In 1891, a young Dutchman named Eugene Dubois commenced what has now been over a century of human fossil discovery outside Europe: a century that has witnessed some profound changes in scientific views of human origins. Dubois entered—and changed—the history of anthropology in October 1891, near the village of Trinil in the middle Solo Valley of central Java. His discovery, a skullcap (or calotte) of apparent human form, belonged to an archaic human species that he called *Pithecanthropus erectus*.

Since 1891, many more finds have come to light in Java and the rest of the world. In this section I intend to review the significance of the Javanese *erectus* populations in their general Old World setting. There are now so many articles and sections of textbooks that discuss the finer physical characteristics of these fossils that I will limit myself in this regard to a few central observations. The overall perspective is of most concern here.

During the past thirty-five years, fossil discoveries in the East African nations of Tanzania, Kenya, and Ethiopia have completely overturned previous theories, which quite frequently postulated an Asian center for the earliest phases of human evolution. This view was not surprising considering that most of the major finds during the period from the 1920s to the Second World War had been made in Java and at Zhoukoudian in China, with the exception of the Australopithecines of South Africa, which at that time had yet to achieve full recognition as potential human ancestors.

Scientific understanding of the course of human evolution today is naturally founded on a much fuller fossil record than it was even thirty years ago. The often-confident assertions of paleoanthropologists might lead to a belief that many important problems have been solved, despite their own often funda-
mental disagreements with each other's interpretations. Common sense, however, would suggest that many surprises may still lie buried in different parts of the Old World. But the advances have certainly been impressive, as one can see by merely comparing recent textbooks with those published about twenty years ago. Paleoanthropology has come a long way indeed since theories of a giant ape ancestry for man were published by Weidenreich as recently as 1945 and 1946. Weidenreich himself was of course a respected and competent scholar who made fundamental contributions to the study of fossil hominids in China and Java, but unfortunately for him he produced his more general theory too soon (an occupational hazard that doubtless is always with us).

I. THE ANTECEDENTS

When the original manuscript for this book was prepared in the early 1980s, it was still widely accepted that the oldest primate genus to contain the first recognizable stage of emergent hominid form was a widespread African and Asian Miocene ape called Ramapithecus. Since then, however, the tide of opinion has turned. Ramapithecus has been transferred out of the human lineage and into a possible ancestor for the orangutan.

Today, the quest for human origins is focused most intensively on the Australopithecines of eastern and southern Africa. Even as I prepare this revision, ideas about human evolution are undergoing yet further upheaval as a result of discovering a new genus and species, Ardiptithicus ramidus (a presumed forebear of Australopithecus) in deposits dating to about 4.5 million years ago in Ethiopia (Wood 1994; White et al. 1994; Gee 1995). A. ramidus is claimed to be the earliest potential hominid to appear in the African fossil record, and the bones of younger Australopithecine species have been found in large numbers of sites in South Africa, Tanzania, Kenya, and Ethiopia.

These African hominids of the Pliocene undoubtedly contain some of the basic physical and cultural roots of our humanity. For instance, A. ramidus is currently placed close to the phylogenetic separation between the human and chimpanzee lines of descent, a separation that might have been encouraged geographically, between 8 and 4 million years ago, with the opening of the African Rift Valley and the development of drier and less forested landscapes in eastern Africa (Tobias 1992; Coppens 1994). Early humans are presumed to have evolved in these areas, whereas the chimpanzees remained closer to the forests in the west. However, as with understanding the tectonic evolution of the Indonesian Archipelago, so too understanding of the course of human evolution becomes more complex and more contested with each new discovery.

When the first edition of this book was being written, biological anthropology was going through a phase of "lumping" in which relatively small numbers
of species were being recognized. In the case of the genus *Homo*, it was believed that only one species existed at any one time, in the general chronological order *Homo habilis* → *H. erectus* → *H. sapiens*. All of this now seems luxuriously simple; the *habilis* and *erectus* grades certainly contained more than one contemporary species if we are to believe many modern commentators (e.g., Groves 1989; Wood 1992; Howell 1994). The original figure 2.1 that accompanied this chapter (reproduced from Johanson and Edey 1981) showed one line of hominid descent from *A. afarensis* through *A. africanus* to *A. robustus* (extinct), and another from *A. afarensis* through *H. habilis* and *H. erectus* to anatomically modern humans. Our understanding of human evolution in 1995 is not so simple. A possible successor evolutionary tree suggested by Wood (1994), far more complicated, now replaces the original (Fig. 2.1).

For this book it is not necessary to prolong the Australopithecine debate as this genus has never been convincingly reported out of Africa (although see Tyler 1992 for suggestions of an Australopithecine presence in Java). The weight of evidence for an emergence of the genus *Homo* from an Australopithecine ancestor somewhere in Africa now seems to be overwhelming. However, it is
not clear which species of the generalized habiline (or early *Homo*) grade—if indeed any of those so far discovered by paleontologists—was/were the ancestor(s) of extra-African *Homo erectus* and other subsequent human populations. Howell (1994:302) has recently suggested that the ancestral *Homo* species that dispersed initially out of Africa was the East African species *Homo ergaster*, which eventually speciated into *Homo erectus* in eastern Asia (see also Fig. 2.1). Howell, however, like numerous modern anthropologists, regards the Asian *Homo erectus* as an extinct branch of hominid evolution with no transmission of genes to modern populations. This brings up a major issue of debate to which I shall return.

As far as the line of anatomically modern human descent is concerned, purely behavioral developments in Africa prior to 2 million years ago are likely to have been heavily embedded in a biological developmental matrix involving reinforcement of bipedal posture, increasing hand flexibility, greater cranial capacity (Fig. 2.2), and the development of the human grinding and chewing dentition. The Australopithecines had attained a partially bipedal posture by at least 3.6 million years ago, if not before, according to a series of footprints preserved at Laetoli in Tanzania (Leakey 1981), but the expansion of the brain seems to have occurred mainly later with the genus *Homo*. Sexual body size dimorphism is well marked among the early hominids, who probably existed on a fairly omnivorous meat and plant diet derived from grassland and savanna territories located close to rivers and lakes (Boaz 1977; Coppens 1994). During the period of transition to the genus *Homo*, around 2.5 million years ago, there is already direct evidence for stone tool use (Clark 1992; Tobias 1992) and, soon afterwards, inferred but disputed evidence for regular dwelling places or campsites (Binford 1983). Perhaps the record also witnesses the evolution of such concepts as the nuclear family, kinship, the incest taboo, and basic human language (Isaac 1980; Wilson 1980; Lovejoy 1981; Bickerton 1990).

In terms of biological morphology, the earliest populations of *erectus* grade in Africa and elsewhere can be regarded as evolved habilines. Bernard Wood (1978: 53–54) has described the major skeletal characteristics of the whole *erectus* group (including the Javanese fossils) as follows: a distinctive cranial shape marked by prominent browridges separated from the rest of the skull by a deep constriction (the postorbital constriction), a low vault with the widest point at the base, extremely thick cranial bones and strongly marked muscle attachments, a broad, large face with large teeth, and an average cranial capacity of about 950 cubic centimeters (Fig. 2.3 and Fig. 2.4). Postcranial remains suggest a body size and posture approaching the *sapiens* grade, with the important proviso that the *erectus* grade spans perhaps a million years or more, so some degree of temporal and also regional variation can be expected. Opinions on this matter differ, however, with Wolpoff (1984) and Clausen (1989) claiming signif-
significant evolutionary change throughout the erectus time span, but Rightmire (1990) claiming virtual stasis.

It is with the early erectus (rather than Australopithecine) evolutionary level that Java takes on a major importance, for this small island contains some of the earliest evidence for human radiation out of Africa through the tropical zones of the Old World. According to different authorities who have claimed absolute dates for the hominids of Java, this radiation might have occurred between 1.8 and 1.0 million years ago (see Chapter 1, Section IVB). I tend to favor the younger age, but freely admit that the whole issue of dating Homo erectus across the Old World is still highly controversial. A date of 1.8 million years for the Perning site in Java (Swisher et al. 1994) would mean that Homo
Fig. 2.3 Top to bottom: lateral views of Homo erectus crania from Sangiran (early or middle Pleistocene), Zhoukoudian (middle Pleistocene) and Ngandong (late Pleistocene). To same scale. From Wolpoff 1980. Courtesy: Alfred A. Knopf, Inc.
Fig. 2.4 Posterior cranial views of ER 1805, a transitional *habilis-erectus* specimen from Kenya, and later *erectus* crania from Sangiran and Zhokoudian (Choukoutien). To same scale. From Wolpoff 1980. Courtesy: Alfred A. Knopf, Inc.

*erectus* here is older than the *erectus*-grade population in Africa, which on current evidence dates from about 1.7 million years ago (Rightmire 1990:Fig. 39). The *erectus* teeth and associated stone tools from Yuanmou in Yunnan (China) have been claimed to date from about 1.7 million years ago (Woo 1980:188; EATQN 15:77), but this date is disputed as being too old by Liu and Ding (1983) who suggest only a middle Pleistocene antiquity (see also Howell 1994:264–265). However, there has been a recent claim that a mandible fragment and some possible stone tools from Longgupo Cave in Sichuan date to almost 2 million years ago (Huang et al. 1995). Needless to say, this claim requires fuller verification if it is to be accepted fully. There are big problems of chronology concerning the radiation of *Homo* out of Africa, and I see no easy resolution at the moment.
II. HOMO ERECTUS IN JAVA

The major find-places for the Javanese fossils have been in the upper Pucangan, Grenzbank, and Kabuh deposits exposed in the anticlinal dome at Sangiran (see Chapter 1, Section IVB and Koenigswald 1956 for descriptive accounts). Additional important fossils have also come from possible Kabuh-equivalent beds at Trinil itself, in central Java, and from Perning, near Mojokerto in eastern Java, but both these sites have major dating problems (see Vos et al. 1982 for Trinil; Swisher et al. 1994 for Perning). At present, all specimens reliably of Pucangan age come from Sangiran (and possibly Perning), and these specimens also appear morphologically to be the oldest in the series. Finally, there is the important late *erectus* cranial series from Ngandong, Sambungmacan, and Ngawi in the Solo Valley, of late middle or late Pleistocene faunal age.

A. The Pucangan Hominids

Of the Pucangan sample from Sangiran, the most complete specimen, Sangiran 4 (popularly called “Pithecanthropus IV”; Koenigswald and Weidenreich 1939), comprises the posterior part of a braincase and the lower portion of the maxilla (mid-facial region). Both belonged to a heavily muscled individual with a cranial capacity of about 900 cubic centimeters, with large teeth and particularly large canines (Holloway 1981). A most unusual feature of the dentition is a gap (diastema) between the upper canines and incisors, into which the lower canines would have fitted to allow the jaw to close. Such diastemata are typically an ape phenomenon; the great apes have very large canines, and they do not occur in any other *erectus* specimen (with the possible exception of the much later Sangiran 17 skull; Thorne and Wolpoff 1981). The Australopithecines from Laetoli and Afar in East Africa do sometimes show this feature (Johanson 1980:48; Wolpoff 1980:134), and it is possible that the diastema in Sangiran 4 implies a relatively early position within the extra-African phylogeny of *Homo*. Of course, as always there is a counterargument: It has been suggested that the diastema in the Sangiran specimen could be due to “labial displacement of the maxillary incisors because of vertical collapse after loss of the posterior mandibular teeth” (Zingeser 1979). In this case the feature would be simply a result of individual trauma, although the lower jaw of the specimen does not survive to allow direct confirmation.

The Sangiran 4 remains may otherwise be taken as fairly representative of an early Pleistocene, robust *Homo erectus* population in Java. They come from a stratigraphically high position in the Pucangan beds and there are mandible fragments in older deposits that appear to be of the same basic grade. Most authors until recently have favored attribution of all to a single species—*Homo*
Fig. 2.5 Late Pliocene and Pleistocene sites and localities in Java.
erectus—suggesting that there is no overwhelming reason why the Javanese fossils should not belong to one single species evolving through a long period of time. Rightmire (1990) certainly takes this view, as does Groves (1989).

As with the dating, however, the issue is not simple. The Indonesian paleoanthropologists Jacob (1980) and Sartono (1985) have long favored the existence of more than one contemporary species of pithecanthropine in Java, a view recently supported by Tyler (1992), by Uytterschaut (1992), and by Howell (1994). Part of the debate revolves around the taxonomic status of some massive mandible fragments. The two most important of these fragments were found at giran in 1941 and 1952, one from the upper Pucangan and the other from the lower Kabuh beds. Clearly hominid, but with massive teeth overlapping in size with those of a gorilla, these specimens were named Meganthropus paleojavanicus by Koenigswald and Weidenreich. Weidenreich (1946) adopted the view that Meganthropus was on a direct line of evolution to anatomically modern humans, occupying a position between the more massive-toothed Gigantopithecus and the smaller Pithecanthropus (Homo erectus). This view never became popular and, as the African evidence accumulated, attempts were made to correlate Meganthropus with the robust Australopithecines (or Paranthropus; Robinson 1968) and with Homo habilis (Tobias and Koenigswald 1964). Even today it is still maintained as a genus quite separate from Homo erectus by the Indonesian scholars Jacob (1978a) and Sartono (1975; see also Orban-Segebarth and Procureur 1983). Tyler (1992) also suggests that Meganthropus might be separate from Homo erectus.

So could the Meganthropus jaw fragments represent a situation similar to that in East Africa, where robust Australopithecines continued to exist alongside Homo in the early Pleistocene? Regardless of the fluctuating opinions of paleoanthropologists on this issue, there is still the question of dating. It is hard to be certain whether the hominid remains in question really do overlap in time, although the occurrence of both Homo erectus and Meganthropus in the Grenzbahn would suggest that some overlap did occur. In 1970 Lovejoy placed Meganthropus firmly at the larger end of a considerable range of dental size variation in Homo erectus, a view also held by Le Gros Clark (1964), by Bernard Wood (1978:56), and by most contemporary authors since. Although few authorities today seem willing to keep Meganthropus in a separate genus from Homo, I agree with Pope that “the question of the validity and reality of Meganthropus must remain open for the present (1985:69).

B. The Kabuh Hominids

From the Kabuh Formation, perhaps dating between 1.0 and 0.5 million years ago (see Chapter 1, Section IVB), there is a much fuller set of fossil remains.
Most specimens again come from Sangiran, and there is also the original find made by Dubois at Trinil: the *erectus* calotte (skullcap) found in the bed of the Solo River during the dry season of 1891. It has been claimed (Bartstra 1982; Vos et al. 1982; Vos and Sondaar 1982) that the mammal fauna from Trinil is much older than the middle Pleistocene fauna called Trinil from Sangiran, but the Trinil skull itself does fit morphologically with the Sangiran remains attributed to this period. It may be that the fauna and the skull from Trinil are not contemporary, and it must be admitted that there have always been problems with Dubois' records. For instance, he recovered a number of human femora from the general vicinity of the Trinil skull that have often been used to reconstruct a totally modern body posture for Javanese *Homo erectus*. Fluorine tests (Bergman and Karsten 1952) appeared to support contemporaneity of the skull and femora, even though well-authenticated *erectus* femora from Africa and Zhoukoudian are considerably more archaic in appearance. However, Day and Molleson (1973) have since thrown doubt on the antiquity of the Trinil femora and certainty is still elusive.

All the other Javanese remains of Kabuh age are cranial or mandibular and represent a population less robust than the earlier Pucangan specimens, but still retaining a high degree of sexual dimorphism. Wolpoff (1980:191) points out that the Javan sample has less projecting browridges than the equivalent African specimens, but more marked facial prognathism, thicker skulls, and stronger muscle attachment areas. Cranial capacities range from 813 to 1,059 cubic centimeters, with an average of 929 (Holloway 1981). Stature probably ranged up to a maximum of around 160 centimeters, and weights may have ranged up to 80 kilograms in the latest populations (Wolpoff 1980:205). It is reasonable to assume that average cranial capacity increased during the time span of *erectus* evolution, although overall shape varied little until the development of high-vaulted *Homo sapiens* in the late Pleistocene, and much of the increase in brain size may simply correlate with a slow increase in body size (Bilsborough 1973). It has also been suggested that the thick vault and massive teeth of *Homo erectus* may relate to continuing selection imposed by the dangers of a hunting life and the frequent use of teeth as tools; the latter would also select for a massive and prognathous face with very powerful muscle attachments.

**C. Farewell to *Homo erectus*? The Ngandong Remains**

The Javanese remains of *Homo erectus* considered so far appear to span a long period of time prior to 500,000 years ago, with the majority coming from the later part of the time range. The oldest human remains of anatomically modern type in the region appear to be not more than 40,000 years old, and between
these two groups there is only one major fossil population—from Ngandong—with related single skull discoveries at Sambungmacan and Ngawi (the latter being on the Solo River, upstream from Ngandong; see Fig. 2.5).

Between 1931 and 1933, Indonesian field assistants employed by the Geological Survey of Indonesia were given the periodic job of excavating a bone-bearing terrace about 20 meters above the dry-season level of the Solo River at Ngandong, downstream from Trinil. The whole terrace deposit was about 3 meters thick and the animal bones (about 25,000 were recovered from a 50- by 100-meter excavation) were apparently fairly heavily concentrated in the lower metre of the deposit. From time to time the site was visited by the geologists Ter Haar and Oppenooorth and also by Koenigswald. Over the two-year period the bone collections eventually yielded no less than eleven crania (all lacking faces) and two tibiae of an advanced population of Homo erectus (see Koenigswald 1951, 1956 and Oppenooorth 1932 for eyewitness accounts). It is quite clear that the human skulls were not found together and Koenigswald noted the unusual circumstance that teeth, mandibles, and other bones apart from the two tibiae were entirely lacking; such selectivity was not noted amongst the other animal remains. Furthermore, of the eleven skulls only two had parts of their bases surviving; Koenigswald (1951) postulated that they had been broken open for purposes of brain eating, after which they were used as bowls. The idea of cannibalism has been disputed by Jacob (1967a, 1972), who pointed out that the skull base is a fragile area subject to natural breakage, but the observation still remains that the human bone sample is taphonomically unusual.

The Ngandong crania (Fig. 2.6) were described by Weidenreich just before his death in 1948 (Weidenreich 1951). Like the earlier Javanese remains, they have been classified and reclassified so many times that I will merely say that most authors regard them as large-brained (the average of five skulls is 1,151 cubic centimeters: Holloway 1980) and late members of Homo erectus (Santa Luca 1980). A few, such as Wolpoff (1980:219), regard them as early sapiens on the grounds of a broadening of the upper braincase, but I think most would agree that they represent fairly direct descendants of the Trinil hominids. More hominid fragments have apparently been found recently at Ngandong (Jacob 1978b), and another cranium of Ngandong type (perhaps slightly more archaic) has been found in a river terrace deposit of Ngandong age at Sambungmacan, also on the middle Solo River (Sartono 1979c). In 1987 a new skull, again without facial features, was found at Ngawi, also on the Solo River (Sartono 1991). All are agreed that the “Solo Man” series is post-Trinil, but beyond this are major questions that fall loosely under the headings of context, environment, and date.

Concerning the context of the Ngandong remains, it is clear from Koenigswald’s accounts (1951, 1956) that the skulls were dispersed amongst other ani-
mal bones in what must once have been a quiet bank of sand and gravel, perhaps on the inside of a river bend. Perhaps they were washed there after being cannibalized in a nearby hunting camp; the presence of articulated vertebral columns of cattle could suggest animal butchery in the vicinity. However, if the cannibalism hypothesis is wrong (and there seems to be no very positive way of knowing this), then another idea might explain their predominance. Brain (1978) has noted the predominance of Australopithecine cranial remains over other body parts in the South African site of Swartkrans and describes for comparative purposes his observations of baboon remains left on the ground after cheetah kills. In these situations crania are left complete, together with some of the long bones, but more fragile items such as the vertebral column are completely destroyed. It could be suggested from this that the Ngandong crania and tibiae are the remains of carnivore kills (Java had a range of tigers, hyenas, and

Fig. 2.6 A reconstruction of the Ngandong cranial morphology. From Weidenreich 1951. Courtesy: American Museum of Natural History.
other smaller carnivores in this period). This view would tie in with the total absence of hearths and verified stone tools from the site; these would perhaps be expected if hominids were living close by.

A totally different suggestion to explain the predominance of skulls has been put forward by Santa Luca (1980), who favors the view that the animal bones form a primary deposit, but the skulls were washed out of an older deposit elsewhere and into the site, perhaps by river action. Bartstra and Basoeki (1989), on the other hand, state that the skulls are likely to be in primary position. It is clear that one could go on to ramify hypotheses about the Ngandong remains with no hope of being able to draw any useful conclusions. The answers now will only come from further scientific investigation of sites of the same period.

Concerning the environment of the Ngandong region, we are on firmer ground. The 25,000 animal bones belong to seventeen species (eighteen if one includes dubious Macaca; for lists see Koenigswald 1951; Medway 1972; Sartono 1976). Of these, twelve or thirteen are shared with the Trinil fauna, and the major post-Trinil additions appear to be more modern forms of pig and deer. The only wholly extinct genus is Stegodon. The fauna as a whole hints at a fairly open landscape and, as noted by Koenigswald, some of the buffalo had horns up to 2.25 meters wide, which would argue against the presence of dense forest. The majority of the bones were of deer and cattle (an ancestral banteng), both animals that are more numerous in open landscapes, although they do also occur in small numbers in the dense forests of Sundaland. In addition, one of Oppenoorth's assistants recovered a bone of a crane (Grus grus) from deposits considered to be of Ngandong age at a nearby location called Watualang (Wetmore 1940); this bird winters in southern China today and the bone's presence in Java could suggest a cooler climate than now.

It is with the date of the Ngandong remains that the most difficulty occurs. The fauna is always classed loosely as late Pleistocene, and the Ngandong terrace deposits certainly postdate the Kabuh beds of central Java (Sartono 1976). However, the fauna is of little help for more precise dating because it is not known when key genera, such as Stegodon, became extinct in Java. Recently the issue of the date of the Ngandong population has been brought into sharper focus with the publication of some provisional uranium/thorium dates on animal bones from the Solo terrace deposits by Bartstra, Soegondo, and Wijk (1988). The dates range from 40,000 to 100,000 years ago with increasing depth, and as the skulls came from the lower layers of the terrace, a date closer to 100,000 years ago seems likely. If the skulls are considerably less than 100,000 years old, then because of their archaic character the undeniable conclusion must be that they are representatives of an extinct sideline of human evolution. This was the stated view of Jacob (1979) and Birdsell (1972:319) and fits current views of a recent African origin for all anatomically modern humans. But on
this whole issue of continuity versus replacement, the battle lines are still drawn, as I will now indicate.¹

**D. Broader Perspectives on Javan *Homo erectus***

The big issue, of course, is that of whether or not Javan *Homo erectus* represents an extinct sideline of human evolution with no genetic transmission to living populations, or a partial ancestor for anatomically modern populations, especially the Australoids. Similar questions arise with *Homo erectus* in China. Two major paradigms currently enliven debate in biological anthropology: the “Out of Africa” (or “Garden of Eden”) and the Multiregional (Fig. 2.7). Alan Thorne and Milford Wolpoff (1992) are leading spokespersons for multiregional evolution on a worldwide basis, a paradigm originally formulated by scholars such as Weidenreich and Coon. Multiregional evolution claims that anatomically mod-

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¹ This text is a part of a larger discussion on the origins and evolution of modern humans. The diagram illustrates two models: the regional continuity model and the out-of-Africa replacement model, both of which are significant in the study of human evolution. The top diagram shows the Multiregional model, while the bottom diagram represents the Out of Africa model. The figure is a visual representation of how different regions have contributed to the evolution of modern humans. The arrows indicate the migration and continuity of populations.
ern humans across the Old World evolved from local *erectus* antecedents, with extensive gene flow maintaining species integrity and spreading advantageous mutations across the human range. Thorne and Wolpoff recognize clear morphological continuity, especially in facial prognathism and posterior tooth size, between the Javanese *erectus* population and certain later Australian *sapiens* remains of the terminal Pleistocene, particularly those from Kow Swamp in Victoria (Wolpoff et al. 1984; Thorne and Wolpoff 1981, 1992; Wolpoff et al. 1994).

The majority of Chinese paleoanthropologists hold a similar view of *erectus* to modern continuity for China (e.g., Wu Xinzhi 1996; see also Pope 1992). The major Chinese *erectus* fossils include the Lantian (Gongwangling) cranium (probably as much as 1.2 million years old; Howell 1994:265), which compares well with the earlier Javan material, and the famous Zhokoudian population dated between 580,000 and 230,000 years ago (Wu Rukang 1982). The hypothesis of multiregional evolution again claims that the Chinese remains lie morphologically in the line of descent of the modern Mongoloids without major interruption.

Since the first edition of this book was written, the hypothesis of multiregional evolution, which was widely popular in the early 1980s, has come under strong attack—not just by other paleoanthropologists, but also by geneticists. A large number of authorities now regard anatomically modern humans as having spread—perhaps from Africa—between 200,000 and 100,000 years ago, according to the genetic evidence derived from detailed studies of mitochondrial DNA (Cann et al. 1987; Wilson and Cann 1992; Rogers and Jorde 1995). These populations replaced *Homo erectus* everywhere in the process. The skeletal observation that Javan *Homo erectus* carries certain unique features (autapomorphies) that are not found in any anatomically modern humans also suggests to many paleoanthropologists that this regional clade cannot be the ancestor of the modern Australoids (Andrews 1984; Groves 1989; Rightmire 1990). Although there are suggestions that a middle-road explanation could be required, favoring radiation out of a restricted homeland combined with some degree of gene flow with preexisting populations (e.g., Bräuer 1992; Smith 1992; and Habgood 1992 for East Asia), the answers are not clear and we are still left with one of the big questions of the 1990s: Is *Homo erectus* an extinct species, or does it have living descendants?

In view of all this debate, one might ask if the author of this book has an opinion on the ultimate fate of Javan *Homo erectus*. In my opinion, it cannot be conclusively shown that the Javan hominids are totally extinct, with absolutely no transmission of genes to modern populations. There is still hope for Javan *Homo erectus* as a partial ancestor for the Australoids, but it is a highly qualified hope—I do not think it is a case of a 100 percent direct ancestry. Humans are migratory animals and it is unreasonable to assume that Java was so isolated
throughout the Pleistocene that its *erectus* inhabitants acquired reproductive barrier mechanisms to divide them biologically from the rest of the contemporary hominid population in Eurasia. Periods of mixing with new populations from the Asian mainland must surely have occurred from time to time. Perhaps we can only hope for a really convincing resolution of these issues in future genetic research on ancient bone, especially within the mitochondrial genome. Should anyone believe that these issues are going to be easily resolved, they should look at the great range of opinion presented in recent monographs on the general topic of anatomically modern human origins (e.g., Mellars and Stringer 1989; Bräuer and Smith 1992; Nitecki and Nitecki 1994). Virtually every reputable scholar, and there are many of them, has a different opinion.

III. *Homo erectus* in Southeast Asia: The Cultural Evidence

It is most unfortunate that all the hominid remains from Java have been found in situations of presumed secondary deposition, devoid of direct cultural context. Stone tools potentially flaked by *Homo erectus* do occur on the island, but never with human fossils and rarely in securely dated contexts; there are no unambiguous examples of “living floors” of the kind found in Africa and western Eurasia. The possibility arises that Javanese *Homo erectus*, unlike contemporary Africans and Chinese, did not make tools of stone. Such a situation would be unusual to say the least, and the evidence, which at present is quite vague, deserves careful consideration.

A. Squeezing Blood from Stones

First I wish to generalize a little about stone tools and to examine the data that can, in theory, be extracted from them. As Isaac (1977a) has pointed out, stone tools can be used in many ways: as markers of human antiquity, as indices of “progress,” as symptoms of cultural differentiation in time and place, and as indicators of economic organization. “However,” as Isaac has said, “we need to assess the limits to the amount of blood that can realistically be squeezed from these stones” (1977a:5). In practice, many assemblages of stone tools, particularly from earlier time periods, comprise bewildering arrays of overlapping and rather amorphous forms. Prehistoric artisans were rarely turning out models for blueprints, although it has to be assumed that there is some form and patterning in all assemblages. The major difficulty is to separate the meaningful information from the background noise.

Attempts have been made to record processes of manufacture and use of stone tools among peoples who have used them up to recent times, particularly
in Australia and New Guinea (e.g., Gould 1977, 1980; Hayden 1979). While many of these observations are particularistic, they do serve the essential function of bringing a healthy dose of reality into what was once a field of rather rambling typology. Similar reality is provided by edge-damage analyses based on controlled experiments and high-powered microscopy. The literature in both these fields is growing rapidly, and all basic field research on stone tool-bearing sites now has to take account of it. However, the spin-off has so far been restricted and it works best for new material analyzed by aware researchers. New material, in terms of the Southeast Asian subject matter that I am about to consider, is decidedly scarce for any period older than late Pleistocene.

The archaeologist may present data concerning a stone tool assemblage in a manner best outlined in Isaac's useful review (1977a). Technologically defined classes such as cores, flakes, chips, and retouched and shaped forms will first be identified and quantified. At this level the researcher is merely dealing with worked stone from a technological and stylistic viewpoint. The "tool" concept comes in when considering function; this is where the edge-damage research is relevant and is the level at which tools can best be separated from waste material. The moral here is that a piece of apparent waste may turn out to be a tool when the edge is examined (assuming that one can recognize true use wear from other forms of edge damage).

After both manufacturing and edge-damage variables have been quantified, the data can be considered as a whole to suggest the most meaningful overall divisions of the material. In the case of the middle Pleistocene sites at Olorgesailie in Kenya, Isaac (1977b) divided the material into shaped tools, unshaped tools, and unutilized waste. This type of classification, which combines variables of both form and function, cannot be applied easily to any Southeast Asian assemblage because the necessary basic information has rarely been recorded, although I will present some rather generalized observations of my own in due course.

The contents of the above diversion will be familiar to readers who have some background knowledge of archaeology. In my opinion this type of research is of extreme importance and renders much earlier work on stone tools of dubious value. This is sadly so when considering East and Southeast Asia. Earlier researchers here confused form and function by using such terms as chopper, point, scraper, and hand-axe, all of which imply specific activities. In many cases these assumptions may be perfectly right, but the problem is that it is generally impossible to verify whether they are right or wrong. The relevant assemblages were often superficially reported and are now spread in museums, some in quite inaccessible parts of the world. Available illustrations are often of poor quality and selective.
By now, the reader may grasp that I am tending strongly toward a negative view of the value of stone tools in Pleistocene research in East and Southeast Asia. Perhaps I can reinforce the negativism by pointing out that the above paragraphs have only discussed the stone tool assemblage per se. When considering problems of date and context, the situation becomes even worse; we quickly find ourselves in situations where we are trying to compare one researcher’s chopper with the scraper of another, knowing next to nothing of what the tool looks like, how old it is, or the context in which it was found. My own research has told me very clearly that what one researcher calls a middle Pleistocene chopper could well be a discarded waste core less than 10,000 years old.

In any case, the problems exist (e.g., Hutterer 1977), and it is pointless to lay blame. In this review, I am forced to use much of the terminology and the data as they have been published, although I will use my own experience of some of the material to follow a simple line where complexity is not warranted.

B. Pleistocene Stone Tool Industries of East Asia

The most important Indonesian industries that have been claimed as the handiwork of Homo erectus come from the Ngembong region of Sangiran, from Ngandong, and from riverine locations in south-central Java (the Pacitanian industry). Potential but problematic outliers occur in other parts of Sundaland and Peninsular Malaysia, in Sulawesi, in Flores and Timor, and in the Cagayan Valley of northern Luzon in the Philippines. These industries will be described in this chapter. Late Pleistocene industries of more specialized type that postdate 40,000 years ago are discussed separately in Chapter 6.

The Javanese Pacitanian industry belongs to a widespread group of “chopper/chopping-tool industries” that occur widely in Southeast Asia, China, and India and that have often been contrasted with the “hand-axe” (Acheulian) industries produced in western Eurasia and Africa during the time span of Homo erectus. This distinction has some statistical validity but it is not absolute; the Pacitanian does have hand-axe forms, as indeed do some Chinese and Korean industries (Yi and Clark 1983).

The South and East Asian industries were first described and compared in a comprehensive way by Movius, in a series of long papers (e.g. 1944, 1948, 1955) that have had a rather fundamental influence on all later work. Movius described a number of tool types made on pebbles, tabular chunks, or flakes. These he divided into bifacial and unifacial types: bifacial chopping tools and hand-axes, and unifacial hand-adzes, proto-hand-axes, and choppers and/or scrapers (Fig. 2.8). These definitions were rather intuitive, as Movius was aware, and with the passage of time they have proved too ambiguous for useful com-
Fig. 2.8 Some major tool forms of the Southeast Asian "chopper/chopping-tool" industries. After Movius 1944; Glover and Glover 1970.

parative purposes. Furthermore, it is clear that many authors have not used these terms as Movius intended, although his definitions were semantically precise (1955:261–262).

My own observations on these classificatory problems stem from my research on later Pleistocene and early Holocene industries, including the Hoabinhian of Peninsular Malaysia and contemporary industries in Borneo, Sulawesi, and the Moluccas. There seems little doubt that these all represent the handiwork of anatomically modern humans of the past 40,000 years. I have elsewhere (Bellwood 1978) referred to all of these industries, which are more fully described in Chapter 6, as "pebble and flake industries." In some remote parts of Southeast Asia they have continued in production into recent historical times, although new technologies did appear in certain regions during the late Pleistocene and Holocene.

Despite local idiosyncrasies that probably depend as much on raw material
as on varying skills, the Pleistocene pebble and flake industries of Southeast Asia and their Holocene survivals all share in common the production of:

a. Fairly heavy tools made by flaking the edges of riverine pebbles, large flakes, or quarried nuclei—these are normally called "pebble tools" in popular parlance and include most of Movius' categories. Variables such as edge length, edge position, edge angle, extent and position of surface flaking, and unmodified cortex all intergrade. The distinction between unifacial and bifacial working can often be used with profit, especially to isolate an interesting category of bifacial "hand-axes" in the Javanese Pacitanian (Fig. 2.9 a,b). Another useful distinction can perhaps be made with edge angles; the pebble tool forms that Movius defined as choppers, chopping tools and hand-axes tend to have fairly low edge angles, but his hand-adzes and scrapers seem to belong to a differentiable category of steep-edged, flat-based, and thick unifacial tools, usually with edge angles over 70° (see Fig. 2.8, Fig. 2.9c).

b. Smaller tools made on true flakes struck from cores (Fig. 2.9 e,f), or sometimes on small chunks of stone. These rarely have specific edge or shape characteristics and if they do not reveal clear patterns of retouch, they can only be separated from purely waste material by edge inspection.

c. Manufacturing waste—items not in categories a and b because they show no signs of post-manufacture retouch or usage. They include unutilized flakes, chips (flakelike pieces lacking bulbs of percussion, caused either by core smashing or flake breakage), shattered cores and chunks, and sometimes true discarded cores. The latter are often hard to recognize as true debitage because the removal of flakes causes edge shattering, which can easily be confused with use damage. The term "horsehoof core" (Fig. 2.9d) is used in Australian archaeology to describe one quite characteristic single-platform variant of this class, but there is often confusion as to whether these are to be considered as steep-edged tools or waste items; each example must be examined individually. Other core shapes are less distinctive, but spherical and conical trends in shape can often be observed.

The selection process in these industries is clearly for tool size and edge morphology; overall shape appears to be rather incidental, although shape, edge, and size often correlate to some degree. Common sense would suggest that there are at least two major tool classes: heavy tools with axelike or chopping functions, and tools with scraping and cutting functions. These functional categories do not correspond directly with categories a and b above, and any given stone tool could have served several different functions during its life.
Fig. 2.9 Pacitanian tool forms from Java: (a,b) hand axes; (c) steep-edged and flat-based tool; (d) "horsehoof" core; (e,f) flakes with signs of utilization. From Barststra 1976; Movius 1944. Courtesy: G-J. Barststra (a–d); Senckenberg Museum (e–f).

C. The Pleistocene Industries of China

Before turning to an examination of the Indo-Malaysian pebble and flake assemblages, I will look at the only area of East Asia where the cultural activities of *Homo erectus* are clearly documented. The Chinese material is reviewed in a number of selectively illustrated sources (Chang 1986; Aigner 1978a, 1978b,
1981; Atlas 1980; Jia 1980; Yi and Clark 1983; Chen and Olsen 1990; Olsen and Miller-Antonio 1992), and when these sources are combined it is clear that a lot of potentially detailed evidence is available.

Early Pleistocene sites in China (Fig. 2.10) are surrounded by considerable uncertainty with respect to date and association. The site of Yuanmou, which has produced some rather indeterminate stone tools and a suggestion for the use of fire, is perhaps of early Pleistocene antiquity. Another assemblage claimed to be of early Pleistocene age, again with traces of fire (here in the form of burnt bone), comes from Gehe locality 6053 (Xihoudou) in Shanxi, but Aigner (1978b: 194; see also Woo 1980:196) disputes the presence of true stone tools. Quite clearly, neither of these sites can be considered as unequivocal evidence for the presence of stone tools during the early Pleistocene in China. However, Howell (1994:265-266) accepts the stone tool assemblages from Lantian (Gongwangling) and the Nihewan Basin in northern China as of likely early Pleistocene antiquity. Several other sites, possibly early Pleistocene, are listed by Olsen and Miller-Antonio (1992; see also Huang et al. 1995).

Better material is reported from the middle Pleistocene of central China. Assemblages that may run from the middle into the late Pleistocene have been recovered from Gehe localities 6054 and 6055 and from Dingcun in Shanxi (Fig. 2.10). The major sites of this period occur in the caves at Zhoukoudian near Beijing, where one of the world's most famous populations of Homo erectus has been found in claimed association with evidence for the use of fire, although in this case the assertion has been disputed (Binford and Ho 1985; see Jia 1989 in reply), and the hunting of large mammals such as Pseudaxius, Megaloceros (both forms of deer), and rhinoceros. Artifacts include a range of possible bone and antler tools (Aigner 1978b:182) and by far the best documented sample of middle Pleistocene stone tools from any site in eastern Asia (Fig. 2.11). The industry appears to have a predominance of small retouched flake tools, together with larger pebble and core tools (including some bifacially flaked forms) and flaked stone balls ("bolas stones": Yi and Clark 1983). Dates for Zhoukoudian range from 230,000 to 580,000 years BP by the uranium/thorium, fission-track, and thermoluminescence methods (Wu Xinzhi 1996).

In southern China the evidence is not as prolific as that from the Yellow River region farther north, but an excellent middle Pleistocene assemblage of retouched flakes and core tools has been excavated at Guanyindong cave in Guizhou. They occur with animal bones from a fauna that includes Stegodon and Ailuropoda, clearly related to the Jetis and Trinil faunas of Java (Olsen and Miller-Antonio 1992:141-143; Howell 1994:269-270). Aigner (1978b:221) has pointed out that the southern industries mostly utilize flakes and that the heavy pebble and core elements tend to be lacking.
Fig. 2.10 Major fossil and archaeological sites of Pleistocene date in China and Southeast Asia.
Fig. 2.11 Stone tools from Zhokoudian (a–d), Gehe (e–g), and Dingcun (h, i): (a) bifacial pebble tool; (b, d) flat-based, steep-edged unifacial tools; (c) core; (e) bifacial core tool; (f) single-platform core; (g) utilized flake; (h) "hand axe"; (i) large retouched flake. From Movius 1944; Yi and Clark 1983. Courtesy: Institute of Vertebrate Paleontology (a–d); University of Chicago Press (e–i).
D. Stone Industries Possibly Made by *Homo erectus* in the Indo-Malaysian Archipelago

(for recent reviews see Allen 1991a; Reynolds 1993)

1. The Pacitanian

Tools of this industry (see Fig. 2.9) were first discovered by Koenigswald and Tweedie in 1935 in the bed of the Baksoko River near Pacitan, in south-central Java. Further investigations in 1938 by Terra, Chardin, and Movius led to characterization of the finds as part of the chopper/chopping-tool complex of Southeast Asia and to an assumption of a middle or late Pleistocene date. Further work was subsequently carried out by Heekeren (1972), who reclassified the material, reported on finds from adjacent valleys, and suggested that the tools were eroding from four implementiferous terraces in the Sunglon and Baksoko Valleys, with the oldest Baksoko material coming from about 15 to 20 meters above the streambed. However, the majority of the tools have been found in secondary positions in the modern streambeds, where they have become rolled and mixed with artifacts of apparent Neolithic provenance.

As described, the industry is made on silicified tuff (the best material), silicified limestone, and fossil wood. It comprises a range of category-a tools (see Section IIIB, above), including bifacial hand-axes and high-backed, steep-angled "scrapers," together with numerous flake tools and waste flakes, some of very large size (Mulvaney 1970). It is not essentially different from the late Pleistocene industries of Borneo, which I will be describing later, but there does appear to be a tendency toward large size. This may be due to collection bias; none of the finds represent contemporary and complete assemblages and it is not clear what the total size range of the material was at any one time.

The most recent work on the Pacitanian has been carried out by Bartstra (1976, 1978a, 1978b; Bartstra and Basoeki 1989). He points out, after exhaustive geomorphological reconnaissance, that alluvial gravels lacking fossils extend up the valley sides to heights of up to 28 meters above the streambeds, but due to slumping and colluvial movement it is not possible to correlate terrace remnants or to recognize individual terraces. Tools are occasionally found in situ up to high gravel levels, and earliest dates according to Bartstra could fall around the middle to late Pleistocene boundary. Bartstra's basic view is that the material could cover quite a long time span indeed, but it is most probably associated with *Homo sapiens* rather than *H. erectus*.

2. The Sangiran Flake Industry

In 1934, von Koenigswald found some small rolled and patinated flakes of jasper and chalcedony in the Sangiran dome and started a controversy that still continues today. His claim (stated in Koenigswald and Ghosh 1973) was always
that the tools originally came from the Notopuro beds—a sequence of volcanic breccias and tuffs that overlie and rest unconformably on the Kabuh layers at Sangiran. These volcanic layers are about 20 meters thick and predate the Ngandong terraces and hominids. They are undoubtedly middle Pleistocene.

The main problem, as Koenigswald admitted, is that the tools were all found on the surface or in superficial layers and the assumption that they originated in the Notopuro beds remains impossible to prove. There has been much disagreement over this in the past. Heekeen (1972:49) claimed that the tools originated from the basal Notopuro, but Bartstra (1974, 1978b; Bartstra and Bassoeki 1989) believes the tools are all from recent colluvial and alluvial deposits and cannot be shown to be from the Notopuro beds at all. He suggests an early late Pleistocene antiquity. Furthermore, Bartstra points out that many of the “tools” are no more than nodules of jasper and chalcedony that occur naturally in the area, although there seems little doubt that the rudiments of a genuine assemblage do exist amongst the collections.

The Sangiran industry from these surface sites consists of tools that are very small, well below the average size of the Pacitanian. They comprise small flakes, some with apparent retouch, but little else—the absence of cores and large pebble tools is most unusual. But there are some definite flake tools, including a class of “small bevel-edged flakes” described by Orchiston (1978).

Recently the Sangiran Flake Industry has been brought back into the limelight by the excavation of a few presumed stone artifacts related to this industry stratified in Kabuh deposits between 4.5 and 9 meters above the Grenzbank at Ngebung, in the northwestern part of the Sangiran dome (Fig. 1.10). These deposits are thus of early middle Pleistocene date. The stone items include two small cores, fifteen flakes, and two blades (Sëmah et al. 1992; Simanjuntak and Sëmah 1996; see also Soejono 1982a for earlier finds at Ngebung), and there are also references to bolas stones and a quartz hammer stone. If the claims are sustained, then the question, “Did Javan Homo erectus make stone tools?” might, after all, be answerable in the affirmative. The evidence is small, but I see no reason to doubt its authenticity.

3. The Ngandong Industry

Material associated with the Ngandong fossils, excavated between 1931 and 1933, is sparse and problematical. According to Koenigswald (1951:216), “a few small stone scrapers and some triangular chalcedony flakes were observed, but they have disappeared from our collection.” Later commentators, such as Sartono (1976), Bartstra et al. (1976), and Jacob (1978b), seem unwilling to accept that any tools were found in direct association with the fossils at all.

Nevertheless, one of the original investigators, Oppenooth (1936; see also Stein Callenfels 1936c), was considerably more enthusiastic. He reported work 1
bone and antler from the general vicinity of the skulls, together with stone balls of andesite apparently similar to those mentioned above from Zhoukoudian. He also found a spine of a marine stingray close to skull VI. However, according to a geological section presented by Sartono (1976, after Ter Haar), all these items were found in superficial layers of the terrace—above the skulls—except perhaps for the bone tools, which have always remained rather dubious. Oppennoorth did find other tools in terrace deposits in other parts of the Ngandong region: more stone balls at Watualang, a beautiful biserial bone harpoon from Sidorejo, and some chalcedony flakes from the surface at Ngawi (are these the ones mentioned by Koenigswald above?). But none of these items can really be claimed as the handiwork of Ngandong Homo erectus; all may be much more recent, particularly the harpoon (which was originally compared with Magdalenian harpoons from Europe).

This rather sad and confusing story could have a happy ending, given the claim by Jacob et al. (1978) that two unrolled tools of basaltic andesite—a well-made unifacial pebble “chopper” and a retouched flake—have been found in a late middle or late Pleistocene gravel deposit at Sambungmacan approximately contemporary with the layer that yielded the skull of a late specimen of Homo erectus. The tools appear to be genuine and it may not be unreasonable to claim that the late erectus population of Java also made stone tools, like its possible forebears at Ngembung.

4. Cabenge, Southwestern Sulawesi

In Chapter 1, Section IVA, I referred to an important late Pliocene faunal collection made in the region of Cabenge in the Walanae Valley. From 1947 onward, stone tools have been found in apparent association with these bones, and several authors (e.g. Heekeren 1972:69) have considered them contemporary. Recent geological work has disproved this, however; the tools come from coarse river sediments of presumed but indeterminate Pleistocene age (Sartono 1979a), and the animal bones that occur in these deposits have probably been washed in from older formations (Bartstra 1978c).

Nevertheless, Bartstra (1978c) does note that the patinated tools found in the highest terrace gravels are rather different from the tools of Toalian type found closer to the river; the latter are of undoubted Holocene date (see Chapter 6, Section III B), and the former may be assumed to be older. In a recent paper, Bartstra et al. (1991–1992) suggest that the tools are probably the work of Homo sapiens rather than Homo erectus. Heekeren describes the tools as small thick flakes struck from irregular cores and refers to a range of scrapers and chopping tools. Soejono (1982a) also mentions massive core tools, hand-axes and horse-hoof cores.
5. Flores, Timor, and Luzon

In Chapter 1, Section IVA, I discussed the significance of the occurrence of two species of Stegodon, one of normal size and one dwarfed, on a number of eastern Indonesian islands including Flores and Timor. Archaeological interest in this situation was aroused in 1970 when Maringer and Verhoven (1970a and b) published their results of investigations on Flores. In one region called Mengeruda they claimed to have found stone tools in association with Stegodon bones in scattered exposures in an area about 3 kilometers long. They described a variety of pebble tools, retouched flakes, and one small bifacial hand-axe. Generalized affinities were drawn with the Pacitanian, Sangiran, and Cabenge industries and the suggestion was made that contemporaries of the Ngandong hominids may have been able to venture along the Lesser Sunda chain.

In 1991–1992 an Indonesian-Dutch expedition reexamined the sites visited by Maringer and Verhoven on Flores and excavated more stone tools from a location near Mata Menge (van den Bergh et al. 1996a). The tools, flakes of chert and basalt, are few but are claimed to be of definite human handiwork and to come from just above a paleomagnetic reversal recorded in a paleosol. This reversal is believed to represent the Matayama-Brunhes boundary at ca. 700,000 years ago. Bones of the large Stegodon trigonocephalus and a giant rat occur in the same layer. Nearby, at Tangi Talo, an older deposit has yielded bones of a pygmy Stegodon, a large tortoise, and Varanus komodoensis—the Komodo dragon—but no stone tools. These finds, newly announced, are exciting indeed and suggest a possible presence of middle Pleistocene Homo erectus within “striking distance” of the Australian continent.

For the other Lesser Sunda Islands and Moluccas there are still no such strong claims for middle Pleistocene tools. Surface finds of “Lower Palaeolithic” type have been reported from many islands, from Lombok in the west (Soejono 1987) through Sumbawa (Soejono 1982a) to Timor in the east (Glover and Glover 1970; Maringer and Verschuuren 1981; Aziz 1981), but stratigraphic contexts are still lacking. The oldest Moluccan industries, to be detailed further in Chapter 6, are contemporary with anatomically modern humans. Similar problems apply to a claimed middle Pleistocene industry from the Cagayan Valley in northern Luzon, Philippines. A genuinely early or middle Pleistocene fauna occurs in deposits exposed in this valley, but as Wasson and Cochrane (1979) note, the stone tools once claimed to be in association with the fauna are probably not; they note also that the industry is quite closely paralleled in terminal Pleistocene and Holocene cave deposits in the area. Pebble tools, horsehoof cores, and retouched flakes are the major forms represented.
6. Peninsular Malaysia

I will close this listing of the Indo-Malaysian stone industries having claimed associations with *Homo erectus* by referring briefly to the "Tampanian" tools recovered from gravels in the Perak Valley of Peninsular Malaysia. In the principal report published by Walker and Sieveking (1962), the tools—which have certain affinities with the Pacitianian—were linked to high sea level alluvial terrace deposits of early or middle Pleistocene ("First Interglacial") date. However, a number of widely held views on the Tampanian were rudely shaken in 1975, when Verstappen (1975:26–27) pointed out that the "terraces" were better regarded as wash and colluvial deposits formed in a tree-savanna landscape during drier glacial periods. In the same year, Harrisson (1975a) suggested younger affiliations for the tools by attempting to associate them with an overlying late Pleistocene ash shower from the Toba eruption in Sumatra.

Recent work at Kota Tampan by Zuraina Majid (1990) supports Harrisson's view and suggests that the site served as a flaking floor. Majid has related the site to a date of ca. 30,000 years ago based on earlier assessments of the age of the Toba eruption, but new dates for this event suggest an age of perhaps 75,000 years (Chesner et al. 1991). Whatever the final decision on age, the tools appear to be the handiwork of anatomically modern humans; they will be discussed in more detail in Chapter 6.

IV. SOME CONCLUSIONS ON "EARLY" INDUSTRIES

When the first edition of this book was published in 1985, none of the Indo-Malaysian industries described occurred in dated or even well-stratified contexts. The situation remains similar today, but in my view the newly excavated discoveries at Ngebung in Java and Mata Menge in Flores hold great promise. They may indeed be the handiwork of middle Pleistocene *Homo erectus* if all claims for these sites are upheld. Having Javan *erectus* as a toolmaker, however, does not *necessarily* save this species from the fate of extinction, since other even more evolved hominids such as the Neanderthals also made stone tools and are considered extinct by many modern authorities. Because the sites are few and the gaps in chronology are long, we still have much to learn.