeolithic times, although the margins of error are so large that even this conclusion is probably unsafe.

I have found figures for comparative accumulation rates from other sites as follows. Under a birds'-nest collectors' hut in a lower cave mouth at Niah, a midden of shell and bones 9 inches deep had formed in probably less than a century and certainly not more than 150 years, that is, at an extrapolated rate of about 72 inches per 1000 years, as a consequence of two visits per annum (for the birds'-nest harvests) lasting two or three weeks on each occasion (Medway 1960*d*). A cave in northeastern Iraq, occupied by man of a microlithic culture at the close of the Würm glaciation, contained a deposit "nowhere more than 2.0 m deep," built up over not more than 2000 years (Turnbull and Reed 1974), that is, an accumulation rate up to 1 m (=39½ inches) per 1000 years. In Hortus cave, France, deposits of Würm II age covering about 20,000 years of frequentation by Neanderthal man attained a depth of 7 m (Lumley 1972), that is, 35 cm (=14 inches) per 1000 years. Against these comparisons, the use of Niah cave by pre-Neolithic man apparently was at low intensity. Assuming that in all environments cave sites are equally attractive as shelters, this can tentatively be taken to show that man was markedly less numerous in late Würm times in Borneo than in temperate Eurasia.

Even during Neolithic times, when the inner part of this mouth served as a cemetery, the evidence suggests that the human population remained small.

Barbara Harrisson (1967) identified 127 Neolithic burials, datable to a 1200-year period. Although continuous use is not implied, a population that produced only this number of dead (even if certain age groups or social classes were excluded) over so many centuries must have been far below the density of a typical modern longhouse community.

Pre-Neolithic man at Niah had no domestic animals and evidently relied on wild creatures for animal protein in his diet. By inference from modern forest-dwelling human societies, he probably also depended for sustenance on vegetable starch derived from wild plants. In the Southeast Asian tropical rain-forest, such plants include wild yams and wild sago. Neither of these plants is amenable to cultivation, and on this and other grounds (e.g., tool types) it appears highly unlikely that Palaeolithic or even Mesolithic man attempted large-scale forest clearance. Neolithic man probably did make use of crop-plants, but possibly only the cultivated sago. Yet, at a very low population density, it is again unlikely that the limited amount of land clearance involved in Neolithic agriculture can have made anything but an insignificant impact on the vast expanse of natural habitat available in Borneo.

MAMMALIAN EXTINCTIONS

The results from Niah nonetheless indisputably show that there have been some past changes in the mammal fauna. As Tom Harrisson noted, the Giant Pangolin, *Manis palaeojavanica*, is the only species concerned that is not still extant elsewhere in Southeast Asia, if not in Borneo. This mammal is also known from Middle Pleistocene (Cromerian to Mindel) deposits in Java. Although noncontemporaneous, representative specimens are apparently indistinguishable (Hooijer 1974).

About one-third of the Middle Pleistocene mammal fauna of Java consisted of species that are now extinct. The survivors are characteristic members of the modern Southeast Asian rain-forest community. The extinct assemblage, by contrast, chiefly comprised browsing or grazing mammals (including hispid hares, proboscideans of several divergent types, the perissodactyl *Nestoritherium*, a large tapir, a large rhinoceros, a hippopotamus, one or two antelopes, and the bovine *Leptobos*) together with appropriate predators (including large dogs, hyenas, and saber-toothed cats) (Medway 1972). It is clear that, to permit the coexistence of these two ecologically distinctive assemblages, the environment must have consisted of a mosaic (on a larger or smaller scale) of forest alternating with open bush or parkland. The existence of vegetation suitable for terrestrial browsers and grazers during ice ages would have depended in part on the comparatively low and seasonal rainfall, and in part on the activity of the herbivores themselves in preventing the regeneration of forest. If, as Whyte (1972) has suggested, suitable grasses (Gramineae) had not at that time reached the Sunda region, the shrub and ground-layer vegetation of open grazing land must have consisted of other taxa, presumably including dicotyledonous herbs and perhaps a diversity of Cyperaceae. Despite this rather profound difference, the environment is likely to have been physiognomically and ecologically similar to Recent tropical grassland savannas, and to have supported a savanna-adapted insect fauna including termites forming huge colonies in large termitaria—similar to those so conspicuous in comparable environments today—upon which a giant pangolin could subsist.

During the Mindel and later glaciations lowered sea-levels would have exposed most of the Sunda shelf and effectively joined the present landmasses (Java, Borneo, Sumatra, and the Malay Peninsula, etc.). Fossil remains of some of these mammals have been found in Malaya, and in the absence of any barrier to distribution it is likely that a broadly homogeneous large mammal fauna occupied the entire area. During the interglacials, raised sea-levels would have had two significant effects. Firstly, a reduction and fragmentation of land area would have lessened the available plains habitat, separated large mammals into relatively small isolated populations, and limited their migration. Secondly, the prevalence of a warmer and more uniformly humid climate would have favored the colonization of open country or scrub by forest. Under such circumstances, the browsing and grazing herbivorous megafauna (and associated carnivorous predators) would have been under great environmental pressure. It is consequently unnecessary to postulate human intervention to explain the disappearance of members of this assemblage.

The specimens from Niah show that the Giant Pangolin survived from Mid-Pleistocene through two interglacials, into the first phase of the Würm glaciation, perhaps succumbing during a subsequent interstadial. Alongside its remains, bones of the smaller Malay Pangolin, *Manis javanica*, were found in relatively greater number. No specialized weapon is needed to capture or kill an animal that, like the pangolins, in self-defense merely rolls up. *Manis javanica* is still abundant in Borneo, frequenting a wide range of habitats from plantation to forest. I suggest that its smaller size (and hence ability to subsist on the smaller termitaria typical of forest) is a factor that allowed this species to survive through the Würmian interstadial when its larger congener apparently disappeared.

No other mammal recovered from Würmian levels at Niah has become totally extinct. Of those which are no longer found in the vicinity, two—the Orang-utan and Sumatran Rhinoceros—have evidently been locally exterminated in historical times. Vigorous populations of both species survived in Borneo at large well after the introduction of Neolithic techniques, and earlier man clearly had no significant influence on numbers. The sensitivity of the Orang-utan to recent human settlement is illustrated by its local decline in areas south of the Rejang River from the late 19th into the 20th century (Urquhart, quoted by Medway 1977a). In the late 19th century, rhinoceroses were already subject to intensive hunting, but nonetheless remained common in underpopulated areas (e.g., the Kelabit country or the lowlands of eastern Sabah; see Medway 1977a).

Natural ecological processes are sufficient to explain the disappearance of the Lesser Gymnure and the Ferret Badger. Each of these species was represented by a single specimen, and clearly neither was the habitual quarry of man. Both are now restricted in their Bornean distribution to elevations above 3500 feet, where the low ambient temperature is comparable to that prevailing at sea level during glacial periods. While other mammals (many of which today do not have altitudinally limited ranges in Borneo) were evidently able to adapt to postglacial warming, these two species are presumably more closely dependent on ecological factors related to lower temperatures.

The standing of the Indian Elephant and the Tiger is unresolved. The elephant probably was present at Niah in Würmian times (see note to Table 2) but, if so, there is no evidence that it was hunted by contemporary man. In its modern range,

it is confined to northeastern Borneo, presumably restricted by ecological factors as yet undetermined.

The Tiger has been recognized by a single canine tooth of a young animal, found at a superficial level, that is, of Neolithic or recent date (0–12 inches). It is not impossible that other skeletal parts exist undetected among postcranial remains from Niah cave. So far, there has been insufficient opportunity to examine every piece in careful detail, and a relatively characterless bone such as a rib, a vertebra, or a foot-bone (excluding the terminal phalanges, which I would undoubtedly have picked out) may yet be identified. The status of the Tiger in Borneo has always been uncertain. Recently, Gersi (1975) has published a sensational account of an encounter with a tiger in East Kalimantan, supported by two photographs purporting to have been taken on the occasion. With due respect to M. Gersi, I do not find the photographs compatible with the circumstantial details of the text, and I am inclined to suspect their authenticity. It is undeniable, however, that Gersi's picture of "la hotte-porte bébé" (p. 87) shows at least one Tiger canine in an authentic setting. This adds to the list of skins and teeth found in the possession of interior Bornean peoples, hitherto generally considered to have been imported (see Medway 1977a for a review). If the Tiger exists in Borneo, its origin is certainly not attributable to zoo-escapes (as suggested by Gersi), and its present range must be very restricted and its status extremely rare. At this stage the Niah specimen may be interpreted as support for an authentic indigenous population. Alternatively, it may have been an early importation (i.e., a pet cub) at a period when man at Niah was clearly at a stage of sophisticated Neolithic or early metal-age culture, compatible with extensive contact and trading exchange among the Sunda Islands.

The Malayan Tapir is also a mammal of controversial status. It is represented at Niah from levels corresponding to an undoubted Würmian date until approximately 6000 B.C. (Medway 1960a; Hooijer 1963). The date of its subsequent extinction is uncertain. Indeed, there is evidence that the species survived into the 20th century (Banks 1949; Medway 1977a).

I am familiar with this mammal in peninsular Malaysia where, although its tracks can be found far in forest, its diet consists chiefly of herbaceous and shrubby vegetation of the forest edge, tracksides, or disturbed or secondary growth (Medway 1974). Unlike the Sumatran Rhinoceros, the Malayan Tapir does not push over or break down the woody plants on which it feeds and hence cannot by its own activity maintain an environment suitable for itself. During glacial phases, as noted above, climatic factors evidently favored the development of a mosaic of forest and open gaps or glades. Under such conditions, the forest-edge facies must have been extensive and resources for tapirs correspondingly rich. With the advent of a warmer and wetter postglacial climate, the colonization of open spaces by tall evergreen rain-forest must progressively have degraded the quality of the environment for tapirs, which presumably became rarer. Under modern conditions, the food supply of tapirs is rich only where the climax vegetation has been disturbed or destroyed by natural events such as windfall or landslide, or by the activities of other large mammals such as rhinoceros or man. Man today, by selective felling or partial forest clearance, recreates an environment favorable for tapirs which, in peninsular Malaysia, they exploit. It early postglacial times in Borneo, man (as evidence from Niah demonstrates) was still at a primitive (Mesolithic) cultural stage, neither

needing to clear nor capable of clearing significant areas of forest. To this extent, then, I conclude that the postglacial decline of the Malayan Tapir is not at all attributable to the abundance of early man or his efficiency as a hunter. On the contrary, it is interpretable as an effect of the rarity of the human species in contemporary Borneo and the insignificant impact by man on the natural environment of that period. Had man reached an agrarian cultural stage somewhat earlier, and been more numerous, his activity might have been sufficient to counteract the ecological processes associated with the postglacial climatic amelioration which are identifiable as sufficient cause of the decline and ultimate disappearance of this element of the Pleistocene mammalian megafauna from Borneo.

AFTERWORD

Lord Medway writes:

I first met Tom Harrisson in 1955 over a drink of something or other in the rooms of common friends at Cambridge. He was in an expansive mood and, more or less, offered to find a job for anyone who presented himself in Sarawak. I took this up, and a mutually agreeable arrangement was negotiated, so that after graduating I sailed for Singapore and Kuching in summer 1956 to assume the invented post of Technical Assistant at the Sarawak Museum. During the 1957 season at Niah I was largely excluded from the archaeological work (and encouraged to concentrate on swiftlets), but for the first half of 1958 (after which I returned to the U.K.) I was specifically charged with the task of field sorting and preliminary identification of all animal remains. In later years, on short visits to Sarawak, I have seen material from subsequent excavations and have re-examined the stored specimens of earlier years. Although my main research developed in the topic of the living vertebrates of the Malaysian region, I have valued this means of relating past and present. The original chance encounter with Tom Harrisson turned my life into completely unexpected pathways, and I shall always be grateful to him for the opportunities he provided.

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