

Early Upper Paleolithic Man and Late Middle Paleolithic Tools

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The appearance of anatomically modern Homo sapiens in Europe, the Near East, and Africa must represent either an in situ evolution of Neandertals or a migration. Those who suggest the latter claim a sudden replacement of Neandertals by anatomically modern Homo sapiens. However, the "evidence" actually cited claims only the sudden replacement of Middle by Upper Paleolithic industries. We criticize the migration explanation on two grounds. (1) There is no "sudden replacement" of Middle Paleolithic by Upper Paleolithic industries, but rather a gradual change in the frequencies of already present tools. Numerous sites in these areas exhibit transitional industries. (2) Concomitantly, there is no morphological evidence indicating a "sudden replacement" of hominids. There is no absolute association between anatomically modern Homo sapiens and Upper Paleolithic industries. Instead, the evidence clearly shows that early anatomically modern Homo sapiens is a late Middle Paleolithic local phenomenon.

THE RELATIONSHIP of Neandertals to *Homo sapiens* has always been of great interest to anthropologists. This work seeks to examine one hypothesis concerning the origin of anatomically modern *H. sapiens*, and to test the implications of this hypothesis against the archaeological and palaeontological record.

By "Neandertals," we refer to all hominid specimens dated within the time span from the end of Riss to the appearance of anatomically modern *H. sapiens*. Applying the term in this way is not unique to this work. Numerous authors have referred to this set of specimens as "Neandertaloid," "Neanderthalian," "Paleoanthropinae," and so on. In fact, this usage is synonymous in content with the "Neandertal Peoples" referred to by Howell (1957:342 and Fig. 4). The specimens are identical, and include the often disputed remains from Fontchevade—again following Howell (Ibid. 341-342). Grouping the specimens in this way can be justified on two grounds. First, there is a gap between this group and *H. erectus*. This gap is temporal, rather than morphological, and is probably the result of sampling accidents. Nevertheless, there are only a very few specimens spanning the time from the well-

represented *H. erectus* populations at terminal Mindel to the beginning of Riss. With the discovery of additional specimens from this period, the temporal gap will close, as the morphological and archaeological gap has already done. Second, there is a general unity of grade among the specimens so referred. Neandertals evince crania expanded to modern size and posterior teeth reduced to modern size, along with anterior teeth and supporting facial architecture maintained in the very robust *H. erectus* condition (Brace 1967a, 1968; Wolpoff 1969, 1971). In most cases, this morphological pattern separates Neandertals from groups occupying the same areas before as well as after them.

We distinguish this usage from the more restricted term: "classic" Neandertals. The latter refers only to the people who inhabited Western and Southern Europe from the beginning of Wurm to the appearance of anatomically modern *H. sapiens* (Howell 1952, 1957; Breitingner 1955; Howells 1967; Le Gros Clark 1964; Hooton 1947; and many others). Thus, an important distinction is maintained throughout this work. The total group referred to as Neandertal consists of two smaller and mutually exclusive groups:

“classic,” and “non-classic.” The distinction is crucial to the case we make, because almost every statement made concerning Neandertal morphology, variation, archaeology, and evolution will, when applicable, be shown to apply to both “classic” and “non-classic” groups. Following a technique used by Howells (1967:190, footnote), the two Neandertal subgroups are also explicitly defined by listing included specimens.

Evidence of hominid morphology, culture, and stratigraphy has been used to substantiate or reject any number of hypotheses concerned with the relationship of Neandertals to anatomically modern *H. sapiens*. One of the earliest hypotheses suggests the sudden replacement of Neandertals by a more modern taxon: anatomically modern *H. sapiens*. A close examination of the “sudden replacement” hypothesis indicates that the claim was established for tools, and not for hominids. For instance, as recently as 1966 Le Gros Clark stated:

At the end of the Mousterian phase of paleolithic culture, the Neandertal inhabitants of Europe were abruptly replaced by people of completely modern European type. There is reason to suppose that this new population, the Aurignacians, having developed their distinctive culture elsewhere, probably in Asia, migrated into Europe and, with their superior social organization, quickly displaced Mousterian man and occupied his territory [1966:116-117].

ABSOLUTE DATES OF LATE NEANDERTALS AND EARLY ANATOMICALLY MODERN *HOMO SAPIENS*

In actuality, the extent of the hiatus measured between the radiocarbon dates of the youngest clearly defined Neandertal and the oldest clearly defined anatomically modern *H. sapiens* specimens is not known with any certainty. Radiocarbon dates for this period of human evolution are neither extensive (Brace 1964; Oakley 1966) nor exceptionally accurate (Butzer 1964). The faunal connections between levels at the same site, let alone between sites, are more often than not incorrect (Kurten 1968). For

these reasons, only dates taken from the actual strata where hominid specimens have been found can be used. Even so, the methodology of many earlier investigators, and the possibility of burial, leave even this association of dates with specimens subject to doubt.

The youngest dates directly associated with Neandertals (A2 dates according to Oakley 1966:7) come from three sources: Haua Fteah Layer XXXIII (McBurney 1967) with mandibles I and II has a date of $40,000 \pm 500$ BP; Tabun Layer C is dated at $40,900 \pm 1000$ BP and Layer B at $39,700 \pm 800$ BP (Oakley 1966); La Quina Level H1 is dated at $35,250 \pm 530$ BP (Oakley 1966). There is some question concerning the validity of the La Quina date as representing a late Neandertal. The hominid from Level H1 at La Quina is #14. This subject is represented by the posterior-inferior section of a left parietal (Henri-Martin 1923:242). The individual represented was a juvenile, and the level has a “final Mousterian” industry. A fragment of this size and age cannot be clearly categorized as either Neandertal or anatomically modern *H. sapiens* (Piveteau 1967). Even if the association with the date is good, we do not know what type of hominid is thus dated.

The earliest dated specimens of anatomically modern *H. sapiens* come from the Pavlovian burials at Dolni Vestonice ($25,820 \pm 180$ BP) and Pavlov ($26,620 \pm 260$), according to Oakley (1966). An earlier date has been claimed for the Niah cave specimen (Harrison 1959). However, this specimen represents a burial (Harrison 1964:526), and the date does not even come from the level where the specimen was found, but rather was taken in a “corresponding” area (Ibid.:526). Without further substantiation, the association of this crucial date with the specimen cannot be unequivocally accepted (see Fitting 1969:351).

With so few dates from this important period, it is difficult to draw well substantiated conclusions from the evidence available. It is interesting that even these few dates from widely scattered areas indicate

Neandertals precede anatomically modern *H. sapiens*. In no instance do either relative stratigraphies or absolute dates indicate anatomically modern *H. sapiens* contemporary with or preceding Neandertals in any area as would have to be the case if the former evolved somewhere separately and then "suddenly replaced" Neandertals all over the world.

MIDDLE PALEOLITHIC INDUSTRIES

Not only do the hominids show a specific sequence and temporal separation, but industries do also. Classically, the Wurm I/II interstadial is said to separate Middle and Upper Paleolithic industries. Wurm I/II is here used in the most standard sense rather than as in the more restricted French terminology where this period is known as Wurm II/III. This general time period has been called Gottweiger (although the type site seems to be Eemian): Paudorf; Arcy; Laufen; Rixdorf; Stillfried B; Molga-Sheksna; Hengelo-Denekamp; Bryansk; Odderade; or Aurignacian interstadial. While Pleistocene sequences in Europe have not been completely worked out, and while stratigraphic correlations are still uncertain, we might quote from one of the most recent geological monographs to the effect that

(of the last glaciation) the Middle Wurm which covers the time between 53,000 BP and 25,000 BP is the part of which not very much is known. While some authors assume the existence of the "Gottweig Interstadial" others deny the possibility of a *notable* interstadial (in central Europe). Certainly the Middle Wurm was not a continuous cold time without any temperature oscillation, but one has to suppose the existence of cooler and warmer periods and of corresponding advances and retreats of the ice sheets. [Woldstedt:1967; italics added].

Most prehistoric archaeologists and quaternary geologists have found evidence for a warmer period of interstadial magnitude, during the Middle Wurm (Flint 1957:381-412; Alimen 1967:211; de Jong 1967:359; Bordes 1968:147; Kurten 1968:20ff; Basten 1969:3-11; Grazzini and

Rosenberg 1969:279-92; Zubakov 1969:Table Z). While the exact dates of these warm periods are not precisely fixed all seem to have occurred some time after 38,000 BP and were concluded by the outset of extremely cold glacial conditions some time after 28,000 BP. It is this "interstadial" which we are using as a temporal horizon in this paper.

Wherever continuous archaeological sequences spanning this period are clear there seems to be no overlap or obviously rapid replacement, but rather a gradual transition from late Middle Paleolithic to early Upper Paleolithic industries. This can be seen in a number of ways. The relative frequencies of various types of stone tools which characterize the Middle and Upper Paleolithic do not display sudden or dramatic changes during the Wurm I to Wurm II period or its geographical equivalent.

Most of the tool types which are considered characteristic of the Upper Paleolithic are present (albeit in lower frequencies) in late Middle Paleolithic assemblages.

The evidence on which the validity of this statement rests is presented by geographic area in the body of this paper. Numerous examples of supposedly characteristic Upper Paleolithic tool types (described by excavators intimately acquainted with the material) are seen in what can only be regarded as Middle Paleolithic assemblages. One way of visualizing this evidence is simply to list the common Upper Paleolithic tool types (as described by DeSonneville-Bordes and Perrot 1953) and note the extensive and repeated occurrences in a Middle Paleolithic context (see Table I). The occurrences identified in Table I are based on both functional and morphological analogies.

In other words, the variation between these tool types occurring at Middle Paleolithic and Upper Paleolithic sites is no greater than the variation among the tool types at Upper Paleolithic sites alone. Purely stylistic variation in functionally similar chipped stone tools has only rarely been identified by Paleolithic archaeologists.

TABLE I. PARTIAL LIST OF UPPER PALEOLITHIC TOOLS (STANDARD LIST)
IN MIDDLE PALEOLITHIC CONTEXTS*

<i>Number</i>	<i>Standard Type</i>	<i>Middle Paleolithic Occurrences</i>
1.	Simple end scraper	La Quina; Arcy-sur-Cure; Šipka Cave; Külna Cave; Haua Fteah; Ordos
2.	Atypical end scraper	Repolust Cave; Weimar; Skhul
3.	Double end scraper	Peche de l'Aze (lower layers)
4.	Ogival end scraper	Repolust Cave; Skhul; Ordos
5.	End scraper on retouched blade or flake	Šipka Cave; Külna Cave; Haua Fteah
6.	End scraper on Aurignacian blade	La Chapelle-aux-Saints; Haua Fteah
7.	Fan shaped end scraper	Ordos; Kokkinopilos
8.	Scraper on flake	All sites
9.	Round or circular scraper	Arcy-sur-Cure; Šipka Cave; Weimar
10.	Thumbnail scraper	Peche de l'Aze
11.	Carinated scraper	La Chapelle-aux-Saints; Repolust Cave; Haua Fteah
12.	Atypical carinated scraper	La Chapelle-aux-Saints; Haua Fteah; Ordos
13.	Thick-nosed scraper	Krapina; Repolust Cave; Weimar; Haua Fteah; Quafzeh (E)
14.	Flat-nosed or shouldered scraper	Šipka Cave; Külna Cave; Weimar; Ordos
15.	Core scraper	Šipka Cave; Külna Cave; Weimar; Ordos
16.	Plane (rabot)	
17.	Scraper-graver	
18.	Scraper-truncated blade	El Wad (F)
19.	Graver-truncated blade	Škhul; Ordos
20.	Borer-truncated blade	Sipka Cave; Weimar; Peche de l'Aze II
21.	Borer-scraper	
22.	Borer-graver	
23.	Borer	Külna Cave; Šipka Cave; Weimar; El Wad; Ordos
24.	Atypical borer or beak	Arcy-sur-Cure; Ordos
25.	Multiple borer or beak	
26.	Micro-borer	Haua Fteah; Peche de l'Aze
27.	Straight dihedral graver	Arcy-sur-Cure; Krapina; Peche de l'Aze II
28.	Lopsided dihedral graver	Krapina
29.	Angle dihedral graver	Ordos
30.	Angle dihedral graver on broken blade or flake	Skhul; Abou-Sif
31.	Multiple dihedral graver	Peche de l'Aze II
32.	Busked graver	Quafzeh (E)
33.	Parrot-beak graver	Krapina; Weimar; Haua Fteah
34.	Graver on straight truncation	Arcy-sur-Cure
35.	Graver on oblique truncation	Repolust Cave; Ordos
36.	Graver on concave truncation	
37.	Graver on convex truncation	Krapina
38.	Transverse graver on lateral re-touch	Tabun (B)
39.	Transverse graver on notch	
40.	Multiple graver on truncation	
41.	Mixed multiple graver	
42.	Noailles graver	
43.	Graver on core	Arcy-sur-Cure; Repolust Cave; Weimar; Ordos
44.	Flat graver	Kokkinopilos
45.	Audi knife	Abri Audi; La Quina; Regourdou
46.	Chatelperron point	Haua Fteah; Quafzeh; Ksar Akil; Peche de l'Aze
47.	Atypical Chatelperron point	Haua Fteah
48.	Gravette point	

*References by geographical area in text.

TABLE I. PARTIAL LIST OF UPPER PALEOLITHIC TOOLS (STANDARD LIST)
IN MIDDLE PALEOLITHIC CONTEXTS* (Continued)

<i>Number</i>	<i>Standard Type</i>	<i>Middle Paleolithic Occurrences</i>
49.	Atypical Gravette point	
50.	Micro gravette	Haua Fteah
51.	Vachos point	
52.	Fort-Yves point	
53.	Humped pieces	All sites
54.	Flechette (dart)	Ksar Akil
55.	Tanged point	Krapina; Haua Fteah; Emireh; Quafzeh
56.	Atypical shouldered Perigoidean point	
57.	Shouldered piece	Haua Fteah
58.	Blade with continuous retouch	Arcy-sur-Cure; Abou-Sif; La Chapelle-aux-Saints; Peche de l'Aze; Kiik-koba; Molodova; Haua Fteah
59.	Blade with non-continuous retouch	Arcy-sur-Cure; Starosele; Molodova; Haua Fteah; Abou-Sif
60.	Piece with straight truncation	Krapina; Weimar; Ordos
61.	Piece with oblique truncation	Ordos
62.	Piece with concave truncation	Haua Fteah
63.	Piece with convex truncation	Haua Fteah; Ordos
64.	Piece with double truncation	
65.	Blade with continuous retouch on one edge	Nietoperzowa Cave; Molodova; Haua Fteah; Ordos; Quafzeh (E); Tabun
66.	Blade with continuous retouch on both edges	Starosel'e; Ksar Akil; Ordos; Peche de l'Aze
67.	Aurignacian blade	La Chapelle-aux-Saints; Kiik-koba; Tabun (B)
68.	Notched or strangled blade	Haua Fteah
69.	Point with plane face (Solutrean)	Sipka Cave; Kulna Cave; Lovas Cave; Krapina; Nietoperzowa Cave; Weimar; Salzgitter
70.	Laurel Leaf Point (Solutrean)	Lovas Cave; Krapina; Weimar; Salzgitter; Mauren Cave

*References by geographical area in text.

There is, however, considerable variation among the various Middle Paleolithic assemblages in the morphology of what are regarded as functionally equivalent tools, just as there is variation among the same "type" of tool found in the numerous Upper Paleolithic industries. Indeed there is a surprising amount of variation within any Middle or Upper Paleolithic assemblage in terms of the morphology of any "functional" tool type (viz. Bordes 1969). The definition of Paleolithic tool types generally depends on their function, as inferred from their morphology, rather than on their method of production (Bordes 1969:1-4).

The gradual frequency changes between Middle and Upper Paleolithic industries demonstrated here are based on such tool type identifications, made by those workers per-

sonally familiar with the material; in addition, we have also attempted to document the gradual changes in production techniques, an important, but separate problem. If we were unwilling to classify morphologically and functionally similar tools as members of the same general category, we would face the reductio that follows when we recognize that every individual chipped-stone tool is in some way different than every other chipped-stone tool in the world.

These considerations are readily apparent in the works of many authors with first hand knowledge of the technologies. For instance, Movius (1969:122) has noted for central France, the "Maginot Line" of the purported invasion, that:

The Chatelperronian of the Grotte du Renne at Arcy-sur-Cure gives the impres-

sion of an assemblage which basically remains Middle Paleolithic on evidence of the majority of the flint tools, but is Upper Paleolithic in terms of the technology and style of the pieces.

The variations in relative frequency which do occur in the period from Wurm I to Wurm II seem no greater than differences between what Bordes has demonstrated (1955, 1961, 1963) to be several contemporaneous Mousterian facies in a single geographic area. The same situation seems also to exist in Eastern Europe (Klein 1969:262-264).

At the same time artifacts considered "typical" of the Middle Paleolithic continue with diminished frequency well into late Upper Paleolithic assemblages. Because of this fact industries or assemblages which can be considered "transitional" between Middle and Upper Paleolithic may or may not be segregated from the continuum, as the investigator's theoretical viewpoint dictates. This situation seems to occur in all areas of the Old World.

Throughout the following discussion of lithic assemblages problems of taxonomic nomenclature occur. In attempting to demonstrate the variability of these industries, the question constantly arises as to whether some particular manifestation should be properly considered Middle Paleolithic. Several solutions present themselves. First, all the assemblages discussed have been called Middle Paleolithic, or the equivalent, by the original investigators; an assignment which never has been seriously questioned. Second, these assemblages occur in a stratigraphic context indicating deposition no earlier than late Riss or Riss/Wurm, and no later than the end of those Middle Wurm "interstadial" oscillations which began about 38,000 BP.

Finally, most if not all of these lithic assemblages, although displaying great internal variability, display some degree of uniformity in terms of some proportion of the manufacturing techniques employed, or some of the tools produced. That is, typologically, as well as chronologically and *authoritatively*, the industries discussed here-

in may all be justifiably considered Middle Paleolithic.

Western Europe

The common Middle Paleolithic industries of Western Europe are termed Mousterian. Bordes (1953, 1961) has clearly shown that this is not a homogeneous lithic assemblage but rather a number of facies each of which contains more or less the same types of tools but in quite different frequencies. The differences between these Mousterian facies are not chronological but rather seem to be functional (Binford and Binford 1966, 1969). In all of these assemblages numerous tool types occur which are generally considered characteristic of the early Upper Paleolithic (DeSonneville-Bordes 1963). In conjunction with Table I, it is significant that out of the standard list of sixty-two Lower and Middle Paleolithic tool types (Bordes 1953, 1955, 1961), over twenty-five percent (nos. 30-39, 42, 44, 52-54, 57, 63) are also characteristic of the Upper Paleolithic assemblages where they appear in relatively high frequency. Even in good Mousterian contexts these "Upper Paleolithic" end scrapers, burins, graters, and backed blades may comprise a significant proportion of the tools. At Le Moustier they comprise twelve percent of the total lithic assemblage. At Pech-de-l'Aze (Level 4) they approach twenty percent of the total assemblage (Vandermeersch 1965). At La Chappelle-aux-Saints the industry is characterized as LaQuina Mousterian within which there existed a number of "Aurignacian" elements such as thin retouched blades, carinated end scrapers, and long, possibly pressure-flaked blades (Bardon and Bouyssonie 1908).

Bordes (1961:810) has noted that "in some Mousterian assemblages blades comprise up to forty percent of the debitage." In this quotation, Bordes did not specify the type of blades referred to. "Blade" is generally defined as any flake the length of which is greater than twice its width or as a long, thin, parallel-sided flake. Blades can be more

precisely defined by their method of manufacture: either soft-hammer direct percussion, hard-hammer direct percussion, indirect percussion (punched), or pressure-flaked. Any of these may or may not have been struck from prepared cores of various types (Jelinek 1965). All of these production techniques have been employed with differing frequency in both Middle and Upper Paleolithic industries (Bordes 1968:242). No single archaeological assemblage regularly displays all of these techniques. While the presence of some sorts of blades, or tools made on blades, is quite common at Upper Paleolithic sites, there are numerous Upper Paleolithic examples where functionally similar tools do not appear to have been produced by any particular "blade" techniques. Conversely, there are Middle Paleolithic sites which show the presence of blades produced by all of these techniques. If confusion is to be avoided, terms like "Mousterian Blades" and "Upper Paleolithic Blades" must be replaced by the well-defined descriptive terms based on methods of production or by detailed metric analyses of blade morphology.

Bone tools, long considered the *sine qua non* of the Upper Paleolithic also occur with some consistency at numerous Mousterian sites. In some cases these Middle Paleolithic bone tools appear morphologically and functionally indistinguishable from some Upper Paleolithic bone tool types (e.g., the bevel-base points from the Perigordian levels at Arcy-sur-Cure are identical to bevel-base bone points from the lower Middle Paleolithic layers [LeRoi-Gourhan 1961; Bordes 1968]; numerous other examples are cited in the Eastern Europe section). More important is the fact that no two Upper Paleolithic "cultures" or "traditions" have the same kinds of bone tools. Indeed the sequent stages of a single Upper Paleolithic "culture" are frequently defined by morphological changes in bone tools. Because of the stylistic dissimilarity of bone artifacts throughout the Upper Paleolithic the traditional viewpoint had considered the presence of any type of well-made bone tool in any

frequency as an indication of Upper Paleolithic affinity (Oakley 1962:27, 93-98; Burkitt 1963:79; Braidwood 1966:80). While Collie's statement (1928:50) that bone tools, as such, first appear in the Aurignacian, is not the latest word on the subject, it still appears reasonable to many. It is to this hypothesis we have addressed our arguments.

At Gibraltar Dorothy Garrod recovered two fragmentary bone artifacts either of which may have been points (1928:50, Fig. 6). Henri-Martin (1923:Figs. 4, 8) noted the presence of a number of bone implements in the upper levels of Al Quina. In England the Pin Hole cave contained a large number of ulnar bones awls and polished split bone points from both Middle Paleolithic and Aurignacian levels (Kitching 1963). At Arcy-sur-Cure LeRoi-Gourhan (1961:1-16) has excavated a "post-Mousterian" Mousterian level containing bevel-base bone points associated with a denticulate-looking Mousterian industry containing backed blades and burins. Movius (1969:112) has recently characterized the deposits from the Grotte du Renne at Arcy-sur-Cure as definitive evidence for the continuity between Mousterian and Chatelperronian.

In addition to the Chatelperronian at Arcy-sur-Cure, numerous other western European sites evince this transitional industry. A partial list of these sites includes Chatelperron, Combe Capelle, Les Cottés, La Ferrassie (E), Cueva Morin, Trou de la Chevre, Roc de Combe (Lot), Grotte d'Fees, and Reclau-Viver (De Sonneville-Bordes 1963; Freeman and Echegaray 1970; Bordes 1968; Pradel 1966). As Bordes has recently observed, "it becomes more and more difficult to avoid the conclusion that this lower Perigordian is derived from a local development of an Acheulean-tradition Mousterian" (1968:148).

As early as 1956 Bordes noted the lack of any real hiatus between the Middle and Upper Paleolithic and stated that the Lower Perigordian represented a typologically traditional industry in western Europe. He also claimed that the hiatus between Mousterian

and Aurignacian was less evident than imagined (1958:176-179). Indeed, Pradel's excavations at Les Cottés (Bordes 1968:150-153) and Le Fontenioux (Bordes, personal communication) seem to demonstrate the development of the Upper Perigordian from the Lower Perigordian, and Bordes has seen characteristic Aurignacian tool types in the La Quina Mousterian (1968:155-156) although he feels the centers of the Aurignacian development were not in southwestern France. More recently Movius (1969:117) has discussed this period and noted clear stylistic continuities between the Lower Perigordian and the Early Aurignacian.

Eastern Europe

The Middle Paleolithic industries of Eastern Europe cover a much larger geographical area than do those of Western Europe and correspondingly greater differences exist among them. Valoch (1968) has recently characterized a number of more-or-less chronological and regional varieties not all of which can be correlated with Bordes' Mousterian facies. The closest parallels seem to occur in south-central Europe (Valoch 1968) where the Middle Paleolithic industries approach the Denticulate and Charentian facies of France. At the Kulna cave (Level 7a) in Moravia (Jelinek 1970:479) there is an industry associated with a hominid jaw which seems to be like Mousterian of Acheulean Tradition B where "quartzite implements of the Mousterian type prevail, however, here and there were also found Acheulean implements as well as a few approaching the type of tools found in Upper Paleolithic cultures" (Jelinek 1966:701). At the Sipka cave in Moravia, Maska reported an early Wurm industry with a high frequency of denticulate scrapers containing a large number of end scrapers, burins, and borers (Valoch 1968:356). The apparently contemporary Szletian industries of Hungary and circum-Carpathian central Europe contain a good proportion of true blades but many more flake tools, some showing the Levallois technique. Associated with these are "Upper

Paleolithic" forms such as dorsally retouched end scrapers, carinated (Aurignacian) scrapers, simple burins and borers, and a large number of leaf-shaped points ranging from crude unifacial to fine bifacial retouch. At some Szletian sites (such as Lovas in Hungary) bone tools also occur (Valoch 1968:358). The latest of these manifestations seem to be stratigraphically dated to a moist cool period around 38,000 B.P. In this area the Lower Aurignacian (Gravettian) is similar to the early Aurignacian of France but contains up to twenty-five percent of Mousterian forms such as side-scrapers and points. The upper stages of these industries (dated to 31,840±250 B.P. at Willendorf II) are lithically quite similar but contain greater frequencies of split base and lozenge section bone points and awls (Valoch 1968:359).

As Jelinek noted (1969:484) the human burials at Predmosti are clearly E. Gravettian (e.g., red ochre burials, fired clay figures, mammoth ivory carving), but they are associated with "a stone industry in which numerous tools belong typologically to the traditions of the Mousterian, Acheulean, and even pebble tool cultures. This variability is reflected at the same time in the many Mousterian sites, both in Czechoslovakia and elsewhere in central and eastern Europe, that are regarded as atypical in containing indications of Upper Paleolithic blade tool types." From the Croatian site of Krapina, Gorjanovic-Kramberger (1913) has illustrated plano-convex bifacially flaked points (Plate V, Figs. 11-13), piercers (Plate VI, Figs. 6-8), graves (Plate IX, Figs. 1-7; Plate X, Figs. 1-5), natural and backed-blade knives (Plate X, Figs. 7-10), basally thinned bifacially worked points (Plate VIII, Figs. 4, 5) along with a large number of discs, scrapers and flake tools. The site also yielded several bone tools among which were two odd split-base bone points (Gorjanovic-Kramberger 1913; Plate XIII, Figs. 1, 2).

According to Wobst (1970:455) "a good case can be made for *in situ* evolution from Middle to Upper Paleolithic" in Slovakia. He reasons that the increased percentage of

Upper Paleolithic tools in late Mousterian and the decreasing frequencies of Middle Paleolithic tools in the early Upper Paleolithic preclude the possibility of a "sudden immigration." The excellent evidence for a gradual change in activities, underlying the transition from Middle to Upper Paleolithic is based on the good preservation of interstadial open-air sites in numerous places.

Elsewhere in central Europe, the Replust cave in Austria has a Middle Paleolithic industry which (on the basis of faunal evidence), may be as early as late Riss/Wurm. This industry is characterized by a high frequency of denticulates but also distinct end scrapers and oblique burins (Mottl 1951). From Thuringia in middle Germany there are several examples of a Middle Paleolithic industry containing Mousterian side scrapers and limaces, numerous unifacially and bifacially retouched points, end scrapers, burins, and borers (Behm-Blanke 1960). Valoch has noted that the Nietoperzowa cave in Galicia contained a Middle Paleolithic industry with leaf-shaped points mostly on blades which is as early as 38,000 BP (1968:358). In northern Germany at the site of Salzgitter-Lebenstedt an industry characterized as Levalloisian Mousterian of Acheulean tradition contained bifacially retouched points, "Clactonian flakes," and a large number of bone and antler tools including "barbed" or split-base points. The site dates by radiocarbon to a slightly warmer period in early Wurm at 55,000 BP (Tode, Prenl, et al. 1953).

In his summary of the Mousterian of European Russia, Klein (1969) has indicated both the sophistication of the cultural adaptations involved in the exploitation of this ecologically diverse area and the high degree of lithic variability which these Middle Paleolithic industries exhibit. Sites such as Starosel'e Kiik-Koba and Molodova yield burins, end scrapers, and backed blades, although in low frequencies (Ibid.:261, Fig. 4). Klein also indicates the occurrence of some amount of worked bone in these Mousterian assemblages (Ibid.:264).

Within central and eastern Europe the Szeletian is sometimes recognized as an example of an industry typologically transitional from Middle to Upper Paleolithic (Valoch 1968:358-359), but even in other traditions most of the tools characteristic of the Upper Paleolithic are clearly present in lower frequencies in the Middle Paleolithic.

North Africa

In north Africa, numerous sites have produced evidence for Middle Paleolithic Levalloiso-Mousterian industrial facies closely akin to those of France (McBurney 1960:129, 135; Bordes 1968:121-122). Many of these contain implements characteristic of the Aterian (equated with early Upper Paleolithic of Europe). The most thoroughly reported site in North Africa is the Haua Fteah of Cyrenacian Lybia. Here the levels deposited during early Wurm (Layers XXXV-XXIX) contain an industry typical of the local Levalloiso-Mousterian (called "evolved Hybrid-Mousterian," McBurney 1967:108-131). The succeeding levels are quite similar to this Levalloiso-Mousterian but include end scrapers on blades, several varieties of small retouched blades, flake awls, carinated scrapers, Chatelperron knives, and an "unexpectedly high lamellar element... approaching a true blade industry" (McBurney 1967:113). McBurney goes on to add "as a whole, this assemblage is characterized by a curious mixture of evolved Levalloiso-Mousterian elements (especially in the technique of primary flaking) and traits which are frankly Upper Paleolithic in their affinities" (1967:113). From the interface of Layers XXXIV/XXXIII two Neandertal mandibles were recovered and have been radiocarbon dated to 40,700±500 BP. Overlying these hominid remains are layers which seem to be rather normal Levalloiso-Mousterian (XXXII/XXXI), and above these, a series of layers (XXVII/XXXI) deposited at the end of early Wurm and containing again a number of assemblages with "Aterian" and "Upper Paleolithic" elements. The conclusion we

reach, opposed to that given by McBurney, would clearly seem to be that in North Africa many of the late Levalloiso-Mousterian assemblages contain large numbers of tools characteristic of the local early Upper Paleolithic and of the later Emiran of the Near East (Garrod 1962).

The Near East

In the Levant, Perrot recognizes several "phyla" of Mousterian (1968:342), most of which are similar to the Levalloisian Mousterian facies of France but which have a relatively high frequency of blades, knives, graters, and burins. Most common, however, is the Levalloiso-Mousterian (which is seen in the early Wurm equivalent in the Levant) which is characterized by a few denticulate tools (1968:346-349). The early Levalloiso-Mousterian levels at many interior sites in the Jordan River-Mount Carmel area shows clear affinities to the coastal sites such as Ras-el-kelb and Chekka where early Mousterian is correlated by beaches to the period just post-Riss/Wurm (Howell 1959:18-19; Perrot 1968:352-356). In the mountain wadi shelters these Mousterian deposits show industrial facies possibly reflecting functional differences (Howell 1959:19; Binford and Binford 1969). At Skhul the hominid remains from Level B were associated with a Levalloiso-Mousterian containing a few burins (Howell 1959:20). Similar assemblages occur mixed within the four meters of Mousterian deposits above Level L (with associated hominid remains) at Quafzeh (Howell 1959:13, 20-21). Perrot notes that it is difficult to determine just when the change from this Middle Paleolithic to the Upper Paleolithic occurs. Numerous sites yield transitional industrial assemblages throughout the area. At Quafzeh (Level E) and Ksar Akil above a number of good Levalloiso-Mousterian layers are levels which contain a large proportion of elongated Mousterian points and side scrapers but which also contain blade tools and "Chatelperron knives" associated with Levallois cores, Mousterian disc cores and

prismatic blade cores (Perrot 1968:354-355). The "type-fossil" of this horizon (Garrod 1962) is the Emirah point. Both Bordes and Perrot feel these points are similar to the thinned Levalloisian points found as early as Level D at Shanidar in a late Levalloiso-Mousterian context (Perrot 1968; Bordes 1968). At any rate, it is clear that at sites such as Quafzeh (Level E), Ksar Akil, Tabun (Level B), Emirah, and El Wad (Level F) an evolved Levalloiso-Mousterian with thinned points, blade tools, prismatic cores, and backed knives exists.

Following these components are a number of levels with fewer of the "typical Mousterian" scrapers and points and with a higher frequency of graters, retouched blades, and Chatelperron knives. The Emirah point is absent but burins (especially dihedral and busked burins), graters on thick flakes, end-of-blade scrapers and carinated scrapers appear in great numbers "announcing the following 'Aurignacian' which has an even greater increase in retouched blades and points, burins, and graters, and split-base bone points" (Perrot 1968:355). South of Shanidar in the Khorrambad valley the Kunji cave yields a Mousterian assemblage with Mousterian points and scrapers as well as blades but no evidence of Levalloisian technique (*sensu stricto*). These levels are dated greater than 40,000 BP (Hole and Flannery 1968).

The earliest true Upper Paleolithic industrial assemblages (Neuville's stage III) occur at Quafzeh (Level D). Ksar Akil (Levels from seven to twelve meters with the twelve-meter level dating at 28,000 BP), Erg et Akmar (Levels E and F), Jabrud Shelter II (Levels 6 and 7), and Shanidar (Level C, dated at 29,000-26,000 BP). These clearly postdate transitional hominid populations. In the Near East it seems that the archaeological evidence, even when based only upon lithic assemblages, will not support any view of a rapid replacement of Middle by Upper Paleolithic either in terms of the morphological attributes of the tools themselves or their method of manufacture (cf. Binford 1968:707-708, 715). As Howell (1959:40)

concluded in an intensive review of the area, "The first recognized stage (1) of the Upper Paleolithic of Southwestern Asia had its roots in the local Mousterian (of Levallois facies)."

Asia

From Shanidar east the Middle Paleolithic is poorly understood (Ivanova 1969). At the site of Dara-i-kure a rock shelter in Afghanistan (Dupree, Lattman, and Davis 1970) Dupree (1970:492) describes a Middle Paleolithic assemblage with Levallois flakes, Mousterian points, large side scrapers, cleavers, flake hand axes, and tortoise cores, as well as flake blades and possible combination tools such as burin-points and burin-end-scrapers. At Teshik-Tash in Uzbekistan a rather generalized Mousterian is associated with an adolescent burial (Okladnikov et al. 1949), while at Kiik-Koba in the Crimea a Mousterian industry contained Levallois flakes, disc cores, and bone points (Mongait 1961:82). Mousterian assemblages have been found at numerous localities in China but are undated for the most part. A late site from the Ordos area which yielded several hominid cranial fragments contained an industry which was reanalyzed by the Bordes and is described by F. Bordes (1968:130) as a "Levallois-Technique Mousterian, with blades well represented (31%), 27% scrapers, 16.6% denticulates, 28% implements of Upper Paleolithic type (end-scrapers, burins, borers, occasional backed knives flakes and truncated blades) a few poor hand axes. . . discs, bladelets. . . . The impression given is in fact that of a very evolved Mousterian in the process of transition to an Upper Paleolithic stage. . . ."

Archaeological Summary

This brief review of the archaeological sequences clearly indicates several important facts. First and most evident, is the continuity which exists throughout the Old

World between Middle and Upper Paleolithic industries.

Given the presence of local transitional industries throughout the Old World, indicated by the data discussed, the interpretation of "sudden replacement" *anywhere* in the Old World becomes both logically improbable and increasingly difficult to verify.

An Upper Paleolithic assemblage directly overlying a Middle Paleolithic assemblage is a common occurrence throughout the Old World, and indicates the relative chronological position of the two occupations. While the Middle Paleolithic is obviously not the same as the Upper Paleolithic, we have described numerous archaeological assemblages which can be considered typologically transitional between the two on a morphological-functional basis. We have also tried to indicate the artificiality of the traditional distinction between Middle and Upper Paleolithic archaeological assemblages, resting as it does upon arbitrary cut-off points in relative frequencies of particular types of stone tools present in both, or upon the purported presence or absence of worked bone tools.

In any area, demonstrating the total and rapid replacement of one tradition or archaeological complex by another requires that no transitional industries exist locally. We have found overwhelming evidence for local transitional industries everywhere Middle Paleolithic industries occur. While we have no doubt been guilty of overlooking numerous relevant publications, it is difficult to imagine what kinds of sources could be used to argue against the interpretation of gradual transition.

Finally, we would note that the Middle Paleolithic is characterized for the first time, by *significant* numbers of special purpose tools. Many of these—borers, graters, burins, and numerous others—indicate that these functional types were not neglected until the Upper Paleolithic. In addition, a large number of characteristic types of bone tools so often diagnostic of the early Upper Paleolithic facies, have a clear prototype in the Middle Paleolithic.

THE ORIGIN OF ANATOMICALLY MODERN *HOMO SAPIENS*

Morphological evidence, too, indicates the continuity between Neandertals and anatomically modern *H. sapiens*. This continuity has been established for all Neandertal populations—even the “classic” Neandertals of glaciated Western Europe—by numerous authors in a series of publications spanning almost a century (Arambourg 1958; Brace 1962b, 1964, 1967c, 1968; Coon 1963; Fraipont and Lohest 1887; Gorjanovic-Kramberger 1906; Hrdlicka 1927, 1930; Jelinek 1969; Pouliancs 1969; Schwalbe 1901, 1914; Tobias 1964; Verneau 1924; Weidenreich 1940, 1947; Weinert 1925, 1936, 1944; Yakimov 1969). We propose that transitions in hominid morphology precede the established changes in hominid industries.

While Upper Paleolithic industries are always associated with anatomically modern *H. sapiens*, the converse is not necessarily true. Anatomically modern *H. sapiens* apparently arises from a Neandertal ancestor still associated with Middle Paleolithic industries. Thus, the earliest anatomically modern *H. sapiens* should be found with Middle Paleolithic cultural material. The earliest clearly dated specimens of anatomically modern *H. sapiens* are associated with an Upper Paleolithic industry, and not a particularly early one. However, there are two lines of evidence indicating the *in situ* evolution of anatomically modern *H. sapiens* from Neandertal populations associated with Middle Paleolithic industries.

NEANDERTAL MORPHOLOGICAL VARIATION AND VARIABILITY

The first line of evidence stems from the variability within the Neandertal populations themselves. Neandertals, contrary to the opinion of many authors (Sergi 1958a; Coon 1963; Howell 1952, 1957; Breitingner 1955), had a high degree of both inter and intra-population variability (Brace 1962b). Witness the extent of difference among the

so-called “classic” specimens from Le Moustier (Weinert 1925), La Ferrassie 1 (Hrdlicka 1930; Boule 1913), La Ferrassie 2 (Captain and Peyrony 1912a; Boule 1913; Heim 1968), and Monte Circeo (Sergi 1940), let alone among other Neandertals such as Mapa (Woo and Peng 1959), Broken Hill (Morant 1928), and Omo 2 (Leakey, Butzer, and Day 1969). Indeed, the normal variability within Neandertal populations is so great that almost every time more than one specimen is found at a single site, “hybridization” is the only explanation deemed sufficient by many to explain the extensive variation among the specimens. Such an explanation has been suggested for the material from Krapina (Gorjanovic-Kramberger 1910; Klaatsch 1923), Quafzeh (Thoma 1965:139), and Skhul (Hooton 1947:336-338; Weckler 1954:1014-1015; Thoma 1958): three of the four Neandertal sites with the remains of more than ten individuals.

A brief perusal of the literature shows that at almost every site with more than one Neandertal specimen, whether “classic” Neandertals or “Neandertals” in the broader sense used here, an extensive amount of variation has been recognized by, among others, the authors who worked with the original material. In addition to those already discussed, skeletal variation which is at least as great as the variation found in small samples of extant populations, hominid or pongid, has been described at the following sites: La Ferrassie (Hrdlicka 1930; Brace 1962b; Captain and Peyrony 1909, 1912a, 1912b, 1921; Boule 1913; Piveteau 1969; Heim 1968), Ehringsdorf (Behm-Blancke 1960; Jelinek 1969; Virchow 1920; Weidenreich 1928; Kleinschmidt 1931), Spy (Morant 1927a; Fraipont and Lohest 1887; Brace 1968), Broken Hill (Wells 1947), Arcy-Sur-Cure (Leroi-Gourhan 1958), Solo (von Koenigswald 1958; Weidenreich 1951) Saccopastore (Howell 1960), Shanidar (Stewart 1958, 1961, 1963), Jebel Irhoud (Ennouchi 1962, 1968, 1969), Subaluk (Kadic, Bartucz, Hillebrand, and Suzbo 1933), and others.

The idea that "classic" Neandertals were particularly lacking in variability has implied, to many, that they were under the influence of extremely strong selection. In the words of Coon (1963:509), "They are in fact so homogenous that a strong selective agency must have been pruning off deviant individuals."

The evidence simply does not support this statement for either "classic" Neandertal specimens or all Neandertal specimens taken together. The coefficient of variation (CV), an index of the standard deviation divided by the mean, provides a convenient way of comparing variability between samples with different means. Coefficients of variation were calculated for the ten cranial measurements given in Table II. A number of samples were utilized in this comparison of Neandertals to chimpanzees, gorillas, and extant populations. The extant *H. sapiens* populations include Andamanese (Sullivan 1921), Australian aborigines (Morant 1927b), Negroes from both Congo and Gaboon areas (Benington 1911), prehistoric Naquada (Morant 1924), a sample from Harappa in India (Gupta, Dutta, and Basu 1962), Moriori (Thomson 1916), a sample from Egyptian dynasties XXVI through XXX (Pearson and Davin 1924), Lower Yukon River Eskimos (Hrdlicka 1942), and Carinthians (Shapiro 1929).

We have sorted the Neandertal sample into "classic" and "non-classic" groups in as conservative a manner as possible. That is, we have only identified as "classic" those specimens to which all other authors would agree on the basis of geographic associations, stratigraphic position, and skeletal morphology (see Howell 1952:378-379). Discovering extensive variability in this restricted sample becomes all-the-more important. Including a wider geographic or temporal range of specimens, or using individuals which workers in disagreement with our hypothesis would question, would increase the observed variation even further but at the same time cover up the meaning and importance of the variation—its range and its

form—in the restricted "classic" Neandertal sample.

Measurements for the Solo sample, a "tropical" Neandertal group, were taken from publications by Weidenreich (1951) and von Koenigswald (1958). The site may be as old as the Eemian interglacial (Howell 1967:489). The "classic" Neandertals utilized in these calculations (following Howell 1967), include Spy I and II (Morant 1927a; Fraipont and Lohest 1887), Gibraltar (Sollas 1908), La Quina 5 (Henri-Martin 1923), Le Moustier (Weinert 1925), Petralona (Kokkorus and Kannelis 1960; Poulianos 1966; Kannelis and Savas 1964), La Chapelle (Boule 1913; Morant 1927a), La Ferrassie 1 (Boule 1913; Coon 1963), Neandertal (Morant 1927a), and Monte Circeo (Sergi 1940). Other Neandertals, included with all of the above in the "total" sample, consist of both Wurm specimens from outside of Southern and Western Europe and pre-Wurm specimens from all areas. These are as follows: Broken Hill (Morant 1928), Saldahna (Singer 1954), Omo 2 (Leakey, Butzer, and Day 1969), Djebel Irhoud 1 (Ennouchi 1962) and 2 (Ennouchi 1968), Galilee (Morant 1927a), Shanidar I (Stewart 1958), Sala (Vleck 1965), Tabun 1 (McCown and Keith 1939), Saccopastore 1 (Sergi 1944) and 2 (Sergi 1948), Ehringsdorf H (Kleinschmidt 1931), Fontechavade 2 (Vallois 1958), Ganovce (Vleck 1955), Krapina crania C and E (Gorjanovic-Kramberger 1906) as well as D (Schaefer 1964), Djebel Quafzeh 6 (Coon 1963; Boule and Vallois 1957), Amud (Suzuki 1965 and 1968), and Skhul 4, 5, 6, and 9 (McCown and Keith 1939). While additional comparisons could have been made with Steinheim (Weinert 1936; Howell 1960) and Swanscomb (Morant 1938), both the morphological position (Brace 1962b, 1964; Sergi 1958a; Stewart 1960; Weinert 1936) and the stratigraphic position (Howell 1960, 1967) of these specimens are clearly transitional between *H. erectus* and the Neandertals. The Upper Paleolithic sample was taken largely from Morant (1925, 1930), Matiegka

TABLE II. MEAN (M) AND COEFFICIENT OF VARIATION (CV) OF CRANIAL DIMENSIONS FOR HOMINOID GROUPS (mm)

	Cranial Capacity	Cranial Length	Cranial Breadth	Cranial Height	Nasion-basion	Upper Facial Height	Nasal Height	Nasal Breadth	Bizygomatic Breadth	Foramen Magnum Area
Solo Neandertals	(M) 1154 (CV) 7.3	202 4.8	149 3.6	123 3.9	113					1383
"Classic" Neandertals	(M) 1399 (CV) 10.4	200 2.9	150 4.7	126 5.4	118 6.7	86 8.2	59 8.9	32.2 11.6	143 6.6	1374
All Neandertals	(M) 1342 (CV) 12.6	200 4.2	148 4.4	123 5.4	112 6.6	84 9.2	58 7.7	31.5 8.5	144 6.3	1223 12.8
Upper Paleolithic Europeans	(M) (CV)	191 4.4	140 3.9	134 3.2	102 6.2	68 7.6	50 8.4	26.0 9.2	135 7.5	1145 12.8
Andamanese	(M) 1199 (CV) 8.8	163 4.2	134 3.2	127 4.0	92 4.0	59 6.8	45 6.9	22.9 6.8	122 4.7	880
Australian Aborigines	(M) 1248 (CV) 8.2	184 3.6	131 3.7	131 4.0	100 4.2	65 6.3	48 6.3	26.5 7.4	130 4.7	1026 10.7
Congo Negroes	(M) 1301 (CV) 9.4	176 3.5	136 4.5	132 3.6	96 4.7	62 8.2	46 6.4	25.7 7.9	125 5.5	1056 11.1
Gaboon Negroes	(M) 1311 (CV) 10.3	176 3.5	133 3.6	133 4.5	98 4.2	65 9.0	47 6.8	25.7 8.3	125 4.9	1021 12.2

TABLE II. MEAN (M) AND COEFFICIENT OF VARIATION (CV) OF CRANIAL DIMENSIONS FOR HOMINOID GROUPS (mm) (Continued)

	Cranial Capacity	Cranial Length	Cranial Breadth	Cranial Height	Nasion-basion	Upper Facial Height	Nasal Height	Nasal Breadth	Bizygomatic Breadth	Foramen Magnum Area
Prehistoric Naqada	(M) 1326 (CV) 7.7	181 3.2	133 3.5	132 4.0	97 4.9	67 6.9	48 6.8	24.6 7.9	121 4.8	1051
Harappa	(M) 1340 (CV) 8.4	181 5.0	133 5.2	130 5.7	65 10.9	48 10.9	25.0 6.1	125 6.7		
Moriori	(M) 1376 (CV) 8.2	183 3.7	141 3.3	134 3.5	104 4.7	74 6.5	56 6.4	25.0 6.2	133 5.7	1080 10.8
Egyptian dynasties XXXVI-XXX	(M) 1386 (CV) 7.9	182 3.1	138 3.4	132 3.8	100 3.9	69 5.9	51 5.7	24.0 7.3	127 3.6	1035 10.0
Lower Yukon River Eskimos	(M) 1435 (CV) 7.9	178 3.4	140 3.4	135 4.1	102 4.1	77 5.5	52 5.0	23.5 6.8	135 3.5	
Carinthians	(M) 1436 (CV) 7.7	175 4.0	145 3.8	127 4.3	96 4.3	68 6.9	50 6.0	24.2 7.7	131 3.9	1140 10.9
Chimpanzees	(M) (CV)	132 6.7	101 6.7	87 6.2	95 9.3	82 13.1	54 10.6	24.7 17.3	123 12.3	693 11.3
Gorillas	(M) (CV)	159 12.2	109 11.7	101 11.5	121 13.7	109 15.4	80 16.6	32.4 17.4	158 14.7	996 14.9

(1938), Maska (1889), Werth (1928), Jelenik (1964) and von Bonin (1935).

Finally, the pongid samples were measured by Wolpoff. Specimens were obtained at the Field Museum in Chicago, the American Museum in New York, and from the Hamann-Todd collection at Case Western Reserve University and the Cleveland Museum of Natural Science. Length, breadth, and height measurements of the vault, disregarding crests and tori, were taken using techniques and measuring points suggested by Randall (1943-1944). In addition, nasion was defined on these primates according to Randall (1943-44). These procedures were followed in order to make the pongid-hominid measurements as comparable as possible.

In six of the nine comparable measurements the "classic" Neandertals are either as variable or more variable than the total Neandertal sample, although the latter includes a far wider geographic area, and spans a greater time. Such extensive variation in a sample all authors recognize as "classic" renders "hybridization" explanations of "non-classic" Neandertal samples unnecessary. It denies support to the idea that "classic" Neandertals were under the influence of strong selective pressures which ultimately lead to their extinction. Finally, the extensive variation evinced by the "classic" sample specifically suggests climatic adaptation. This sample, spread across the climatic extremes of partially glaciated Europe, shows the greatest variation, and the greatest difference in variation compared with all Neandertals, in nasal breadth—a feature closely tied with respiratory adaptations to cold climates (Wolpoff 1968).

The "classic" Neandertals are more variable in most features than any extant group. The most similar sample of anatomically modern *H. sapiens* is, as one could well expect, the Upper Paleolithic Europeans (Schluginhaufen 1946). Concomitantly, coefficients of variation for the latter sample and all Neandertals are almost identical. Variation in the fossil hominid samples is not, however, unusual for primates. Com-

parison with the two pongid samples evinces greater variation among the pongids. While high coefficients of variation for gorillas may result from the extensive sexual dimorphism, such an explanation cannot account for the nearly as high coefficients shown for chimpanzees. The same relation occurs for cranial capacities. The coefficient of variation for thirty Neandertals is 12.6. This compares favorably with the coefficient for 200 anatomically modern *H. sapiens* specimens of 11.7 (Ashton and Spence 1958) and of 14.1 for twelve specimens of *H. erectus* (Wolpoff 1969). Further, 144 chimpanzees have a cranial capacity coefficient of variation of 6.8, while the coefficient for 653 gorillas is 13.6 (Ashton and Spence 1958).

With one exception, the average dimensions for the "classic" Neandertals are almost identical with both those for the Solo sample and for the total sample. The exception is cranial base length or nasion-basion diameter. The significantly greater diameters for the "classic" specimens is a direct measure of the total facial prognathism separating nasal passages from brain which appears to be part of the Neandertal cold adaptation (Coon 1964). While all Neandertals have a longer cranial base than do any group of anatomically modern *H. sapiens* the "classic" sample dimensions are far greater yet.

Finally, Table II provides an excellent indication that the Upper Paleolithic Europeans are metrically transitional between succeeding Neandertal populations and extant Europeans.

After sorting out "classic" Neandertals on extremely conservative grounds, using among other things *morphological* criteria for specimens lacking adequate provenience such as Le Moustier, Neandertal, and Gibraltar, (Howell 1952:379), the same morphological criteria applied to all of the specimens available at this time indicate the largely arbitrary and anatomically unjustified basis of the initial sorting. Use of the *t* test evinces no significant differences between the "classic" and the "non-classic" samples for any of the measurements in Table II except nasion-basion; the only

consistent differences occur in features reflecting climatic adaptation (Coon 1963). All of the differences between "classic" and "non-classic" groups discussed here, as well as differences discussed in the following sections, are far less than those which regularly occur among extant groups living side-by-side (see Hrdlicka 1928, 1942; DeVilliers 1968; Benington 1911; Larnach and Macintosh 1966). These extensive metric, variational, and morphologic similarities and the complete overlap of ranges occur between a group very restricted in time and space, thought by some to represent a genetic isolate and a much larger group representing a greater time span and occupying all of the Old World. If under these conditions the similarities do not indicate the phylogenetic unity of the two groups, what further evidence could possibly be required to demonstrate this point?

The pattern of metric variation overlap is evinced by other morphological features presumably associated with the "classic" Neandertals. This is made particularly clear when one reviews the evidence underlying a compiled list of distinguishing "classic" Neandertal features such as that presented by Boule and Vallois (1957:251-2). The "simian" characters claimed for the vertebral column and limb bones will be ignored in the light of work by numerous authors demonstrating the completely modern anatomy of "classic" Neandertal post-cranial skeletons (Schwalbe 1914; Patte 1955; Straus and Cave 1957). Extensive lists of presumably distinctive "classic" Neandertal cranial and facial features have been prepared by a number of authors (Howell 1951, 1952, 1957; Boule and Vallois 1957; Hooton 1947). We will show both that some "classic" specimens as well as some "non-classic" specimens have almost all of these features. On the other hand, many other specimens without these characteristics can be found in both groups. The latter fact is of greater potential importance, because no feature distinguishes all "non-classic" or all "classic" specimens from anatomically modern *H. sapiens*.

Conversely, all of the presumed "distinguishing characteristics" for anatomically modern *H. sapiens* occur, with regular frequency, in both "classic" and "non-classic" Neandertals. For instance, La Chapelle (Boule 1913), Ehringsdorf H (Kleinschmidt 1931), Cova Negra (de Lumley 1970), and Amud (Suzuki 1965, 1968) are large headed, while La Ferrassie 2 (Hrdlicka 1930; Heim 1968), Petralona (Kannelis and Savas 1964), Ganovce (Vlcek 1955), La Chaise (Krukoff 1970), Gibraltar (Sollas 1908), and Tabun (McCown and Keith 1939) are not. The forehead is high in Petralona (Jelinek 1969), La Ferrassie 1 (Coon 1963), Djebel Irhoud 1 (Ennouchi 1962), Krapina E (Schaefer 1964) and Shanidar 1 (Stewart 1958), but is quite low in the Neandertal calvarium (Hrdlicka 1930), Broken Hill (Morant 1928), Saccopastore 1 (Sergi 1944), Krapina D (Gorjanovic-Kramberger 1906), and Tabun 1 (McCown and Keith 1939). Parietal bones of Krapina E (Schaefer 1964), Ehringsdorf H (Kleinschmidt 1931) and C (Behm-Blancke 1960), La Quina 5 (Henri-Martin 1923), and Saldanha (Singer 1954) are flat and evenly rounded, while Omo 2 (Leakey, Butzer, and Day 1969), Krapina K (Jelinek 1969), Broken Hill (Morant 1928), Ehringsdorf B and D (Behm-Blancke 1960), and Spy 2 (Hrdlicka 1930) have high, rooflike parietals with a pronounced boss. Heinz (1967) has shown that Neandertal parietal heights overlap extensively with those of anatomically modern *H. sapiens*. Thus, while La Ferrassie 1 (Boule 1913), Ganovce (Vlcek 1955), Fontechevade 2 (Vallois 1958), Saccopastore 1 (Sergi 1944), and Amud (Suzuki 1965, 1968) show rounded contours in norma occipitalis. Spy 2 (Hrdlicka 1930), Le Moustier (Weinert 1925), Ehringsdorf D (Behm-Blancke 1960), Broken Hill (Morant 1928), and Djebel Irhoud 1 (Ennouchi 1962) have parallel sided contours.

The supraorbital torus is heavy with glabellar and lateral elements merged and the supraorbital sulcus obliterated in Mapa (Woo and Peng 1959), Broken Hill (Morant 1928), Neandertal (Boule 1913; Schwalbe

1914), Krapina D (Gorjanovic-Kramberger 1906), Galilee (Kurth 1965), Saccopastore 2 (Sergi 1948), Saldanha (Singer 1954), Mount Circeo (Sergi 1940), and Ehringsdorf H (Weidenreich 1928). It is lightly developed in Le Moustier (Weinert 1925), Gibraltar (Sollas 1908), Amud (Suzuki 1965, 1968), Krapina C (Gorjanovic-Kramberger 1906), Omo 2 (Leakey, Butzer, and Day 1969), and Djebel Irhoud 2 (Ennouchi 1968). In addition, both Sala (Vlcek 1965) and Galilee (McCown and Keith 1939) have a sulcus separating glabellar and lateral portions. The occipital area is low, flattened, heavily muscled, and clearly displays the bunned condition in La Quina 5 (Henri-Martin 1923), Ganovce (Vlcek 1955), and the Spy crania (Hrdlicka 1930). Gibraltar (Sollas 1908) is bunned but lightly muscled. In other specimens, such as Broken Hill (Morant 1930), Amud (Suzuki 1965), Omo 2 (Leakey, Butzer, and Day 1969), and Djebel Irhoud 2 (Ennouchi 1968), the bunning is not as apparent, although vertical compression of the occipital region is retained. Saldanha (Singer 1954) has a clear occipital torus but no bunning. Finally the occipital region of the cranium is not at all bunned, but rather is small and rounded with light muscle attachments in Le Moustier (Weinert 1925), Saccopastore 1 (Sergi 1944), Tabun 1 (McCown and Keith 1939), and Djebel Irhoud 1 (Ennouchi 1962). The mastoid process is very small in La Quina 10 and 27 (Vallois 1969), Djebel Irhoud 2 (Ennouchi 1968), Saccopastore 2 (Sergi 1948), Spy 1 and 2 (Hrdlicka 1930), Petralona (Poulianos 1966), and Broken Hill (Morant 1928). However, in Saccopastore 1 (Sergi 1944), Amud (Suzuki 1965, 1968), La Quina 5 (Henri-Martin 1923), Ehringsdorf H (Weidenreich 1928), and Djebel Irhoud 1 (Ennouchi 1962) the process is quite large. According to data recently published by Vallois (1969:396 and Table 7) mastoid process size for La Chapelle and La Ferrassie 1 fit well within the range of variation for modern man. There is very little, if any, mid-facial prognathism in La Ferrassie 1 (Brace 1962b), Djebel Irhoud 1 (Ennouchi

1962), and Broken Hill (Morant 1928), but a significant amount of prognathism in the nasal-maxillary region of Le Moustier (Weinert 1925), Petralona (Kokkoros and Kannelis 1960), and Tabun 1 (McCown and Keith 1939). The amount of mid-facial prognathism is sufficient to obliterate the canine fossa in most Neandertals. However, there is a definite canine fossa in Djebel Irhoud 1 (Ennouchi 1962), Krapina C (Gorjanovic-Kramberger 1906), Kulna (Jelinek 1969), and to a lesser extent Broken Hill (Hrdlicka 1930).

The face is relatively long compared with the calvarium in Petralona (Kokkoros and Kannelis 1960; Kannelis and Savas 1964), Saccopastore 1 (Sergi 1944), and La Ferrassie 1 (Coon 1963), but it is significantly smaller in Le Moustier (Weinert 1925), Gibraltar (Sollas 1908), and Amud (Suzuki 1968). As with all of the other features, the claim of "large rounded orbits" is neither consistent within nor distinctive for the "classic" Neandertals. Orbit shape can be expressed in terms of the orbit index (height/breadth). For five "classic" Neandertals (Gibraltar, La Chapelle, La Ferrassie, Monte Circeo, and Le Moustier), the average index is 84, ranging from 75 to 100. Eight "non-classic" specimens average 85, and range from 76 to 100. As a size measure, the orbit areas of these two samples are, respectively, 1685 mm² and 1686 mm².

Shelving of the maxilla into the malar occurs in Saccopastore I (Sergi 1944), La Ferrassie (Boule 1913), and Shanidar I (Stewart 1958), but is completely absent (a 90 degree angle) occurs in Djebel Irhoud I (Ennouchi 1962), Broken Hill (Morant 1928), and La Quina H5 (Henri-Martin 1923). With teeth, La Chapelle is intermediate.

There is a definite mental eminence in the mandibles of La Ferrassie 1 (Boule and Vallois 1957), La Quina 9 (Piveteau 1964), Monte Circeo 3 (Sergi 1958b), Tabun 2 (McCown and Keith 1939), Amud (Suzuki 1968), the Djebel Irhoud juvenile (Ennouchi 1969), Shanidar 1 and 2 (Stewart 1958, 1961), and Sipka (Kadic, Bartucz,

Hillebrand and Szabo 1933). This region is receding in Arcy-sur-Cure 2 (Leroi-Gourhan 1958), Regardou (Piveteau 1964), Le Moustier (Weinert 1925), Tabun 1 (McCown and Keith 1939), La Quina 5 (Henri-Martin 1923), Ehringsdorf adult (Virchow 1920), Krapina H (Gorjanovic-Kramberger 1906) and Spy 1 (Hrdlicka 1930). The teeth have taurodont pulp cavities in the Krapina jaws (Gorjanovic-Kramberger 1907), Ochoz (Jelinek 1969), Spy 2 (Hrdlicka 1930) and Amud (Suzuki 1965). However, the pulp cavities are non-taurodont in the mandible from Abri Bourgeois-Delaunay (Debenath and Piveteau 1969), Dire Dawa (Vallois 1951), and Tabun 2 (McCown and Keith 1939).

One could continue this demonstration indefinitely, but there seems little point in doing so. Two conclusions are apparent. First, the distinction long maintained between "classic" and "non-classic" Neandertals is without substantive basis. The few features which distinguish the group means (although not the individual specimens) show a tendency in the Western European Wurm group for heavier bunning in the occipital region and more extensive mid-facial prognathism. The trends do not have an elaborate basis, and are slight enough so that statistical significance usually cannot be verified. Second, it is quite apparent that Neandertals overlap with anatomically modern *H. sapiens* in almost every morphological feature, as well as almost every metric one.

The form, as well as the range, of variation within Neandertal populations clearly indicates their ancestral relationship to the succeeding populations of anatomically modern *H. sapiens* (Brace 1964) found occupying the same caves and hunting the same game at a later time (Hrdlicka 1927, 1930). Average Neandertal morphological and metric parameters are not always identical with those of modern man: Neandertals are not, after all, anatomically modern *H. sapiens*. On the other hand, there is extensive overlap between the range of almost every Neandertal characteristic and the range

of the corresponding characteristic in modern man. It is not surprising that the group of anatomically modern *H. sapiens* represented in Table II showing the greatest metric similarity to the "classic" Neandertals are the Upper Paleolithic Europeans!

The close relationship of Neandertals and succeeding anatomically modern *H. sapiens* populations can be seen on an individual basis, in comparisons of La Ferrassie 1 with Predmost 3, let alone in the often discussed comparison of Skhul 5 with Predmost 3 (Brace 1967a, 1968). Predmost 3, the object of these comparisons, is gracile compared with some specimens associated with Upper Paleolithic industries such as Brux, Podkumok, and Brunn 1 (Weinert 1944:153-161). We believe that this similarity is the result of the *in situ* evolution of European Neandertals (see Jelinek 1969). In this respect, the hominids and the industries display the same relationship.

Finally, the clearly ancestral position of Neandertals is also evinced by the morphology, and postulated ontogeny, of Neandertal adolescents and children (Vlcek 1964; Fenart 1969; Carbonell 1965; Senyurek 1959; Piveteau, de Lumley, and Mme de Lumley 1963; Piveteau 1969; Thoma 1963). In a recent study of Neandertal characteristics in the ontogeny of anatomically modern *H. sapiens* Vlcek concludes "the development and presence of some morphological features typical for a Neandertal skeleton can be established on the skeleton of present man in his ontogenetic development" (1964:81).

These data suggest a re-examination of the conclusions based on Morant's metric analysis (1927a:374-375). First, Neandertals ("classic" or otherwise) are not "remarkably homogeneous." This conclusion is adequately demonstrated in Table II. If anything, they are remarkably variable. Second, the distinct hiatus reported between Neandertals and modern groups is no longer as distinct as first believed. While differences are demonstrable with modern population averages, numerous individuals overlap. In Europe, the Upper Paleolithic populations are clearly transitional (Jelinek 1969; Schwalbe 1906).

Third, while no living group seems more closely related to Neandertals than any other, Upper Paleolithic Europeans are clearly transitional between European Neandertals and living European populations in both metric and morphological features. The final point is not only apparent in the distributions discussed here but has been convincingly demonstrated by Jelinek (1969), Maska (1889), Matejka (1938), Jelinek, Palisek, and Valoch (1959), Brace (1964), Coon (1963), Schwalbe (1906), and others.

TRANSITIONAL SPECIMENS:
THEIR IDENTIFICATION AND
ARCHAEOLOGICAL ASSOCIATIONS

The second line of evidence indicating worldwide evolution of Neandertals into anatomically modern *H. sapiens* stems from the cultural associations of the truly transitional specimens.

Transitional specimens can best be seen in contrast to a general picture of the ways in which Neandertals differ from extant populations. While there is overlap in almost every feature, differences in averages can still be found.

Most distinctive Neandertal characteristics were maintained as the result of selection for *technological*, and sometimes also *climatic* adaptation. Indeed, it was the appearance of the greatest climatic extremes

in sub-glacial Western Europe which resulted in both increased continent-wide variability and highest frequencies of characteristics associated with the so-called "classic" Neandertals.

Dental Adaptation

The most important features distinguishing Neandertal dentitions from those of extant modern groups are metric, rather than morphological (Dahlberg 1963). The major differences occur in the incisors and canines: the anterior teeth (Brace 1962a, 1964, 1968; Wolpoff 1970). The posterior dentition is not particularly distinctive. Table III shows the summed areas of the posterior teeth, mandibular and maxillary, for a number of hominid taxa and extant groups. The table was prepared by summing the individual averages for specimens in each group. Data for the fossil groups was taken from Wolpoff (1971), as were measurements for "Australoids," "Caucasoids," New Britain Islanders, and Dickson Mound Indians. The latter two were measured by Wolpoff. The Japanese data was published by Miyabara (1916), Lapp data by Selmer-Olsen (1949), and Teso data by Barnes (1969). It is apparent that the Neandertal group average falls within the range of variation of extant group averages with respect to summed posterior areas.

TABLE III. SUMMED AREAS OF POSTERIOR TOOTH ROW
FOR MAXILLA AND MANDIBLE (mm²)

	<i>Maxilla</i>	<i>Mandible</i>
Australopithecines	935	906
<i>H. erectus</i>	630	638
Neandertals	543	533
Anatomically modern <i>H. sapiens</i>	490	487
"Australoid"	581	539
New Britain	537	520
Dickson Mound Indian	495	495
Teso	483	482
"Caucasoid"	466	457
Japanese	449	449
Lapps	388	391

The primary function of the anterior teeth is in gripping, holding, exerting torsion, and other manipulations. These uses have been established for extant groups (Campbell 1925, 1939; Van Reenen 1966; Brothwell 1959, 1963; Barnes 1969; Leigh 1928, 1937; Turner and Cadien 1969; Brace and Molnar 1967; Waugh 1937; Taylor 1963; Bailit, DeWitt, and Leigh 1968; Gessain 1959; Noble 1926). Other uses observed include such diverse functions as leather treating (Pedersen 1938), pulling (Noble 1926), fashioning thong, reed and thread (Dahlberg 1963), straightening wooden shafts (Sollas 1924), and prying off rusted gasoline drum covers (de Poncine 1941). Indications of similar, although more extensive, use of the anterior dentition is characteristic of Neandertals. For instance, Dahlberg (1963) shows extensive differential incisor wear for the right maxillary teeth of La Ferrassie 1. The right side is considerably more worn than the left resulting in an uneven and undulating occlusal plane. Brace (1962a:347-348) shows a similar pattern of wear in Shanidar 1, Ternifine 3 (an *H. erectus* specimen), and Krapina J. Wear of this nature clearly could not result from mastication alone (Brace and Molnar 1967).

The anterior teeth of Neandertals were apparently important tools in the manipulation of the environment. As such, they required robust roots and supporting structures. These features are characteristic of Neandertal jaws and faces. The anterior displacement and robustness of the maxilla in part causes the region in the vicinity of the canine fossa to become convex rather than concave, thus eliminating the fossa. In addition, these features are characteristic of *H. erectus* faces. These also exhibit robust anterior dentitions.

Tables IV and V give data for averaged individual mandibular (Table IV) and maxillary (Table V) anterior summed tooth lengths (L), breadths (B), and areas (L*B). Data for Illinois Indians and Sub-Saharan Africans have been published by Wolpoff (1971). In addition to average values, the ranges, sample sizes (N), and coefficients of

variation (CV) are listed. Because of the presence of small sample sizes *t* tests were calculated to determine the significance of differences between *H. erectus* and Neandertals, as well as between Neandertals and anatomically modern *H. sapiens*. Comparing *H. erectus* with Neandertals at the five percent significance level, mandibular summed length is significantly greater in the former. All other dimensional comparisons for both jaws reveal no significant difference. On the one percent level *no* comparison of *H. erectus* with Neandertal reveals a significant difference. Comparing the Neandertals with anatomically modern *H. sapiens*, on the other hand, there is a significant difference at the five percent level for *every* dimension in both jaws. At the one percent level, the length comparisons for both jaws are not significant, but all other comparisons are. It appears that while the anterior dentitions of Neandertals and *H. erectus* are not statistically distinguishable for length, breadth, and area (for all intents and purposes), there is a very significant dimensional decrease for anatomically modern *H. sapiens*. The breadth, and subsequently area, decreases are slightly more significant. Therefore, the Middle Pleistocene anterior dentition is demonstrably larger than that of anatomically modern *H. sapiens*, with particular emphasis on increased breadth. The size difference has both statistical and morphological significance.

We feel that the large Neandertal anterior teeth are a specific adaptation to the type of extensive use implied by the pattern of anterior occlusion seen in Neandertal jaws, as well as the general muscularity evinced by Neandertal skeletal rugosity. This implication is substantiated by observation of tooth use in non-agricultural peoples. The increased breadth is an effective means of structural reinforcement. Indeed even slightly worn Neandertal incisors tend to be almost square.

Climatic Adaptation

Climate must also be considered in the analysis of Neandertal morphology, for the

TABLE IV. AVERAGED MANDIBULAR ANTERIOR TOOTH ROW SUMMED LENGTHS (L), BREADTHS (B), AND AREAS (L*B). N IS THE SAMPLE SIZE AND CV THE COEFFICIENT OF VARIATION (mm)

	L(M-D)				B(B-L)				L*B			
	Mean	Range	N	CV	Mean	Range	N	CV	Mean	Range	N	CV
Australopithecines	20.3	17.2-23.0	14	7.8	23.0	20.0-26.5	13	8.6	160	129.6-197.1	13	13.3
<i>H. erectus</i>	21.1	18.2-23.8	12	7.6	23.8	21.4-27.8	12	7.5	170	145.6-201.8	12	10.0
Neandertals	20.0	17.5-22.8	31	6.7	24.3	21.4-28.0	29	6.8	166	130.3-200.8	29	9.9
Anatomically modern <i>H. sapiens</i>	19.2	14.2-22.4	180	7.8	20.4	14.5-25.0	170	7.8	133	82.0-178.0	167	12.9
"Australoid"	21.1	20.0-21.8	6	3.0	22.3	21.0-24.3	4	6.8	160	148.0-176.0	4	7.7
Sub-Saharan African	19.9	16.5-22.4	25	7.5	20.9	14.5-24.2	21	11.3	141	82.0-172.0	21	17.4
Illinois Indian	19.5	18.6-20.5	10	2.5	20.4	18.9-22.7	9	7.0	134	124.0-149.0	9	6.6
Dickson Mound Indian	19.4	17.4-22.2	85	5.2	20.0	17.1-23.0	84	6.6	132	101.0-158.0	84	9.7
New Britain	19.4	17.8-21.2	25	4.6	20.6	18.8-23.9	24	6.0	134	114.0-153.0	23	7.8
"Caucasoid"	17.4	14.2-21.3	28	11.4	21.0	18.4-25.0	25	7.8	124	94.0-178.0	25	18.3

TABLE V. AVERAGED MAXILLARY ANTERIOR TOOTH ROW SUMMED LENGTHS (L), BREADTHS (B), AND AREAS (L*B). N IS THE SAMPLE SIZE AND CV THE COEFFICIENT OF VARIATION (mm)

	L(M-D)				B(B-L)				L*B			
	Mean	Range	N	CV	Mean	Range	N	CV	Mean	Range	N	CV
Australopithecines	26.3	22.7-29.0	10	7.1	24.7	21.4-28.6	20	8.1	216	183.4-238.8	8	9.1
<i>H. erectus</i>	28.0	24.2-29.5	4	8.3	27.6	25.7-32.6	4	10.5	260	208.7-320.2	4	14.3
Neandertals	26.1	24.0-30.0	14	7.9	25.9	22.9-29.2	14	6.3	226	196.8-268.2	14	11.5
Anatomically modern <i>H. Sapiens</i>	24.5	18.7-29.4	164	7.5	23.0	18.8-30.3	160	7.7	190	131.0-258.0	160	13.0
Sub-Saharan African	25.8	21.0-29.4	14	9.7	23.8	18.8-26.7	14	10.3	207	131.0-250.0	14	17.7
Dickson Mound Indians	24.9	21.9-27.6	85	4.8	22.7	19.1-25.7	85	5.4	190	140.0-227.0	85	8.9
New Britain	24.8	23.2-26.5	22	4.3	23.0	21.6-25.9	20	4.5	192	168.0-228.0	20	7.1
"Australoid"	24.4	21.8-26.9	8	8.0	25.2	19.8-30.3	8	15.2	208	145.0-258.0	8	20.1
Illinois Indian	24.2	20.9-25.2	8	5.9	22.4	20.0-23.8	8	5.5	182	146.0-195.0	8	9.0
"Caucasoid"	22.7	18.7-27.4	27	10.7	23.3	20.8-28.2	25	8.7	178	131.0-258.0	25	18.7

so-called "classic" Neandertals were clearly adapted to a cold climate (Coon 1963, 1964). The anterior displacement of the entire face from nasion downward, so characteristic of Western European Neandertals, is much reduced in specimens such as Broken Hill (Morant 1928), Djebel Irhoud 1 (Ennouchi 1962), and others. This anterior displacement helps separate the nasal passage from the relatively low positioned brain (Coon 1963:533). Thus the brain is maximally separated from inspired cold air. The necessity of warming such inspired air accounts for the great breadth of the Neandertal nose (Wolpoff 1968). The resulting massive face is balanced with a relatively long and low cranium, with expanded nuchal area for muscle attachments. As a result, the Wurm adapted Neandertal crania have the highest incidence of bunning and greatest occipital breadths. The increased facial prognathism completely eliminates the canine fossa in this group, a feature which regularly appears in the "non-classic" Neandertals. The resulting total morphological pattern for the "classic" group is one of cold adaptation built upon the morphology of the Neandertal grade of evolutionary development. The postcranial morphology, particularly as reflected in limb to trunk proportions (Patte 1955; Vallois 1958), similarly displays a cold-adapted pattern.

This total morphological pattern includes the frontal sinus complex. While the form and size of the Neandertal frontal sinus is directly intermediate between that of *H. erectus* and that of anatomically modern *H. sapiens* (Vlcek 1967:188), the supraorbital torus is especially well developed in some of the Western European glacial Neandertals (Vlcek 1964). The size and form of this sinus is directly related to both the supraorbital torus and the extent of mid-facial prognathism. The intermediacy of the sinus form helps corroborate the hypothesis of direct Neandertal ancestry, while the excessive development of the sinus, and hence of mid-facial prognathism, in glacial adapted Neandertals substantiates the hypothesis of climatic selection.

Most Neandertal features are not too different from those of *H. erectus*. Neandertals differ from the latter mainly in the reduction of the posterior dentition and the expansion of the brain to modern size. Table 2 identifies many of the metric features characterizing the difference between Neandertal means and the means of extant groups. These data characterize Neandertal crania—"classic," "tropical" (Solo), and all referred specimens taken together, as long, low, and relatively broad. The great cranial length and nasion-basion diameter can be taken as an indication of the degree of total facial prognathism. The latter dimension is maximized in the Western European Neandertals. While Neandertal nasal height is great, the breadth of Neandertal noses is almost one third again as large as the maximum for extant groups. Total facial size for the Neandertals is large. It is only partially approached by the Eskimo sample. With the exception of cranial capacity and cranial height the average Neandertal dimensions exceed those of all extant group averages. However, in cranial breadth, upper facial and nasal heights, and foramen magnum area the Neandertal sample is closely approached by some of the extant group averages. The specific pattern of the most significant differences results from a combination of climatic and dental adaptations. The general massiveness of Neandertal cranial dimensions and rugosity of muscle attachments attests to the major function of individual body strength in Neandertal pattern of life.

This complex of features is maintained by both climatic selection and selection maintaining the large anterior dentition. Neandertal populations maintain these characteristics at their highest frequencies in Europe where climatic selection is greatest. A large number of specimens come from outside of Europe. These retain features resulting from the massive anterior dentition and supporting structures, such as a long and low calvarium, large face, and so on. However, the additional effects of maxillary protrusion, nasal size, and other cold-

weather adaptations, are not present. As a result, many of the features common to both dental and climatic adaptation appear in a less extreme form. Therefore a distinctive morphology resulting from the interaction of both climatic and dental adaptation is associated with the so-called "classic" Neandertals from Western Europe, forming an adaptive complex. Rather than indicating the isolation of Western European Neandertal populations from populations in other areas, this continuity emphasizes the presence of consistent gene flow.

The Transitional Specimens

A "transitional" Neandertal population can be defined with respect to these features. There are a number of specimens representing such transitional populations. The fact that they all are associated with Mousterian type industries constitutes the second line of evidence indicating the *in situ* evolution of Neandertals into anatomically modern *H. sapiens*.

The first specimen representing a transitional population comes from the Kulna cave in Czechoslovakia. The maxilla, described by Jelinek (1966, 1969) has a canine fossa indicating a decrease in anterior maxillary expansion. According to Jelinek (1966:701) other progressive features include the specific morphology of the canine and premolars, as well as the deep palate. These features are mixed with others more commonly distinctive of Neandertals. With PM⁴ not fully in occlusion, the specimen can be aged at fourteen to fifteen. Even for an adult the lower facial height is unusually large so that for an adolescent the very great size of the lower face is a Neandertal feature. Judging from the occlusal view (Jelinek

1969: Figure 4a), the anterior incisor sockets and the canine which is present indicate a great breadth for the anterior dentition. In addition, the maxilla has a prenasal fossa coupled with a very weakly developed anterior nasal spine.

The second transitional group comes from Arcy-sur-Cure in Western Europe. Here, along with the excellent sequence of industrial evolution from Middle to Upper Paleolithic (Movius 1969), there is a corresponding sequence of hominid evolution (Leroi-Gourhan 1958). Hominids are found at almost every level, although most of the material recovered is dental. Teeth discovered in the highest Mousterian levels (12 to 15) are indistinguishable from those of anatomically modern *H. sapiens*. Some anterior teeth are represented (Ibid.: 113).

According to Jelinek (1969:477,499), the Sipka mandible is dated in the Wurm I/II interstadial by both the geology and the fauna of the site. Because of this date and the association with a Mousterian industry (Maska 1882, 1886), one would expect the mandible to evince transitional characteristics, if the model proposed here is correct.

The dentition of the Sipka mandible suggests a transitional status (Vlcek 1969). Neandertals differ from anatomically modern *H. sapiens* in the size (breadth, area) of the anterior dentitions. Table VI gives anterior lower incisor breadth and area sums for fifteen European Neandertals. When an individual had both sides present, one was chosen at random. Four Skhul specimens are separately represented. The data for Sipka were published by Virchow (1882). References for most of the other specimens are given in another publication (Wolpoff 1971). The three Krapina mandibles (E, H, I) were

TABLE VI. SUMMED BREADTHS AND AREAS OF MANDIBULAR INCISORS

	Breadth				Area(mm ²)			
	Mean	Range	N	CV	Mean	Range	N	CV
Neandertals								
European	15.5	14.2-16.8	15	4.6	96.4	85.5-112.6	12	8.3
Skhul	14.2	13.2-15.7	4	7.8	83.9	71.9-107.7	4	19.3

measured by Dr. C. L. Brace; this data is used with his kind permission. While neither the summed breadths (15.0mm) or the summed areas (87.2mm²) of the Sipka incisors are the smallest in the European sample, they fall in the lower end of the range. Only two mandibles (the Subaluk adult and the Teshik-Tash adolescent) have a narrower summed incisor breadth, and only one (Regourdou) has a smaller summed area. Of greatest importance, *not one* European Neandertal has both smaller breadth *and* area sums. On the other hand, the Sipka values lie on the upper end of the Skhul range, breadth and area only exceeded by Skhul 10. The transitional position of the Sipka dentition is clear.

No morphological characteristics of the mandible contradict the transitional interpretation (Jelinek 1969). The dimensions of the jaw, while robust, are not unusual for anatomically modern *H. sapiens* and can regularly be matched in extant populations (Ibid.:477).

A number of transitional specimens come from the Near East. While some of the Near Eastern Neandertals closely approach anatomically modern *H. sapiens* in their metric and non-metric morphology (Quafzeh 6, Skhul 5), others closely approach the

"classic" Neandertals (Tabun, Shanidar I) save for the extremes of cold adaptation. Actually, there are excellent archaeological and anatomical reasons for considering all the specimens members of a late non-cold adapted Neandertal group, imperceptibly grading into anatomically modern *H. sapiens*.

Table VII presents measurements for the seven most complete Near Eastern Neandertal crania. All diameters from porion are projected in the median sagittal plane. Measurements for the Amud cranium were published by Suzuki (1965, 1969) or measured from the scaled photograph (1968:Fig. 3). The Shanidar I measurements were published by Stewart (1958), or measured from the several scaled photographs in that publication. The estimated cranial capacity, over 1700 cc. comes from Coon (1962:564). The three Skhul crania, and the Tabun cranium were measured by McCown and Keith (1939). Finally, measurements for Quafzeh 6 were taken from the scaled photograph published by Boule and Vallois (1957: Fig 247) or from the photograph published by Coon (1963: Plate XXVIII), scaled by computing the cranial length from the published cephalic index (73.7) and cranial breadth (146mm).

TABLE VII. CRANIAL MEASUREMENTS
OF THE SEVEN RELATIVELY COMPLETE NEAR EASTERN NEANDERTAL CRANIA (mm)

	<i>Amud</i>	<i>Shanidar</i> <i>1</i>	<i>Skhul</i> <i>9</i>	<i>Quafzeh</i> <i>6</i>	<i>Skhul</i> <i>4</i>	<i>Skhul</i> <i>5</i>	<i>Tabun</i> <i>1</i>
Cranial Capacity (cc)	1800	1700	1587	1560	1554	1518	1271
Length	215	206	213	198	206	192	183
Breadth	155	157	145	146	148	143	141
Maximum Height							
Above Frankfort Plane	122	125	115	113	116	121	105
Porion - Prosthion	133	125		109	110	116	111
Nasion	116	111	109	102	109	95	100
Glabella	125	114	122	113	117	106	105
Lambda	115	116	111	104	104	108	100
Opistocranium	108	110	101	95	100	100	93
Inion	90	97	98	81	85	89	79
Upper Facial Height	91	88	74	73	79	73	79
Nasal Height		63	55	54	55	53	58
Calotte Height Above							
Glabella - Inion	94	103	87	102	99	100	85
Glabella - Lambda	63	66	53	55	64	68	47

Skhul cave at Mount Carmel is the origin of a large number of fossil hominids (McCown and Keith 1939) which taken together, represent a sample of a truly transitional group (Brace 1962b, 1964, 1967a; McCown and Keith 1939; Boule and Vallois 1957:376-378; Howell 1958). The morphological characteristics of these specimens are well known, so that repetition is not necessary. The direct association with a Levalloiso-Mousterian industry is unquestionable (Garrod and Bate 1937). As an individual specimen, Skhul 5 fits completely within the range of variation for anatomically modern *H. sapiens*.

At Djebel Quafzeh more than thirteen hominids have been recovered; although not one has been even partially described (Vandermeersch 1966, 1969b, 1970), the crania of one of the first six individuals has been pictured (Boule and Vallois 1957, Fig. 247; Coon 1963: Plate XXVIII). There has been a relatively great amount of reconstruction in the vault form, although the face is largely unreconstructed. The form, morphology, and shape of the cranial vault fit equally well within both Neandertal and anatomically modern *H. sapiens* ranges of variation. It is most similar to crania from Mount Carmel (Boule and Vallois 1957). The "Neandertalian" characteristics which it possesses, according to Boule and Vallois (1957:377), include a relatively broad nose and a very large palate. On the other hand, the index of upper facial height to cranial length—37, falls within the Skhul range (35-38, $n=3$) and far below the range of "classic" Neandertals (41-50, $n=6$). Similarly, the ratio is significantly smaller than the ratios for the three large-faced Near Eastern specimens: Amud (42), Shanidar I (43) and Tabun (43).

Table VII reveals a mixture of modern and archaic features in the metric dimensions and proportions. For instance, the distance from porion to glabella is greater than that of Skhul 5. However, the porion-prosthion measure is far less, while the porion-nasion measure is again greater. Quafzeh 6 shows the total facial prog-

nathism common to Neandertals, rather than the alveolar prognathism evinced by Skhul 5. Another archaic feature of the specimen is a very low calvarium, as indicated by the small auricular height value. However, while they are of Neandertal proportion, the facial dimensions of the cranium are absolutely small: most distances from porion (excepting height) are best matched by Tabun 1, a far less transitional specimen with a much smaller cranial capacity. The calvarium is similar to many extant crania. Like Skhul 5 it bears some resemblances to crania of Australian aborigines. Comparison with a particularly rugged Australian aborigine cranium pictured by Larnach and Macintosh (1966: Plate I) is striking. The index of facial height to cranial length in this Australian aborigine specimen is 35. As we have already noted, the Quafzeh skeletons are unquestionably associated with a Levalloiso-Mousterian industry. Vandermeersch, who has recovered a number of the skeletons from the Quafzeh Mousterian levels, observes "les hommes de Quafzeh sont à ranger parmi les neanthropiens bien qu'ils soient associés à une industrie mousterienne" (1969a:17).

Another transitional specimen comes from the Amud cave (Suzuki 1965, 1968) associated with a Levalloiso-Mousterian industry (Binford 1968:709). The specimen combines a number of transitional characteristics (Vallois 1962) and is clearly related to other Near Eastern hominids from Skhul and Quafzeh on the one hand, but also to hominids from Shanidar. The resemblance to Shanidar 1 (Stewart 1958) is marked. The anterior dentition, supraorbital torus, and upper third molars of this specimen are each relatively small. The mastoid process is well developed, the forehead high, and a mental eminence is present (Suzuki 1965). The calvarium is absolutely high. Maximum height above the Frankfort Horizontal, measured from the scaled photograph (Suzuki 1968) measures 122mm. This is higher than any "classic" Neandertal, but is exceeded by Shanidar 1. These, then, are features reminiscent of anatomically modern *H. sapiens*. On

TABLE VIII. CRANIAL MEASUREMENTS OF AFRICAN AND ASIAN NEANDERTAL CRANIA (mm)

	Omo		African- <i>Djebel</i> <i>thropus</i>		Broken <i>Hill</i>		Saldanha		Solo		3	5	6	9	10	11
	1	2	1	1	2	1	1	1	1							
Cranial Capacity (cc)		1435	1400	1450	1280	1250	1200	1300	1175	1135	1055	1060				
Length	210	215	191	197	209	200	196	220	192	201	203	200				
Breadth	144	145	142	148	145	144	148	147	146	150	159	144				
Maximum Height Above Frankfort Plane	138	118	98	108	106		108	116	108	115	117	111				
Porion - Nasion	113	111	107	106	104		93	113	106	107	107	115				
Glabella	130	120	114	115	114		105	126	114	118	118	115				
Lambda	121	113	90	94	103		104	107	99	97	105	104				
Opistocranium	105	102	84	85	98		94	106	90	89	99	94				
Inion	88	102	79	85	98		94	106	90	89	99	94				
Calotte Height Above Glabella - Inion	105	90	75	84	85		84	81	78	78	80	80				
Glabella - Lambda	66	57	55	68	55		60	56	55	52	48	51				

the other hand, the calvarium is extremely long (215mm) and broad (155mm); the face is long and broad with an upper facial height of 91mm. This is one of the largest Neanderthal faces matched or exceeded only by Broken Hill, La Ferrassie I, and Petralona. The occipital contour of the skull is round, the occipital region is vertically compressed in a manner similar to that of Djebel Irhoud 2, and the ratio of facial height to cranial length is relatively great (41), indicating a Neanderthal sized and proportioned face. Measurements from porion to prosthion and porion to nasion (Table VII) indicate extensive mid-facial prognathism.

The remaining transitional specimens come from Africa. There, the recently discovered crania from the Kibish formation of the Omo basin evince a mixture of features found both in Neanderthals and in anatomically modern *H. sapiens* (Leakey, Butzer, and Day 1969). No features occur which are not found in other Neanderthals. However, the combinations are unique. The three skeletons have not been precisely dated. They are reported to come from Member I of the formation, although only some remains of Omo 1 were recovered *in situ*: Omo 2 and 3 were collected from the surface. A radiocarbon date of 37,000 BP was reported for an *Eutheria* bank in Member III, overlying Member I. The skeletal material is probably older, although some uncertainty stems from the fact that shell-based dates have a tendency to appear older than they actually are (Crane 1956). Corroborating dates from other sources would be useful. For the time being, the Omo skeletons appear to be roughly contemporary with European and Near Eastern Neanderthals.

Table VIII gives metric data for the two better preserved Omo crania. For purposes of comparison the other reasonably complete African and Asian Neanderthal crania are tabulated. The Omo measurements were taken from Day (Leakey, Butzer, and Day 1969), and measured from the photographs in this publication. The scale indicated for the photographs is at variance with the measurements published in the text. The

text was assumed correct (Day, personal communication), and the photographs rescaled accordingly in order to obtain the data in Table VIII. Sources for most of the other material have been discussed. The "Africanthropus" calvarium was published by Weinert (1940).

Omo 1, like Skhul 5, would be identified as anatomically modern *H. sapiens* if found in another context. Modern features include the large mastoid process, high calvarium (the auricular height is 138 mm. and is the Neanderthal maximum), rounded occipital region and low inion, and mandibular mental eminence. The breadth of the heavily worn upper canine, 8.1 mm., is at the low end of the Neanderthal range of variation. Of 35 individuals, only Spy 1 and Skhul 1 are narrower. The length of 8.9 mm., on the other hand, is greater than that of twenty-five individuals, and is within 0.1 mm. of an additional five. Following Day (Leakey, Butzer, and Day 1969:1142), the tooth is robust by modern standards. Other features falling within the Neanderthal range of variation include the heavy supraorbital torus coupled with the absence of a supraorbital sulcus (similar to "Africanthropus"), robust facial bones, low position of maximum cranial breadth, and great cranial length. In both metric and non-metric morphology, the cranium is extremely similar to Amud. Both share the heavy supraorbitals without a supraorbital sulcus, the mental eminence of the mandible, the rounded occipital contour and low inion position, the large mastoid process, and the evenly rounded lateral contour from glabella to inion. In dimensions the two are almost identical. They are clearly more similar to each other than either is to any other Neanderthal cranium. This relation is even true of the relatively great distance from porion to glabella, characteristic only of these two crania. The only difference lies in the fact that the Amud cranium is about one centimeter lower and one centimeter broader.

Omo 2 differs from Omo 1 in a number of ways. Yet there is an apparent similarity between the two calvaria. They share a

heavy supraorbital torus associated with a receding forehead and absence of a supra-orbital sulcus. However, Omo 2 shows extensive and detailed similarities with Solo 5. Both are long and moderately high, with identical morphology of the supraorbital region as well as the region of inion. In both, inion and opistocranium are identical. The nuchal tori are massive, and the nuchal planes flat. Inion is somewhat higher in Solo 5: while the auricular heights are the same, height above the glabella-inion line is greater in Omo 2. Most dimensions of the two are nearly identical. Indeed, the resemblance of Solo 5 to Omo 2 is greater than to any other of the Solo calvaria.

Omo 1 clearly meets the criteria of a transitional specimen. It should not be surprising that in East Africa, in a sense geographically between Java and the Near East, two crania show detailed and extensive similarities with specimens from these other areas. The associated lithic materials (if any) have not been described.

In sum, where appropriate archaeological associations exist, unquestionable transitional populations are clearly associated with Middle Paleolithic industries in Eastern and Western Europe, Africa, and the Near East. The evolution of local populations associated with Middle Paleolithic industries is thus indicated.

AN ADAPTIVE MODEL

The hypothesis critically addressed by this work was recently summed up by Howell (1969:xxi): "Beginning some 35,000 years ago new peoples with new ideas and new designs for living displaced and eventually replaced antecedent Neanderthal peoples and their Mousterian way of life."

To the contrary, we suggest that *in situ* transitions of both hominids and their industries took place throughout the Old World within the period of the last glaciation. These transitions did not occur at the same time. The evolution of anatomically modern *H. Sapiens* clearly precedes that of Upper Paleolithic industries. Thus, the

selective factors leading to the evolution of anatomically modern populations are not to be sought in the Upper Paleolithic. Rather, we must seek their origins in the Middle Paleolithic.

We must ask what factors throughout the Old World undergo significant change *within* the Middle Paleolithic, and, of course, what factors do not. There are several indications that significant changes in human ecology do not occur at this time. The age distributions of "classic" Neandertals and an Upper Paleolithic sample, both published by Vallois (1961), are almost identical to each other and to the age distribution of Indians from Indian Knoll (Snow 1948). Similar adaptive effectiveness for groups spanning this time range is thus indicated (Birch 1948; Cole 1954; Cannon 1968). The extensive hunting of megafauna has already been demonstrated at numerous Acheulean sites (see Howell 1965; Hemmer 1965). The specialized and intensive hunting of particular species can be seen as early as locality 1 at Choukoutian (Howell 1964). These two hunting behaviors do not necessarily occur together, although they often do. The areas exploited by the Acheulean hunter-gatherers included both ecologically homogeneous areas such as Ternifine (Arambourg 1963) and edge areas or ecotones such as Toralba (Butzer 1964:366-371). For these reasons, a recent suggestion concerning Neandertal evolution (Binford 1968) can be dismissed. It was suggested that the Neandertal exploitation of ecotones containing large game on a regular seasonal basis led to the formation of larger groups for more efficient exploitation. Clearly, such conditions were met long before the recent date Binford suggests. In any event, the formation of larger and more exogamous groups would slow, rather than hasten, the effects of selection, all other factors remaining equal (Wright 1938).

We see the major behavioral changes within the Middle Paleolithic in industrial factors. These do not relate to any single specific tool type, but rather to a general increase in the numbers of different types of

tools. A single purpose tool is generally more effective for the purpose for which it was made than any general purpose tool. With respect to the action of selection upon hominid morphology, the major implication of changes from general to specific tools concerns the use of the jaws as a vice. The importance of this usage is indicated by the maintenance of large anterior teeth (actually increasing in breadth for *early* Neandertals) throughout the Lower and Middle Pleistocene, while the posterior dentition progressively reduces. To put a hole in a piece of wood with a knife requires more use of a vice than if one were using a drill. That is, the development of special purpose tools reduces selection for both *force* and *power* (force over time) in the anterior dentition through a combination of less strenuous use and use over shorter periods of time. Indeed, the reduction of the anterior dentition is part of a general trend reducing skeletal and muscular rugosity, replacing them with more efficient technology.

With the reduction of selection acting to maintain a large anterior dentition, and later the increasing efficiency of cultural adaptations to cold, there is a concomitant reduction of robustness and size of Neandertal anterior teeth, and ultimately of the supporting facial morphology. This reduction allows the redistribution of cranial mass in a more spherical array. Weidenreich was aware of this redistribution and of its importance in the evolution of anatomically modern *H. sapiens* from Neandertal ancestors, although he was unable to account for it by recourse to evolutionary principles (1940, 1941, 1945, 1947).

Evidence for a selective advantage to cranial mass distribution is considerable. Schultz (1942) was able to show that in both man and apes the weight of the head is always greater anterior to the occipital condyles than it is posterior to them. Because the occipital condyles act as a fulcrum about which the nuchal musculature works, the force which must be exerted by these muscles depends upon both the moment of

inertia of the weight distribution in front of the condyles and the distance of the muscles behind the condyles. The counterbalancing effect of Neandertal bunning is not so much to bring additional weight behind the condyles, but is rather to lengthen the lever arm for the nuchal musculature as well as to provide a horizontal orientation of the nuchal plane, increasing its leverage. The changes furthest anterior to the condyles have the greatest effect upon the length and orientation of the nuchal lever arm. The anterior dentition, and its supporting facial architecture, are the most anterior features of the cranium. The reduction of this complex would, by necessity, result in selection acting to shorten the nuchal lever arm and make it more vertical. The resulting crania (anatomically modern *H. sapiens*) are shorter and narrower but higher, and thus maintain the same cranial capacities.

In this respect, Schultz's work (1942) was particularly important. His empirical determinations evince a surprisingly constant balance ratio for modern crania, associated with a consistent occipital condyle position. Apparently, the conditions for balance in *H. sapiens* represent a selective optimum for erect hominids. A similar selective optimum, with longer anterior and posterior lever arms, was reached with Neandertals evincing larger faces and anterior dentitions.

Other studies of cranial balance yield much the same results (Schultz 1918; Fischer and Mollison 1923). The position of the occipital condyles is fairly constant, and the force exerted by the nuchal musculature in both static and dynamic functioning is sensitive to small mass changes maximally anterior to the condyles.

Therefore, the loss of the distinctive Neandertal cranial form is a direct consequence of selection relaxation for the anterior dentition and supporting facial architecture, and resulting change in selection acting on the static and dynamic properties of the nuchal musculature. That succeeding cold-adapted populations did not develop mid-facial prognathism follows from the

raised position of the calvarium relative to the nasal passages in anatomically modern *H. sapiens*.

We submit that these considerations are sufficient to account for the association of Early Upper Paleolithic man and Late Middle Paleolithic tools.

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