

On the relevance of the  
regional continuity features  
of the face  
in East Asia

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# Contents

<b>1 Introduction</b> .....	<b>1</b>
1.1 The background: theories on modern human origins .....	1
1.1.1 The Multiregional Evolution model .....	2
1.1.1.1 History of the Multiregional Evolution model .....	2
1.1.1.2 The hypothesis of the Multiregional Evolution model .....	3
1.1.2 The Out-of-Africa model .....	5
1.1.2.1 Out-of-Africa: the palaeontological basis .....	5
1.1.2.2 Out-of-Africa: the genetic basis .....	7
1.2 The current debate .....	8
1.3 Regional continuity features: the ongoing debate .....	9
1.3.1 Suggested evidence for continuity in China .....	10
1.3.2 Evidence against regional continuity features in China .....	15
1.3.3 Current conclusions and perspectives .....	18
1.4 Aims of this study .....	19
<b>2 Material and Methods</b> .....	<b>21</b>
2.1 Material .....	21
2.2 Methods .....	24
2.2.1 Features and methods of their assessment .....	24
2.2.2 Statistical methods .....	38
<b>3 Results</b> .....	<b>41</b>
3.1 The occurrence of the suggested East Asian regional continuity traits in China	41
3.1.1 Sagittal keeling on the frontal and parasagittal depression .....	41
3.1.2 Pronounced frontal orientation of the malar facies and the frontosphenoidal process of the zygomatic bone .....	44
3.1.3 Anteriorly facing frontal process of the maxilla with distinct paranasal inflation .....	48
3.1.4 Anterior surface of the zygomatic process faces more forward .....	49
3.1.5 Junction of the lower margin of maxilla and zygomatic bones is more angular in shape .....	51
3.1.6 Facial height reduction .....	52
3.1.7 Lower border of the zygomatic process of the maxilla oriented horizontally .....	57
3.1.8 Middle part of the face is not very protruding .....	58
3.1.9 Lack of anterior facial projection and low degree of prognathism .....	60

3.1.10	Horizontal course of the nasofrontal and frontomaxillary sutures . . . . .	65
3.1.11	Flatness of the nasal saddle . . . . .	66
3.1.12	Non-depressed nasal root . . . . .	70
3.1.13	No difference between upper part and middle part of the nasal bones . .	72
3.1.14	Presence of incisura malaris . . . . .	73
3.1.15	Shape of orbits is more or less quadrangular . . . . .	74
3.1.16	Rounded inferolateral margin of the orbit . . . . .	76
3.1.17	Presence of malar tuberosity . . . . .	78
3.1.18	Large naso-malar angle . . . . .	80
3.2	Summary of the distribution of the East Asian continuity features . . . . .	82
<b>4</b>	<b>Occurrence of regional continuity features</b>	
	<b>in Chinese Pleistocene fossil hominids . . . . .</b>	<b>86</b>
4.1	Comparison between present and past . . . . .	86
4.2	Chinese fossil hominids: a further comparison . . . . .	87
4.3	Multivariate comparison of recent and fossil faces . . . . .	95
<b>5</b>	<b>Discussion and conclusions . . . . .</b>	<b>102</b>
5.1	Regional approach to regional continuity . . . . .	102
5.1.1	Chinese internal morphological variability . . . . .	102
5.1.1.1	From fossil to modern humans: a gradual evolution? . . . . .	105
5.1.2	China: an intermediate position . . . . .	107
5.1.2.1	Chinese Pleistocene population . . . . .	108
5.1.3	The Inuit Problem . . . . .	111
5.1.3.1	Inuit features: an impact of climate adaptation? . . . . .	112
5.2	Is there regional continuity in East Asia? . . . . .	113
<b>6</b>	<b>Summary . . . . .</b>	<b>117</b>
<b>7</b>	<b>References . . . . .</b>	<b>121</b>
<b>8</b>	<b>List of individuals included in this study . . . . .</b>	<b>135</b>

# Chapter 1

## Introduction

### 1.1 The background: theories on modern human origins

Over the last two decades, the origin of modern humans has been a controversial topic in palaeoanthropology. The evolution and dispersion of regionally distinct groups of humans are crucial elements in the ongoing debate (Wolpoff et al., 1984; Kamminga and Wright, 1988; Groves, 1989; Bräuer, 1992, in press; Habgood, 1992; Stringer, 1992; Frayer et al. 1993; Lahr, 1996).

Two contrasting models dominate the debate on modern human origins: the Out-of-Africa model and the Multiregional Evolution model.

The Multiregional model denies that modern humans arose first in Africa. This model emphasizes the role of both genetic continuity over time in different regions and gene flow between contemporaneous populations. The proponents of this model argue that modern humans arose not only in Africa, but also in Europe and Asia. The weaker variant of this model is the Assimilation model suggested by Smith et al. (1989). The Assimilation model accepts an African origin for modern humans. This model emphasizes the importance of gene flow, admixture, changing selection pressures and resulting directional morphological change. It accepts that at least in some areas in Europe and Asia, continuity could play an important role in the emergence of modern humans.

The Out-of-Africa model is based on both palaeontological data and genetic evidence. The palaeontological data is mainly used by Bräuer and Stringer with their 'African Hybridization and Replacement' and 'Recent African Origin' theories. These models argue that modern humans first arose in Africa about 130,000 years ago and spread from there throughout the world. The first model argues for a possibly greater extent of hybridization between the migrating and indigenous populations, whereas the latter suggests that the migrating populations replaced the indigenous premodern populations outside of Africa, with little, if any, hybridization between the groups. The Out-of-Africa model is much supported by the genetic evidence.

## 1.1.1 The Multiregional Evolution model

### 1.1.1.1 History of the Multiregional Evolution model

In the beginning of the 1940s, Weidenreich (1943) discussed the evolution of regionally distinct groups of humans. In his monograph describing *Sinanthropus* or *Homo erectus* from Zhoukoudian, China, he identified regional morphological patterns between *Sinanthropus* and certain living Asian groups, especially from North China. The regional morphological features he identified are: mid-sagittal crest and parasagittal depression, a metopic suture, Inca bones, „Mongoloid“ features of the cheek region, maxillary, ear and mandibular exostoses, a high degree of platymerism in the femur, a strong deltoid tuberosity in the humerus, shovel-shaped upper lateral incisors, and a horizontal course of the nasofrontal and frontomaxillary sutures (see Wolpoff et al., 1984).

Based on these features, which he believed indicated morphological continuity in the region, he concluded: „There are clear evidences that *Sinanthropus* is a direct ancestor of *Homo sapiens* (in China) with closer relation to certain Mongolian groups than to any other races...” (Weidenreich, 1943: 276-277, parentheses added). However, he was careful to stress that *Pithecanthropus* and *Sinanthropus pekinensis* were not the direct ancestors of modern Australian aborigines or Mongoloids in general.

Weidenreich proposed a polycentric theory of modern human origins: „Human evolution was not limited to a certain geographical centre but went on over a vast area comprising, possibly, the entire of the world; there was always great variation with a tendency to racial differentiation; this process of human evolution and racial differentiation went on over a long period of time starting in the middle tertiary and ending in the Upper Pleistocene, interrupted for longer or shorter intervals possibly by changes in the environment...” (Weidenreich, 1943: 256). Furthermore he wrote that the hominids have formed and still form one family or, in a strictly taxonomic sense, one species and are all more or less related to each other in spite of manifold regional variations.

Historically, Weidenreich proposed an early form of what was to become known as the Multiregional Evolution model (Wolpoff et al., 1984: 417, 424). Wu added that this model is based on the fact that there are some common morphological characters, which are shared by *Homo erectus pekinensis* and modern Mongolian groups (Wu X., 1997: 284).

Based on Weidenreich’s ideas, Coon later formulated his view that modern humans emerged independently with genetic isolation and evolved at different rates, crossing a *sapiens* threshold at different times. Coon (1962: 658) stated that only genetic isolation could account for the development and maintenance of regional differentiation: „At the

beginning of our record, over half a million years ago, man was a single species, *Homo erectus*, perhaps already divided into five geographic races or subspecies. *Homo erectus* then gradually evolved into *Homo sapiens* at different times, as each subspecies, living in its own territory, passed a critical threshold from a more brutal to a more sapient state, by one genetic process or another“. So he believed that before *Homo sapiens*, there were already distinct races. Each race had different living territories of habitation, different patterns of selection, and different grade-changing mutations at different times. However, according to the more recent supporters of the Multiregional Evolution model, Coon’s explanation is problematic. He has reduced the importance of genetic exchange (gene flow and migrations) in the evolutionary process (Fraye et al., 1993: 16; Caspari and Wolpoff, 1996: 265).

### **1.1.1.2 The hypothesis of the Multiregional Evolution model**

Continuing Weidenreich’s idea „to relate the morphological differences seen in *Homo erectus* remains from northern and southern portions of east Asia to the morphological differences between populations from these extreme ends of the region today“ (Wolpoff et al., 1984: 447), the proponents of the polycentric model have emphasized the morphological differences in the fossil record, particularly in East Asia and Australasia. A number of fossils from East Asia are considered to be of relevance in this respect: Yuanmou, Lantian, Zhoukoudian, Hexian, Dali, Maba, Dingcun, Changyang, Ziyang, Chilinshan, Liujiang, and Upper Cave. Wolpoff et al. (1984: 435) found some features characterizing the East Asian fossils: „...though these characteristics are not absolutely absent in other populations of the Pleistocene world, they have much lower frequencies and are distributed discontinuously in regions other than China“. To the fossil record from Australasia belong the specimens from Sangiran, Sambungmacan, Ngandong, Wadjak, Kow Swamp, Keilor, Cohuna, and Willandra Lakes. Regional features characterizing Australasia have also been suggested. Thus, these authors concluded that there is evidence for local differentiation and continuity within these areas (East Asia and Australasia). In other words, some of the features distinguish major human groups, such as Asians and Australasians, from other groups (Wolpoff et al., 1984: 423-446; Wolpoff 1985: 357-363, 1989: 77-84, 1992: 50-51; Frayer et al., 1993: 21-27).

Based on Weidenreich’s idea and further assumptions of a polycentric process of evolution, Wolpoff, Wu and Thorne, proposed the Multiregional Evolution model in 1984 as „an explanation for the worldwide pattern of Pleistocene human evolution“ (Fraye et al., 1993: 17).

The Multiregional Evolution hypothesis is based primarily on anatomical features that appear to indicate genetic continuity across the archaic/modern human boundary throughout the Pleistocene in Europe as well as Africa and particularly in the Far East

(Wolpoff et al., 1984: 447; Smith et al., 1989a: 39; Thorne and Wolpoff, 1992: 77; Aiello, 1993: 78).

The process of Multiregional Evolution involves two distinguishable stages (Wolpoff et al. 1984: 448):

1. The establishment of initial polytypic populations: „Regional variants first became distinct at the geographic edges, a consequence of the colonization events that limited peripheral variability, primarily because of drift and bottlenecking“ (Frayser et al., 1993: 17).
2. The maintenance of the contrasting pattern of central and peripheral variation for long periods of time: „Regional differences were maintained through a series balanced between (1) genetic exchange often but not always from the centre toward the peripheries, and (2) selection (for some features) and drift (for others) that may have been more intense at the peripheries“ (Frayser et al. 1993: 17).

As a summary of the pattern of change, Wolpoff et al. (1984: 463) suggested:

„... that drift, due to small population effects, and differences in selection resulting from environmental variation as well as the existence of regionally distinct morphotypes, both characterized populations at the marginal or peripheral portions of the hominid range. The initially different gene pools of these populations were established during the process of first habitation. The pattern of regional variation was maintained throughout most of the Pleistocene by a balance between the local forces promoting homogeneity and regional distinction and multidirectional gene flow. As a consequence, a long-lasting dynamic system of morphological clines came to characterize the multiregional distribution of our polytypic lineage. It makes no sense, in our view, to argue about whether gene flow or selection or drift „predominated“ to account for a specific local evolutionary sequence because the multiregional evolution model requires all of these, and focuses on the balance between them in explanation of evolutionary change“.

The assimilation view is a weaker variant of the Multiregional Evolution model (Smith, Falsetti and Donnelly, 1989: 62). This perspective is an outgrowth of the Multiregional Evolution model (Aiello, 1993: 79) differs from the Out-of-Africa models in denying replacement, or population migration, as a major factor in the appearance of modern humans. Based on observations of the fossil record of the Old World, especially Eurasia (Smith, 1984, 1985; Smith et al., 1989a-b; Simmons and Smith, 1991), Smith et al. (1989) suggested that the origin of modern humans is the result of assimilation. They do not accept that modern humans arose as a result of speciation as is indicated by Stringer's and Andrews' Test Model (Stringer and Andrews, 1988). The Assimilation model recognizes the important role of continuity in conjunction with the increasingly strong evidence that

modern humans first appeared in Africa. This model also emphasizes the importance of gene flow, admixture, changing selection pressure and resulting directional morphological change, instead of population replacement. In other words, gene flow, or the assimilation of new elements into an existing gene pool, is regarded as the force that spread modern human morphology into Eurasia (Smith, 1985: 214-215; Smith et al., 1989a; Smith et al. 1989b; Simmons and Smith, 1991).

### **1.1.2 The Out-of-Africa model**

The hypothesis opposing the Multiregional Evolution model is the Out-of-Africa model, suggesting a single common origin of anatomically modern humans. The supporters of this model propose that Africa is the probable continent of origin of modern *Homo sapiens*.

Early ideas on a single and recent origin of modern humans were suggested in the 1970s. In 1976, Howells proposed the „Noah’s Ark“ hypothesis assuming that there was a single local centre of origin for modern man with subsequent outward migration in all directions (1976: 484). At that time some dating evidence pointed to Southern Africa as the place of earliest modern humans (Protsch, 1975; Beaumont, 1979, 1980; De Villiers, 1976; see Bräuer, 1984: 146).

#### **1.1.2.1 Out-of-Africa: the palaeontological basis**

Based on a new morphological analysis of the fossil hominids in Africa and Europe, Bräuer (1982) proposed his Afro-European-sapiens hypothesis or African hybridization and replacement model. In this model, Bräuer suggested that there was a rather gradual process of evolution from early to late archaic *Homo sapiens* which led to an early emergence of anatomically modern humans in Africa during the late Middle and/or early Upper Pleistocene. As regards the appearance of modern Europeans, he proposed that “a.m. humans (of Africa) seem to have “spread” further via the Near East, into Europe, increasingly absorbing and replacing the Neandertals that were living there. This period of replacement probably lasted for several thousand years, and it can also be assumed that various degrees of hybridization between Neandertaloid and modern populations occurred during this time” (Bräuer, 1984a: 395; 1984c: 22). Bräuer allows for some hybridization between the migrating and the indigenous premodern populations. Furthermore, in another study, he mentioned that an essential element of this Out-of-Africa model was the assumption that the replacement process was a complex population biological process involving various degrees of gene flow between spreading modern populations and resident archaic groups in different parts of the world (Bräuer, in press).

Concerning his hypothesis, Bräuer also reviewed the fossil evidence from North and South Eastern Asia. He found that there is a considerable morphological gap between archaic hominids like Dali and Maba and early anatomically modern *Homo sapiens* (1992: 408, 1984b: 160-162). There are no well-preserved cranial remains from North and central East Asia bridging the gap until the late Upper Pleistocene. Moreover, the early modern cranial remains from Liujiang and Upper Cave are believed to differ from living ‚Mongoloids‘. This difference also holds for the Holocene specimens from Minatogawa, Japan (see Bräuer, 1984b: 162). Concerning Southeast Asia, there also appears to be a morphological gap between the specimens from Ngandong (dated to the late Middle or early Upper Pleistocene, and recently redated to c. 27.000-53.000 years BP, Swisher et al., 1996) and early anatomically modern specimens such as Niah (c. 40.000 years B.P.). Other early anatomically modern findings from Wajak and Tabon, as analysed by Santa Luca (1980), also show considerable morphological differences to the Ngandong specimens. In view of the gaps in the fossil record and some possible indications of a certain degree of continuity in some of the specimens, Bräuer (1992: 409) pointed out that: „a more complex migration and mixing process, as I have suggested for the western part of the Old World, could also be in agreement with the current evidence from East Asia“.

Following the influential study on mitochondrial DNA (Cann et al, 1987) and its possible implications, Stringer and Andrews (1988) proposed the Recent African Origin model as an extreme test model assuming total replacement. This African Origin model is based largely on the early appearance of modern anatomy in Africa and on the genetics of living human populations. In this test model, the authors proposed that Africa is the best candidate for the source of modern humans, who arose approximately 100.000 years ago (Stringer and Andrews, 1988: 1267). However, concerning the Neandertal/modern transition, Stringer (1992: 20) agrees that hybridization and gene flow probably could have occurred, especially in central Europe: “So even if the existence of hybridization between Neandertals and early modern humans were demonstrated, this would by no means prove that they were conspecific, nor would it automatically mean that the Neandertals contributed significantly to the modern human gene pool beyond (possibly mobile) hybridization zones”.

Comparing the morphological variation in Asia, the authors added that late Middle Pleistocene fossils from China (Yinkou and Dali) show a change from the Middle Pleistocene pattern, through a greater resemblance to European and African Middle Pleistocene hominids and a greater contrast with their supposed local ancestors. Stringer and Andrews agree with Bräuer’s view that there are no informative fossils known from the critical period (50.000 to 100.000 years ago) immediately preceding the first appearance of modern *Homo sapiens* in this region. Moreover, the authors pointed out that

Australasia completely lacks fossil evidence from the early part of the late Pleistocene period. The Willandra Lakes specimen (WLH 50) that is believed to show a somewhat intermediate morphology between Indonesian *Homo erectus* and modern Australians, is pathological (see also Brown, 1999) and according to most recent dating c. 12.000-18.000 years old (Simpson and Grün, 1998 cited by Brown, 1999). Some of the east Asian and Australian early *Homo sapiens* fossils (from Liujiang, Zhoukoudian Upper Cave, Mungo and Keilor) are also more similar to those of western Eurasia than might be expected from the Multiregional Evolution model. For Australasia Stringer and Andrews (1988: 1267) concluded: „from the recent African origin model, the first Australasian *Homo sapiens* should have been no more archaic than Eurasian early sapiens. If the Niah Cave (Borneo) and Mungo and Keilor fossils can be taken as representative of the first *Homo sapiens* in the area, this is indeed true. However, if accurate dating can establish that more robust populations were also present at an early date, this would need to be explained. Perhaps Australia was a special case where local differentiation, cultural practices, or pathologies led in some cases to apparent evolutionary reversals“.

#### **1.1.2.2 Out-of-Africa: the genetic basis**

The Out-of-Africa model has been much supported by genetic evidence. Initial studies of mitochondrial DNA by Cann et al. (1987) suggested that Africa is a likely source for the human mitochondrial gene pool. With regard to the Asian hominids, the authors suggested that *Homo erectus* in Asia was replaced without mixing much with the invading *Homo sapiens* from Africa. Stoneking and Cann (1989: 26-28) concluded from the molecular biological and palaeoanthropological evidences: “The common mtDNA ancestor lived some 200.000 years ago and was a member of an archaic African population of humans whose descendants underwent a transformation to anatomically modern humans by 100.000 years ago. Some members of the anatomically modern population dispersed out of Africa to other parts of the world, while others remained in Africa”. In other words, Africa is the home of the first split and the source of the last transformation to modern humans. Cann (1992: 71) stressed that mtDNA sequence data now strengthen this estimate to a split in the population ancestral to modern humans dating to 200.000 years ago. She stated that Y-chromosomal data supported the interpretations based on mtDNAs. The nuclear genetic data reinforce the view that all modern humans share a relatively recent African past (Cann, 1994: 146). These studies have been supported by Horai et al. (1995: 535-536) who studied the complete mitochondrial DNA sequences. The authors proposed that the age of the last common ancestor is estimated to  $143.000 \pm 18.000$  years. This estimation is based on the synonymous substitutions and all substitutions in the D-loop region. The recent ancestry of human mtDNAs, together with those of the observation that the African sequence is the most diverged among humans, strongly support the recent African origin of modern

humans. Nei (1996: 27-33) constructed phylogenetic trees of human populations for five different sets of gene frequency data (microsatellite DNA Set I, microsatellite DNA set II, RFLP data, protein polymorphism data, and *Alu* insertion polymorphism data) and compared these data sets with those of chimpanzees. The results of his study support the Out-of-Africa model. Furthermore, he states that all five sets of gene frequency data indicate that the root of the human populations exists in the branch connecting Africans and non-Africans and that it is statistically supported in four data sets. This indicates that Africans are the first group of people that split from the rest of the human populations.

Recently, Krings et al. (1997) studied the mtDNA of the Neandertal type specimen, found in 1856 in Germany. Based on a sequence of the hypervariable region I of the mtDNA (positions 16,023 to 16,400) and phylogenetic analyses, these authors concluded that the Neandertal mtDNA lies outside the modern mtDNA variation. Furthermore, they explained that the diversity among Neandertal mtDNAs would have to be at least four times larger than among modern humans. The date for the divergence between Neandertals and modern humans is estimated to 550,000 to 690,000 years BP. According to the authors, this estimation is consistent with the paleontological and archaeological evidence. Another study based on the sequence of the hypervariable region II by Krings et al. (1999) has reinforced this result. It indicates that the Neandertal mtDNA and the human ancestral mtDNA gene pools have evolved as separate entities for a substantial period of time (Krings et al., 1999: 5584). The phylogenetic study shows that the Neandertal mtDNA sequence supports a scenario in which modern humans arose recently in Africa. There is wide agreement between the palaeoanthropological and genetic evidence concerning the divergence between Neandertals and modern humans. However, the authors emphasize that the results do not rule out the possibility that Neandertals contributed other genes to modern humans.

## **1.2 The current debate**

Recently, the Out-of-Africa model has been criticized by the proponents of the Multiregional Evolution model based on the interpretations of mtDNA studies (Frayer et al., 1993, 1994). Frayer et al. questioned the ‘total replacement’ proposed by Cann et al. (1987), which they called the ‘Eve theory’. They also questioned Bräuer’s and Stringer’s idea, which allows for admixture between Eve’s descendants and the natives they replaced.

According to the supporters of the Multiregional Evolution model, if the Eve theory (total replacement) were correct: “there should be evidence of a spreading technological advantage in the archaeological record that accounts at least in part for the replacement,

the evidence of the earliest modern people should be found in Africa, everywhere outside Africa the earliest modern humans should resemble these African ancestors and not the local people who lived there first, there should be no anatomical evidence of mixing between the earliest modern African people and the populations they replaced, in regions outside of Africa there should be no evidence of anatomical continuity spanning the period before and after replacement event” (Frayser et al., 1994: 19-20).

Bräuer and Stringer (1994,1997) regard this criticism as a misinterpretation of their data. There are three reasons for this: „misreading of the available data, selectivity of data used, and bias in the assessment of the merits of Eve theory/Recent African origin versus Multiregional evolution evidence“ (Stringer and Bräuer, 1994: 416).

As regards complete replacement, Bräuer and Stringer differentiate between the ‘Eve theory’ and Recent African Origin. The Eve theory is only one possible interpretation of the mtDNA data which proposes a complete replacement of all existing populations by the descendants of a single Eve who lived in Africa about 200.000 years ago. However, even Cann (1992, 1994) does not exclude the possibility of mixing but considers the finding of Neanderthal maternal lineages in present-day humans unlikely. Both Bräuer and Stringer do not regard the extreme ‘Eve theory’ as a realistic scenario. Thus, the Eve theory (ET) which Frayer et al (1993) intend to disprove is not equal to the Out-of-Africa model, as has often been claimed by the proponents of the Multiregional Evolution model (Bräuer and Stringer, 1997: 193; Stringer and Bräuer, 1994: 422).

Instead, Stringer and Bräuer (1994: 416) have suggested that the mode of emplacement of modern human morphology in the non-African Old World was indeed by a replacement of pre-existing archaic populations but accompanied by minimal gene flow (Stringer) or by a greater degree of hybridization (Bräuer) between dispersing moderns and resident archaics during the dispersal phase. Thus, basically, Bräuer’s and Stringer’s views on the replacement event and the Out-of-Africa model do not differ and they have emphasized that “equating the Eve theory and Recent African Origin is inadequate” (Bräuer and Stringer, 1997: 193; cf. Bräuer, in press). Concerning the evidence of continuity, the authors (Stringer and Bräuer, 1994: 417) pointed out that limited hybridization or mixing could have occurred that mimicked some regional continuity (‘in situ’ evolutionary change). The polarization of the more recent debate (since 1988) was partly artificial since the ‘Eve theory’ was wrongly used to disprove the Out-of-Africa model (Stringer and Bräuer, 1994: 416).

### **1.3 Regional continuity features: the ongoing debate**

Regional continuity features are the basic assumption of the Multiregional Evolution model. According to Frayer et al (1993: 17) these traits evolved over a long period of time

in approximately the same geographic region where these traits are found in their highest frequency, distinguishing major human groups such as Asians, Australians or Europeans. In the sense of the Multiregional Evolution model, the distinct regional variants are a consequence of the colonization events at the periphery that limited peripheral variability, primarily because of drift and bottlenecks. These regional differences were maintained through a series of balance between genetic exchange and selection and drift, that may have been more intense at the peripheries, but in any event, tended to be unique from one peripheral area to another (Wolpoff et al., 1984: 450-453; Frayer et al., 1993: 17).

However, it is not clearly explained whether regional continuity features were supposedly being maintained through drift or selection, as is criticized by Stringer and Bräuer (1994: 416): „if the former, their persistence over most of the Pleistocene in the face of climatic changes and extensive gene flow is remarkable; if the latter, then these features could have continually reevolved in the same regions, producing homoplasy rather than phylogenetic continuity“. Nei (1995: 6721) has also emphasized the problem of drift or selection. Selective advantage can certainly explain regional continuity. However, he questioned „What is the biological basis of the selection advantage and what are the extents of the selective advantage and gene flow that can explain both the regional continuity of the morphological characters and the evolutionary change of *Homo erectus* into *Homo sapiens* at the same time“. Wolpoff et al. (1984: 463) explain that: “it makes no sense, in our view, to argue about whether gene flow or selection or drift ‘predominated’ to account for a special local evolutionary sequence because the multiregional evolution model requires all of these, and focuses on the balance between them in explanation of the evolutionary change”.

The proponents of the Multiregional Evolution model claim that the regional continuity features occur mainly in East Asia and Australasia, which they believe were peripheral areas. In the sense of the Multiregional Evolution model, the occurrence of these traits is an evidence of the continuity between ancestral and modern populations.

### **1.3.1 Suggested evidence for continuity in China**

In his monograph on *Sinanthropus* or *Homo erectus pekinensis*, Weidenreich (1943) also dealt with the evolutionary relationships between these fossil hominids and modern humans in China. He proposed twelve regional continuity features for China. Some decades later other specialists developed and enlarged the number of suggested East Asian regional continuity features (Aigner, 1976; Wolpoff et al., 1984; Wolpoff et al., 1984; Wolpoff, 1992; Wu, 1992, 1995; Frayer et al., 1993).

In East Asia it is the midfacial region which is believed to display the largest number of regional traits. Other regions (e.g. the lower face or occipital region) are not

particularly useful in addressing the question of regional continuity (Pope, 1992: 276). Thus, the suggested East Asian regional continuity features analysed in this study mainly refer to the face (see Table 1).

Over the last decades, the evidence of suggested regional continuity features has been examined by a number of researchers with contrasting results.

Wu (1981: 538) placed the late Middle Pleistocene cranium from Dali, Shaanxi Province, as an early *Homo sapiens* or intermediate between *Homo erectus* and modern man. He has pointed out that Dali has many features in common with other human remains from China, i.e., the presence of sagittal keeling, the profile of the nasal bones, the orientation of the frontosphenoidal process of the zygomatic bone and the angled contour at the lower margin of the junction between the maxilla and the zygomatic bone. In sum, Wu suggested that Dali should also be placed on the continuous human evolutionary line in China. In 1992, he described a number of features which he believed are a characteristic complex in Pleistocene human skulls in China. These are: the fronto-nasal and fronto-maxillary sutures form a more or less horizontal curve, the antero-lateral surface of the zygomatic process faces more forward, helping to make the upper part of the face flatter, the lower border of the zygomatic process of the maxillary bone is curved, a flat nasal region, a low upper facial part, the middle part of the face is not very protruding, as shown by the comparatively more obtuse zygomaxillary angle, the infero-lateral part of the orbital margin is rounded, and shovel shape incisors are present. According to Wu, these features can be seen in early *Homo sapiens* and *Homo erectus* from China more frequently than in those from Europe and Africa (Wu, 1992: 373; 1995: 267-274).

Wolpoff et al. (1984) discussed the evidence for continuity in China. Based on their observations on fossils from *Homo erectus* to anatomically modern *Homo sapiens* (Lantian, Gongwangling, Hexian, Zhoukoudian, Maba, Dali, Ziyang, Changyang, Chilishan, Liujiang, Upper Cave), they have found various features indicating morphological continuity of human fossils in China. These features include incisor shovel-shaping, facial reduction and posterior dental reduction, flatness of the upper middle face and particularly of the nasal saddle, the frontosphenoidal process of the zygomatic faces more forward than in other regions, the junction of the lower margin of the maxilla and zygomatic bones is more angular in shape when viewed from beneath, lower upper face, sagittal keeling, Inca bones, presence of relatively small frontal sinuses, frontonasal and frontomaxillary sutures are almost in a straight line, upper and middle part of the nasal bones are more or less similar, exostoses on the jaw bones, large naso-malar angle, and shape of orbit (Wolpoff et al., 1984: 434-435). However, Wolpoff et al. (1984: 435) pointed out: „These features have become less frequent but still occur more regularly

in Mongoloids than in groups from many other areas“. They differentiated their evaluation of the presence of these features, claiming that some features clearly change through time. These features include: Sagittal keeling, frequency of Inca bones, the presence of relatively small frontal sinuses, lower frequency of exostoses on the jaw bones in the later specimens, frontonasal and frontomaxillary sutures form a straight line, and the upper and middle part of the nasal bone are more or less similar.

Li and Etler (1992) described the Yunxian crania EV 9001 and EV 9002. Both are damaged but relatively complete adult specimens and have been found in Middle Pleistocene terrace deposits of the Han River in Yun county (Yunxian), Hubei Province, China. These crania show features of the mid-face common to “non-Neandertal late archaic and early modern *Homo sapiens* from East Asia” (Li and Etler, 1992: 404). These features are: a flattened and orthognathic face with moderate alveolar prognathism, presence of distinct canine fossa, the lateral part of the maxilla is oriented coronally and highly angled to the zygomatic, there is a high origin of the zygomatic root, a horizontal inferior zygomaxillary border and a pronounced malar incisure. However, Etler (1996: 284) found that the Yunxian crania show some morphological similarities with Middle Pleistocene western archaics such as Petralona, Arago and Atapuerca from Europe, and Bodo and Kabwe from Africa. These are: extremely large cranial and facial dimensions, lack of well-expressed ectocranial buttressing features, the form of the supraorbital tori and ophryonic region of the frontal and the reduced postorbital constriction. They retain, however, other features seen in the Zhoukoudian *Homo erectus* sample; these are the overall shape of the cranial vault; a long and broad occipital nuchal plane; low placement of greatest cranial breadth; and a discrete morphology of the cranial base. Thus, the evidence from the new crania points to a greater morphological variation than had been assumed before.

Similar indications of a greater heterogeneity were yielded by Pope’s (1992) detailed review of the craniofacial evidence in China. He found that specifically East Asian features are concentrated in the midfacial region. These include: anterior orientation of the frontosphenoidal process of the malar, wider interorbital distance, more acute angulation of the junction of the lateral and anterior portions of the zygoma, perpendicular-everted orientation of the anterior facies of the cheek bone to the lateral wall of the maxilla, more horizontal orientation of the zygomatic process of the maxilla, form of the IZM contour, incisura malaris, shovel-shaped incisors, intermediate to low height of the anterior root of the zygomatic process on the lateral maxillary wall, rectangular-shaped orbits with laterally round corners and low nasal saddle. However, Pope also stated that shovel-shaped incisors occur in early African *Homo erectus* (WT 15000) and in Neanderthals (Krapina). Moreover, he pointed to the fact that some of the earliest anatomically modern humans and some of the latest archaics exhibit features very similar to those of other

geographically widely dispersed contemporaneous hominids. Jebel Irhoud and Cro-Magnon are examples of non-Asian specimens which display the Asian traits (horizontal orientation of infero-zygomaxillary margin, associated with a vertically short maxilla, remarkably rectangular orbits). Jinniushan and Maba also express features that are not found in other fossil Chinese (large frontal sinuses and relatively thin cranial bones; Maba also shows very rounded orbits). Pope pointed out that Jinniushan and Maba may represent immigrating populations from outside of China or the result of admixture with archaic *Homo sapiens* or Neanderthals. Similarly, Jebel Irhoud and Cro-Magnon could be interpreted as premodern and anatomically modern humans from the Far East. However, he found no reason to assume that either Europe or Africa are a source of these features. The occurrence of the 'imported' features could be seen as admixture between these populations rather than replacement (1992: 288).

In 1993, Frayer, Wolpoff, Smith and Pope suggested that "there is evidence of anatomical links across time and of transitional specimens that connect the area's ancient to its modern inhabitants in North Asia" (Frayer et al., 1993: 24). They suggested a number of features which distinguish China from other regions. "These features can be seen in the Chinese fossil record of the last million years. The Chinese fossils are less robust and have smaller faces and teeth, flatter, flaring cheeks in a very anterior position, and rounder foreheads separated from their arched brow ridges. Their noses are much less prominent and flattened at the top. The most distinctive midfacial features include relatively horizontal and anteriorly facing cheek bones, anteriorly facing frontal process of the maxilla with distinct paranasal inflation, frequent presence of a distinct notch along the lower border of the cheek and presence of the maxillary incisors shovelling" (Frayer et al., 1993: 25).

As a summary, Table 1 shows the regional continuity features of the face which are believed by the major proponents of the Multiregional Evolution model to distinguish between Chinese and other populations.

**Table 1** Suggested East Asian regional continuity features of the face.

<b>No.</b>	<b>Feature</b>	<b>Reference</b>
1.	Sagittal keeling on the frontal	Weidenreich, 1943: 277; Wolpoff et al., 1984: 435; Wu and Poirier, 1995: 234
2.	Pronounced frontal orientation of the malar facies and frontosphenoidal process of the zygomatic bone	Weidenreich, 1943: 208; Wolpoff, 1984: 435; Wu and Poirier, 1995: 235; Frayer et al., 1993: 25
3.	Anteriorly facing frontal process of the maxilla with distinct paranasal inflation	Pope, 1992: 289; Frayer et al., 1993: 25
4.	Anterior surface of the zygomatic process faces more forward	Wu, 1995: 271; Wu, 1997: 285
5.	Junction of the lower margins of the maxilla and the zygomatic bones is more angular in shape	Wolpoff et al., 1984: 435
6.	Facial height reduction	Wolpoff et al., 1984: 435; Wu, 1995: 270; Wu, 1997: 286
7.	Lower border of the zygomatic process of the maxilla is oriented horizontally	Pope, 1992: 289; Wu and Poirier, 1995: 235; Wu, 1995: 272
8.	Middle part of the face is not very protruding	Wu, 1992: 373; Wolpoff et al., 1984: 435
9.	Lack of anterior facial projection and low degree of prognathism	Wolpoff, 1992: 52
10.	Horizontal course of the nasomaxillary and frontomaxillary sutures	Weidenreich, 1943: 207; Wolpoff et al., 1984: 435; Wu, 1995: 270
11.	Flatness of the nasal region	Weidenreich, 1943: 207; Wolpoff et al., 1984: 435; Wu and Poirier, 1995: 235; Frayer et al., 1993: 25; Wu, 1995: 271
12.	No difference between upper and middle part of the nasal bone	Weidenreich, 1943: 74; Wolpoff, 1984: 435; Frayer et al., 1993: 25
13.	Presence of the incisura malaris	Pope, 1992: 289; Frayer et al, 1993: 25
14.	Shape of orbits is more or less quadrangular	Wu, 1995: 271
15.	Rounded inferolateral margin of the orbit	Weidenreich, 1943: 83; Wu, 1992: 373
16.	Presence of the malar tuberosity	Weidenreich, 1943: 83; Wu, 1992: 373
17.	Large naso-malar angle	Wu, 1995: 270

### **1.3.2 Evidence against regional continuity features in China**

Other authors came to different conclusions and deny the evidence for regional continuity features as proposed above.

Kamminga and Wright (1988; Kamminga, 1992; Wright, 1995) studied the early modern sample represented by Zhoukoudian Upper Cave, Liujiang and Minatogawa fossils. Their multivariate studies based on cranial measurements of the face such as indices of shape, showed that the sample falls outside the range of recent Chinese populations. No morphological similarities between Upper Cave 101 and modern Mongoloid populations could be found. In reply to Thorne and Wolpoff (1992) and Wolpoff (1994), Wright (1995: 181) examined Upper Cave 101. He used discriminant function analysis as used by Wolpoff (1994). The results revealed that Upper Cave 101 does not show a Mongoloid morphology. On the contrary, Upper Cave 101 has morphological affinities with African, Australian and Melanesian crania. This study is supported by Neves and Pucciarelli (1998). They examined whether there are morphological affinities between Mongoloid populations and the first Americans. Their study shows that there are no morphological affinities between first Americans and Mongoloids of northern Asia (China, Japan and Siberian populations), or between Zhoukoudian Upper Cave hominids and Mongoloids. But they found some affinity between the first Americans and Upper Cave hominids (Upper Cave 101, 103) and also between the Upper Cave hominids and South Pacific and African populations. In sum, they assume „ that people very similar to the native populations that presently occupy most of South Asia and Australia once dominated all of Eastern Asia, and departed to the Americas before the differentiation of Mongoloids in the Old World. In this scenario, Zhoukoudian Upper Cave hominids should be seen as part of this non-mongoloid population“ (Neves and Puciarelli, 1998: 220). This result is supported by Howells (1993: 92-93). Using a multivariate statistical approach, he concluded that Upper Cave 101 does not have any connections to North Asians. In contrast, this specimen closest to Holocene crania from Elmenteita, Kenya.

The suggested regional continuity traits in East Asians and Australasians were also examined by Groves (1989: 274-283). He has tested sixteen regional traits in Mongoloids (mid-sagittal crest and parasagittal depression; high frequency of metopic suture, high frequency of Inca bone, Mongoloid features of the cheek region, mandibular exostoses, ear exostoses, maxillary exostoses, femoral platymeria, strong deltoid tuberosity of humerus, shovel-shaped upper incisors, a horizontal course of the naso-frontal and fronto-maxillary sutures, rounded profile of nasal saddle and nasal roof, rounded infraorbital margin, reduced posterior teeth, higher frequency of M3 agenesis, and small frontal sinuses), nine in Australoids, and nine additional features, which are said to link the

Ngandong sample to modern Australoids. The results of this study did not support the Multiregional Evolution model: "...there is a little evidence for special likeness of modern ,Mongoloids' to *Homo erectus pekinensis*..." and "...from ,shared characters' point of view, the regional continuity model lacks much real substance" (1989: 279, 281).

Habgood (1992) also examined whether there is evidence for morphological continuity or discontinuity in East Asia. He analysed seventeen traits that were proposed as continuity features in East Asia. These are: Agenesis of a third molar, persistence at maturity of a foramen Huschke, auditory exostoses, a high degree of platymerism, an earlier reduction in face, interorbital distance, shape of orbit, lack of anterior facial projection, sagittal crest, a non-depressed nasal root, non-projecting and more perpendicularly oriented nasal bones, flat upper face with forward-jutting malar bones, shovel-shaped incisors, a relatively horizontal course of the frontonasal and frontomaxillary sutures, the presence of a marginal process below the zygomaticofrontal suture, presence of an incisura malaris and rounding of the infraorbital margin of the orbit. According to Habgood, there is none of the proposed 'regional continuity traits' which can be said to be documenting 'regional features', because these features are not unique to East Asia. The continuity features are also common in other regions. Habgood, however, mentioned that there are a number of features that appear to have only a limited distribution outside of East Asia. These features are not all commonly found on single individuals from outside East Asia (e.g. Petralona, Zuttiyeh etc). They include: a non-depressed nasion, more perpendicularly oriented nasal bones, frontonasal and frontomaxillary sutures on almost the same level and an angular rather than a rounded junction of the zygomatic process of the maxilla.

Bräuer (1992: 407-409) sees that there is a gap in the fossil record between archaic specimens like Jinniushan, Dali and Maba and early modern *Homo sapiens* like Longtanshan, Liujiang and Upper Cave. Between Maba and the earliest modern remains is a gap of nearly 100.000 years. Wu and Bräuer (1993: 257) see morphological similarities in some features between early modern specimens from China and African archaic and early modern *Homo sapiens*. These facts, according to Bräuer, make the main pillar of the Multiregional Model rather weak. In replies to Frayer et al. (1993, 1994), Bräuer and Stringer (1994, 1997) questioned the evidence of regional continuity in the Far East. They also see high frequencies of suggested Asian and Australasian clade features among North African late Pleistocene cranial samples (Stringer and Bräuer, 1994: 419). Bräuer and Stringer regard the evidence for regional continuity in the Far East as problematic. According to Bräuer and Stringer (1997: 194), some of these problems are: "Is the respective feature clearly defined? Has the variability and present geographic distribution of the features been determined by adequate worldwide studies? Can a feature occurring among archaic *Homo sapiens* or *Homo erectus* be regarded as representing the

same trait as in recent humans? Has the feature been maintained through drift or selection? Is the feature derived with regard to a specific hominid group? What evidence is needed and available to decide in favor of regional evolution or alternatively, as evidence of mixing or gene flow during a replacement period?"

In his review on the existence of regional continuity features, Stringer (1992: 16-17) pointed out that the percentage occurrence of suggested regional continuity features is in fact highly variable within recent „Mongoloid“ and „Australoid“ crania. Furthermore, he sees that these features are also present in the Middle-Late Pleistocene African hominids (e.g. M3 agenesis, zygomaxillary tubercle). Moreover, he regards these characters as primitive retentions or late local modifications to a fundamentally modern morphology which was probably African in origin. In another work, Stringer (1999: 3) found that Pleistocene fossil crania from China and Japan cannot be shown to be closely related to recent populations of the region. Based on craniometric analyses, he found that Upper Cave 101 resembles Australian, Native American or African crania; Upper Cave 103 resembles Australian or Andamanese crania, Liujiang is close to African or some East Asian crania, and Minatogawa resembles to Australian, Ainu or African specimens.

A very detailed study on the relevance of the proposed regional continuity features in recent populations has been carried out by Lahr (1994). She tested eleven proposed East Asian regional continuity features and nineteen features of Australasians. The eleven East Asian features examined are sagittal keeling; mandibular exostoses; course of the nasofrontal and frontomaxillary sutures; profile of the nasal saddle and nasal roof; rounded frontal; orbital shape; M3 agenesis; reduced posterior dentition; facial flatness; lateral facial flatness; and rounding of the inferolateral margin of the orbit. Among these eleven features only two supposedly showed high frequencies in East Asia as claimed by the supporters of the Multiregional Evolution model. These features are M3 agenesis and lateral facial orientation. Lahr (1994: 32, 34, 41), however, stressed that lateral facial orientation is not associated with facial flatness in terms of alveolar prognathism. She tested also the degree of expression of the suggested regional continuity features among the Epi-Paleolithic populations from Afalou and Taforalt, North Africa and found that facial flatness, frontal flatness and position of minimum frontal breadth are present in highest frequencies in these African samples. In sum, she found that a number of features were more pronounced at a higher frequency in other regions, and not in East Asia or Australia. Moreover, no trait presented an exclusive regional incidence. Thus, according to this study, the proposed East Asian regional features claimed by the Multiregional Evolution model do not characterize this region and therefore should not be used as regional clade traits (Lahr, 1994: 49).

Recently, Brown (1999: 120-121) has pointed out that Upper Cave 101, Liujiang and Minatogawa 1 are not readily recognizable as East Asians or as being ancestors of any modern East Asian population. This conclusion reinforced the previous results reached by other researchers. A number of morphological traits he studied (facial height, shape of orbit, malar morphology, and relative vault dimensions), show that Upper Cave 101, Liujiang and Minatogawa 1 fall outside the broad East Asian range of variation. Facial height, orbital shape, malar morphology and relative vault dimensions exclude them from the East Asians. Moreover, he stated that in the early Holocene and Late Pleistocene, human crania tended to have low, rectangular orbits, a longer and lower cranial vault and greater curvature in the occipital region. Greater supraorbital development, including an inflated glabella, more pronounced superciliary ridges and a depressed nasion were common features in this period throughout the world. In other words, the presence of some of these features in Liujiang, Upper Cave 101 and Minatogawa 1 do not indicate that these features are unique to East Asians.

In his newest work, Hanihara (2000) examined the evidence of the frontal and facial features among modern populations. He compared the frontal and facial features of 112 populations from around the world. The deep infraglabellar notch, marked prognathism, and flat frontal bone show distinctive Australo-Melanesian characters among recent populations. Very flat faces in the transverse plane are the most common condition in eastern Asians. Some sub-Saharan Africans display characteristics similar to Australians in prognathism and flat frontal bones in the sagittal plane, and with Eastern Asians in flat nasal and zygomaxillary regions. Moreover, he pointed out that „the features of Australians having transversely projecting faces and of Eastern Asians showing weak infraglabellar notches, ortho-/mesognathism, and rounded frontal bones can be interpreted as a differential retention of ancestral traits of anatomically modern humans“. Hanihara sees these results as supporting both models, Out-of-Africa and Multiregional.

This review shows that researchers came to different conclusions, although they examined similar features and studied similar materials, both fossils and recent populations. The ‚pros and contras‘ described above show that the occurrence of the regional continuity features is still an important topic in human evolution.

### **1.3.3 Current conclusions and perspectives**

The debate on modern human origins continues to the present (see Frayer et al., 1993, 1994; Stringer and Bräuer, 1994; Bräuer and Stringer, 1997; Wu, 1997). The proponents of the Multiregional model still continue to stress that regional continuity features occur in the Old World. On the other hand, there are many studies denying the occurrence of regional continuity features.

The proponents of the Multiregional Evolution model still argue that there is a continuous succession of human fossil remains in China and that the origins of the multiple features which distinguish the modern East Asian face can be found in the Chinese fossil record of the last million years. The arguments for an occurrence of regional continuity features are based to a large extent on the situation in China. According to the Multiregional Evolution model, the Zhoukoudian remains, Yunxian, Dali and Jinniushan are believed to be a good demonstration of continuing modernization in China. Wu (1997) used the regional continuity features as the basic argument in favor of the Multiregional Evolution model. He claimed a number of features as common traits among the Chinese. However, Wolpoff et al. (1984: 435) see that some of the Chinese regional features change through time. These features may occur in other populations, but not in such high frequency as in China. Pope (1992) even concedes that Jinniushan exhibits non-Chinese features and stated that Jinniushan was possibly an immigrant from outside China.

With regard to regional features, Stringer and Bräuer (1994: 419, see also Stringer, 1992) found that North African late Pleistocene cranial samples show high frequencies of supposed Asian and Australian 'clade' features. Furthermore, Bräuer and Stringer (1997) criticized that the regional features are not clearly defined, for example facial flatness or shape of orbits (see also Habgood, 1992; Lahr, 1996). The increasing evidence from recent studies (see above) shows many problems with most of the suggested regional features.

In order to curtail the artificial polarization and misinterpretations, Bräuer and Stringer (1997: 200) suggested: „It would be more sensible to make efforts to agree on the real problems and then to look for adequate approaches to examine and perhaps to solve them“. Furthermore, Bräuer and Stringer (1997: 197) see that “in particular the model of regional continuity must be demonstrated for each grade of human evolution, including the establishment of present-day regionality”.

## **1.4 Aims of this study**

It is evident that the proposed regional continuity features are still problematic. There are two aspects that can be summarized here regarding the problem of the regional continuity features: The methods of determining the features, and the occurrence of the features among the suggested populations.

## 1. Method of determining the features

It is particularly difficult to examine features which have no standardized definition. How can one compare traits such as malar tuberosity, which some researcher claim to be present in a certain fossil, whereas others declare it is absent in the same fossil. How can one researcher say that the occurrence of the sagittal keeling is strong and another describes it as weak with regard to the same specimen? The interpretation of such features may lead to considerable ambiguities. The second problem is a 'lack of uniformity' in the description of the features. In some cases, the proponents of the Multiregional Evolution model have various definitions. As Bräuer and Stringer (1997) mentioned, facial flatness is a complex feature. How can this feature be determined? Ishida (1992, see also Hanihara, 2000) determined the facial flatness by three different angles of the face. Wu (1995, 1997) did not determine facial flatness as one single character, but he determined this feature by using two of the angles Ishida used and plus another angle. A lack of such agreement on the definition of a feature may lead to confusion and to divergent results.

## 2. The occurrence of the regional continuity features among populations

As explained above, over the past few years a number of specialists have examined the existence of different sets of suggested East Asian regional features (Kamminga and Wright, 1988; Groves, 1989; Habgood, 1992; Bräuer, 1992; Lahr, 1994; Neves and Puciarelli, 1998; Brown, 1999; Hanihara, 2000). Most of them have compared the incidence of these features between recent populations and archaic hominids found in the same region.

With respect to both aspects, the worldwide occurrence of East Asian or Chinese regional continuity traits was examined in this study. Since most of the suggested Chinese characters concentrate on the face (see Pope, 1991), only the features of this anatomical region were analysed here. Based on the proposed features, already available as well as newly developed methods and definitions were used to determine the non-metrical and metrical traits as exactly as possible.

Based on the study of the distribution of the features in recent samples from the different continents it was examined which of the suggested East Asian features occur significantly more frequently in this region. Furthermore, it was explored whether these conditions are also present on fossil human remains from China, thus possibly pointing to some degree of regional continuity.

Besides the important univariate approach, the affinities between the recent samples and fossil Chinese specimens were also analysed by using multivariate statistical methods. It is the aim of the present study to contribute to the understanding of the origin of modern East Asians.

# Chapter 2

## Material and Methods

### 2.1 Material

The cranial samples used in this study derive from various recent populations, including series from China, Indonesia, Greenland, South America, Australia, Melanesia, Polynesia, North Africa, sub-Saharan Africa (South Africa, West Africa and East Africa) and Europe. The criteria for the selection of the populations were:

1. Worldwide geographic representation. The material was not chosen based on 'racial' concepts but rather on geographical criteria, in order to cover the major geographic regions of the world.
2. Availability of complete crania. According to the purpose of this study, only well preserved crania with complete faces were selected.

Moreover, only adult crania were considered based on cranial features and information from museum catalogues. Due to the difficulties in sexing isolated crania from different parts of the world and due to the lack of information on the sex in the museum records, it was decided not to consider the sex here.

The entire recent cranial material consists of 256 individuals, located at the Natural History Museum, London, the Duckworth Collection Laboratory, Cambridge, and the Institute for Human Biology, Hamburg (detailed list of samples see Appendix).

#### 1. *China*

41 individuals were studied. These crania come from native cemeteries from different regions in China, e.g. Shanghai, Ningpo, Hongkong, Peking, Canton, Kowloon and Suchow, and date from the early 1800s. Some of the crania come from outside of the Chinese mainland, having been pirates, seamen or labourers from other regions.

#### 2. *Indonesia*

The Indonesian sample stems from the whole region of Indonesia, i.e. Borneo, Java, Malaya, Moluccas, Bali, Bima, Timor, Makasar, Lampung, Batak and Madura. The sample comes from the period between 1600 and 1900 A.D. The entire sample studied consists of 24 individuals.

### 3. *Greenland*

Sixteen Inuit crania from different regions in Greenland, e.g., Upernavik, Edgesminde, Sermermint and Rodebay, were included in the sample. For some crania the exact locality of origin is unknown.

### 4. *South America*

Nineteen American Indian crania (R. Kruszinsky, pers. comm., 1998) were studied. The specimens come from Peru, Paraguay, Patagonia, Argentina and Cerro del Orro.

### 5. *Australo-Melanesia*

This sample consists of 36 individuals from the whole of Australia and Melanesia: South Australia, Western Australia, New South Wales, Queensland, Tasmania, Papua New Guinea, Solomon Island and Fiji Island. The Australian samples are Australian aborigines (R. Kruszinsky, pers.comm., 1998).

### 6. *Polynesia*

Eleven crania from Polynesia could be analysed. The samples come from New Zealand (Maori) and New Caledonia.

### 7. *North Africa*

The sample consists of 15 individuals from ancient Egypt derived from the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> and 18<sup>th</sup> Dynasties.

### 8. *Sub-Saharan Africa*

This sample consists of 45 individuals; 15 individuals derived from South Africa (Khoisan, Bantu, Zulu, Basuto); 15 derived from West Africa (Ibo, Hausa, Ogoja, Mandingo, Timmanis, Kounga), and 15 individuals derived from East Africa (Lake Nyassa, Tanganyika, Uganda, Mozambique, Mauritius, Teita, Turkana).

### 9. *Europe*

The European material consists of 49 crania, taken from a medieval cemetery in Lübeck, Germany. The skeletal remains were excavated during construction work near the St. Petri church.

### 10. *The Chinese fossil hominids*

Seven casts of Chinese fossil hominids with more or less well preserved faces were examined. The Zhoukoudian *Homo erectus* (*Sinanthropus pekinensis*) was unearthed in 1921-1937 at Zhoukoudian, near Beijing. Recently, this *Homo erectus* site has been

redated based on ESR yielding an age of 300.000-550.000 years B.P. (Grün et al., 1997). In 1937 Weidenreich reconstructed a cranium based on a calotte, a right mandibular corpus and left maxilla (Tattersall et al., 1996: 312). All of these fragments came from individuals identified by Weidenreich as female. In 1996 Tattersall and Sawyer reconstructed another cranium including a left maxilla, left mandibular corpus and right ramus, fragmentary frontal process of the maxilla, a fragmentary left zygomatic, and isolated teeth. The facial morphology of the new reconstruction shows striking differences from that of Weidenreich's. Furthermore, the authors proposed that in terms of overall proportions, the new reconstruction possesses significantly greater facial depth and was identified as a male (Tattersall et al. 1996: 311-314; see also Johanson, 1998). In view of these significant differences both *Homo erectus pekinensis* specimens were included in this study. Another Chinese specimen which was examined is the archaic *Homo sapiens* from Maba. Maba was unearthed in Guandong Province, southern China and is dated to ca. 120.000-140.000 years B.P. (Etler, 1996). The well-preserved fossil cranium from Dali is also included in this study. This specimen could only be assessed based on photographs taken from the literature (Johanson, 1998). The Dali specimen was found in Shaanxi Province, northwestern China and is dated to between 180.000-230.000 years based on U-series (Chen and Zhang, 1991). However, according to Pope (1992) this date cannot be confidently associated with the hominid. Finally, four anatomically modern *Homo sapiens* crania were included in this study. These are the Liujiang and the Zhoukoudian Upper Cave specimens (101, 102, 103) which are 20.000 to 30.000 years old (Etler, 1996). Thus, altogether eight Chinese fossil specimens are included in this study.

**Table 2** Recent cranial samples used in the present study

Major geographic region	N	Location
1 China	41	Natural History Museum, London Duckworth Collection Laboratory, Cambridge
2 Indonesia	24	Natural History Museum, London
3 Greenland	16	Natural History Museum, London
4 South America	19	Natural History Museum, London
5 Australo-Melanesia	36	Natural History Museum, London Duckworth Collection Laboratory, Cambridge
6 Polynesia	11	Natural History Museum, London Duckworth Collection Laboratory, Cambridge
7 North Africa	15	Natural History Museum, London
8 Sub-Saharan Africa	45	Natural History Museum, London Duckworth Collection Laboratory, Cambridge
9 Europe	49	Institute for Human Biology, Hamburg
Total	256	

## 2.2 Methods

### 2.2.1 Features and methods of their assessment

Table 1 (see p. 14) shows the seventeen features of the face, which were analysed in the present study. These features have been suggested by supporters of Multiregional Evolution as regional continuity traits for East Asia.

In order to determine the conditions of the different traits as exactly as possible, descriptive and metrical methods were used. Regarding measurements, I mainly followed the standard references such as Martin/Saller (1958), Howells (1973) and Bräuer (1988). For Martin's measurements the respective numbers are given, and Howells' measurements are indicated by abbreviations plus numbers as in Bräuer (1988; for definitions of the measurements used in this study see Appendix). For some measurements and a number of scoring methods, Lahr's (1996) and Etler's (1994) scoring methods were applied. Furthermore, additional metrical and non-metrical methods were developed in this study.

#### 1. *Sagittal keeling on the frontal*

According to Weidenreich's definition (1943:194), sagittal keeling may be defined as a central ridge or keel, which usually begins above the frontal tuberosity and disappears in the obelion region. At bregma the crest can broaden into a cross-like eminence which extends along the bregmatic section of the coronal suture on either side. Sometimes there is a parasagittal depression on either side. Following Weidenreich's definition, only sagittal keeling on the frontal bone was assessed in this study.

The keeling that is said to be characteristic for China occurs in the middle to upper part of the frontal squama (Wu, 1995: 268; see also Wu and Bräuer, 1993: 244). Furthermore, Wu stated that the shape of keeling is ridge-like and different from that outside China. The keeling is more or less uniform in width along its whole length except the part near the anterior and posterior ends where the keeling attenuates. However, Wu stated that the occurrence of keeling is common in the skulls of *Homo erectus* and early *Homo sapiens* and becomes weaker in the other Pleistocene skulls.

The prominence of the keeling was determined following Etler's grade categories (1994).

Grades:

- a. none
- b. slight (palpable)
- c. moderate (discernible)
- d. strong (clearly visible)

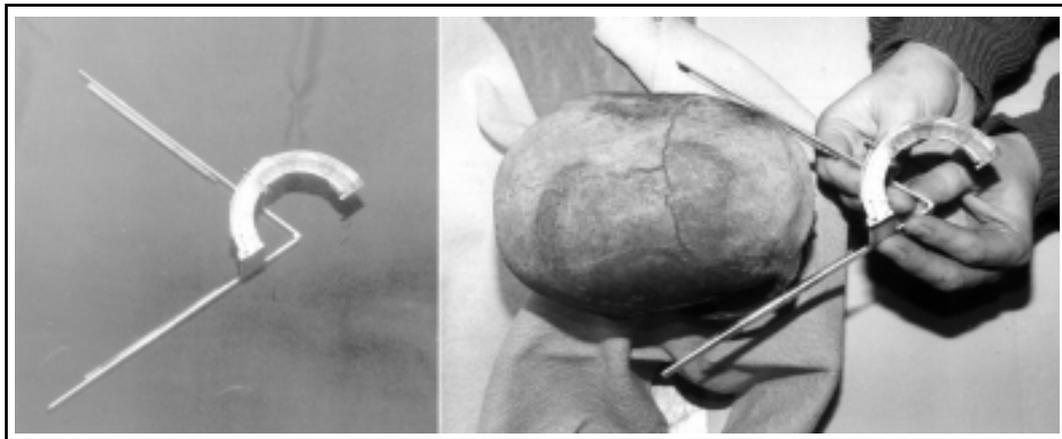
It is often difficult to exactly determine the extension of keeling. Thus, in the present study the location of the keeling was determined by examining where it begins along the frontal squama. The following grades were applied based on the idea of Wu (1995) (see above):

Grades:

- a. Lower part (first third of the frontal squama)
- b. Middle part (second third of the frontal squama)
- c. Upper part of the frontal squama

2. *Pronounced frontal orientation of the malar facies and frontosphenoidal process of the zygomatic bone*

Since in some cases the edges of the process have an orientation different from the center, it is difficult to determine frontosphenoidal orientation of the whole surface of the process. Therefore two different methods to assess this feature were used.



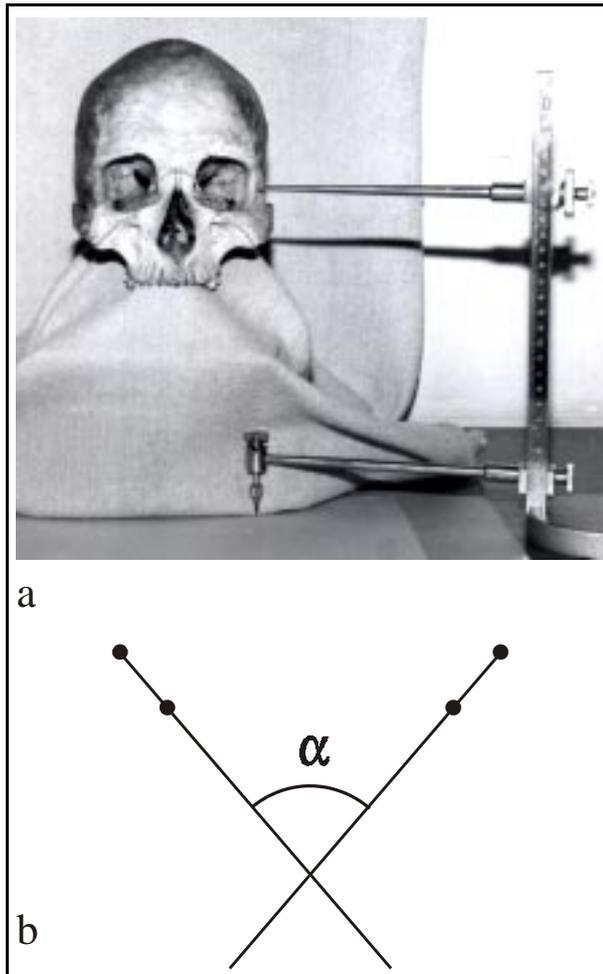
**Fig. 1** Method A: the assessment of the projection of the frontosphenoidal process of the zygomatic bone using a special goniometer (see Knußmann and Bräuer, 1988: 150)

Method A:

In the so-called direct method the angle formed by the antero-lateral surfaces of the right and left frontosphenoidal processes was determined directly using a special goniometer (see Figure 1). This method was first used by Wu and Bräuer (1993). A wider angle implies a more frontal orientation of the frontosphenoidal process of the zygomatic bone. However, this method does often not consider the orientation near the edges of the process.

Thus, a second method was developed in order to determine the angle formed by the antero-lateral surfaces of the right and left frontosphenoidal processes more accurately.

## Method B:



**Fig. 2** Method B: (a): The assessment of the projection of the fronto-sphenoidal process of the zygomatic bone using a perigraph. (b): The two lines form the angle between the frontosphenoidal processes.

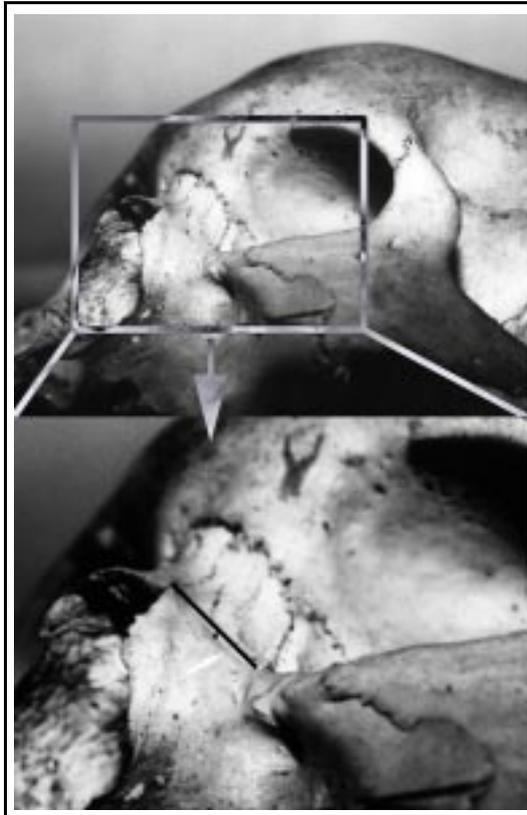
Two points close to the anterior and posterior edges in the middle of the frontosphenoid process were determined using a perigraph (see Figure 2a). The two lines joining these points form an angle that was measured to show the degree of the orientation (see Figure 2b). The angle was measured without considering a midsagittal plane. Concerning method B, the problem of bilateral assymetry might appear. As assymetry is not of much relevance for this study, this problem was not considered.

### *3. Anteriorly facing frontal process of the maxilla with distinct paranasal inflation*

The degree to which the frontal process of the maxilla faces forward was determined based on the convexity of this feature. This feature is best viewed from below and obliquely (see Figure 3). The simplest method to determine the degree of convexity is by applying a ruler to the middle of the frontal process at the level of the inferior orbital border. Compared to the straight edges of the ruler one can determine, whether the frontal process is convex or not. The degree of anteriorly facing frontal process of maxilla was assessed based on following grade categories:

Grades:

- a. concave    b. flat    c. convex



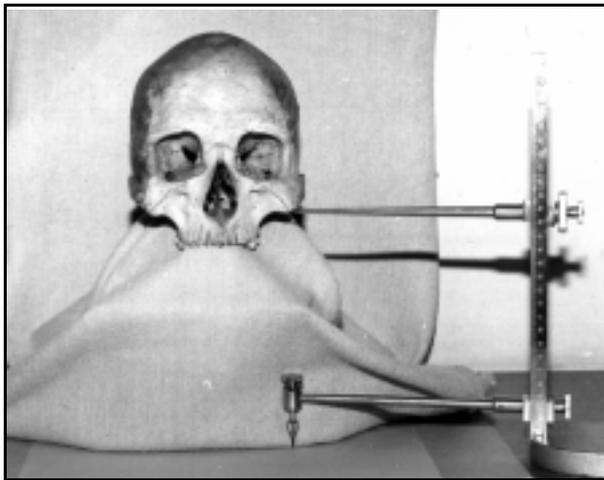
**Fig. 3** Anteriorly facing frontal process of maxilla

*4. Anterior surface of the zygomatic process of maxilla faces forward*

The forward orientation of the zygomatic process of the maxilla is regarded as a distinct character of the Chinese (Wu, 1997: 285). To determine the degree of projection of the zygomatic process, the method suggested by Wu (pers. comm. 1998) was applied: the horizontal contour of the maxillary bone passing through the zygomaxillare (zm) of both sides was taken to describe the orientation of the anterior surface of the zygomatic process of the maxilla. The line drawn using a perigraph can be seen in Figure 5. Assymetry was not considered in this study. However, to avoid a biased interpretation only the left side of the crania was analysed.

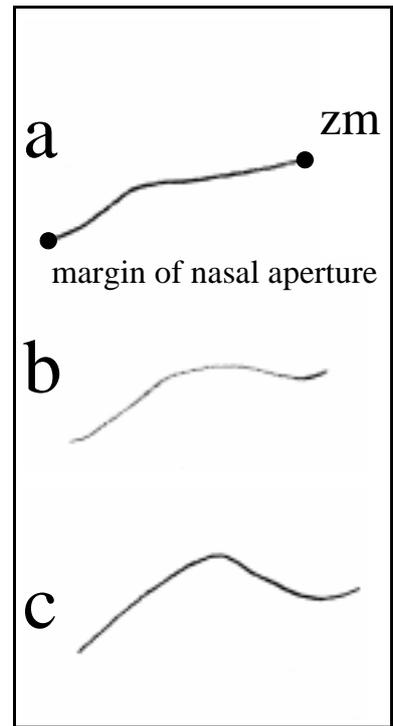
Grades:

- a. receding (Fig. 5a)  
b. transverse (flat) (Fig. 5b)  
c. protruding (Fig. 5c)



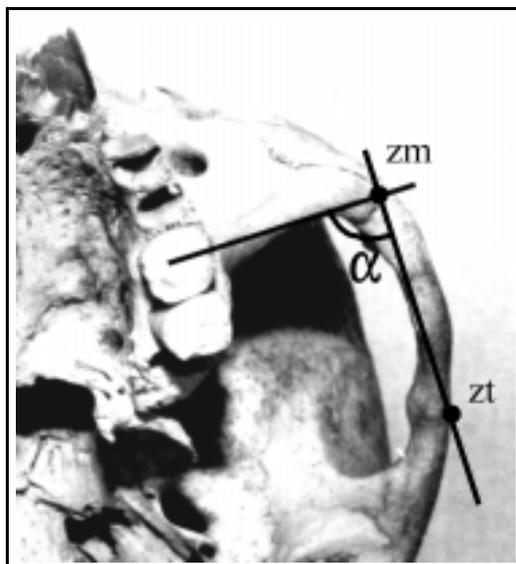
**Fig. 4** The assessment of the orientation of the anterior surface of the zygomatic process using a perigraph

**Fig. 5** Line drawing of the anterior surface of the zygomatic process of maxilla



5. *Junction of the lower margins of the maxilla and zygomatic bone is more angular in shape*

This feature is best determined from below. To determine the shape of the junction of the maxilla and zygomatic bone, a straight line was drawn along the zygomatic bone from zygotemporale (zt) to zygomaxillare (zm). Another line was drawn along the lower border of the maxillary bone to zm. The angle representing the junction of the lower margins of maxilla and zygomatic bones is measured on the photograph as shown in Figure 6.



**Fig. 6** Junction of the zygomatic process of the maxilla and the maxillary process of the zygomatic bone determined as an angle ( $\alpha$ ).

## 6. Facial height reduction

To determine the absolute and relative heights of the face the following measurements were used:

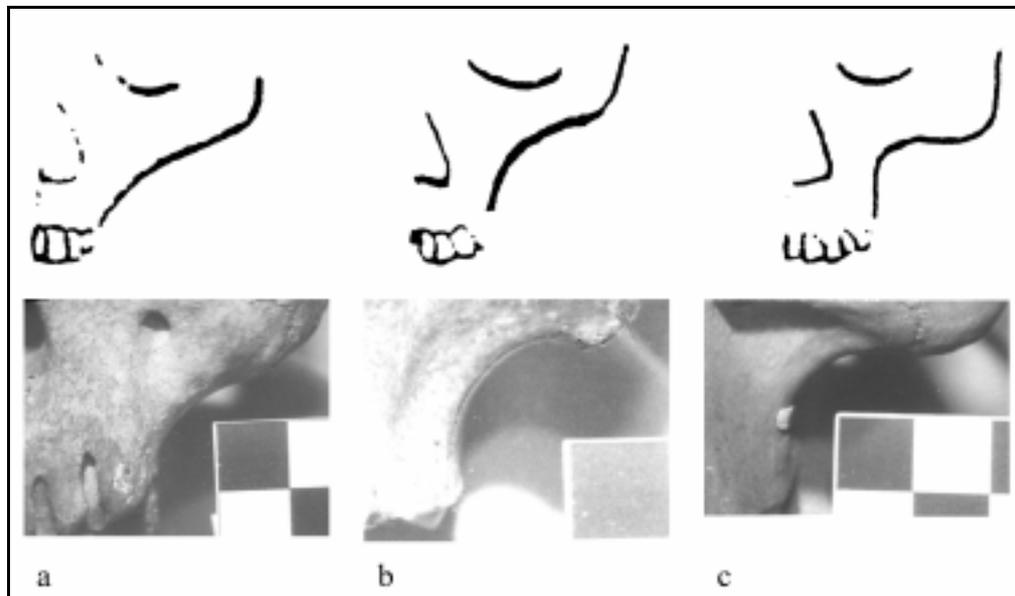
- Nasion-prosthion height (NPH) (48)
- Bizygomatic breadth (45)
- Upper facial index (I39)
- Bimaxillary breadth (46)
- Malar-upper facial index (I 39(1))

## 7. Lower border of the zygomatic process of the maxilla oriented horizontally

The lower border of the zygomatic process of the maxilla can be best seen in frontal view. The orientation of the lower border of the zygomatic process of the maxilla can be determined by the line from the alveolar plane to the zygomaxillare (see also Pope, 1991: 197). Etler's (1994) grade categories were applied in this study (see Figure 7).

Grades:

- oblique (Fig. 7a)
- arched (Fig. 7b)
- horizontal (Fig.7c)



**Fig. 7** Course of the lower border of the zygomatic process of the maxilla (after Etler, 1994)

#### 8. Middle part of the face is not very protruding

This feature concerns the flatness of the middle part of the face. It can be measured by the zygomaxillary angle which was determined by the following measurements:

- Bimaxillary breadth (ZMB) (46b)
- Bimaxillary subtense (SSS) (46c)
- Zygomaxillary angle (SSA) (76a)

#### 9. Lack of anterior facial projection and low degree of prognathism

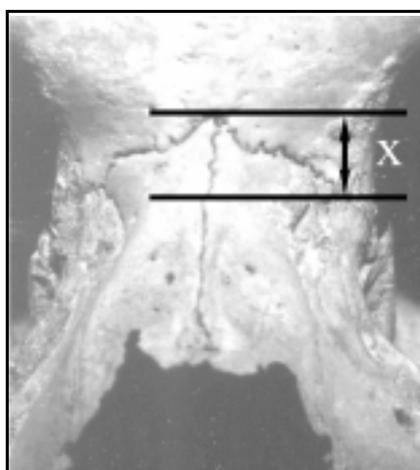
The degree of mid-sagittal facial projection or prognathism is measured here by the profile angle and the alveolar profile angle. In addition the Gnathic index was determined.

The following measurements were taken:

- Profile angle (72)
- Alveolar profile angle (74)
- Basion-nasion length (BNL) (5)
- Nasion-prosthion height (NPH) (48)
- Basion-prosthion length (BPL) (40)
- Gnathic index (I60)

#### 10. Horizontal course of the nasomaxillary and frontomaxillary sutures

To determine whether the nasofrontal and frontomaxillary sutures form a continuous horizontal course as described by Weidenreich (1943: 71), the distance between both sutures was measured following Lahr's method (1996: 57): The trait was measured by drawing a horizontal line from nasion to the orbital edge, then measuring the distance (x) between this line and a parallel line through the frontomaxillary suture at the orbital edge (see Figure 8). In cases where the nasofrontal and frontomaxillary sutures follow a horizontal course, the distance should be zero.



**Fig. 8** Vertical distance between nasofrontal and frontomaxillary sutures (after Lahr, 1996)

## 11. Flatness of the nasal region

This is a complex feature consisting of the profile of the nasal saddle and nasal roof as well as of the non-depressed nasal root.

### 1. Profile of nasal saddle and nasal roof

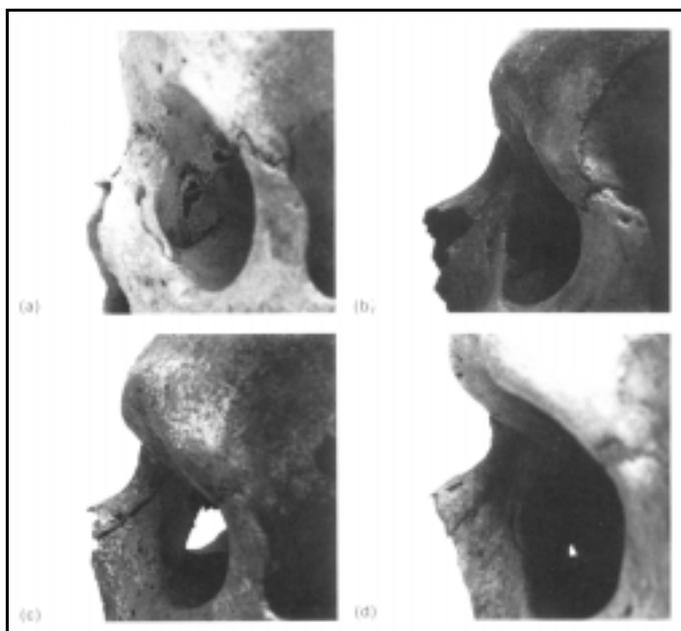
Among the Chinese, the flatness is claimed to be particularly evident in the upper part of the nasal bones (see Wolpoff et al., 1984: 435; Frayer et al., 1993: 25). The angle measured in this area implies the degree of flatness. The variation regarding flatness of the whole nasal bones was also measured.

To assess the degree of flatness, the following measurements were taken:

- Simotic chord (WNB) (57)
- Simotic subtense (SIS) (57a)
- Simotic angle (SIA) (75b)
- Upper breadth of nasal bones (at frontonasal suture)
- Nasion subtense to upper nasal breadth

### 2. Non-depressed nasal root

A non-depressed nasal root indicates a flat upper region of the nasal bones and is best viewed from lateral (see Figure 9). The flattened nasal root was determined in relationship to the projection of the glabella. The determination of the degree of flatness was based on Lahr's grade categories (1996:343-344), consisting of four grades.



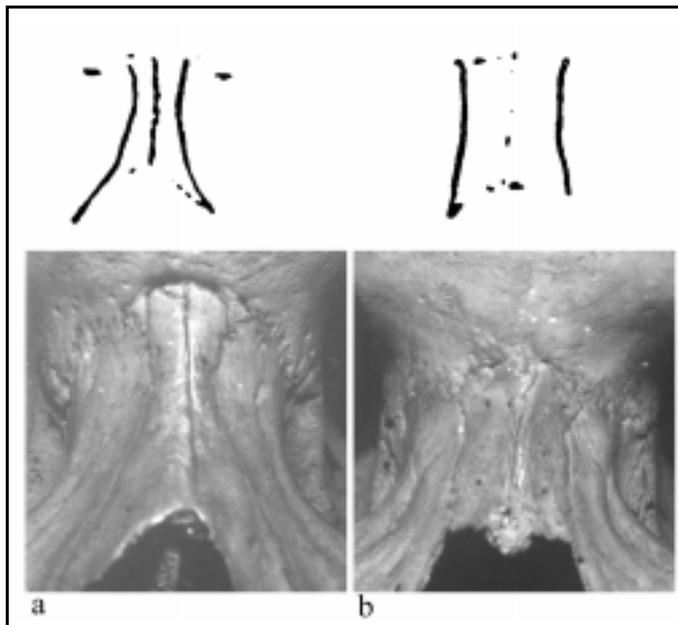
**Fig. 9** Different degrees of nasal root depression (from Lahr, 1996: 344)

Grades:

- a. Non-projecting glabella and flat nasion; both landmarks on approximately the same level (Fig. 9a)
- b. Slightly or non-projecting glabella, but angled nasals, forming a slight curve in profile (Fig. 9b)
- c. Prominent glabella and relatively deep and wide nasion angle or depression (Fig. 9c)
- d. Very prominent glabella, with very deep and narrow nasion angle or depression (Fig. 9d)

*12. No difference between upper and middle part of the nasal bones*

This feature describes the shape of the upper part of the nasal bones. As stated by Weidenreich (1943: 74): „There is practically no difference between the upper breadth and the least one which usually is found within the upper moiety of the bone“. Etler (1994) has developed grade categories to describe this feature (see Figure 10).



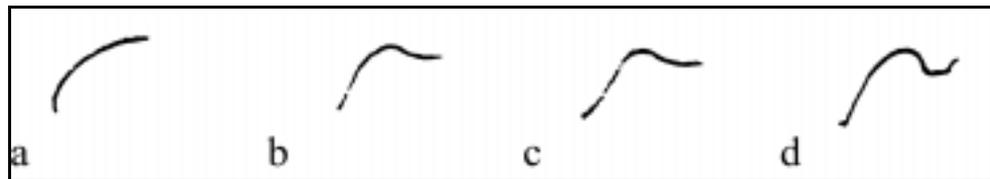
**Fig. 10** The difference between upper and middle part of the nasal bones following Etler's grade scores (1994)

Grades:

- a. different (Fig. 10a)
- b. not different (Fig. 10b)

*13. Presence of incisura malaris*

The incisura malaris is described in East Asians as a deep notch which separates the masseteric margin and the malar tuber from the ascending root of the process (Weidenreich, 1943: 82). Frayer et al. (1993: 25, see also Pope, 1991, 1992) state that a



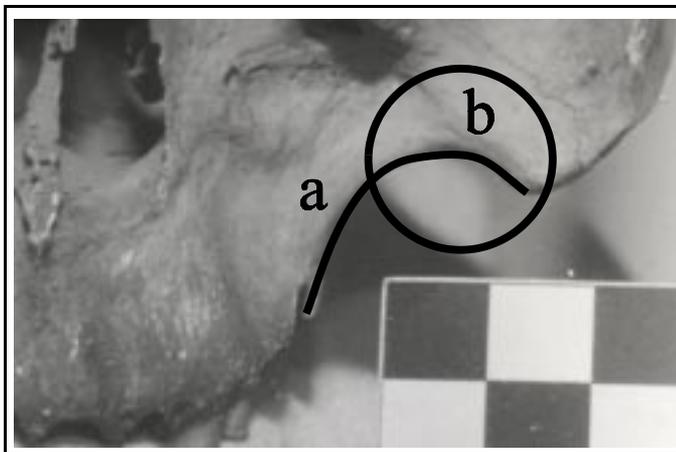
**Fig. 11** Presence of incisura malaris, based on Etler's grade scores (1994)

distinct notch along the lower border of the cheek is frequent among the Chinese. To determine the depth of the notch, Etler's (1994) grade categories were applied.

Grades:

- a. none (Fig. 11a)
- b. weak (Fig.11b)
- c. moderate (Fig. 11c)
- d. strong (Fig. 11d)

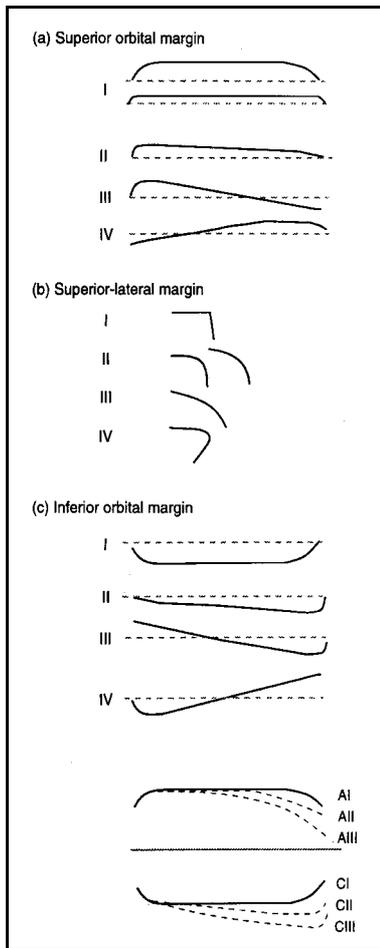
This feature differs from feature 7 (lower border of the zygomatic process of maxilla), in that the lower border of the zygomatic process of the maxilla describes the course of the lateral wall of the maxilla (see Figures 7, 12a; Wu, 1995: 272; Pope, 1991: 196). In contrast the incisura malaris (Figure 12b) is a deep notch lying between the lower border of the zygomatic process of the maxilla and the zygomatic bone, separating the masseteric margin and malar tuber (see above; Wu, 1995: 272).



**Fig. 12** Lower border of the zygomatic process of maxilla and incisura malaris: the difference of location

#### 14. Shape of orbits is more or less quadrangular

Lahr (1996: 67) developed a scoring method for the shape of the orbit (see Figure 13). She used the relative inclination of three elements of the orbit: the superior, lateral and inferior borders. She did not treat „the shape of orbits as a single character in terms of variation (,square‘, ,rounded‘, ,rectangular‘), but as a complex trait composed of three elements: (1) frontal element or superior orbital margin; (2) a zygomatico-frontal element



**Fig. 13** Shape of orbits, based on the inclination of the superior, lateral and inferior part of the orbit (from Lahr, 1996: 67)

or superior lateral corner; and (3) a zygomaxillary element or infero-lateral margin. The condition of each of these elements (shape/angle) was combined to obtain orbital shape“.

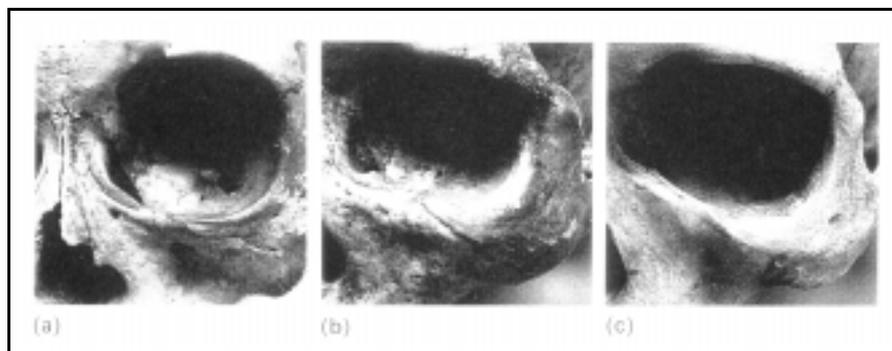
The shape of the orbit is one of the features which is claimed to characterize the Chinese. Being extremely variable, it is a feature difficult to examine. When the proponents of Multiregional Evolution, such as Wu (1995: 271), suggested that the common shape of the orbit among ‚Mongoloids‘ is rectangular, with the only exception of the early late Pleistocene hominid from Maba, they did not clearly define to which rectangular shape they were referring. For example the ‚rectangular‘ orbit of Liujiang is different from that of Upper Cave. Therefore, Lahr’s method was used as a more adequate method for determining the shape of the orbits and to largely avoid the subjectivity in determining the shape of orbit. The term ‘rectangular’ or ‘spherical’ is too vague to categorize any shape of orbit. With respect to this problem, the terms ‚rectangular (quadrangular) or spherical‘ are not used in this study.

### 15. Rounded inferolateral margin of the orbit

A well known feature among the suggested ‚Mongoloid‘ traits is the rounding of the infero-lateral margin of the orbits. According to Wu and Bräuer (1993), this trait shows a range of variation commonly seen also in Africa without significant differences. However, this trait is still used as a characteristic of China. Weidenreich (1943: 84) stated: „I failed to find any data recording the frequency of this feature in different races but, as much as I was able to see, an even floor and a rounded inferior lateral angle, as they occur in *Sinanthropus*, are rather common features in Mongolian skulls“. According to Weidenreich’s definition (1943: 84), there are two independent elements: 1. There is no sharply edged margin but a rounded one, 2. The facies orbitalis does not slope to a deep depression beyond the margin but stays even. It is possible for both elements to occur in the same individual. Lahr’s grade scores were applied in this study (1996: 352, see Figure 14).

Grades:

- a. Sharp, high line dividing the floor of the orbit from the facial portion of the malar (Fig. 14a)
- b. Relatively rounded orbital margin, but raised in relation to the floor of the orbit (Fig. 14b)
- c. Pronounced rounding of the inferior lateral border, which is levelled with the floor of the orbit (Fig. 14c)



**Fig. 14** Rounding of infero-lateral margin of orbit (from Lahr, 1996: 352)

### 16. Presence of malar tuberosity

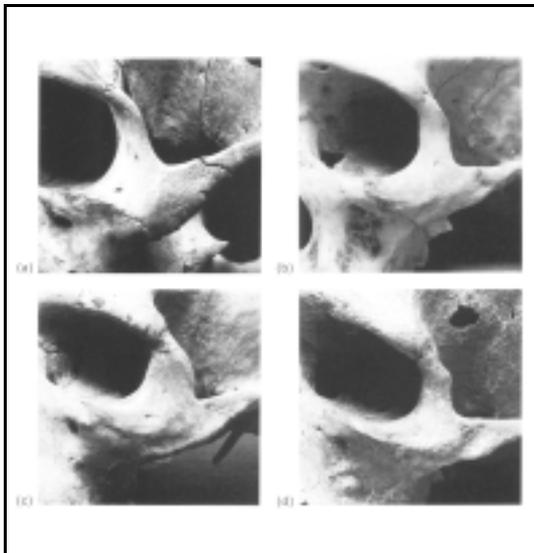
A tuberosity is a large, usually rugose eminence of variable shape; it is often a site of tendon or ligament attachment (White, 1991). Weidenreich (1943: 83-84) has defined the malar tuberosity as follows: „viewed from below, this malar tuber appears as a knob-like thickening of the whole region. The surface of the projection is generally smooth; but crossing it from front to back there is a slightly rough band which continues in an elevated

line directed upward on the reverse side, the facies temporalis. This structure probably represents the remainder of the obliterated zygomaticomaxillary suture“. Weidenreich’s definition can be difficult to examine, because it is problematic to differentiate whether it is a malar tuberosity or only a bulging malar bone. Therefore, the malar tuberosity as defined by Ferner (1939), and also mentioned by Weidenreich (1943), was applied in this study: „The malar tuberosity is a prominent ridge on the malar surface running parallel with the inferior border of the bone. In other words, the zygomaxillary tuberosity is an elevation on the malar surface between its orbital and free margins. This elevation may develop into a pronounced ridge, running parallel to the inferior free border, which virtually divides the malar surface into upper and lower portions“.

To determine the variation of presence of a malar tuberosity, Lahr’s grade categories were applied as follows:

Grades:

- a. Surface of the malar bone is smooth and flat (Fig. 15a)
- b. Presence of a tubercle of small dimensions (Fig. 15b)
- c. Tubercle present, more pronounced and horizontally extended (Fig. 15c)
- d. Very large tubercle, forming a ridge along the surface of the malar, parallel to the lower free margin of the bone (Fig. 15d)



**Fig. 15** Conditions of malar tuberosities (from Lahr, 1996: 347)

### 17. Large naso-malar angle

Regarding the flatness of the upper part of the face, the following measurements were taken:

- Bifrontal breadth (FMB) (43a)
- Nasio-frontal subtense (NAS) (43b)
- Nasio-frontal angle (NFA) (77a)

Compared with trait 2 (frontal orientation of the facies malaris and the frontosphenoidal process of the zygomatic bone), this feature refers to the position of nasion in respect to the lateral rims of the orbits, thus providing another aspect of facial flatness.

Since feature 11 was divided into two traits, eighteen suggested regional continuity features were analysed in this study: for a detailed assessment of these traits a total of 25 metrical and 11 non-metrical variables were used. Table 3. gives a list of the features and the variables used in this study

**Table 3** The eighteen suggested East Asian regional continuity features and the variables for analysis applied in this study.

No.	Feature	Variables used in this study
1	Sagittal keeling on the frontal	1. Expression of keeling (after Etler, 1994) 2. Location of keeling
2	Frontal orientation of the malar facies and the frontosphenoidal process of the zygomatic bone	1. Method A (using a special goniometer) 2. Method B (using a perigraph)
3	Anteriorly facing frontal process of the maxilla with distinct paranasal inflation	1. Projection of the frontal process of the maxilla
4	Anterior surface of the zygomatic process of the maxilla faces more forward	1. Projection of the zygomatic process of the maxilla (after Wu, pers. comm. 1998)
5	Junction of the lower margins of the maxilla and the zygomatic bone is more angular in shape	1. Junction between the maxilla and the malar bone
6	Facial height reduction	1. Nasion-prosthion height (NPH) (48) 2. Bizygomatic breadth (45) 3. Upper facial index (I39) 4. Bimaxillary breadth (46) 5. Malar-upper facial index (I39(1))
7	Lower border of the zygomatic process of the maxilla is oriented horizontally	1. Orientation of the lower border of the zygomatic process of the maxilla (after Etler, 1994)

No.	Feature	Variables used in this study
8	Middle part of the face is not very protruding	1. Bimaxillary breadth (ZMB) (46b) 2. Bimaxillary subtense (SSS) (46c) 3. Zygomaxillary angle (SSA) (76a)
9	Lack of anterior facial projection and low degree of prognathism	1. Profile angle (72) 2. Alveolar profile angle (74) 3. Basion-nasion length (5) 4. Nasion-prosthion height (NPH) (48) 5. Basion-prosthion length (BPL) (40) 6. Gnathic index (I60)
10	Horizontal course of the nasomaxillary and frontomaxillary sutures	1. Distance between nasofrontal and frontomaxillary sutures (after Lahr, 1996)
11	Flatness of the nasal region	1. Simotic chord (WNB) (57) 2. Simotic subtense (SIS) (57a) 3. Simotic angle (SIA) (75b) 4. Upper breadth of the nasal bones (at frontonasal suture) 5. Nasion subtense to upper nasal breadth
12	Non-depressed nasal root	1. <i>Profile of the nasal root (after Lahr, 1996)</i>
13	No difference between upper and middle part of the nasal bones	1. <i>The difference between upper and middle part of the nasal bones (after Etler, 1994)</i>
14	Presence of the incisura malaris	1. <i>Incisura malaris (after Etler, 1994)</i>
15	Shape of orbits	1. <i>Shape of orbit (after Lahr, 1996)</i>
16	Rounded inferolateral margin of the orbit	1. <i>Rounded inferolateral margin of the orbit (after Lahr, 1996)</i>
17	Presence of the malar tuberosity	1. <i>Malar tuberosity (after Lahr, 1996)</i>
18	Large naso-malar angle (Nasio-frontal angle)	1. Bifrontal breadth (FMB) (43a) 2. Nasio-frontal subtense (NAS) (43b) 3. Nasio-frontal angle (NFA) (77a)

Non-metrical variables are in *italics*

### 2.2.2 Statistical methods

To describe the variation of the variables various parameters were calculated. For the quantitative variables the arithmetic mean ( $\bar{x}$ ), the standard deviation (sd) and the coefficient of variation (CV) are given. The smallest (min) and largest (max) values are also shown. The qualitative variables were described using frequency tables.

To test whether there are significant differences between the means of the various samples the Analysis of Variance (ANOVA) was applied. This method can be used under

the assumptions that the data are normally distributed and there is homogeneity of the variances. To examine these conditions the Kolmogoroff-Smirnoff test and the Levene test were used (SPSS Base 8.8, 1998; Norusis, 1990; Sachs, 1997). The Levene Test was applied because it is fairly robust to deviations from normality (SPSS Base 8.8, 1998). The statistical significant of the F-values was determined as follows:

$$F = \frac{\frac{SS_{between}}{k-1}}{\frac{SS_{within}}{N-k}} = \frac{MS_{between}}{MS_{within}}$$

In which SS is the sum of squares; MS, mean squares (variance); df, the degree of freedom as symbolized by (k-1) and (N-k). The levels of significance used here are 5%; 1%; and 0.1%. The null hypothesis is rejected if the F value is significant at the respective level.

However, the F-value of ANOVA test does not show which populations differs from others. Therefore, to find which populations were significantly different from others, the Scheffé Range test was used here. As a multiple comparison of mean-test, the Scheffé Range test is recommended especially if the number of compared samples are unequal (Knußmann, 1992).

Concerning the non-metrical variables, significant differences in the distribution of frequencies of a trait among the samples can best be determined by a test of independence from a contingency table. The method to test it is the  $\chi^2$  Test. The formula of the  $\chi^2$  is described as follows:

$$\chi^2 = \sum_{i=1}^k \sum_{j=1}^l \frac{(o_{ij} - e_{ij})^2}{e_{ij}}$$

where  $o$  is the observed value for the  $i_{th}$  category,  $e$  is the expected value for the  $i_{th}$  category, and  $k$  is the total number of categories. The  $\chi^2$ -statistics are based on the differences between the observed and expected values. In other words,  $\chi^2$  is the sum of the squared differences between the observed and expected values, divided by the expected value. To test the significance,  $\chi^2$ -value was generally used. Since there were too many cells with expected values less than 5, a Monte Carlo simulation was applied. This method is reliable and provides an unbiased estimate of the exact p value (Mehta and Patel, 1996).

Besides the univariate calculations, a multivariate analysis was also carried out in order to study the relationship between recent groups and fossil specimens based on a number of variables. Principal Components Analysis (PCA) was used since it allows the reduction

of many intercorrelated variables to a few new variables or components. The components can be interpreted with regard to the original variables (factor loadings) and it is possible to calculate the positions of the individuals (factor scores) on the new components. PCA was calculated using both the raw data and shape transformed variables. This latter transformation was proposed by Darroch and Mosiman (1985; see also Corruccini, 1987; Simmons et al., 1991). This method allows one to eliminate the size factor which might be of special importance when dealing with individual specimens as in this study. Size is defined here as the geometric mean of all variables. The geometric mean of  $n$  variables is calculated as  $\bar{x}_g = (x_1 \cdot x_2 \cdot \dots \cdot x_n)^{\frac{1}{n}}$ . Each variable is divided by the geometric mean of that case to create a scale-free, or dimensionless, shape variable. Then, this variable is log-transformed to create a log-shape variable (Simmons et al., 1991).

All statistical calculations were done using SPSS for Windows 9.0.1 and STATISTICA 5.5 in the Institute for Human Biology, University of Hamburg.

## Chapter 3

### Results

#### 3.1 The occurrence of the suggested East Asian regional continuity traits in China

Eighteen suggested East Asian regional continuity features listed in Table 3 have been studied by using 25 metrical and 11 non-metrical variables. The metrical variables were analysed with an ANOVA test and the non-metrical variables were tested with Chi-square. The levels of significance used in this study are 0.001 (\*\*\*), 0.01 (\*\*) and 0.05 (\*). The basic statistical results of the measurements for each population are illustrated in the Tables and Figures in this section. The Boxplots display the variation in all samples, using China as a basis for comparison. The line plot graphics display the mean values which were sorted from the smallest to the greatest, to find which populations tend to be close to others.

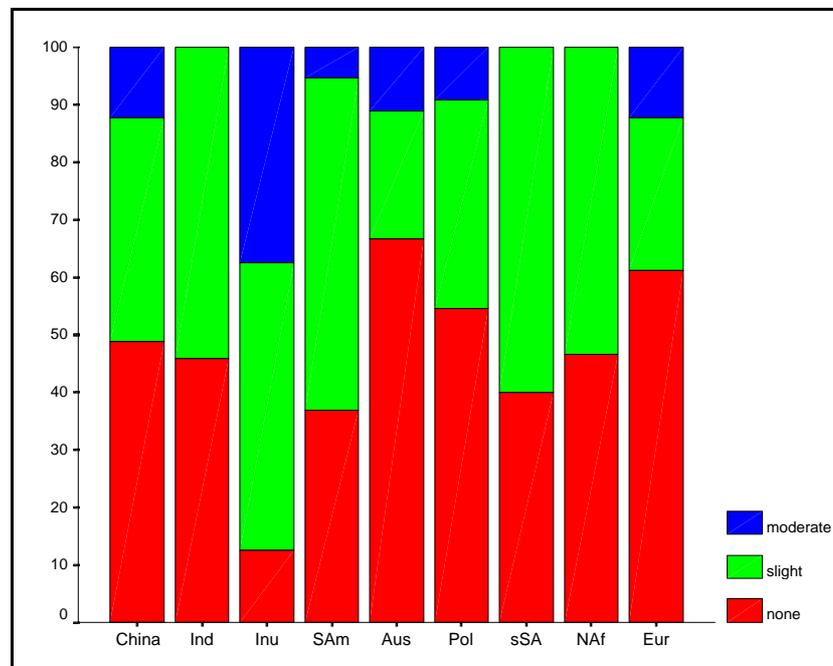
In the next step, the distribution of the variables were described in order to assess the occurrence of the suggested East Asian regional continuity features in the Chinese and other regional samples. Features which occur with higher frequency in China than in other populations or show a significantly different mean value from others are categorized as characteristic for the Chinese population (Weidenreich, 1943; Wolpoff et al., 1984; Wu X, 1995; Frayer et al., 1993; Wolpoff et al., 1994; see also Lahr, 1996; Bräuer and Stringer, 1997).

To find which populations were significantly different from others, the Scheffé Range test was applied based on the ANOVA test. In this case, the Chinese sample is the basis for comparison. In other words, the Chinese were compared primarily with other populations in order to assess whether the occurrence of the regional features is significantly different from other populations. The non-metrical features did not occur as a single value (character) but in grades. The Chi-square test shows that the distributions of most non-metrical features are significant. However, such significant distributions do not yet reflect whether the features examined are typically Chinese or not. Therefore, it will be examined whether other groups show higher frequencies than the Chinese.

##### 3.1.1 Sagittal keeling on the frontal and parasagittal depression

The keeling trait was observed in nine population samples, using the categories: „none“ (absent), „slight“, „moderate“ and „strong“. Figure 16 shows that presence (slight and moderate) and absence of keeling occur with similar frequencies in most samples. „Slight“

keeling occurs more frequently than „moderate“ keelings. In European and Australo-Melanesian populations sagittal keeling is frequently absent. In contrast, the Inuit have a high frequency of keeling: 37.5% of the skulls examined show a „moderate“ degree of this feature and 50% show a „slight“ degree. Similar patterns also occur in sub-Saharan Africans (60% show a „slight“ degree of keeling) and South Americans (57% show a „slight“ keeling and 5.3% a „moderate“ keeling).



**Fig. 16** Occurrence of the sagittal keeling on the frontal

It is evident that, based on the distribution of this feature (see also Table 4), „strong“ sagittal keeling does not appear in any of the populations examined. In addition, parasagittal depressions were not found among the nine population samples.

Concerning East Asian regional continuity, sagittal keeling on the frontal and parasagittal depression are suggested characteristics for China. The distribution of frequencies shows that the Chinese do not exhibit a marked pattern for this feature. Neither presence nor absence of keeling indicate a special pattern of the Chinese sample. Instead, both categories occur approximately in similar frequencies (c. 50%); „slight“ keeling occurs somewhat more frequently (39%) than „moderate“ keeling (12.2%). According to the Multiregional Evolution model, the Chinese should have a greater occurrence of sagittal keeling than other populations (Wolpoff et al., 1984: 435; Wu, 1995: 272). This study shows that sagittal keeling, on the basis of the „moderate“ category, is present in Chinese, but not in as high a frequency as would have been expected. Even when the occurrence of sagittal keeling was determined on the basis of the „slight“ category, the Chinese do not show the highest frequency. The Indonesians, Inuit, South Americans, sub-Saharan Africans and North Africans show a slight keeling in higher frequencies than the Chinese. Of all samples studied, the Inuit are the only

population, in which sagittal keeling is a common condition (50% show slight and 37.5% moderate keeling). Groves (1989: 276) came to similar results. He did not find evidence of sagittal keeling among the modern ‚Mongoloids‘, though he found ridge-like keeling but lack of parasagittal depression among the Eskimo and Australians.

These results do not agree with the suggestion of the Multiregional Evolution model that the presence of sagittal keeling *appears more regularly* in ‚Mongoloids‘ than in groups from any other area.

**Table 4** Occurrence of the sagittal keeling on the frontal (\*\*\*)  $p < 0.001$ )

Sample	none		slight		moderate		total	
	N	%	N	%	N	%	N	%
$\chi^2=45.59, df=16$ ***								
Chinese	20	48.8	16	39.0	5	12.2	41	100
Indonesian	11	45.8	13	54.2	0	0	24	100
Inuit	2	12.5	8	50.0	6	37.5	16	100
South American	7	36.8	11	57.9	1	5.3	19	100
Australo-Melanesian	24	66.7	8	22.2	4	11.1	36	100
Polynesian	6	54.5	4	36.4	1	9.1	11	100
sub-Saharan African	18	40.0	27	60.0	0	0	45	100
North African	7	46.7	8	53.3	0	0	15	100
European	30	61.2	13	26.5	6	12.2	49	100
total	125	48.8	108	42.2	23	9.0	256	100

Another aspect of the sagittal keeling was also examined: its location. Since the end of the keeling was generally less clearly marked, only the beginning of the keeling was used for determining the location. Table 5 illustrates the distribution of the location of the keeling in the nine populations studied.

As shown in Table 5, 131 individuals of the total sample exhibit a sagittal keeling. 84.6% of the total sample show that the keeling starts in the lower part (lower third) of the glabella-bregma arc. Only in 15.38% of the specimens does the keeling begin in the middle part (middle third) of the arc, while no case of keeling has been found in this study that starts in the upper part. In the Chinese sample, the keeling starts in the lower part in 61.9% of the skulls, mostly continuing along the frontal and disappearing near the bregma, whereas in 38.1%, the keeling begins in the middle third. Such a pattern also occurs in the Inuit population: in 71.4% of the keeling in the Inuit sample occurs in the lower part of the glabella-bregma arc and in 28.57% in the middle third. No keeling could be found in any of the individuals that starts in the upper part. Similar patterns of

distribution are also found in the Indonesian, Polynesian, South American, and Australo-Melanesian populations. However, it should be emphasized that the frequencies of middle third keeling are very small in some of these groups, which makes the significance of this condition dubious. It is also lacking completely among the North Africans, sub-Saharan Africans and Europeans.

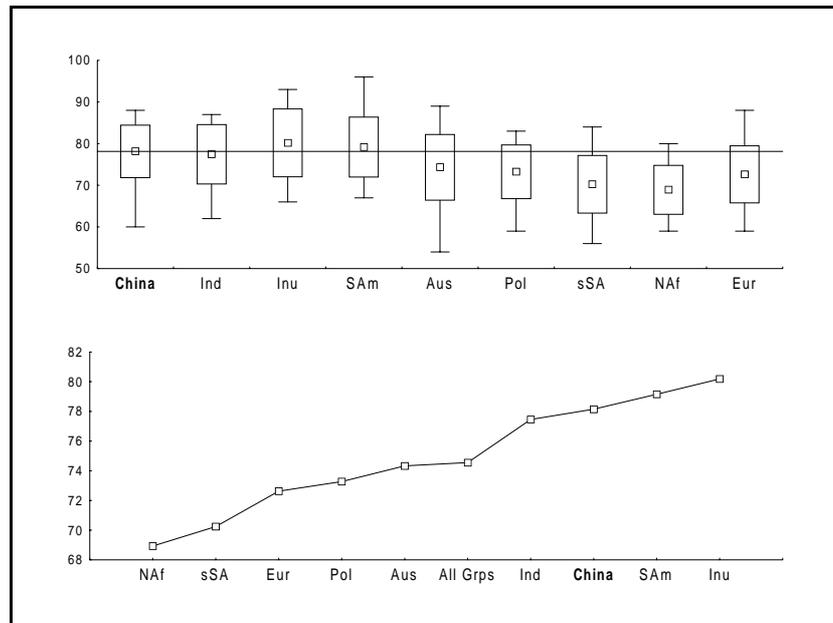
Concerning the Chinese, the results for the location of the keeling do not confirm the suggestion of the proponents of the Multiregional model as e.g. that of Wu (1992) who argues that the keeling in the Chinese occurs in the middle part. This study has shown that the keeling in this area occurs in lower frequency than in the lower part.

**Table 5** The location of the keeling

Sample	lower part		middle part		upper part		total	
	N	%	N	%	N	%	N	%
Chinese	13	61.9	8	38.1	0	0	21	100
Indonesian	12	92.3	1	7.7	0	0	13	100
Inuit	10	71.4	4	28.6	0	0	14	100
South American	10	83.3	2	16.7	0	0	12	100
Australo-Melanesian	10	83.3	2	16.7	0	0	12	100
Polynesian	2	40.0	3	60.0	0	0	5	100
North African	8	100.0	0	0.0	0	0	8	100
sub-Saharan African	27	100.0	0	0.0	0	0	27	100
European	19	100.0	0	0.0	0	0	19	100
total	110	84.6	20	15.4	0	0	131	100

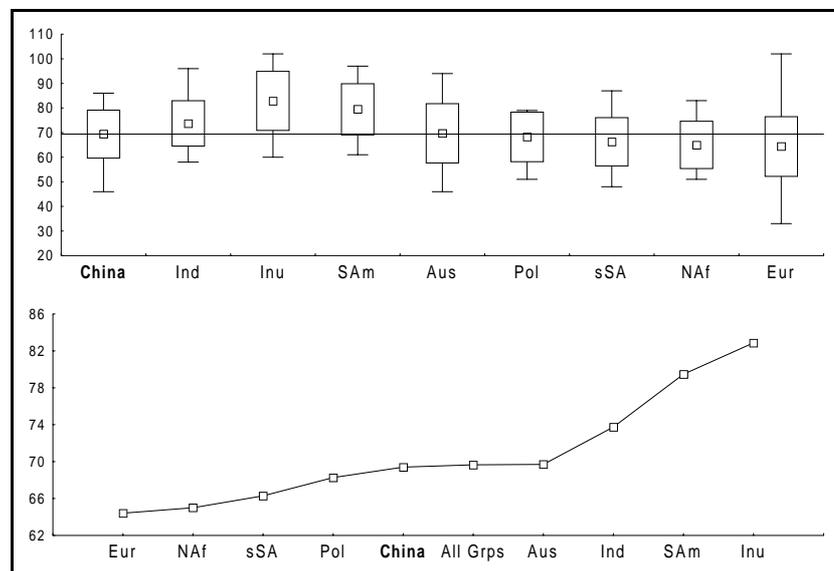
### **3.1.2Pronounced frontal orientation of the malar facies and the frontosphenoidal process of the zygomatic bone**

As mentioned in Chapter 2, the angle describing the frontal projection of the frontosphenoidal process is determined by two methods. Figure 17 and Table 6 show the variation of the features using method A. There are significant differences among the population samples ( $F=8.00$ ,  $p<0.001$ ), in which the Indonesians, Chinese, South Americans and Inuit have more obtuse angles than others, indicating that the frontosphenoidal process is more frontally oriented. The Europeans, Polynesians and Australo-Melanesians exhibit more intermediate conditions. Other groups that show more acute angles are the African populations (North Africans and sub-Saharan Africans).



**Fig. 17** Variation of the projection of the frontosphenoidal process of the zygomatic bone (angle determined by method A)

In general, the results obtained by using the more precise method B are similar to that of method A (see Figure 18). The Inuit, South Americans and Indonesians represent a group showing a more frontal projection of the frontosphenoidal process. Interestingly, the Chinese fall outside of this group and join other groups that do not show a pronounced



**Fig. 18** Variation of the projection of the frontosphenoidal process of the zygomatic bone (angle determined by method B)

frontal orientation of the frontosphenoidal process. These are the European, North African, sub-Saharan African and Polynesian samples. The variation between the groups (Table 7) is also significant for this variable ( $F=7.80, p<0.001$ )

Do the Chinese exhibit an obtuse angle indicating a marked flatness of the upper face? Based on method A, the Chinese have a mean value of  $78^\circ$  which lies above the mean value of all samples and indicates a rather obtuse angle. At the 5% level, the Chinese differ significantly from the sub-Saharan African and North African samples. These African populations have more acute angles (with means of approximately  $70^\circ$ ). Their frontosphenoidal processes of the zygomatic bones are not as frontally oriented as in the Chinese. Indonesians, Inuit and South Americans are closer to the Chinese and also show obtuse angles. The last two populations even have somewhat more obtuse angles than the Chinese ( $\bar{x}=80.19^\circ$  and  $79.16^\circ$ , respectively).

However, using method B (see Figure 18 and Table 7), the Chinese show a less obtuse angle ( $\bar{x}=69.4^\circ$ ). The mean value of the Chinese falls near the average of all populations ( $70^\circ$ ), i.e. the Chinese do not show a special condition for this feature. With regard to this angle, the Chinese also differ significantly at the 5% level from the Inuit. Compared to the African and European populations, the Chinese are not significantly different. Otherwise, the sub-Saharan Africans ( $\bar{x}=66.29^\circ$ ) and Europeans ( $\bar{x}=64.42^\circ$ ) differ significantly at the 0.1 % level from the Inuit and South Americans, showing a similar pattern to the Chinese. The North Africans ( $\bar{x}=65^\circ$ ) were significantly different at the 1% level from the Inuit. Among the nine samples examined, the Inuit show the most obtuse angle ( $\bar{x}=82.87^\circ$ ), followed by the South Americans ( $\bar{x}=79.47^\circ$ ).

Regardless of how the angle has been determined (method A or B), it is evident that the suggested East Asian condition occurs in other populations as well. The Inuit and South Americans have even more obtuse angles than the Chinese. Moreover, using the more exact method B, the Chinese sample exhibits a lesser degree of frontal projection of the frontosphenoidal process which does not show any significant difference from the Europeans and Africans. Thus, it can be concluded that the condition seen in the Chinese population is not in agreement with the Multiregional model.

**Table 6** Variation of the projection of the frontosphenoidal process of the zygomatic bone (method A)

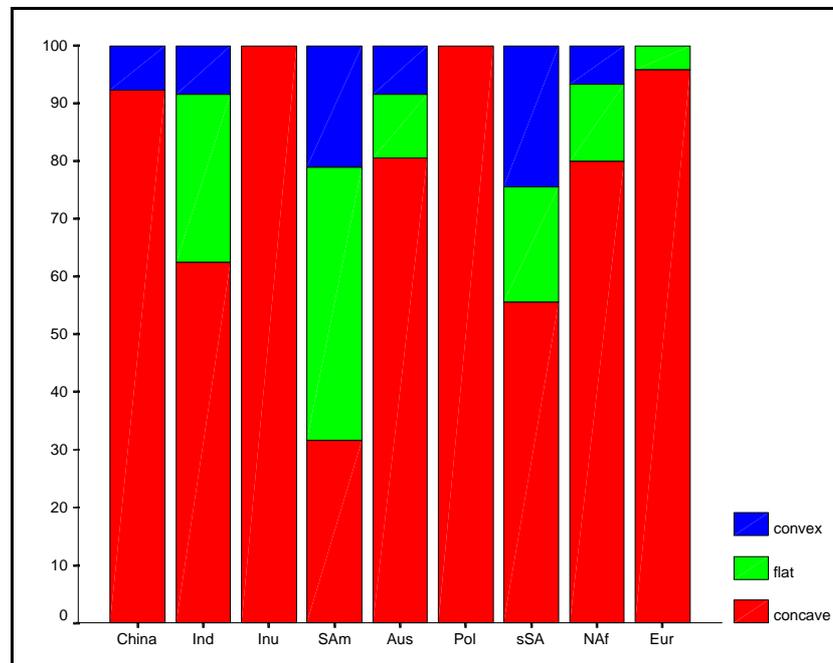
sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	78.15	6.32	8.09	60.00	88.00
Indonesian	24	77.46	7.16	9.24	62.00	87.00
Inuit	16	80.19	8.12	10.13	66.00	93.00
South American	19	79.16	7.20	9.10	67.00	96.00
Australo-Melanesian	36	74.33	7.89	10.61	54.00	89.00
Polynesian	11	73.27	6.45	8.80	59.00	83.00
sub-Saharan African	45	70.24	6.93	9.87	56.00	84.00
North African	15	68.93	5.89	8.54	59.00	80.00
European	49	72.63	6.87	9.46	59.00	88.00
total	256	74.55	7.75	10.40	54.00	96.00

**Table 7** Variation of the projection of the frontosphenoidal process of the zygomatic bone (method B)

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	40	69.40	9.77	14.08	46.00	86.00
Indonesian	24	73.75	9.19	12.46	58.00	96.00
Inuit	16	82.87	11.99	14.47	60.00	102.00
South American	19	79.47	10.43	13.12	61.00	97.00
Australo-Melanesian	36	69.69	12.05	17.29	46.00	94.00
Polynesian	11	68.27	10.03	14.69	51.00	79.00
sub-Saharan African	45	66.29	9.83	14.83	48.00	87.00
North African	15	65.00	9.61	14.78	51.00	83.00
European	48	64.42	12.13	18.83	33.00	102.00
total	254	69.65	11.85	17.01	33.00	102.00

### 3.1.3 Anteriorly facing frontal process of the maxilla with distinct paranasal inflation

The conditions of the projection of the frontal process of the maxilla were determined using the categories „concave“, „flat“ and „convex“. Figure 19 and Table 8 show that concavity of the frontal process occurs in high frequencies among the populations examined, indicating a common condition. The Inuit and Polynesians exhibit 100% concavity at the frontal process of the maxilla, followed by Europeans and Chinese ( $\bar{x}$ =95.9% and 92.3%, respectively). Flat frontal processes occur more rarely; the South American, Indonesian and sub-Saharan African samples show relatively high frequencies of this category ( $\bar{x}$ =47.4%, 29.2% and 20%, respectively). A convex frontal process occurs in only 9.5% of all samples. The South Americans show this category in 21.1% and sub-Saharan Africans in 24.4%.



**Fig. 19** Variation of the anteriorly facing frontal process of maxilla

The anteriorly protruding frontal process of the maxilla („convex“ category) should be a common condition among the Chinese as suggested by the supporters of the Multiregional Evolution model (Frayser et al., 1993: 25; see also Wolpoff et al. 1994: 186-187). In contrast, this study shows that only 7.7% of the Chinese have an anterior bulging of the frontal process of the maxilla (convexity). Moreover, the South Americans and sub-Saharan Africans show higher frequencies in this category, though it is not a common trait here. The present results show that the „convex“ category is neither a characteristic of the Chinese, nor a very frequent condition in other populations.

**Table 8** Variation of the anteriorly facing frontal process of maxilla (\*\*\*) $p < 0.001$ 

Sample	concave		flat		convex		total	
	N	%	N	%	N	%	N	%
$\chi^2=69,64$ df=16 ***								
Chinese	36	92.3	0	0	3	7.7	39	100.0
Indonesian	15	62.5	7	29.2	2	8.3	24	100.0
Inuit	15	100.0	0	0	0	0	15	100.0
South American	6	31.6	9	47.4	4	21.1	19	100.0
Australo-Melanesian	29	80.6	4	11.1	3	8.3	36	100.0
Polynesian	11	100.0	0	0	0	0	11	100.0
sub-Saharan African	25	55.6	9	20.0	11	24.4	45	100.0
North African	12	80.0	2	13.3	1	6.7	15	100.0
European	47	95.9	2	4.1	0	0	49	100.0
total	196	77.5	33	13.0	24	9.5	253	100.0

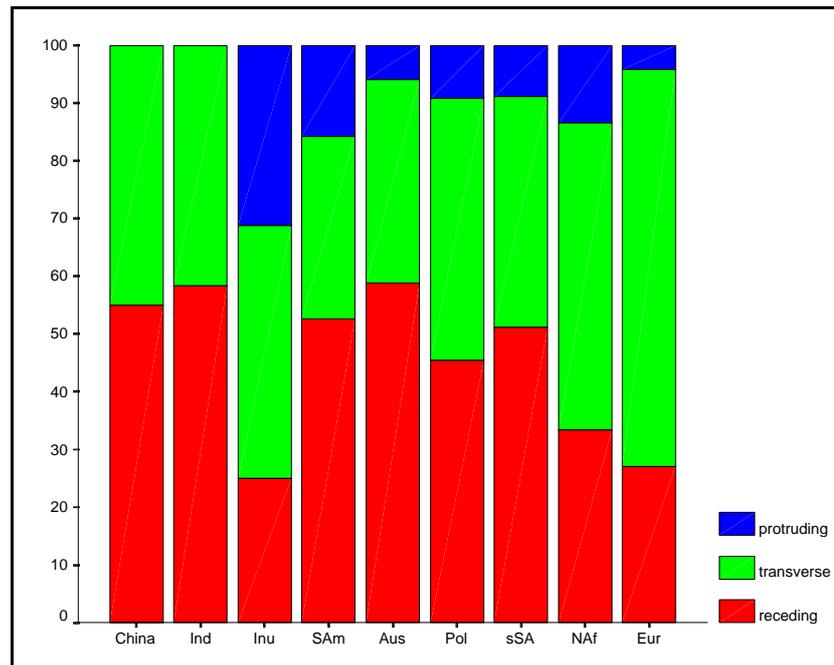
### 3.1.4 Anterior surface of the zygomatic process faces more forward

The orientation of the zygomatic process of the maxilla was expressed through three categories: „receding“, „transverse“ and „protruding“. Table 9 (see also Figure 20) shows the distribution of these three categories that was statistically significant. The „receding“ and „transverse“ categories of the zygomatic process of the maxilla have approximately similar frequencies in the total sample (46%). This indicates that both categories are normal conditions among the samples. The Indonesian and Australo-Melanesian samples show higher frequencies of the „receding“ category, whereas the „transverse“ category occurs mostly in Europe and North Africa. Only 7.5% of the total sample show a protruding zygomatic process of the maxilla. Of these, the Inuit have the highest frequency.

Of the three categories, the Chinese sample shows only two („receding“ and „transverse“), both of which occur with approximately similar frequencies. A protruding surface of the zygomatic process of the maxilla was totally absent in the Chinese sample.

The proponents of the Multiregional Evolution model suggest that the protruding surface of the zygomatic process of the maxilla is a characteristic of the Chinese, so that this condition should occur in high frequency in this population (Wu, 1995: 271; 1997: 285). The above results show that of the nine populations examined, the Inuit exhibit this condition with highest frequency (31.3%), followed by the South Americans (15.8%) and

North Africans (13.3%). However, this condition is not a *major condition* of these populations.



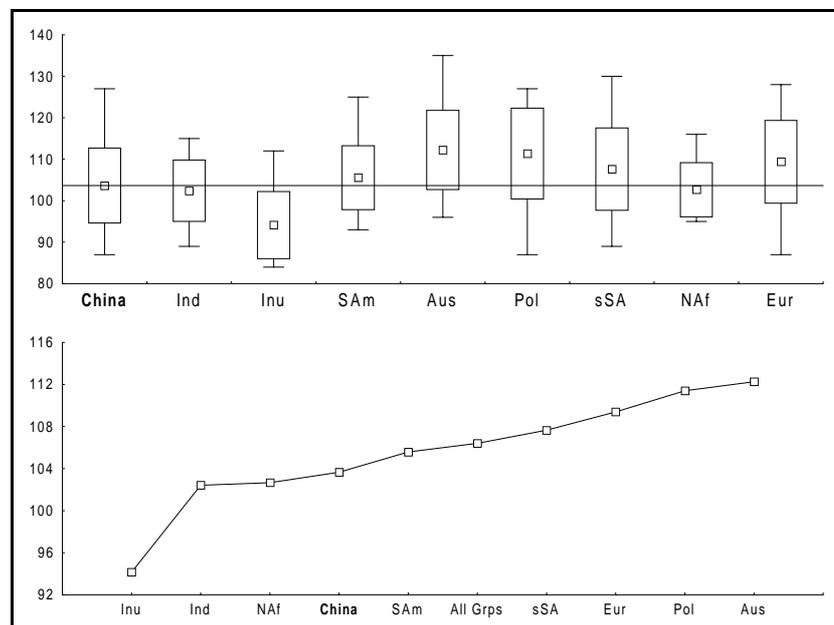
**Fig. 20** Distribution of the orientation of the zygomatic process of the maxilla

**Table 9** Distribution of the orientation of the zygomatic process of the maxilla (\*\*p<0.01)

Sample	receding		transverse		protruding		total	
	N	%	N	%	N	%	N	%
$\chi^2=36.74, df=16$ **								
Chinese	22	55.0	18	45.0	0	0	40	100.0
Indonesian	14	58.3	10	41.7	0	0	24	100.0
Inuit	4	25.0	7	43.8	5	31.3	16	100.0
South American	10	52.6	6	31.6	3	15.8	19	100.0
Australo-Melanesian	20	58.8	12	35.3	2	5.9	34	100.0
Polynesian	5	45.5	5	45.5	1	9.1	11	100.0
sub-Saharan African	23	51.1	18	40.0	4	8.9	45	100.0
North African	5	33.3	8	53.3	2	13.3	15	100.0
European	13	27.1	33	68.8	2	4.2	48	100.0
total	116	46.0	117	46.4	19	7.5	252	100.0

### 3.1.5 Junction of the lower margin of maxilla and zygomatic bones is more angular in shape

Figure 21 and Table 10 show the variation of the angle describing the junction of the zygomatic process of the maxilla and the zygomatic bone. The mean values for this feature vary from 94° to 112°. This variation was statistically significant ( $F=7.14$ ,  $p<0.001$ ). The mean values of Europeans, sub-Saharan Africans, Polynesians, Australo-Melanesians and South Americans lie above the average of all samples. Of these, the Australo-Melanesians express the most obtuse angles, followed by the Polynesians, whereas more acute angles are expressed by the South Americans, Chinese, Indonesians, North Africans and Inuit as shown in the lineplot graphic. Of these populations, the Inuit show the most acute angle.



**Fig. 21** Variation of the angle describing the junction of the lower margin of the maxilla and the zygomatic bones

In the Chinese, the angle of the lower margin of the maxilla and zygomatic bones measures 104° on average. This group differs at the 5% level from Australo-Melanesians, who have the most obtuse angle. Compared with the African and European populations, the Chinese do not show any significant differences.

Based on the results of this study, the Inuit should be considered more 'Mongoloid' than the Chinese themselves, i.e. the Inuit have a more angular shape of this feature than any other sample examined. Moreover, the mean values seen in the Chinese sample do not differ significantly from those of North Africans, sub-Saharan Africans and Europeans.

**Table 10** Variation of the angle of the junction of the lower margin of maxilla and zygomatic bones

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	103.66	9.05	8.73	87.00	127.00
Indonesian	24	102.42	7.40	7.23	89.00	115.00
Inuit	13	94.15	8.08	8.58	84.00	112.00
South American	19	105.58	7.72	7.31	93.00	125.00
Australo-Melanesian	35	112.26	9.54	8.50	96.00	135.00
Polynesian	10	111.40	10.96	9.84	87.00	127.00
sub-Saharan African	44	107.66	9.93	9.22	89.00	130.00
North African	15	102.67	6.55	6.38	95.00	116.00
European	43	109.40	10.00	9.14	87.00	128.00
total	244	106.40	10.01	9.41	84.00	135.00

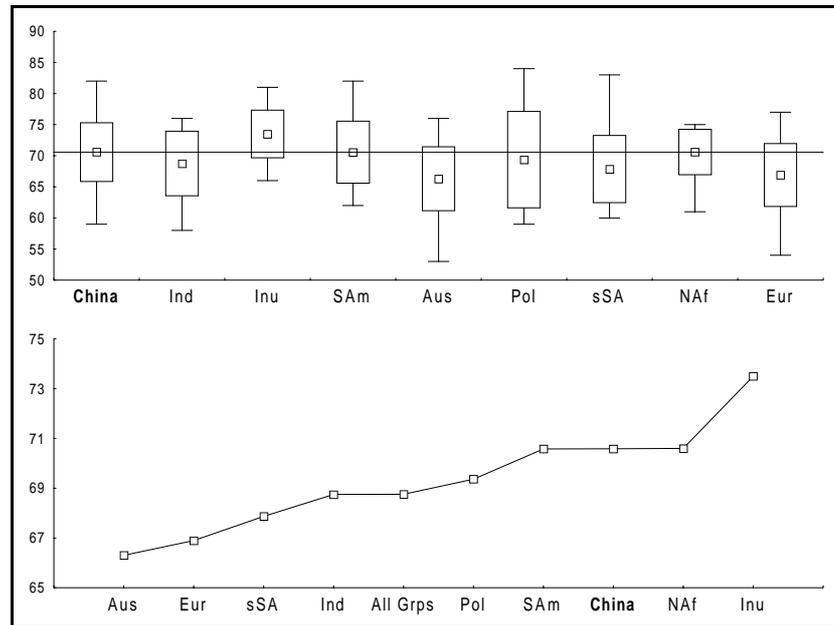
### 3.1.6 Facial height reduction

With regard to the upper facial height (Table 11 and Figure 22) the means of the nine observed groups vary from 66 mm to 74 mm and the differences are statistically significant ( $F=5.00$ ;  $p<0.001$ ). The South American, Polynesian, Chinese, North African and Inuit populations show high upper faces, with the Inuit having the highest upper face ( $\bar{x}=73.5$  mm). Other groups, i.e. the sub-Saharan Africans, Australo-Melanesians and Europeans tend to have lower faces, whereas Australo-Melanesians have the lowest values for this feature ( $\bar{x}=66.3$  mm).

The means of the bizygomatic breadth of all samples were tested statistically and show that the variance among the samples is significant ( $F=3.62$ ,  $p\leq 0.001$ ). The mean values vary between 127 mm and 137 mm (see Table 12), with the South American skulls exhibiting the largest bizygomatic breadth ( $\bar{x}=136.6$  mm), followed by the Polynesians ( $\bar{x}=134$  mm). On the other side of the range, the North African, European, Australo-Melanesian, and sub-Saharan African samples all have a narrow face. The Chinese, Indonesians and Inuit are all similar in that they have moderately broad faces.

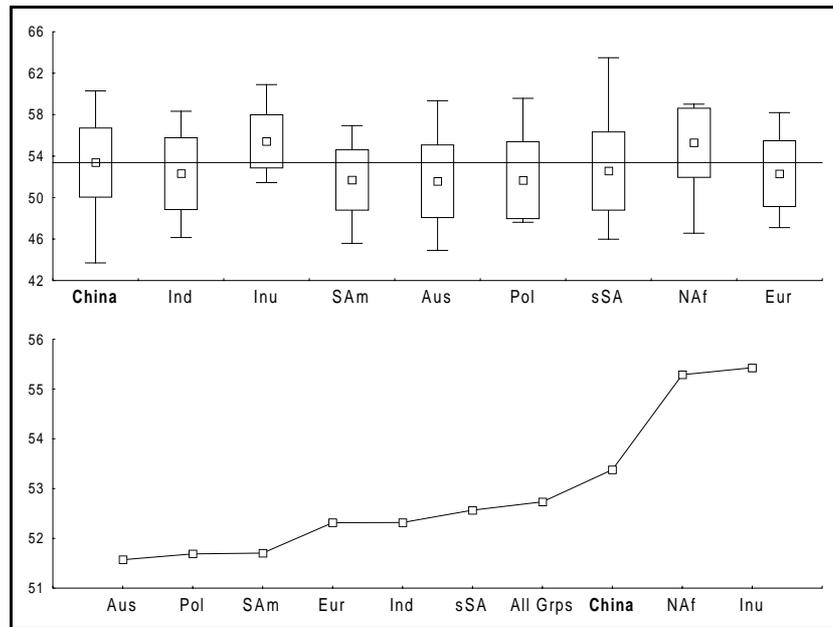
The geographic means of the bimaxillary breadth of all populations were tested statistically and show that the variance among the populations was highly significant ( $F=9.42$ ,  $p<0.001$ ). The mean values vary from 91 mm to 101 mm. In this breadth dimension, the Australo-Melanesian and European samples exhibit the lowest averages ( $\bar{x}=91.33$  mm and 91.59 mm, respectively), as shown in Table 13. Broader faces are expressed by the Inuit, Chinese, Indonesians, Polynesians, North Africans and Sub-

Saharan Africans, while the South American skulls have the broadest faces among the samples ( $\bar{x}=101.26$  mm). With regard to this variable, the Chinese differ significantly at the 1% level from the Australo-Melanesians and Europeans.



**Fig. 22** Nasion-prosthion height

More informative than the absolute measurements are the two indices calculated from these measurements that describe the facial shape. Except for the Inuit and the North Africans (Figure 23 and Table 14), the faces of the samples are categorized as being of moderate height on average. The differences in the variation were significant ( $F=3.57$ ,  $p \leq 0.001$ ). The Australo-Melanesians and Europeans are near to the lower limit of this category. The Inuit and North Africans have slightly higher means of the upper facial index than the others samples, indicating that these groups tend to have narrower faces. In this shape measurement, the Chinese do not show any significant difference from the other populations. Similar results were also obtained for the malar-upper facial index (Table 15), for which no significant difference was found among the samples.



**Fig. 23** Upper facial index

Based on the analysis of the facial height and breadth measurements and indices, it can be concluded that a facial height reduction or relatively broad face, as proposed as an East Asian continuity feature (see Wolpoff et al., 1984: 435, Wolpoff et al., 1994: 186; see also Frayer et al. 1993: 25) is not a characteristic of the Chinese population.

**Table 11** Nasion-prosthion height

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	70.59	4.71	6.67	59.00	82.00
Indonesian	24	68.75	5.18	7.53	58.00	76.00
Inuit	16	73.50	3.83	5.21	66.00	81.00
South American	19	70.58	4.97	7.04	62.00	82.00
Australo-Melanesian	36	66.31	5.14	7.75	53.00	76.00
Polynesian	11	69.36	7.75	11.17	59.00	84.00
sub-Saharan African	45	67.87	5.42	7.99	60.00	83.00
North African	15	70.60	3.64	5.16	61.00	75.00
European	49	66.90	5.08	7.59	54.00	77.00
total	256	68.76	5.40	7.85	53.00	84.00

**Table 12** Bizygomatic breadth

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	132.39	7.12	5.38	111.00	146.00
Indonesian	24	131.46	6.21	4.72	120.00	142.00
Inuit	16	132.69	5.83	4.39	120.00	142.00
South American	19	136.63	8.29	6.07	124.00	153.00
Australo-Melanesian	36	128.75	8.50	6.60	110.00	144.00
Polynesian	11	134.00	8.60	6.42	122.00	151.00
sub-Saharan African	44	129.32	6.73	5.20	115.00	145.00
North African	15	127.87	5.46	4.27	115.00	139.00
European	42	128.43	7.69	5.99	111.00	143.00
total	248	130.70	7.60	5.81	110.00	153.00

**Table 13** Bimaxillary breadth

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	97.90	7.19	7.34	71.00	108.00
Indonesian	24	98.33	5.24	5.33	89.00	106.00
Inuit	16	97.38	6.71	6.89	90.00	112.00
South American	19	101.26	5.47	5.40	93.00	111.00
Australo-Melanesian	36	91.33	4.95	5.42	83.00	105.00
Polynesian	11	96.00	7.14	7.44	87.00	114.00
sub-Saharan African	45	96.16	5.06	5.26	86.00	113.00
North African	15	96.00	5.06	5.27	83.00	105.00
European	49	91.59	5.56	6.07	75.00	103.00
total	256	95.53	6.50	6.80	71.00	114.00

**Table 14** Upper facial index

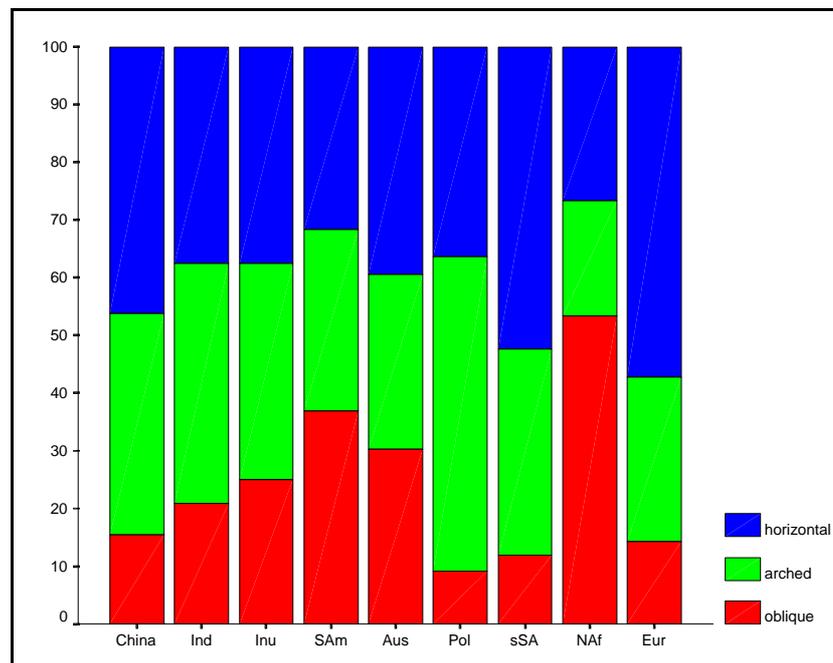
sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	53.38	3.33	6.24	43.70	60.29
Indonesian	24	52.32	3.46	6.61	46.15	58.33
Inuit	16	55.43	2.57	4.64	51.45	60.90
South American	19	51.70	2.92	5.65	45.59	56.94
Australo-Melanesian	36	51.57	3.51	6.81	44.92	59.35
Polynesian	11	51.69	3.71	7.18	47.62	59.57
sub-Saharan African	44	52.57	3.76	7.15	45.99	63.49
North African	15	55.29	3.32	6.00	46.56	59.02
European	42	52.31	3.19	6.10	47.11	58.20
total	248	52.73	3.51	6.66	43.70	63.49

**Table 15** Malar-upper facial index

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	72.38	5.89	8.14	61.46	87.23
Indonesian	24	69.97	4.68	6.69	61.22	78.65
Inuit	16	75.69	4.65	6.14	65.74	83.51
South American	19	69.78	4.53	6.49	59.26	75.53
Australo-Melanesian	36	72.68	5.50	7.57	59.57	84.71
Polynesian	11	72.39	7.76	10.72	62.77	88.42
sub-Saharan African	45	70.66	5.46	7.73	61.86	84.95
North African	15	73.69	4.72	6.41	62.89	80.72
European	49	73.25	6.48	8.85	57.45	83.53
total	256	72.15	5.78	8.01	57.45	88.42

### 3.1.7 Lower border of the zygomatic process of the maxilla oriented horizontally

The course of the lower border of the zygomatic process of the maxilla was determined by three categories: oblique, arched and horizontal. As can be seen from Table 16 and Figure 24, a horizontal orientation of the lower border of the zygomatic process of the maxilla occurs with highest frequency in the total samples studied. For the „horizontal“ category the Europeans (57.1%) and sub-Saharan Africans (52.4%) exhibit higher frequencies than the Chinese. Only 22% of the total sample show an „oblique“ category and 34% an „arched“. The „oblique“ category occurred most frequently in North Africans (53%), whereas 55% of Polynesians exhibit an „arched“ condition.



**Fig. 24** Lower border of the zygomatic process of maxilla

Regarding the assumption of East Asian regional continuity, the Chinese population was expected to be characterized by a horizontal orientation of the lower border of the zygomatic process of maxilla (Wu, 1995: 272; Wu and Poirier, 1995: 235; see also Pope, 1997: 278). In this study, 46.2% of the Chinese exhibit a horizontal orientation. This value is somewhat greater than that for the “arched” category (38.5%). On the other hand, the Chinese population is not the only one that exhibits such a high frequency of the horizontal condition. The sub-Saharan Africans and Europeans show even higher frequencies of this category (52.4% and 57.1%, respectively). Based on this result, this feature can not be regarded as a characteristic trait of the Chinese population.

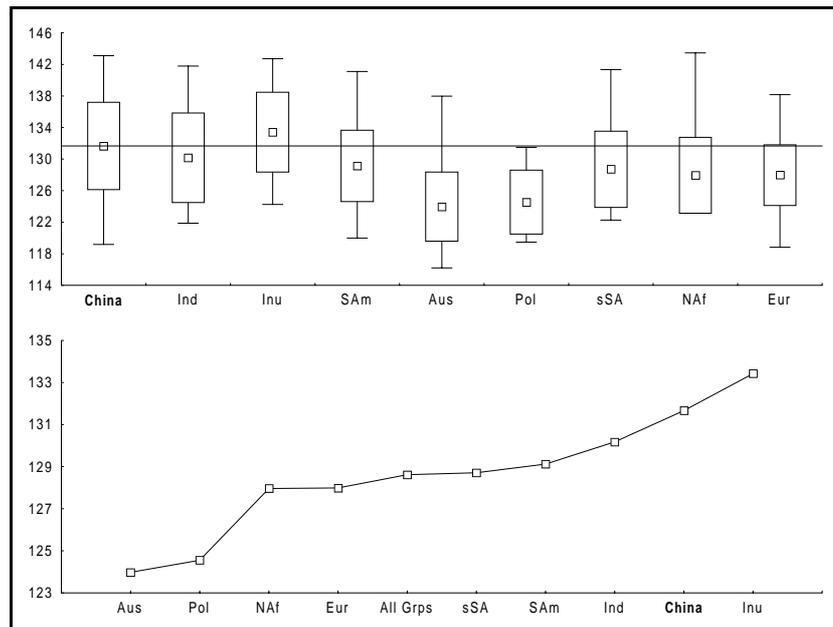
**Table 16** Lower border of zygomatic process of maxilla ( $p>0.05$ )

Sample	oblique		arched		horizontal		total	
	N	%	N	%	N	%	N	%
$\chi^2=22.85$ , $df=16$								
Chinese	6	15.4	15	38.5	18	46.2	39	100.0
Indonesian	5	20.8	10	41.7	9	37.5	24	100.0
Inuit	4	25.0	6	37.5	6	37.5	16	100.0
South American	7	36.8	6	31.6	6	31.6	19	100.0
Australo-Melanesian	10	30.3	10	30.3	13	39.4	33	100.0
Polynesian	1	9.1	6	54.5	4	36.4	11	100.0
sub-Saharan African	5	11.9	15	35.7	22	52.4	42	100.0
North African	8	53.3	3	20.0	4	26.7	15	100.0
European	6	14.3	12	28.6	24	57.1	42	100.0
total	52	21.6	83	34.4	106	44.0	241	100.0

### 3.1.8 Middle part of the face is not very protruding

To assess the degree of mid-facial projection the Zygomaxillary angle was determined based on Bimaxillary breadth and Bimaxillary subtense. The variation for both absolute measurements (Tables 17, 18) was statistically significant ( $F=7.21$ ,  $p\leq 0.001$ ;  $F=7.39$ ,  $p<0.001$ , respectively). The variation of the Zygomaxillary angle is illustrated in Figure 25 and Table 19; it does not show homogeneity among the samples ( $F=9.87$ ,  $p<0.001$ ). Among the nine populations examined, Indonesians, Chinese and Inuit exhibit more obtuse angles expressing a relative flatness of the middle part of the face. In contrast, the Oceanian populations (Australo-Melanesian and Polynesian) exhibit more acute angles. Though the Europeans, North Africans, and sub-Saharan Africans show less obtuse angles, these samples do not differ significantly from the Chinese ( $p>0.05$ ).

Nevertheless, there is a tendency towards flatter mid-faces in the Chinese and even less protruding faces in the Inuit as assumed by Wu (1992: 373) who wrote that „the middle part of the face is not very protruding as shown by the comparatively *more obtuse zygomaxillary angle*“. But it remains unclear whether this feature can be regarded as a characteristic of recent Chinese populations, or can even be derived from Chinese *Homo erectus* (see Chapter 1).



**Fig. 25** Variation of the Zygomaxillary angle in nine samples

**Table 17** Bimaxillary breadth (ZMB)

sample	N	$\bar{x}$	sd	CV	min	max
<b>Chinese</b>	41	97.49	6.55	6.72	75.00	108.00
<b>Indonesian</b>	24	98.00	5.04	5.14	89.00	107.00
<b>Inuit</b>	16	94.63	6.53	6.90	87.00	108.00
<b>South American</b>	19	100.74	4.92	4.88	94.00	110.00
<b>Australo-Melanesian</b>	36	92.78	5.49	5.92	83.00	104.00
<b>Polynesian</b>	11	95.18	6.72	7.06	87.00	111.00
<b>sub-Saharan African</b>	45	96.84	5.01	5.17	88.00	111.00
<b>North African</b>	15	95.20	4.96	5.21	83.00	103.00
<b>European</b>	49	91.96	5.43	5.90	76.00	104.00
<b>total</b>	256	95.53	6.12	6.41	75.00	111.00

**Table 18** Bimaxillary subtense

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	21.83	2.44	11.18	16.00	26.00
Indonesian	24	22.75	2.67	11.74	18.00	28.00
Inuit	16	20.38	2.63	12.90	15.00	25.00
South American	19	23.95	2.25	9.39	18.00	28.00
Australo-Melanesian	36	24.67	2.23	9.04	19.00	29.00
Polynesian	11	25.00	2.32	9.28	20.00	28.00
sub-Saharan African	45	23.27	2.58	11.09	17.00	28.00
North African	15	23.27	2.66	11.43	16.00	25.00
European	49	22.45	2.22	9.89	16.00	27.00
total	256	22.97	2.66	11.58	15.00	29.00

**Table 19** Zygomaxillary angle

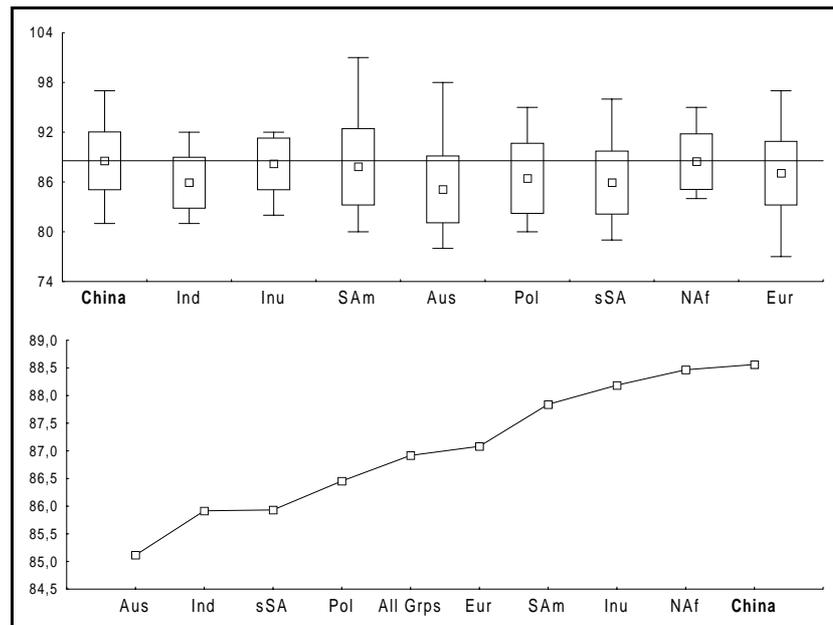
sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	131.67	5.55	4.22	119.19	143.11
Indonesian	24	130.18	5.67	4.36	121.87	141.79
Inuit	16	133.42	5.06	3.79	124.25	142.73
South American	19	129.13	4.52	3.50	119.99	141.10
Australo-Melanesian	36	123.98	4.39	3.54	116.20	137.98
Polynesian	11	124.55	4.07	3.27	119.47	131.48
sub-Saharan African	45	128.71	4.83	3.75	122.27	141.35
North African	15	127.96	4.81	3.76	123.97	143.47
European	49	127.99	3.84	3.00	118.83	138.17
total	256	128.62	5.39	4.19	116.20	143.47

### 3.1.9 Lack of anterior facial projection and low degree of prognathism

The anterior facial projection and degree of prognathism were determined by the Profile angle, the Alveolar profile angle and the Gnathic index. The total facial prognathism was measured from nasion to prosthion in relation to the Frankfurt Horizontal (Profile angle). Besides the total face, the degree of prognathism was also considered for the alveolar region, measured as the angle between subnasale-prosthion

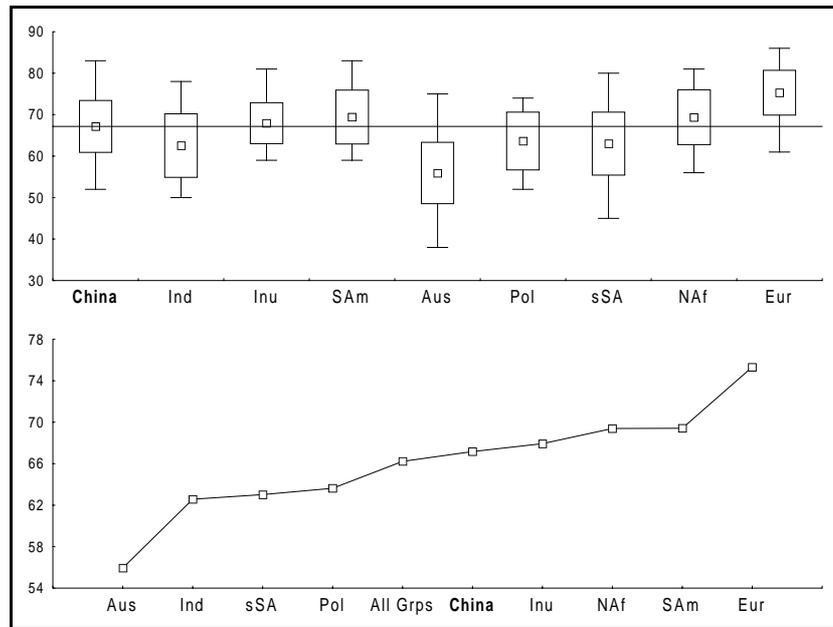
and the Frankfurt Plane. The Gnathic index is based on the upper facial height and basion-prosthion length.

Figure 26 and Table 20 display the mean values of the Profile angle in the nine populations. The ANOVA test shows that the differences among the samples are significant ( $F=3.32$ ,  $p<0.05$ ). The means of the profile angle show that all samples fall into the 'orthognathic' face category ( $85^\circ - <93^\circ$ ). The Scheffé test shows that the Chinese do not differ significantly from the African populations, Europeans, Polynesians, Indonesians, Inuit and South Americans ( $p>0.05$ ).

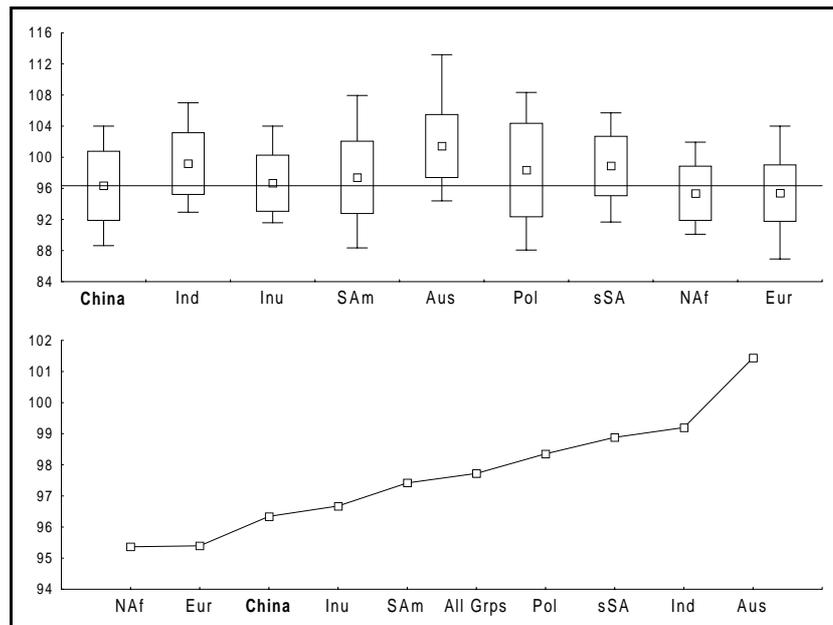


**Fig. 26** Profile angle

The variation of the Alveolar profile angle was statistically significant ( $F=25.45$ ,  $p\leq 0.001$ ). With regard to the alveolar region (Figure 27, Table 21), the Australo-Melanesians display a rather acute angle ( $\bar{x}=55.9^\circ$ ) on average. This indicates that the Australo-Melanesians have a relatively prognathous alveolar part. According to the grade categories listed in Bräuer (1988), this degree is called ultraprognathous ( $<60^\circ$ ). In contrast to the Australo-Melanesians, the Europeans show the most obtuse alveolar profile angle ( $\bar{x}=75.3^\circ$ ). The Chinese and sub-Saharan Africans show a similar pattern and both differ significantly at the 1% level from the Australo-Melanesians and Europeans. The Indonesians exhibit close similarities to the sub-Saharans. The results also show that the populations such as the Inuit, South Americans and North Africans have a tendency towards a flatter alveolar part as exhibited by the Europeans. On the other hand, the Indonesian and Polynesian populations tend to have a more projected alveolar part as shown by the sub-Saharan Africans. The Chinese are placed between the poles of variation.



**Fig. 27** Variation of the Alveolar profile angle in nine samples



**Fig. 28** Variation of the Gnathic Index in nine samples

The results concerning the Gnathic index are shown in Figure 28 and Table 22. The individual means of the Gnathic index vary strongly from 95.4 (orthognathic,  $x \leq 97.9$ ) to 101.44 (mesognathic, 98.0-102.9). The variation of the Gnathic index was statistically significant ( $F=7.95$ ,  $p \leq 0.001$ ). Similar to the results for the alveolar region, there are two extreme poles: The Australo-Melanesians and the Europeans. The former population has the greatest mean (101.44) tending towards prognathism, whereas the Europeans show a much flatter face. The Chinese do not differ significantly from other populations except

the Australo-Melanesians ( $p>0.05$ ). On the other hand, the Europeans differ significantly from the Australo-Melanesians and sub-Saharan Africans. The results indicate that the Chinese, North Africans and Europeans with their relatively similar means tend to have flatter faces, whereas the Australo-Melanesians and sub-Saharan Africans have more prognathous faces. The remaining groups such as Polynesians, Indonesians, Inuit and South Americans do not show clear differences from other populations. However, the Indonesians and Polynesians tend to be close to the Australo-Melanesian and sub-Saharan African samples, while the Inuit are rather close to the group exhibiting flatter face.

**Table 20** Profile angle

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	88.56	3.47	3.92	81.00	97.00
Indonesian	24	85.92	3.08	3.58	81.00	92.00
Inuit	16	88.19	3.12	3.54	82.00	92.00
South American	19	87.84	4.60	5.24	80.00	101.00
Australo-Melanesian	35	85.11	4.04	4.75	78.00	98.00
Polynesian	11	86.45	4.23	4.89	80.00	95.00
sub-Saharan African	45	85.93	3.81	4.43	79.00	96.00
North African	15	88.47	3.34	3.78	84.00	95.00
European	49	87.08	3.83	4.40	77.00	97.00
total	255	86.92	3.89	4.48	77.00	101.00

With respect to these three shape measurements, it can be concluded that none of them reflects a characteristic condition of the Chinese. Based on the assessment of the profile angle, the Chinese do not show any difference from the remaining populations, though they differ significantly from the Australo-Melanesians who have more projected faces. Based on the assessment of the alveolar region, the Chinese do not exhibit any pattern implying a low degree of prognathism. This population lies between the two poles, „flat“ and „projected“ face, and even joins the sub-Saharan Africans. Using the Gnathic index, the Chinese show a relatively similar pattern to that of the North Africans and Europeans. These results imply that the lack of facial projection and low degree of prognathism cannot be called a Chinese characteristic. Lahr (1994, 1996) found in her study that, based on the Gnathic index, the greatest prognathism was found among the sub-Saharan Africans, followed closely by the Australians, and both samples differed significantly from the East Asians and Europeans. In the present study, the Chinese even show a flat face with regard to the Gnathic index. But other populations like Inuit and South Americans exhibit rather similar values. Even the North Africans and Europeans show

lower mean values than those found in the Chinese, Inuit and South Americans. Both the present study and Lahr's analysis show that although the Chinese have relatively non-projected faces, this population is not the only one with such a condition.

**Table 21** Alveolar profile angle

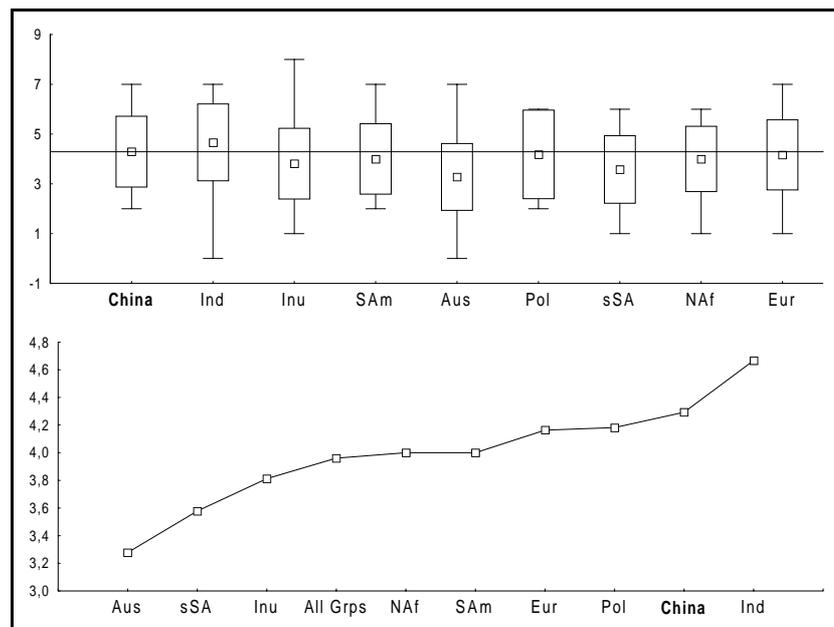
sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	67.17	6.22	9.26	52.00	83.00
Indonesian	24	62.58	7.67	12.26	50.00	78.00
Inuit	16	67.94	4.92	7.24	59.00	81.00
South American	19	69.42	6.51	9.38	59.00	83.00
Australo-Melanesian	35	55.94	7.41	13.25	38.00	75.00
Polynesian	11	63.64	6.98	10.97	52.00	74.00
sub-Saharan African	45	63.02	7.60	12.06	45.00	80.00
North African	15	69.40	6.64	9.57	56.00	81.00
European	49	75.33	5.38	7.14	61.00	86.00
total	255	66.23	8.87	13.39	38.00	86.00

**Table 22** Gnathic index

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	96.34	4.45	4.62	88.64	104.00
Indonesian	24	99.20	3.97	4.00	92.93	107.00
Inuit	16	96.68	3.62	3.74	91.58	104.00
South American	19	97.42	4.66	4.78	88.35	107.95
Australo-Melanesian	36	101.44	4.04	3.98	94.39	113.19
Polynesian	11	98.35	6.01	6.11	88.07	108.33
sub-Saharan African	45	98.88	3.83	3.87	91.67	105.71
North African	15	95.37	3.48	3.65	90.10	101.94
European	49	95.40	3.61	3.78	86.92	104.00
total	256	97.72	4.51	4.62	86.92	113.19

### 3.1.10 Horizontal course of the nasofrontal and frontomaxillary sutures

To determine the course of the nasofrontal and frontomaxillary sutures, the distance between nasion and the intersection point of the orbital rim and frontomaxillary suture was measured following Lahr's method. Among 256 modern crania, the distance of both sutures varies between 0 and 8 mm (see Figure 29 and Table 23). The average of the population means is 3.96 mm. This variation was statistically significant ( $F=2.66$ ,  $p<0.01$ ). Regarding the horizontal course between nasofrontal and frontomaxillary sutures, no population shows a mean value close to 0 mm. Of the nine populations, the Australo-Melanesians show the smallest mean value ( $\bar{x}=3.28$  mm), followed by the sub-Saharan Africans and Inuit. However, these values do not reflect a horizontal course. The North Africans, South Americans, Europeans, Polynesians and Chinese exhibit averages between 4.0 and 4.29 mm. Figure 29 also shows that in contrast to the multiregional expectations the Chinese sample shows the second greatest mean difference between the nasofrontal and frontomaxillary sutures. Even closer to the assumed Chinese condition are those found in sub-Saharan Africans and Australo-Melanesians.



**Fig. 29** Variation of the course of the nasomaxillary and frontomaxillary sutures in nine samples

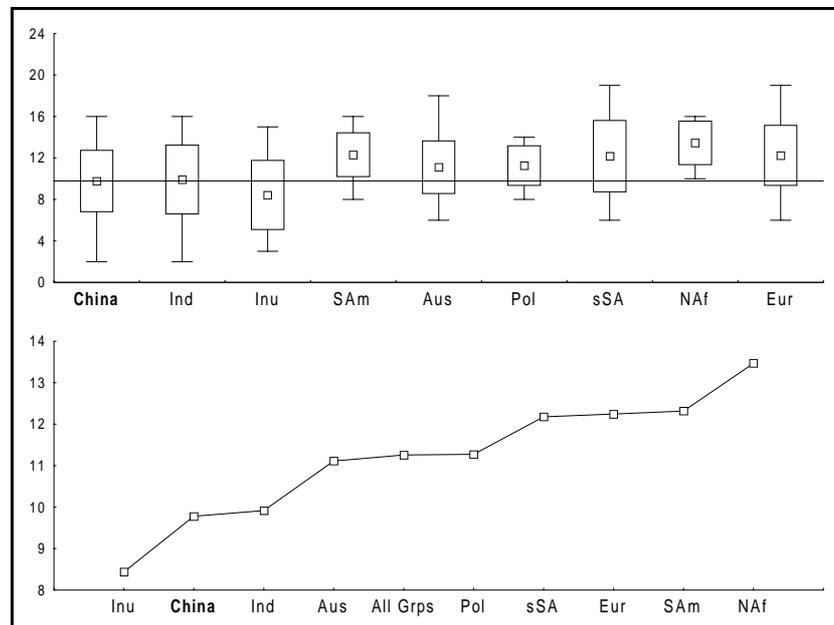
These results are consistent with the study from Lahr (1996). In her study, Lahr did not find a horizontal course between the nasofrontal and frontomaxillary sutures in the Chinese. On the contrary, she found that of the five recent regional samples she examined, the Chinese presented the most pronounced inclination between both sutures ( $\bar{x}=4.26$  mm). Thus, it is evident that this condition contradicts the multiregional assumption that assumes a horizontal course of both sutures to be characteristic of the Chinese (see Wolpoff et al., 1984: 435; Wu, 1995: 270, 1997: 285).

**Table 23** Horizontal course of the nasomaxillary and frontomaxillary sutures

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	4.29	1.42	33.10	2.00	7.00
Indonesian	24	4.67	1.55	33.19	0.00	7.00
Inuit	16	3.81	1.42	37.27	1.00	8.00
South American	19	4.00	1.41	35.25	2.00	7.00
Australo-Melanesian	36	3.28	1.34	40.85	0.00	7.00
Polynesian	11	4.18	1.78	42.58	2.00	6.00
sub-Saharan African	45	3.58	1.36	37.99	1.00	6.00
North African	15	4.00	1.31	32.75	1.00	6.00
European	49	4.16	1.40	33.65	1.00	7.00
total	256	3.96	1.45	36.62	0.00	8.00

### 3.1.11 Flatness of the nasal saddle

Flatness of the nasal saddle was determined in two ways by the Simotic angle (based on the Simotic chord and subtense) and the subtense on the Upper breadth of the nasal bones ( $F=5.49$ ,  $p<0.001$ ;  $F=8.81$ ,  $p<0.001$ , respectively).

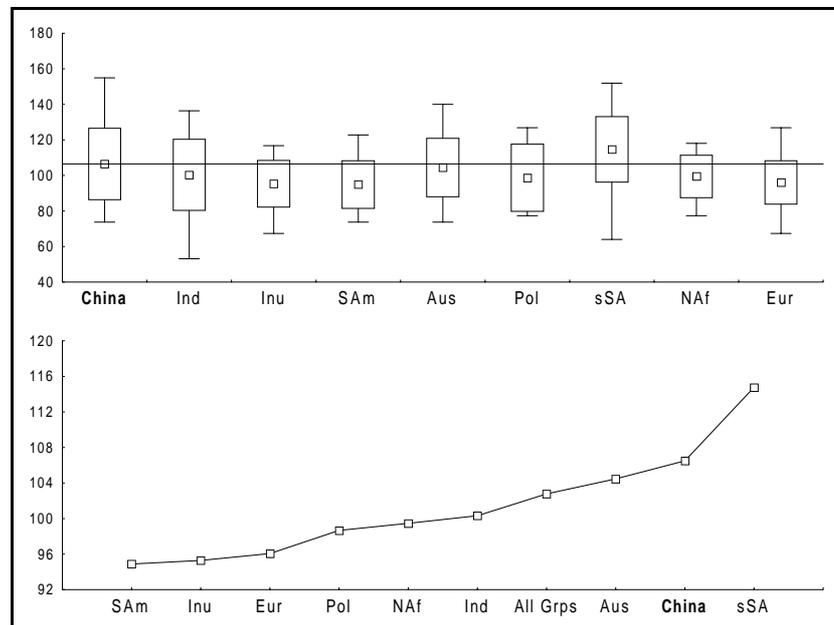


**Fig. 30** Variation of the Upper breadth of the nasal bones in nine samples

For the Upper breadth of the nasal bones the means of the different samples vary from 8.44 mm to 13.47 mm (see Table 26, Figure 30). The variation of these means shows

significant differences ( $F=6.50, \leq 0.001$ ). The North African sample has the broadest upper nasal bones followed by the sub-Saharan Africans, Europeans and South Americans. In contrast, the Chinese, Indonesians and Inuit tend to have a narrow upper breadth of the nasal bones, while the Polynesians and Australo-Melanesians lie in between. The Chinese differ significantly in this measurement at the 5% level from the North Africans and Europeans.

The variation of the Subtense at the upper breadth of the nasal bones (illustrated in Table 27) was statistically significant ( $F=12.88, p<0.001$ ). Two groups show different tendencies in this feature: one group consisting of the Chinese, Inuit, Indonesians and sub-Saharan Africans has a low nasion subtense, whereas the remaining samples have higher subtenses. At the 5% level the Chinese show significant differences from the North Africans, Europeans and South Americans.



**Fig. 31** Simotic angle

Tables 24 and 25 show the variation with regard to the Simotic chord and Simotic subtense ( $F=5.49, p<0.001$ ;  $F=8.81, p<0.001$ ). Figure 31 and Table 28 illustrate the variation of the Simotic angle among the nine samples. The variation was also statistically significant ( $F=5.38, p<0.001$ ). The South Americans and Inuit display high nasal bridges, followed by Europeans. In contrast, the Chinese, Australo-Melanesians and sub-Saharan Africans exhibit low nasal bridges ( $\bar{x}=106.5^\circ, 104.47^\circ$  and  $114.76^\circ$ , respectively), indicating a flatness of the middle part of the nasal bones. With regard to the Simotic angle, the Chinese do not show significant differences from any other population examined. However, though the Chinese do not differ significantly from the sub-Saharan Africans, the latter have the most obtuse Simotic angle indicating the flattest middle part

of the nasal bridge. On the basis of the evidence of the Simotic angle, it can be concluded that this feature cannot be regarded as a Chinese regional continuity trait.

**Table 24** Simotic chord

sample	n	$\bar{x}$	sd	CV	min	max
Chinese	41	7.73	2.39	30.92	3.00	12.00
Indonesian	24	7.87	2.82	35.83	1.00	13.00
Inuit	16	6.81	2.34	34.36	4.00	13.00
South American	19	9.16	1.57	17.14	6.00	12.00
Australo-Melanesian	36	8.97	1.80	20.07	5.00	12.00
Polynesian	11	8.82	2.23	25.28	7.00	14.00
sub-Saharan African	45	9.67	2.67	27.61	5.00	19.00
North African	15	10.73	1.87	17.43	8.00	14.00
European	49	9.33	2.38	25.51	3.00	16.00
total	256	8.84	2.48	28.05	1.00	19.00

**Table 25** Simotic subtense

sample	n	$\bar{x}$	sd	CV	min	max
Chinese	41	2.88	1.14	39.58	1.00	6.00
Indonesian	24	3.17	1.09	34.38	1.00	5.00
Inuit	16	3.06	0.85	27.78	2.00	4.00
South American	19	4.21	0.85	20.19	3.00	6.00
Australo-Melanesian	36	3.53	1.13	32.01	2.00	7.00
Polynesian	11	3.82	1.08	28.27	2.00	5.00
sub-Saharan African	45	3.09	1.04	33.66	1.00	5.00
North African	15	4.60	1.12	24.35	3.00	6.00
European	49	4.24	1.22	28.77	1.00	7.00
total	256	3.55	1.22	34.37	1.00	7.00

**Table 26** Upper breadth of the nasal bones

sample	n	$\bar{x}$	sd	CV	min	max
Chinese	41	9.78	2.96	30.27	2.00	16.00
Indonesian	24	9.92	3.31	33.37	2.00	16.00
Inuit	16	8.44	3.33	39.46	3.00	15.00
South American	19	12.32	2.11	17.13	8.00	16.00
Australo-Melanesian	36	11.11	2.53	22.77	6.00	18.00
Polynesian	11	11.27	1.90	16.86	8.00	14.00
sub-Saharan African	45	12.18	3.45	28.33	6.00	19.00
North African	15	13.47	2.10	15.59	10.00	16.00
European	49	12.24	2.90	23.69	6.00	19.00
total	256	11.26	3.15	27.98	2.00	19.00

**Table 27** Nasion subtense of upper nasal breadth

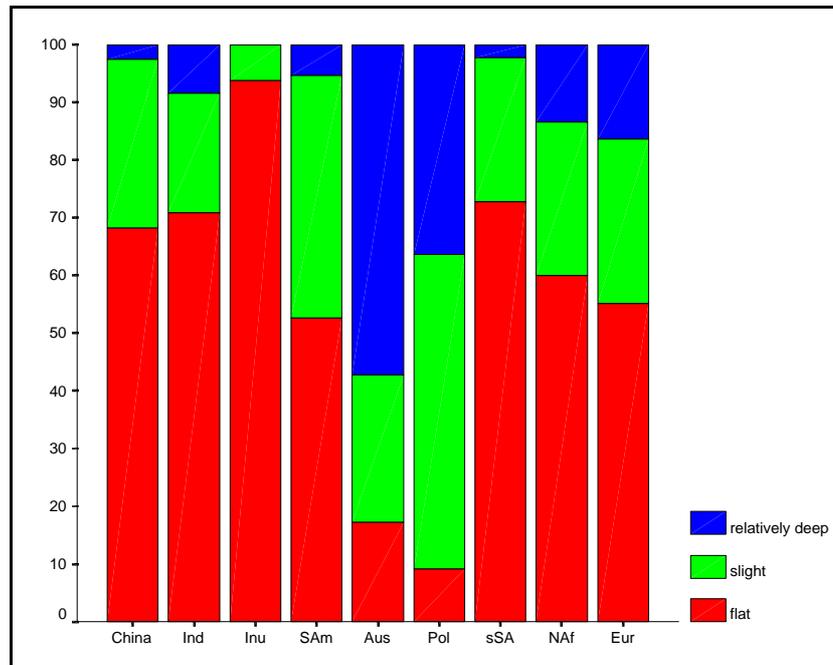
sample	n	$\bar{x}$	sd	CV	min	max
Chinese	41	2.54	1.00	39.37	1.00	6.00
Indonesian	24	2.71	1.00	36.90	1.00	5.00
Inuit	16	2.69	1.20	44.61	1.00	5.00
South American	19	4.53	1.35	29.80	2.00	7.00
Australo-Melanesian	36	3.47	1.18	34.01	2.00	8.00
Polynesian	11	3.73	1.42	38.07	2.00	6.00
sub-Saharan African	45	2.91	1.22	41.92	1.00	7.00
North African	15	5.00	1.56	31.20	2.00	9.00
European	49	4.22	1.39	32.94	1.00	7.00
total	256	3.43	1.45	42.27	1.00	9.00

**Table 28** Simotic angle

sample	n	$\bar{x}$	sd	CV	min	max
Chinese	41	106.50	20.09	18.86	73.73	154.92
Indonesian	24	100.32	20.03	19.97	53.12	136.38
Inuit	16	95.30	13.09	13.74	67.37	116.77
South American	19	94.88	13.37	14.09	73.73	122.76
Australo-Melanesian	36	104.47	16.42	15.72	73.73	140.02
Polynesian	11	98.66	18.86	19.12	77.31	126.85
sub-Saharan African	45	114.76	18.44	16.07	64.00	151.91
North African	15	99.47	11.97	12.03	77.31	118.06
European	49	96.06	12.27	12.77	67.37	126.85
total	256	102.78	17.74	17.26	53.12	154.92

### 3.1.12 Non-depressed nasal root

The nasal root depression is best seen from a lateral perspective. The projection of the nasal root (at the level of the nasion) was determined in relation with the development of the glabella (Table 29). Thus, it differs from the „nasion subtense of upper nasal breadth“ (Table 27) which describes the orientation of the two nasal bones to each other (see Figure 9, Chapter 2). The assessment of „non-depressed nasal root“ was based on Lahr’s grade scores: „flat“, „slight“, „relatively deep“ and „very deep“ nasal root. Of the four categories, the category “very deep nasal root” was not found in this study. As shown in Table 29 and Figure 32, 57.1% of the total sample exhibit the „flat“ category indicating a non-depressed nasal root. Of these, the Inuit show the highest percentage (93.8%). A slightly depressed nasal root occurs more rarely among the samples (27.6%). In this category, the Polynesian and South American samples exhibit high frequencies. Only 15.4% of the total sample exhibit a relatively deep nasal root which occurs mostly in Australo-Melanesians, followed by Polynesians.



**Fig. 32** Distribution of the degrees of nasal root depression in nine samples

**Table 29** Degrees of nasal root depression (\*\*\*) $p < 0.001$

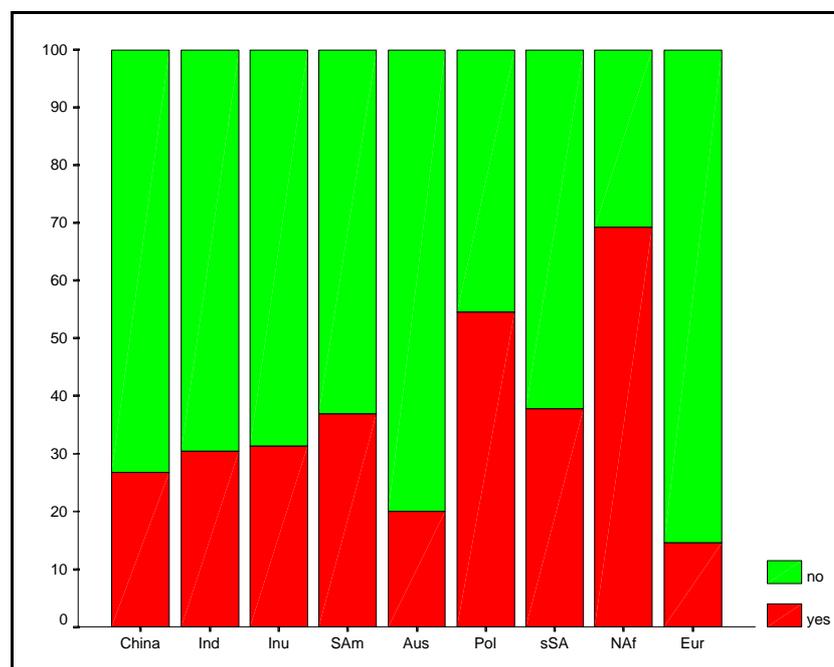
Sample	flat		slight		relatively deep		total	
	N	%	N	%	N	%	N	%
$\chi^2=86.19, df=16$ ***								
<b>Chinese</b>	28	68.3	12	29.3	1	2.4	41	100.0
<b>Indonesian</b>	17	70.8	5	20.8	2	8.3	24	100.0
<b>Inuit</b>	15	93.8	1	6.3	0	0	16	100.0
<b>South American</b>	10	52.6	8	42.1	1	5.3	19	100.0
<b>Australo-Melanesian</b>	6	17.1	9	25.7	20	57.1	35	100.0
<b>Polynesian</b>	1	9.1	6	54.5	4	36.4	11	100.0
<b>sub-Saharan African</b>	32	72.7	11	25.0	1	2.3	44	100.0
<b>North African</b>	9	60.0	4	26.7	2	13.3	15	100.0
<b>European</b>	27	55.1	14	28.6	8	16.3	49	100.0
<b>total</b>	145	57.1	70	27.6	39	15.4	254	100.0

The Chinese along with some other populations most frequently exhibit a non-depressed nasal root (68.3%). Nevertheless, this condition cannot be regarded as a distinct feature of the Chinese, as suggested by the proponents of the Multiregional Evolution model (Frayer et al., 1993: 25; Wolpoff et al., 1994: 186). The Indonesians, sub-Saharan

Africans and Inuit show even higher frequencies of this trait (70.8%, 72.7%, 93.8%, respectively) than is found in the Chinese. However, it should be noted that this character is also influenced by sexual dimorphism.

### 3.1.13 No difference between upper part and middle part of the nasal bones

The shape of the nasal bones or, more specifically, a narrowing from the frontonasal suture towards the mid-nasal region has been studied using two categories: no narrowing and narrowing. Table 30 and Figure 33 show that the former category is the most frequent one in most samples with the exception of the North Africans and Polynesians (69.2% and 54.5%, respectively).



**Fig. 33** Distribution of „no difference between upper and middle part of nasal bones“ in nine samples

As suggested by the Multiregional Evolution model, most of the Chinese specimens studied (73.2%) show no narrowing of the nasal bones. However, this study reveals that the feature occurred more frequently in the Australo-Melanesian and European populations. Though the other populations do not show frequencies as high as in China, this category, however, also occurs as the most frequent one in the sub-Saharan Africans, South Americans, Inuit and Indonesians (62.2%, 63.2%, 68.8%, 69.6%, respectively). Therefore, this feature cannot be supported as a regional trait.

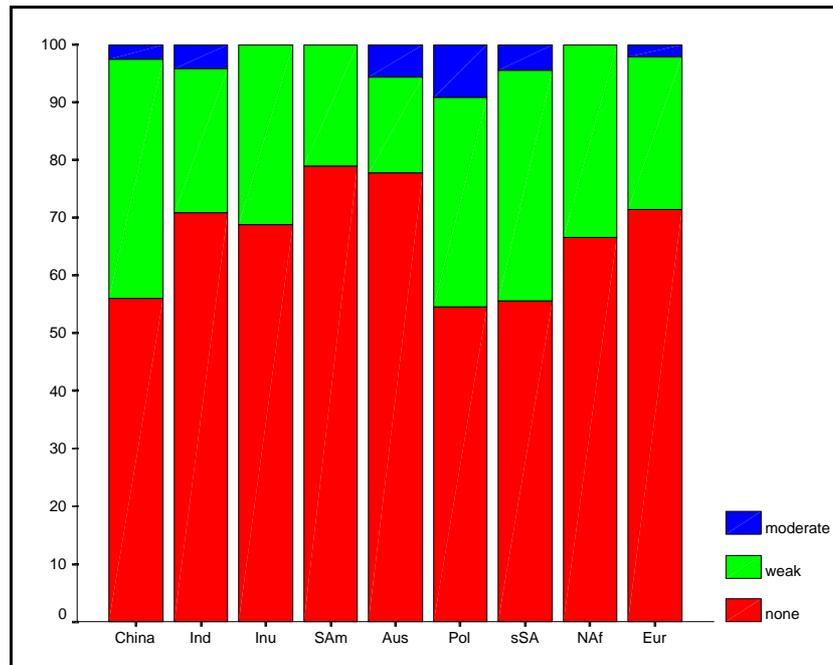
**Table 30** No difference between upper and middle part of nasal bones (\*\*p<0.01)

Sample	yes		no		total	
	N	%	N	%	N	%
$\chi^2=21.59$ , df=8 **						
Chinese	11	26.8	30	73.2	41	100.0
Indonesian	7	30.4	16	69.6	23	100.0
Inuit	5	31.3	11	68.8	16	100.0
South American	7	36.8	12	63.2	19	100.0
Australo-Melanesian	7	20.0	28	80.0	35	100.0
Polynesian	6	54.5	5	45.5	11	100.0
sub-Saharan African	17	37.8	21	62.2	45	100.0
North African	9	69.2	4	30.8	13	100.0
European	7	14.6	41	85.4	48	100.0
total	76	30.3	175	69.7	251	100.0

### 3.1.14 Presence of *incisura malaris*

The presence of an *incisura malaris* was determined as „none“ (absent), „weak“, „moderate“ and „strong“. No case of the “strong” category was found in this study. As shown in Table 31 and Figure 34, the absence of an *incisura malaris* is not a rare condition in any of the samples. The category “weak” occurs in 30.5% of the total sample and only 3.1% of the total sample show the „moderate“ category. Only the Chinese, sub-Saharan African and Polynesian samples show somewhat higher frequencies of a weak presence of the *incisura malaris*.

For China it can be concluded that 41.5% of the sample have a „weak“ *incisura malaris* and only 2.4% a „moderate“ *incisura malaris*. These frequencies are nearly identical to those found in the sub-Saharan sample (40% and 4.4%, respectively). The supporters of the Multiregional Evolution model suggested that the Chinese should exhibit a *distinct* *incisura malaris* as one of the regional characteristics (Frayner et al., 1993: 25, see also Wolpoff et al., 1994: 188), but based on the results of this study this feature was present in only low frequency. Even on the basis of the „weak“ category, the Chinese population is not the only one with a high frequency of this category. There is no difference in the occurrence of the „weak“ condition in China and sub-Saharan Africa.



**Fig. 34** Distribution of the incisura malaris in nine samples

**Table 31** Presence of incisura malaris ( $p>0.05$ )

Sample	none		weak		moderate		total	
	N	%	N	%	N	%	N	%
$\chi^2=13.61, df=16$								
<b>Chinese</b>	23	56.1	17	41.5	1	2.4	41	100.0
<b>Indonesian</b>	17	70.8	6	25.0	1	4.2	24	100.0
<b>Inuit</b>	11	68.8	5	31.3	0	0	16	100.0
<b>South American</b>	15	78.9	4	21.1	0	0	19	100.0
<b>Australo-Melanesian</b>	28	77.8	6	16.7	2	5.6	36	100.0
<b>Polynesian</b>	6	54.5	4	36.4	1	9.1	11	100.0
<b>sub-Saharan African</b>	25	45.6	18	40.0	2	4.4	45	100.0
<b>North African</b>	10	66.7	5	33.3	0	0	15	100.0
<b>European</b>	35	71.4	13	26.5	1	2.0	49	100.0
<b>total</b>	170	66.4	78	30.5	8	3.1	256	100.0

### 3.1.15 Shape of orbits is more or less quadrangular

The shape of orbit was assessed using the grade scores developed by Lahr (1996). Thus, according to Lahr, the shape of orbit is not determined as a single character such as round or rectangular, but as a combination of the superior, lateral and inferior margin of the orbit (see Figure 13 in Chapter 2). Following Lahr's method, in this study the variation

of the orbital shape is very large. 32 combinations of the orbital shape are observed in the nine populations. Among these, the combinations I/II/II, followed by II/II/II and I/II/I occur relatively frequent (16.4%, 14.8%, 10.2%, respectively). These indicate that a transverse superior margin of the orbit occurs more frequently than an oblique one. In contrast, the oblique inclination of the inferior margin of the orbit occurs more frequently than other types. The superior-lateral margin type II is the most common pattern in all populations.

Of the total of 32 combinations, the Australo-Melanesians show 21 combinations. This shows that the shape of orbit varies strongly in this sample. Strong variation is also found among the Chinese, sub-Saharan Africans, Europeans and North Africans (18, 15, 15 and 13 combinations, respectively).

Regarding the Chinese, the combinations of the orbital shape that occur frequently are I/II/II, II/II/II, III/II/II and II/II/I (17.1%, 12.2%, 12.2% and 9.8%, respectively). These prevalent combinations of orbital shape indicate that, like other populations the Chinese often have a vertical superior-lateral margin and an oblique inferior margin, while the inclination of the superior margin is variable. Type I/II/II is the most frequent combination in the Chinese. This combination, however, occurs also with high frequencies in the Polynesian, sub-Saharan African and European populations (45.5%, 22.2% and 20.4% respectively). Similar to this type I/II/II, the second most frequent type (II/II/II) occurs with higher frequencies in the Indonesian, Inuit, South American and European populations. The third type of the orbital shape occurs in 12.2% of the Chinese at about the same frequency as in Europeans (10.2%).

Lahr (1996) also found that the shape of orbit among the samples she examined varies enormously. She argued that the Southeast Asian and East Asian samples are so variable that generalisations are difficult.

Based on the distribution of the orbital shape combinations, it can be said that no distinct shape of orbit was found in this study. Moreover, 18 of the 32 combinations of orbital shape documented among the modern Chinese show that the Chinese do not have any specific pattern in orbital shape. 18 combinations are too variable to be claimed that the Chinese have a certain, distinct orbital shape, that could be regarded as characteristic.

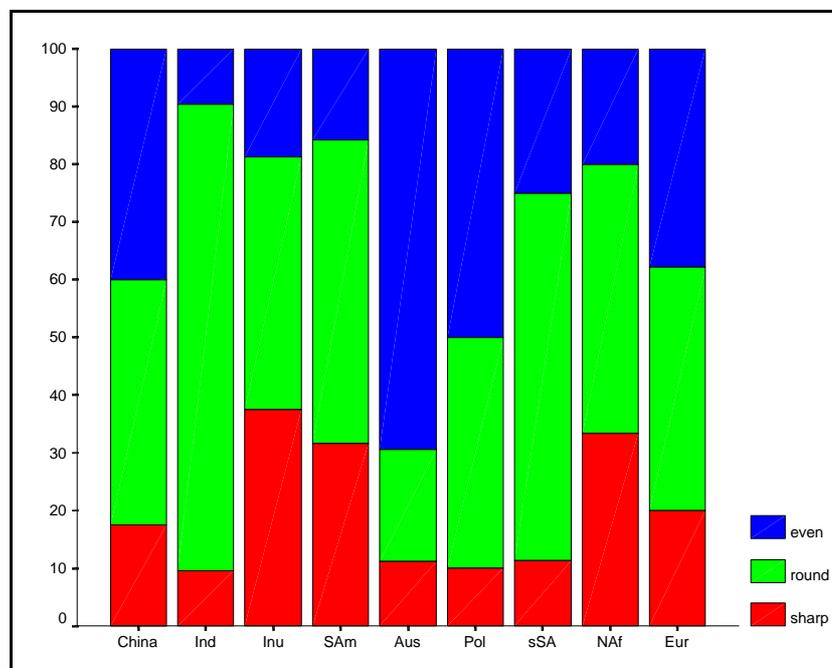
**Table 32** Combination of the three elements describing the shape of orbit ( in %)

Comb.	Chi	Ind	Inu	Sam	AuM	Pol	NAf	sSA	Eur	total
1 2 1	4.9	8.3	25.0	21.1	5.6	18.2	6.7	6.7	12.2	10.2
1 2 2	17.1	0	12.5	5.3	13.9	45.5	13.3	22.2	20.4	16.4
1 2 3	4.9	4.2	6.3	5.3	5.6	0	0	17.8	2.0	6.3
1 3 2	0	0	0	0	0	0	6.7	0	0	.4
1 4 1	0	0	0	10.5	2.8	0	13.3	0	0	2.0
1 4 2	2.4	0	0	0	5.6	0	6.7	4.4	2.0	2.7
1 4 3	2.4	0	0	0	2.8	0	6.7	4.4	0	2.0
2 2 1	9.8	4.2	12.5	5.3	8.3	0	6.7	6.7	2.0	6.3
2 2 2	12.2	25.0	25.0	21.1	8.3	9.1	6.7	8.9	20.4	14.8
2 2 3	4.9	20.8	0	0	5.6	0	6.7	4.4	12.2	7.0
2 2 4	0	0	6.3	5.3	0	0	0	0	0	.8
2 3 2	0	0	0	0	0	0	0	2.2	0	.4
2 4 1	2.4	0	0	0	2.8	9.1	6.7	0	0	1.6
2 4 2	4.9	4.2	0	15.8	2.8	0	6.7	4.4	2.0	4.3
2 4 3	2.4	0	0	0	2.8	0	0	4.4	0	1.6
3 2 1	4.9	12.5	0	0	2.8	0	0	0	2.0	2.7
3 2 2	12.2	4.2	0	0	2.8	0	0	0	10.2	4.7
3 2 3	0	12.5	0	5.3	0	0	0	0	4.1	2.3
3 3 1	2.4	0	0	0	0	0	0	0	0	.4
3 3 2	2.4	0	0	0	0	0	0	0	0	.4
3 3 3	4.9	0	0	0	0	0	0	0	0	.8
3 4 1	0	0	0	0	2.8	0	0	0	0	.4
3 4 2	2.4	0	0	0	5.6	9.1	0	0	2.0	2.0
3 4 3	0	4.2	0	0	2.8	0	0	4.4	0	1.6
4 2 1	0	0	0	5.3	2.8	9.1	0	0	0	1.2
4 2 2	0	0	12.5	0	0	0	6.7	4.4	4.1	2.7
4 2 3	0	0	0	0	2.8	0	0	2.2	2.0	1.2
4 2 4	0	0	0	0	0	0	0	2.2	0	.4
4 3 3	0	0	0	0	0	0	6.7	0	0	.4
4 4 2	0	0	0	0	5.6	0	0	0	0	.8
4 4 3	0	0	0	0	5.6	0	0	0	2.0	1.2
4 4 4	2.4	0	0	0	0	0	0	0	0	.4
total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

### 3.1.16 Rounded inferolateral margin of the orbit

The expression of a rounded infero-lateral margin of the orbit was determined by two categories: 1. rounded at the margin of the infero-lateral part of orbit (“round”), 2. rounded infero-lateral margin and levelled with the floor of orbit (“even”) (see Figure 14, Chapter 2). As illustrated in Figure 35 and Table 33, a rounded infero-lateral margin of the orbit (in terms of both categories) is a frequent condition in all samples. The distribution was statistically significant ( $\chi^2=47.43$ ,  $df=16$ ,  $p<0.001$ ). Only 18% of the total sample

exhibit a sharp infero-lateral margin of the orbit. An “even” (levelled) category is mostly expressed in the Australo-Melanesians. A “round” category is mostly expressed by Indonesians, followed by the sub-Saharan Africans and South Americans. Some populations show more or less similar proportions of these categories. These are the Polynesians, Chinese and the Europeans. Only the Inuit, South Americans and North Africans have a frequency of more than 30% of a sharp infero-lateral margin of the orbit.



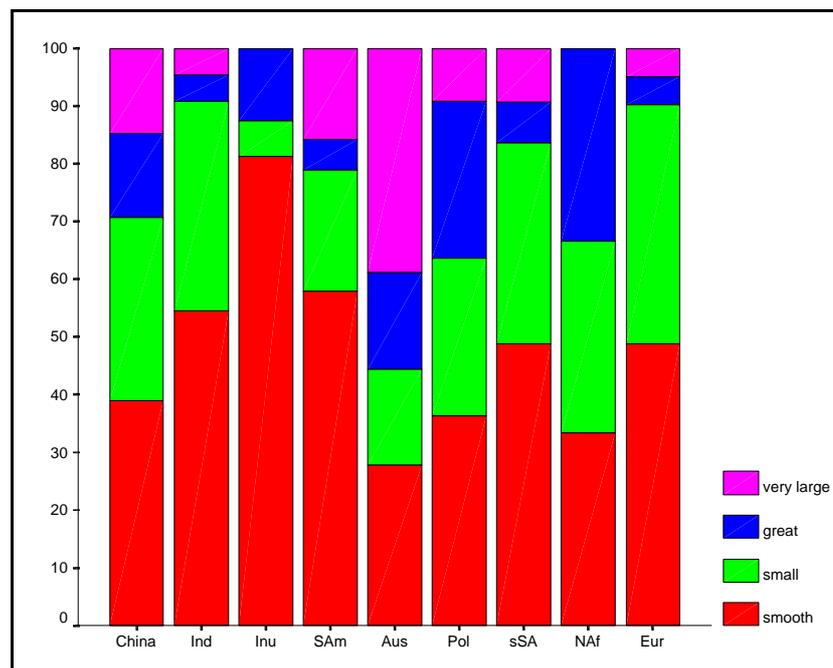
**Fig. 35** Rounded infero-lateral margin of orbit

With regard to the Chinese, both categories (“round” and “even”) occur more frequently than the “sharp” category (42.5%, 40% and 17.5%, respectively). This is confirmed by the study of Weidenreich (1943: 212), who said: „the infero-lateral margin is rounded and is at the same level as the even floor of the orbit (...) A rounded margin and an even floor are very common in ‚Mongolian‘ skulls“. Taken both categories together („round“ and „even“), this feature is present in higher frequency in the Sub-Saharan Africans, Inuit, Australo-Melanesians, Polynesians and Indonesians in different patterns of distribution. The sub-Saharan Africans and Indonesians show a higher frequency in the rounded margin of the orbit. Finally, the Europeans show the closest similarities with the Chinese in the frequencies of all three categories. On the other hand, the Australo-Melanesians and Polynesians show a different pattern compared with the others, in that the rounded edge at a level with the floor of the orbit is present more frequently. These results are similar with Lahr’s study (1996). She found that the feature occurs more frequently in the Australo-Melanesian populations. Besides, according to Lahr the „round“ category is a common condition in the total sample she examined. Based on these results, this trait cannot be classified as a regional feature of the Chinese.

**Table 33** Rounded infero-lateral margin of orbit (\*\*\*) $p < 0.001$

Sample	sharp		round		even		total	
	N	%	N	%	N	%	N	%
$\chi^2=47.43, df=16$ ***								
Chinese	7	17.5	17	42.5	16	40.0	40	100.0
Indonesian	2	9.5	17	81.0	2	9.5	21	100.0
Inuit	6	37.5	7	43.8	3	18.8	16	100.0
South American	6	31.6	10	52.6	3	15.8	19	100.0
Australo-Melanesian	4	11.1	7	19.4	25	69.4	36	100.0
Polynesian	1	10.0	4	40.0	5	50.0	10	100.0
sub-Saharan African	5	11.4	28	63.6	11	25.0	44	100.0
North African	5	33.3	7	46.7	3	20.0	15	100.0
European	9	20.0	19	42.2	17	37.8	45	100.0
total	45	18.3	116	47.2	85	34.6	246	100.0

### 3.1.17 Presence of malar tuberosity



**Fig. 36** Variation of the presence of malar tuberosity in nine samples

The malar tuberosity was determined by four grades: smooth malar („absent“), presence of a small tubercle, a pronounced and horizontally extended tubercle („large“), and presence of a very large tubercle (see Table 34 and Figure 36). Absence of the malar tubercle is frequently found in all samples. 81.3% of the Inuit lack such a tubercle,

followed by the South Americans with an absence in 58%. The presence of a small tubercle occurs mostly in the European, Indonesian, and sub-Saharan African samples (-41.5%, 36.4% and 34.9%, respectively). Pronounced and very large tubercles occur rarely among the nine populations examined. Only 11.9% of the total sample exhibit a pronounced tubercle and 12.7% a very large tubercle. Compared with the other samples, the North Africans and Polynesians show a somewhat higher percentage of the large tubercle (33.3% and 27.3%, respectively). Interestingly, the very large tubercle occurs more frequently in the Australo-Melanesian sample, implying a common condition of this region.

Concerning the evidence of this feature in China, the malar tuberosity in any of the three categories is present in 60.9% of the sample: 31.7% exhibit a small malar tubercle, 14.6% a large malar tubercle and 14.6% a very large one (ridge). Only 39% of the Chinese do not exhibit a malar tuberosity. Based on this distribution, it is evident that the condition of the malar tuberosity is rather variable in China.

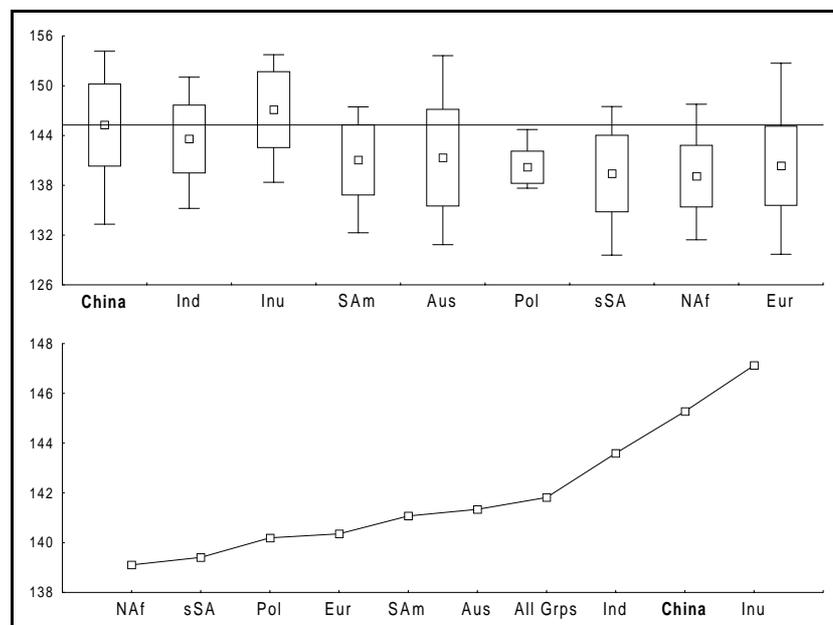
However, this does not reflect a pattern specific to the Chinese. Some populations exhibit higher frequencies of a small tubercle than the Chinese, i.e. the Australo-Melanesians, Indonesians, sub-Saharan Africans, North Africans and Europeans. Of this category, the Europeans show the highest frequency. The large tubercle occurs most frequently in North Africans, followed by Polynesians and Australo-Melanesians, while the “very large” category occurs more frequently in South Americans and Australo-Melanesians than in Chinese. As the occurrence of the malar tuberosity varies strongly in the populations examined, this feature can not be classified as a Chinese character. Even if the determination of presence of malar tubercle was based on the “small” category, the Chinese do not present the highest frequency. Similar results have also been found by Lahr (1996). All groups she studied, with the exception of the Africans, showed cases of all four grades, but they varied as to which grade is the most frequent. The Europeans and Southeast Asians showed a „pronounced“ tubercle as the most common expression, while the Africans and East Asians showed a „smooth“ malar as the most common condition.

**Table 34** Presence of malar tuberosity (\*\*\*) $p < 0.001$ )

Sample	absent		small		large		very large		total	
	N	%	N	%	N	%	N	%	N	%
$\chi^2=58.00, df=24$ ***										
Chinese	16	39.0	13	31.7	6	14.6	6	14.6	41	100.0
Indonesian	12	54.5	8	36.4	1	4.5	1	4.5	22	100.0
Inuit	13	81.3	1	6.3	2	12.5	0	0	16	100.0
South American	11	57.9	4	21.1	1	5.3	3	15.8	19	100.0
Australo-Melanesian	10	27.8	6	16.7	6	16.7	14	38.9	36	100.0
Polynesian	4	36.4	3	27.3	3	27.3	1	9.1	11	100.0
sub-Saharan African	21	48.8	15	34.9	3	7.0	4	9.3	43	100.0
North African	5	33.3	5	33.3	5	33.3	0	0	15	100.0
European	20	48.8	17	41.5	2	4.9	2	4.9	41	100.0
total	112	45.9	72	29.5	29	11.9	31	12.7	244	100.0

### 3.1.18 Large naso-malar angle

To assess the degree of upper facial projection, the Nasio-frontal angle was determined based on bifrontal breadth and nasio-frontal subtense (Tables 35, 36). The variation of bifrontal breadth and nasio-frontal subtense was statistically significant ( $F=2.32, p < 0.05$ ;  $F=8.74, p < 0.001$ , respectively).



**Fig. 37** Variation of the Naso-frontal angle in nine samples

As a most interesting feature the Nasio-frontal angle expresses how much the upper face projects. The Inuit, Chinese and Indonesians show more obtuse angles than the other groups, indicating that these groups have flatter upper faces. The differences of means among the samples was statistically significant ( $F=8.74$ ,  $p<0.001$ ) and this can be seen in Figure 37 and Table 37.

Concerning the Chinese, this group exhibits a large mean Nasio-frontal angle of  $145^\circ$ , indicating that the upper part of the face at the level of the orbits tends to be relatively flat. At the 5% level, the Chinese differ significantly from the sub-Saharan Africans, North Africans and Europeans, who have a stronger projection of the nasal region in relation to the lateral orbital edges. Among the populations examined, only the Inuit show a greater mean value for this angle ( $147^\circ$ ) than the Chinese, but they do not differ significantly ( $p>0.05$ ). The Indonesians, South Americans, Australo-Melanesians and Polynesians tend to have a flat face similar to the Chinese.

It has been suggested that this feature is one of the regional characteristics of the Chinese (Wu, 1992). Based on the results of the study, this feature indeed indicates a somewhat greater flatness in the upper face than found in the African and European samples. However, the Inuit exhibit an even more obtuse angle, and the mean values of the Indonesians, South Americans, Australo-Melanesians and Polynesians do not show significant differences from those of the Chinese.

**Table 35** Bifrontal breadth

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	96.05	4.81	5.01	86.00	109.00
Indonesian	24	96.96	5.10	5.26	87.00	107.00
Inuit	16	98.31	4.66	4.74	89.00	105.00
South American	19	98.53	5.47	5.55	91.00	110.00
Australo-Melanesian	36	99.97	5.44	5.44	90.00	111.00
Polynesian	11	99.09	5.34	5.39	92.00	107.00
sub-Saharan African	45	99.71	4.97	4.98	92.00	111.00
North African	15	97.53	4.36	4.47	88.00	102.00
European	49	97.61	5.20	5.33	84.00	109.00
total	256	98.17	5.18	5.28	84.00	111.00

**Table 36** Nasio-frontal subtense

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	15.05	2.52	16.74	11.00	22.00
Indonesian	24	16.00	2.48	15.50	12.00	22.00
Inuit	16	14.50	2.16	14.90	12.00	19.00
South American	19	17.42	2.19	12.57	14.00	22.00
Australo-Melanesian	36	17.58	3.06	17.41	11.00	24.00
Polynesian	11	17.91	0.94	5.25	17.00	20.00
sub-Saharan African	45	18.49	2.69	14.55	14.00	24.00
North African	15	18.20	2.08	11.43	14.00	23.00
European	49	17.63	2.60	14.75	12.00	23.00
total	256	17.04	2.83	16.61	11.00	24.00

**Table 37** Nasio-frontal angle

sample	N	$\bar{x}$	sd	CV	min	max
Chinese	41	145.28	4.94	3.40	133.31	154.17
Indonesian	24	143.59	4.10	2.86	135.22	151.04
Inuit	16	147.13	4.59	3.12	138.37	153.75
South American	19	141.07	4.22	2.99	132.28	147.46
Australo-Melanesian	36	141.34	5.82	4.12	130.85	153.63
Polynesian	11	140.19	1.94	1.38	137.66	144.73
sub-Saharan African	45	139.41	4.61	3.31	129.58	147.50
North African	15	139.11	3.72	2.67	131.43	147.78
European	49	140.36	4.76	3.39	129.69	152.73
total	256	141.82	5.23	3.69	129.58	154.17

### 3.2 Summary of the distribution of the East Asian continuity features

The suggested East Asian regional continuity features which are believed to show stable regional morphological continuity over a time span of a million years cannot be proved in this study. The results of this study on the basis of 18 features claimed most often show that these are not characteristics for the Chinese as would have been expected. In contrast, these features exhibit a wide geographical distribution. Only two features

appear to show a tendency as suggested by the Multiregional model: flatness at the upper face expressed by an obtuse Nasio-frontal angle (no. 18), and flatness at the middle part of the face expressed by an obtuse Zygomaxillary angle (no. 8). The Inuit are the only population that exhibits similar or even greater angles than the Chinese as shown in Table 38, while the other populations show more acute angles than the Chinese. As a summary, Table 38 shows the population samples in which the suggested East Asian regional continuity features could be found with higher frequencies or stronger conditions than in the Chinese group. These results generally contradict the expectations of the Multiregional model.

**Table 38** Populations in which the suggested East Asian regional continuity features occur in higher frequency or stronger expression than assumed by the Multiregional model (in decreasing order)

Feature	Population
1. Sagittal keeling on the frontal	Inuit, European
2. Pronounced frontal orientation of the malar facies and the frontosphenoidal process of the zygomatic bone	Inuit, South American, Indonesian, Australo-Melanesian
3. Anteriorly facing frontal process of the maxilla	Sub-Saharan African, South American
4. Antero-lateral surface of the zygomatic process faces more forward	Inuit, South American, Australo-Melanesian, Polynesian, Sub-Saharan African, North African, European
5. Junction of the lower margins of the maxilla and the zygomatic bones is more angular in shape	Inuit, Indonesian, North African
6. Facial height reduction (Upper facial index)	Australo-Melanesian, Polynesian, South American, European, Indonesian, sub-Saharan African.
7. Orientation of lower border of the zygomatic process of the maxilla	European, Sub-Saharan African
8. Middle part of the face is not very protruding	Inuit
9. Lack of anterior facial projection and low degree of prognathism	North African, European
10. Horizontal course of the nasofrontal and fronto-maxillary sutures	Australo-Melanesian, sub-Saharan African, Inuit, North African, South American, European.
11. Flatness of the nasal region	Sub-Saharan African
12. Non-depressed nasal root	Inuit, Indonesian, sub-Saharan African
13. No difference between upper and middle part of the nasal bones	European, Australo-Melanesian
14. Presence of the incisura malaris	Polynesian, Australo-Melanesian, Sub-Saharan African, Indonesian

Feature	Population
15. Shape of orbit	Total number of combinations is 32. Of these 6 combinations occur in Polynesian; 7 in Inuit; 10 in Indonesian and South American; 13, North African; 15, European and sub-Saharan African; 18 Chinese; 21 Australo-Melanesian.
16. Rounded infero-lateral margin of the orbit	Australo-Melanesian, Polynesian, Indonesian, Sub-Saharan African
17. Presence of the malar tuberosity	Australo-Melanesian, Polynesian, North African
18. Large naso-malar angle (Nasio-frontal angle)	Inuit

The sagittal keeling on the frontal is assumed by the Multiregional model to occur in distinct expression. However, a distinct keeling was not found in this study. Of the three categories („none“, „slight“ and „moderate“) it was the category „none“ that occurs mostly in China. In other words, sagittal keeling on the frontal is mostly absent in China. Only 12.2% of the Chinese exhibit „moderate“ keeling. This category occurs with the same frequency in the Europeans (12.2%) and most frequently in the Inuit (37.5%). Other populations also show low frequencies or an absence of moderate keeling but high frequencies in the category „slight“. The degree of frontal orientation of the malar facies and the frontosphenoidal process of the zygomatic bone, as determined by measuring the angle (Method B), shows that the Chinese do not exhibit the most obtuse angle as expected. Instead, the Australo-Melanesians, Indonesians, South Americans and Inuit show more obtuse angles on average. Other populations show similar or more acute angles than the Chinese. Even the Europeans, North and sub-Saharan Africans exhibit only slightly lower values, but all show a tremendously large individual variation for this feature. The frontal process of the maxilla is supposed by the proponents of the Multiregional model to be anteriorly oriented („convex“ category). However, this category occurs in only 9.5% of the total sample. Only 7.7% of the Chinese exhibit this category, which occurs more frequently in the South Americans and sub-Saharan Africans. A „depressed“ frontal process of maxilla is the most common condition in the recent samples (77.5%).

Another feature, the forward facing of the anterior surface of the zygomatic process was completely absent in the Chinese. Instead, the „protruding“ category of this feature occurs more frequently in the Inuit, South American, North African, Polynesian, sub-Saharan African, Australo-Melanesian and European populations. The junction between the zygomatic process of the maxilla and the zygomatic bone is not indicative of an angular shape in the Chinese population, as is shown by the rather obtuse angles mostly found in the Chinese. In contrast, the North African and Indonesian populations show a slightly more angular junction than the Chinese, while the Inuit exhibit the most acute

angle. Facial height reduction is mainly determined by the Upper facial index i.e. facial height (NPH) is regarded in relation to its breadth. Based on the Upper facial index, most samples, including the Chinese and sub-Saharan Africans, exhibit faces of moderate height on average. It is quite interesting that the Inuit and North African populations tend towards higher and narrower faces. This indicates that the shape of the upper face is not specialized in the Chinese. Moreover, the Chinese are supposed to be characterized by a horizontal orientation of the lower border of the zygomatic process of maxilla. In fact, the results of this study show that this feature is a geographically widespread condition. All samples exhibit this feature. Even the sub-Saharan Africans and Europeans show this feature with higher frequencies than the Chinese. With regard to prognathism, based on the Gnathic index, the North Africans and Europeans show more orthognathic faces on average than the Chinese.

The course of the nasofrontal and frontomaxillary sutures is supposed to be horizontally oriented in the Chinese. However, contrary to this expectation, the present study has shown that the Chinese show great distances between both sutures. The Australo-Melanesians, sub-Saharan Africans, Inuit, North Africans, South Americans, and Europeans exhibit more horizontal courses than those shown by the Chinese. Also, the flatness of the nasal bones as determined by the Simotic angle indicates the most obtuse angles or flat nasal bones in the sub-Saharan Africans, whereas the Chinese exhibit conditions similar to those of Australo-Melanesians. A flat or non-depressed nasal root is not a Chinese characteristic, but is frequently found in other recent populations. The Inuit, Indonesians and sub-Saharan Africans are the populations that show higher frequencies than the Chinese for this condition. A strong incisura malaris is generally absent in all populations. "Moderate" conditions were assumed to occur with high frequencies in China, but were only found occur in extremely low frequencies. The Polynesians, Australo-Melanesians, sub-Saharan Africans and Indonesians show slightly more frequent occurrences. The shape of the orbits was not determined as spherical or rectangular but in a more precise manner as the combination of the superior, lateral and inferior part of the orbit. In this study, the Chinese were found to exhibit the second highest number of combinations of the orbital shape, indicating strong heterogeneity in the shape of the orbits. The Polynesian, Inuit, Indonesian, North African, sub-Saharan African and European population samples exhibit lesser numbers of combinations than the Chinese and Australo-Melanesians. Finally, the two suggested East Asians features „rounded infero-lateral margin of orbit“ and „degree of malar tuberosity“ occur more frequently in Australo-Melanesians, Polynesians, Indonesians and North and sub-Saharan Africans.

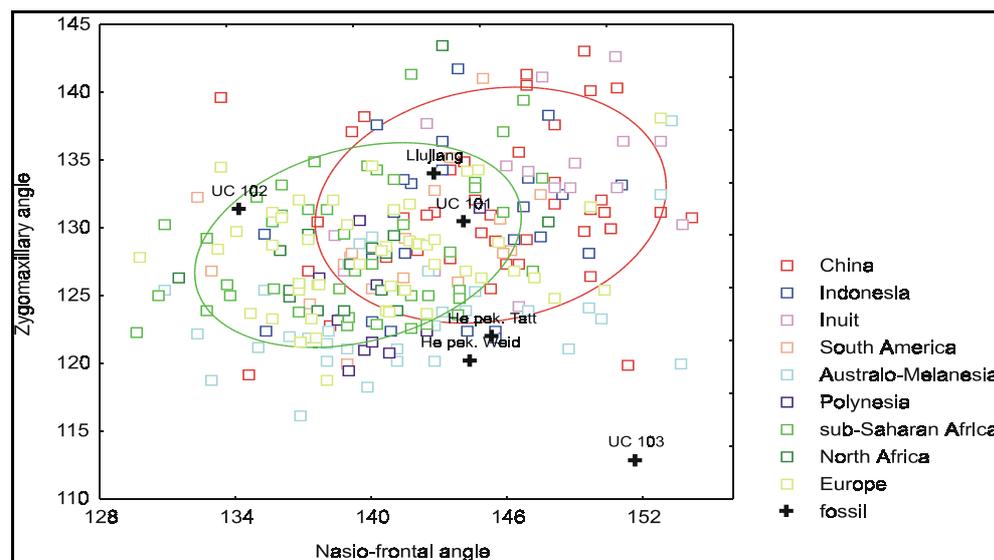
The results of the present study revealed that 16 of the 18 suggested East Asian regional continuity features do not occur as has been proposed. In other words, the Chinese sample lacks the majority of these features.

# Chapter 4

## Occurrence of regional continuity features in Chinese Pleistocene fossil hominids

### 4.1 Comparison between present and past

In the previous chapter, the occurrence of the 18 suggested East Asian regional continuity features was examined in the sample of modern populations. The results revealed that only two of these features show tendencies as suggested by the Regional Continuity model, although their occurrence in the Chinese does not differ significantly from that in other populations. These features are the rather weak protrusion of the middle part of the face (no. 8) and the relatively large Nasio-frontal angle (no.18). Since the Multiregional model assumes that these conditions already occurred in earlier Chinese back to *Homo erectus*, it was further examined whether these features are present in various Chinese Pleistocene fossil hominids.



**Fig. 38** Bivariate scatterplot of the Zygomaxillary angle and the Nasio-frontal angle based on 256 modern crania stemming from nine populations. For two samples (Chinese, sub-Saharan Africans) the 95% confidence ellipses are given.

Figure 38 shows that there are great overlappings between the recent samples with regard to both angles, but most obviously for the Zygomaxillary angle. This is also evident for the Chinese and sub-Saharan groups. The 20.000 to 30.000 year old specimens Upper Cave 101 and Liujiang fall in the overlapping zone of the 95% ellipses of the sub-Saharan Africans and Chinese. The Upper Cave 102 cranium shows great differences

from the Chinese concerning its low Nasio-frontal angle, indicating a more protruding upper face than in modern Chinese which is even marginal to the sub-Saharan sample. Because of the generally great overlap for the Zygomaxillary angle, no special affinities can be seen for Upper Cave 102 as well as 101. The Upper Cave 103 specimen falls completely out of the range of all geographical groups with regard to its small Zygomaxillary angle, whereas the upper face is unusually flat. Thus, for these early modern specimens no clear evidence can be seen pointing to close similarities to the recent Chinese. What about the two reconstructed crania of *Homo erectus pekinensis*? Both the male and the female cranium lie outside the 95% distribution of the recent Chinese sample, but show some affinities to Australo-Melanesian specimens. The positions of the *Homo erectus* crania are due to low values for the Zygomaxillary angle, i.e. their midfaces are not as flat as can be seen in the Chinese and other recent samples. For the Nasio-frontal angle both *erectus* specimens fall in the overlapping zone of Chinese and sub-Saharan Africans.

Summarizing the comparisons of recent and fossil humans for the upper and midfacial flatness it can be concluded that *Homo erectus* of China does not have a flat middle face and is thus clearly different from recent Chinese and other modern samples. With regard to its upper face, it exhibits a degree of flatness which is very frequent in many recent groups, such as sub-Saharan Africans, Chinese, Europeans and others.

The four early modern specimens are so widely scattered with regard to both variables that no clear tendency or affinity to recent Chinese can be seen. Besides, the very separated position of Upper Cave 103, the other three individuals exhibit values for the midfacial flatness which occur frequently in Chinese, sub-Saharans and other recent samples. Altogether it can be concluded that the early modern Chinese do not show the tendency of flat upper and middle faces as found in recent Chinese. *Homo erectus* from Zhoukoudian also differs strongly from the recent condition in its less flat midface.

## **4.2 Chinese fossil hominids: a further comparison**

Although the occurrence of upper and middle facial flatness as evidence for a gradual lineage in China could not be supported, three further features were included in order to check all possibilities for an occurrence of regional continuity features in the fossil crania. These suggested East Asian regional features were taken based on their high frequencies in the Inuit sample (see also Cavalli-Sforza et al., 1994, Kamminga, 1988: 751) and the availability in fossil crania (see Table 38 in Chapter 3). These features include the anterior orientation of the frontosphenoidal process (no. 2), the more forward facing of the anterior surface of the zygomatic process (no. 4), and the non-depressed nasal root (no. 12).

Although sagittal keeling on the frontal also occurs in high frequency in the Inuit sample, this feature was not included, because according to the proponents of the Multiregional model there is a change in its expression over time: sagittal keeling appeared more regularly in the earlier skulls (*in China*) and became gradually fainter in the later specimens (Wolpoff et al., 1984: 435). Another feature, the more angular shape of the junction of the lower margins of the maxilla and the zygomatic bones (no. 5), which showed the most acute angulation in the Inuit could not be included since this junction was not preserved in most fossils. Table 39 shows the expressions of the three additional features analysed in fossil specimens. For one of these features the archaic *Homo sapiens* crania from Dali and Maba could be included as well.

**Table 39** Conditions of three suggested East Asian features (with highest frequencies/strongest expressions in the Inuit) in Chinese fossil hominids.

Specimen	Pronounced orientation of the malar facies and frontosphenoidal process (method B)	Anterior surface of the zygomatic process faces more forward	Non-depressed nasal root
H.e. pek. Weid	87°	protruding	slight
H.e. pek. Tatt	84°	receding	slight
Dali	-	-	very deep*
Maba	-	-	rel. deep**
UC 101	79°	protruding	rel. deep
UC 102	53°	transverse	slight
UC 103	88°	receding	rel. deep
Liujiang	81°	transverse	slight

\*= assessed from photograph

\*\*= assessed from cast

Although the determination of the angle in both *Homo erectus pekinensis* crania is based on reconstructions with some uncertainties, it seems that the angle describing the orientation of the frontosphenoidal process of the zygomatic bone is relatively large (87° and 84°), much larger than the average in the Chinese (69.4°). Even the South Americans and Indonesians exhibit greater means than the latter (79.5° and 73.8°, respectively). Thus, although the frontosphenoidal processes form a large angle in Chinese *Homo erectus*, a direct connection to modern Chinese can hardly be seen. The Inuit exhibit a rather obtuse angle (82.87°) on the average, which is only somewhat lower than that of the

Tattersall reconstruction. Weidenreich's reconstruction shows an even higher value than those of the Inuit.



**Fig. 39** Female *Homo erectus pekinensis* reconstructed by Weidenreich. a. orientation of facies malaris and frontosphenoidal process. b. orientation of zygomatic process (see Figure 46). c. nasal root depression. (housed in Natural History Museum, London)

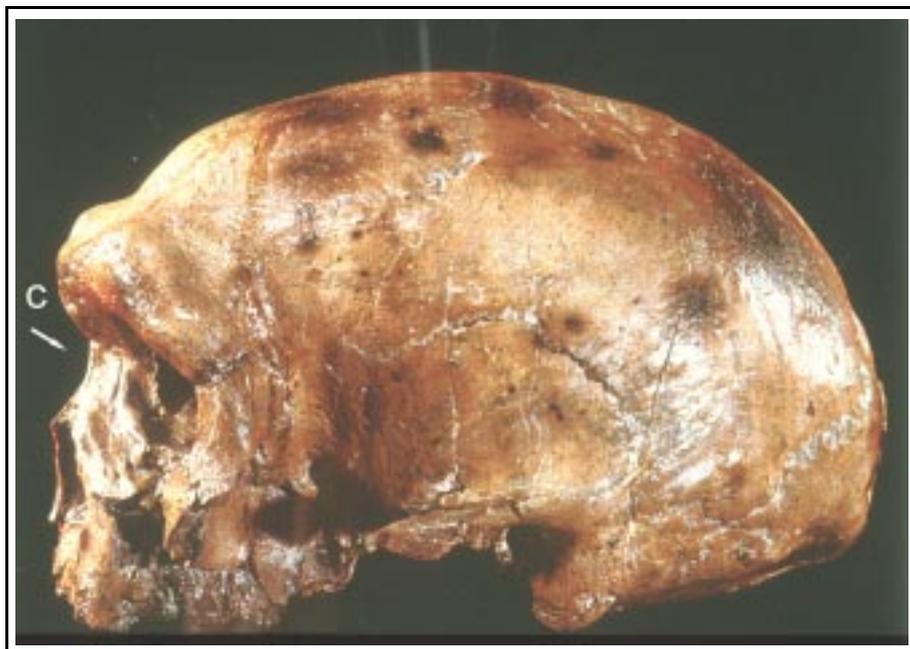


**Fig. 40** Male *Homo erectus pekinensis* reconstructed by Tattersall. a-c see Figure 39. (photograph from Johanson, 1998)

According to the assumptions of the Multiregional model, the zygomatic process of the maxilla should be protruding in the Chinese population. However, Tattersall's new reconstruction shows a process which is classified as receding. It is remarkable that the „multiregionalist“ Weidenreich reconstructed a more protruding zygomatic process. As shown in chapter 3, it is the category „receding“ which occurs mostly in modern Chinese, whereas the category „protruding“ is totally absent. In the Inuit all categories of the zygomatic process are present with different frequencies, of which the category “transverse” is the most frequent in this population; compared with China and other

populations, the category (“protruding”) occurs relatively frequently (31.3%). In South American and North African populations protruding zygomatic processes occur, but with lower frequencies (15.8% and 13.3%, respectively). Thus, Weidenreich’s *Homo erectus* reconstruction shows similarities to the Inuit and also to other populations.

The third feature that was assessed in the fossils is the condition of the nasal root. According to the Multiregional model, this trait should be „flat“ or non-depressed. Both *Homo erectus pekinensis* skulls show a slightly depressed nasal root, while the condition of the nasal root in modern Chinese is mostly non-depressed (68.3%). This is also true for the sub-Saharan Africans with 72.7% of „flat“ nasal roots. A „slight“ depression occurs in lower frequencies in modern Chinese as well as in Inuit, but more frequently in Polynesian and South American populations.



**Fig. 41** Archaic *Homo sapiens* from Dali showing a very depressed nasal root (c) (photograph from Johanson, 1998).

On the archaic *Homo sapiens* specimens from Dali and Maba only the conditions of the nasal root could be included in this comparison (for Dali photographs were used and for Maba a cast). The Dali specimen shows a „very deep“ or very depressed nasion region. This category was not found among any of the modern Chinese individuals.

In Maba the nasal root is „relatively deep“ and clearly depressed. This condition occurs in only 2.4% of the modern Chinese sample and was totally absent in the Inuit. In contrast, this condition occurs more frequently in the Australo-Melanesians. Thus, both the Dali and Maba hominids do not show a pattern of regional continuity from *Homo erectus* nor close affinities to recent East Asians.



**Fig. 42** Early *Homo sapiens* specimen Upper Cave 101 („the Old Man“). a-c see Figure 39. (housed in Natural History Museum, London)

Finally, the conditions in the four early modern specimens are considered, beginning with the Upper Cave skulls. Using the more precise method B to assess the orientation of the frontosphenoidal process of the zygomatic bone, the Upper Cave 101 specimen exhibits an obtuse angle of  $79^\circ$ , which is much closer to the mean of the South Americans ( $79.4^\circ \pm 10.43^\circ$ ) than to that of modern Chinese ( $69.4^\circ \pm 9.77^\circ$ ). The antero-lateral surface of the zygomatic process is „protruding“, whereas the nasal root is „relatively deep“. With its slightly protruding zygomatic process, Upper Cave 101 shows similarities to Weidenreich’s but not to Tattersall’s *Homo erectus* reconstruction. Moreover, this condition is totally absent in the modern Chinese sample but occurs in other populations in low frequencies. A relatively deep nasal root as found in Upper Cave 101 does not occur frequently in modern Chinese but is more often seen in Australo-Melanesians. Upper Cave 101 shares this condition with the archaic *Homo sapiens* specimen from Maba. This condition, however, does not reflect close affinities to modern Chinese or even Inuit.

In Upper Cave 102 the frontosphenoidal process of the zygomatic bone is not anteriorly oriented, as can be seen by the acute angle of  $53^\circ$ . Compared with the modern Chinese ( $69^\circ \pm 9.77^\circ$ ), this specimen exhibits a much more acute angle. This contradicts to Wu (1995: 270) who said that in the Chinese skulls „the antero-lateral surface of the sphenofrontal process of the zygomatic bone is facing more forward and helping to make the upper part of the face flatter“. Therefore, Upper Cave 102 does not show a pattern of regional continuity. In this aspect, the Inuit lie at the opposite pole with their most obtuse angle ( $82.87^\circ \pm 11.99^\circ$ )



**Fig. 43** Early modern *Homo sapiens* crania, Upper Cave 102 classified as of Australoid type by Weidenreich. a-c see Figure 39 (housed in Natural History Museum, London)

The anterior surface of the zygomatic process of the maxilla does not face forward in Upper Cave 102. The horizontal line drawing along this surface shows a „transverse“ condition. Such an orientation of the zygomatic process occurs in all populations and more frequently in Europeans and North Africans than in the others. The nasal root is „slightly“ depressed whereas most modern Chinese were classified as „flat“ (68.3%). Polynesians and South Americans show slightly depressed nasal roots (54.5% and 42.1%) more frequently, while these occurred in only 6.3% of the Inuit sample.



**Fig. 44** The Upper Cave 103 cranium regarded by Weidenreich as Eskimoid type. a-c see Figure 39. (housed in Natural History Museum, London)

Compared with the other Upper Cave individuals and also with modern Chinese, the 103 specimen shows a strongly frontal orientation of the frontosphenoidal process which is indicated by a highly obtuse angle ( $88^\circ$ ). This angle is more obtuse than that found in the Inuit ( $82.87^\circ \pm 11.99^\circ$ ). Upper Cave 103 shows a receding course of the zygomatic process as is also exhibited in Tattersall's *Homo erectus* reconstruction. Thus, Upper Cave 103 does not exhibit a protruding zygomatic process as suggested by the proponents of the Multiregional model. Finally, the 103 specimen does not exhibit a flat nasal root but a „relatively“ depressed condition which is also present in Maba and Upper Cave 101. However, a relatively deep nasal root is very rare among modern Chinese as well as Inuit.



**Fig. 45** The Liujiang specimen. a-c see Figure 39. (housed in Natural History Museum, London)

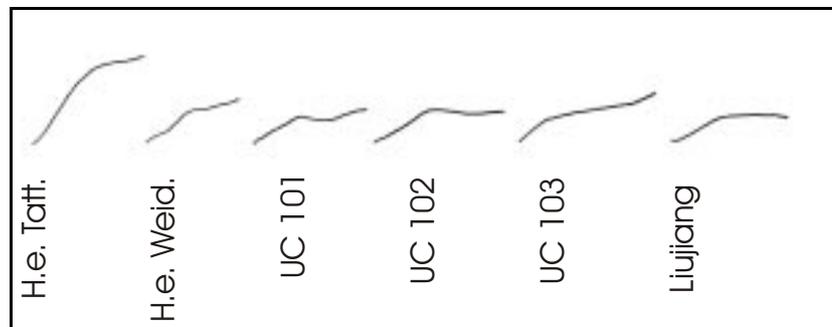
The Liujiang cranium exhibits a flat upper face as shown by the obtuse angle ( $81^\circ$ ). This angle is more obtuse than the average found for the modern Chinese ( $69.4^\circ \pm 9.8^\circ$ ) but closer to the Inuit ( $82.87^\circ \pm 11.9^\circ$ ). The zygomatic process is „transversely“ oriented in Liujiang as is the case in Upper Cave 102. Again, although this condition occurs more frequently among the individual fossils and also in relatively high frequency in modern Chinese, it is not the expected condition as proposed by the Multiregional model. Moreover, in all populations such an orientation is present. Liujiang shares a similar pattern with Upper Cave 102 in its slightly depressed nasal root. In modern Chinese, slightly depressed nasal roots occur in approximately 30%. Similar frequencies were found in the European, North African, sub-Saharan African, Australo-Melanesian, and Indonesian populations (28.6%, 26.7%, 25%, 25.7% and 20.8%, respectively). The most frequent occurrences of this category are in the Polynesians and South Americans (54.5% and 42.1%, respectively).

Besides the general variation of these three suggested East Asian regional features in Chinese Pleistocene hominids the following summary can be given:

*Pronounced frontal orientation of the malar facies and the frontosphenoidal process of the zygomatic bone*

Among the fossils the variation of the angle ranges from 53° to 88°. Upper Cave 102 exhibits the most acute angle (53°). In contrast, Upper Cave 103 exhibits the most obtuse angle (88°), followed by Weidenreich's *Homo erectus* reconstruction, Tattersall's *Homo erectus*, Liujiang and Upper Cave 101 (87°, 84°, 81° and 79°, respectively). All fossils, except Upper Cave 102, exhibit rather obtuse angles indicating a strong flatness in terms of the frontal orientation of the frontosphenoidal processes. However, the recent individual variation is very large for this feature (see Table 39) with similar ranges of variation for the Chinese (46°-86°) and sub-Saharan Africans (48°-87°) and even larger ranges for Europeans (33°-102°) and Australo-Melanesians (46°-94°). Nevertheless, the angles of the fossil Chinese specimens are closest to the means of Inuit ( $82.87^{\circ} \pm 11.9^{\circ}$ ) and South Americans ( $79.47^{\circ} \pm 10.43^{\circ}$ ). However, a regional continuity can hardly be identified for this trait, because the modern Chinese ( $69.40^{\circ} \pm 9.77^{\circ}$ ) do not exhibit such an obtuse angle. On the contrary, the fossil values are closer to the means of the Australo-Melanesians ( $69.69^{\circ} \pm 12.05^{\circ}$ ) and even sub-Saharan Africans ( $66.29^{\circ} \pm 9.83^{\circ}$ ).

*Antero-lateral surface of the zygomatic process of the maxilla faces more forward*



**Fig. 46** Variation of the antero-lateral surface of the zygomatic process of the maxilla in the fossils (from zm to the edge of the nasal aperture, see also Figure 5).

The orientation of the zygomatic process is quite variable among the fossils. Liujiang and Upper Cave 102 exhibit a „transverse“ orientation, whereas Tattersall's new *Homo erectus* reconstruction and Upper Cave 103 show „receding“ processes. „Slightly protruding“ zygomatic processes occur in only two of the six fossils (Weidenreich's *Homo erectus* reconstruction and Upper Cave 101). However, this expected East Asian condition („protruding“) does not even occur in the Chinese sample. In contrast, „receding“ and „transverse“ zygomatic processes are common expressions in modern

Chinese. Therefore, the suggestion that the protruding orientation is a characteristic for the Chinese can be rejected. The condition of this feature in the fossil specimens indicate that the orientation of the zygomatic process is probably also variable in *Homo erectus pekinensis*.

#### *Non-depressed nasal root*

The expression of the nasal root in Chinese fossils varies strongly. The expected category („flat“) could not be identified in any of the fossil specimens. In contrast, the „very deep“ category that did not occur in the recent Chinese, was identified in the Dali cranium. Both *Homo erectus* crania, Upper Cave 102 and Liujiang show „slight“ depression, whereas Maba, Upper Cave 101, and 103 exhibit „relatively deep“ depressions. Among the recent Chinese the category „flat“ occurs more frequently (68.3%) than the other categories („slight“ 29.3% and „relatively deep“ 2.4%). This pattern of expression of this feature does not show an evolutionary continuity in China. A similar pattern can also be seen among the sub-Saharan Africans („flat“ 72.7%, „slight“ 25%, „relatively deep“ 2.3%). Among the recent samples, „slight“ depressions occur more frequently in the Polynesians and South Americans, whereas the „relatively deep“ ones are not rare among the Australo-Melanesians. The facts show that the expression of this feature is highly variable among the fossils and the conditions occur in all samples.

The results show, even based on an enlarged number of suggested regional continuity features, that the fossils do not exhibit the complex of features as suggested by the Multiregional model (Wolpoff, 1999). The features are variable and do not occur as a single pattern or combination of traits which would indicate a regional evolution over about half a million years or more. Some fossils exhibit expected features but these features are not characteristic for modern Chinese. Based on these reasons it is difficult to regard these features as evidence for a regional evolution in China.

### **4.3 Multivariate comparison of recent and fossil faces**

In order to analyse the relationships of fossil Chinese specimens and modern populations, 9 measurements (Table 40) were used, which are also considered by proponents of the Multiregional model (Wolpoff et al., 1984; Wu, 1992; Wu and Poirier, 1995) to demonstrate regional continuity in the face. Besides, only measurements could be included that were available on the fossil human crania.

**Table 40** Metric data on fossil hominids discussed in this study

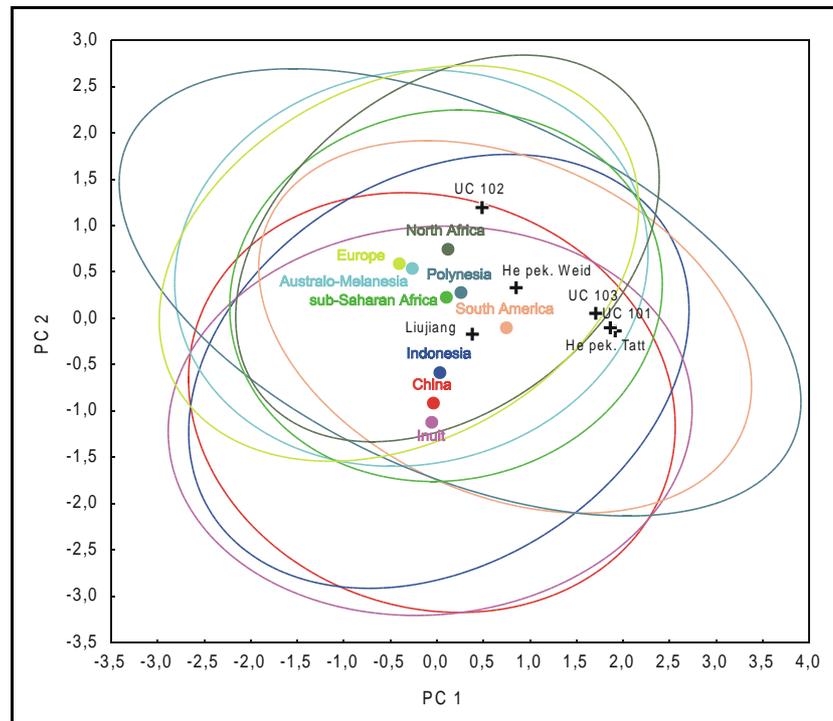
Variable used	H.e. pek. Weid	H.e. pek. Tatt	Liujiang	UC 101	UC 102	UC 103
Nasion-prosthion height (NPH) (48)	77	76	67	78	72	70
Bizygomatic breadth (45)	148	150	136	143	131	137
Bimaxillary breadth (46)	88	100	98	102	95	108
Simotic chord (WNB) (57)	11	13	11	8	10	9
Simotic subtense (SIS) (57a)	2	2	3	5	5	4
Bifrontal breadth (FMB) (43a)	112	109	101	111	104	111
Nasio-frontal subtense (NAS) (43b)	18	17	17	18	22	14
Bimaxillary breadth (ZMB) (46b)	87	101	99	104	93	101
Bimaxillary subtense (SSS) (46c)	25	28	21	24	21	34

**Table 41** Factor loadings of PCA based on raw data. PC1 accounts for 38.5% and PC2 for 20.8% of the total variance

Variable	PC 1	PC 2
Bimaxillary breadth (ZMB) (46b)	0.844	-0.282
Bizygomatic breadth (45)	0.815	-0.277
Bifrontal breadth (FMB) (43a)	0.788	0.167
Bimaxillary breadth (46)	0.781	-0.403
Nasion-prosthion height (NPH) (48)	0.647	-0.204
Nasio-frontal subtense (NAS) (43b)	0.359	0.691
Simotic subtense (SIS) (57a)	0.298	0.660
Simotic chord (WNB) (57)	0.313	0.698
Bimaxillary subtense (SSS) (76a)	0.342	0.374

Principal Components Analysis was applied to reduce the multidimensional data to a few uncorrelated new variables or components. The Principal Components Analysis was first carried out using the raw data which contains information on both size and shape. In a second approach the raw data were transformed to shape variables following the method suggested by Darroch and Mosiman (1985, see also Corruccini, 1987, Simmons et al. 1991). The shape transformation (see chapter 2) appears to be useful since especially for

the comparison of recent and fossil crania, the size component is thus excluded, and the resulting affinities between the specimens and samples are based on shape alone. For an adequate interpretation both ways of analysing the data might be of relevance.



**Fig. 47** PCA based on raw data of 9 measurements that were taken on nine modern samples and six Chinese fossils. The 95% confidence ellipses are shown. PC1 represents 38.4% and PC2 20.8% of the variance.

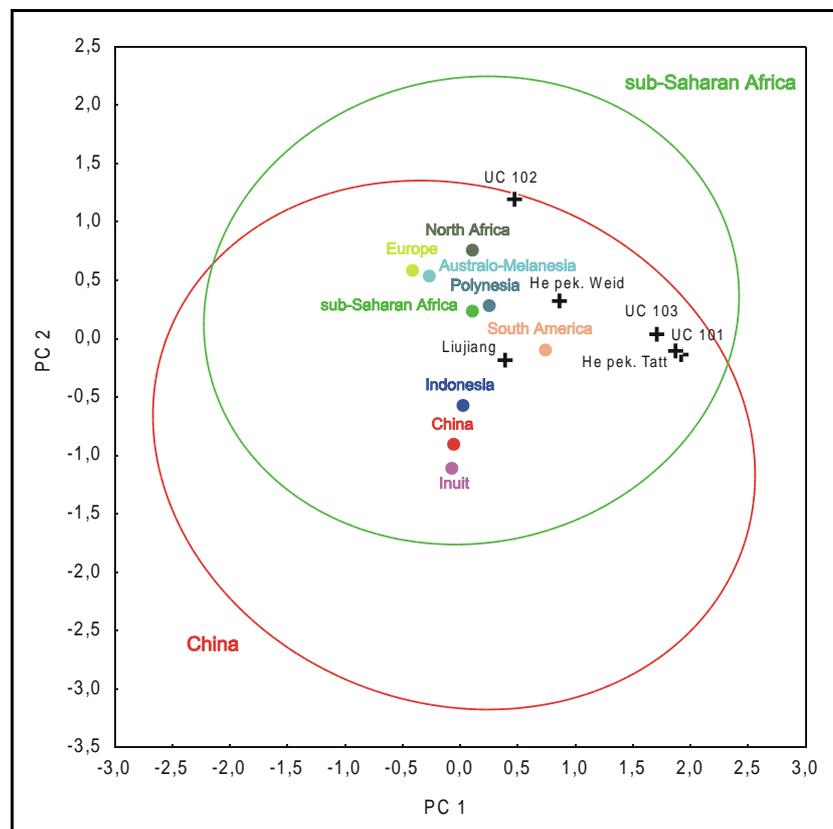
The loading of the Principal Components based on raw data are presented in Table 41. Figure 47 and 48 show the 95% confidence regions of the individual factor scores for PC1 and PC2. Figure 47 shows that all populations largely overlap with each other, indicating that the facial dimensions do not separate the different geographic populations. The same result is also illustrated in Figure 48 by showing only two confidence ellipses. It is evident here that all modern centroids as well as nearly all fossil crania fall within the overlapping area.

PC1 separates a group consisting of *Homo erectus* reconstructed by Tattersall, Upper Cave 101 and 103, from the population group centroids and other individual fossils. The factor loadings of the variables for the PC1 (see Table 41) indicate that the factor is largely determined by breadth measurements. Most modern centroids point to affinities between the recent samples. The greatest differences appear between Europeans and South Americans. In contrast, the fossil specimens show a stronger deviation in this component. Most different from the recent populations, including the Chinese and Inuit, are Tattersall's *Homo erectus* reconstruction, Upper Cave 101 and 103. Weidenreich's

reconstruction exhibits a more intermediate position between the recent populations and Tattersall's reconstruction. Liujiang and Upper Cave 102 are closer to the population centroids.

PC2 exhibits high loadings for variables describing the projection of the nasal region or the upper face (see Table 41). With regard to PC2, the greatest differences among the recent centroids are between the Inuit and North Africans, whereas the other recent populations fall between these poles. Only slight differences exist between the Chinese and Inuit. But both populations are marginal with regard to the modern centroids. The Chinese fossils are very close to the modern human range. Weidenreich's *Homo erectus* is closest to the sub-Saharan Africans and Polynesians. Tattersall's *Homo erectus* is somewhere intermediate between Indonesians and sub-Saharan Africans, whereas Upper Cave 101 and 103 are slightly closer to South Americans and sub-Saharan Africans. Upper Cave 102 is most different from the Indonesian, Chinese and Inuit populations in its closest relationships to the North Africans. Liujiang is somewhere intermediate between Indonesian and South American populations.

Based on these results Chinese *Homo erectus* is very separate from recent populations, including modern Chinese and Inuit. This is also true for Upper Cave 101, 102 and 103. The position of Liujiang is somewhere intermediate and less clear.



**Fig. 48** The same PCA as illustrated in Fig. 47, only two 95% ellipses are shown here.

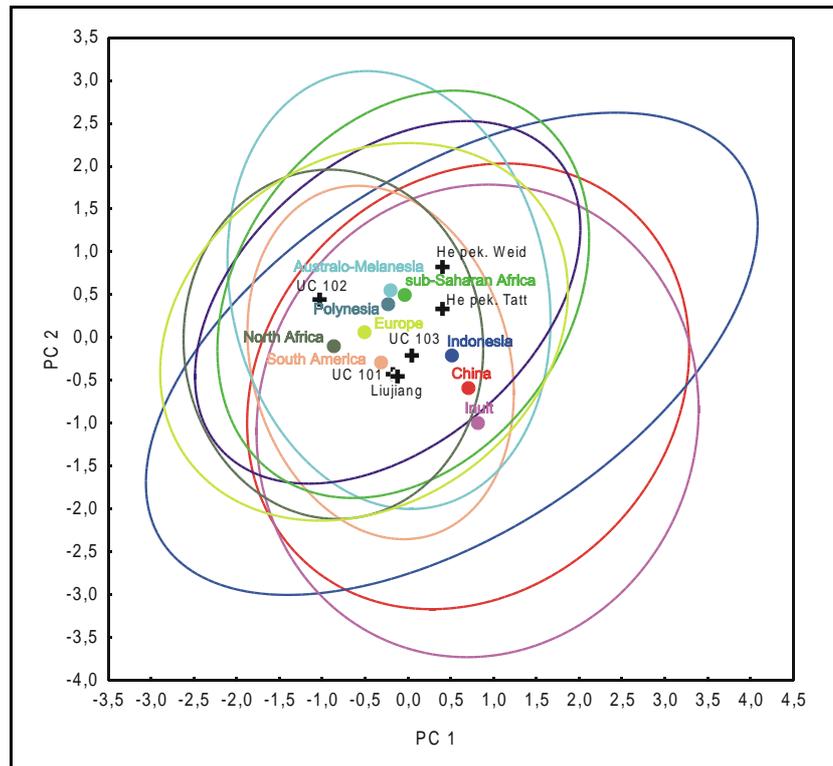
**Table 42** Factor loadings based on log shape variables. PC1 accounts for 59.5% and PC2 for 14.6% of the total variance

Variable measured	PC 1	PC 2
Bizygomatic breadth (45)	0.924	-0.179
Bimaxillary breadth (ZMB) (46b)	0.923	-0.134
Bimaxillary breadth (46)	0.906	-0.208
Bifrontal breadth (FMB) (43a)	0.892	0.087
Nasion-prosthion height (NPH) (48)	0.818	-0.172
Simotic subtense (SIS) (57a)	-0.800	-0.281
Simotic chord (WNB) (57)	-0.738	-0.144
Nasio-frontal subtense (NAS) (43b)	-0.023	0.882
Bimaxillary subtense (SSS) (76a)	0.419	0.551

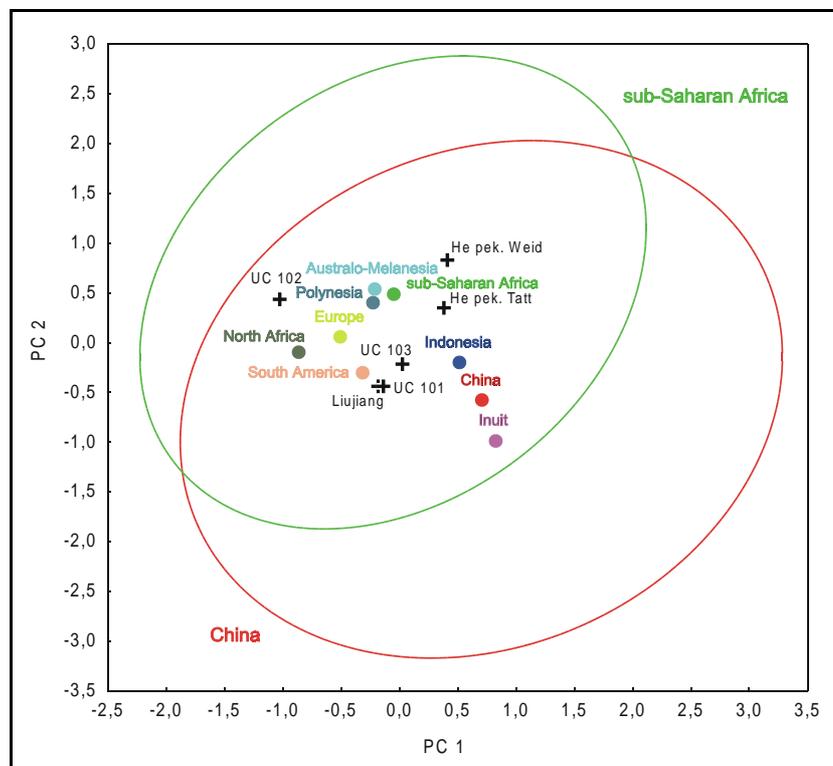
The second Principal Components Analysis was based on log shape variables. The factor loadings are given in Table 42. Figure 49 and 50 show the 95% confidence ellipses of the individual factor scores for PC1 and PC2, respectively. Figure 49 again shows the great overlap of all populations. The positions of the centroids and fossil specimens differ somewhat from the PCA using raw data. However, among the modern populations, the greatest differences again appear between the North African and Inuit samples, and the Chinese position is still intermediate between Indonesians and Inuit.

On PC1 high factor loadings are shown by breadth measurements, upper facial height and the Simotic subtense. Figure 50 shows that all populations and individual fossils fall in the overlapping area between Chinese and sub-Saharan Africans. In contrast to the distribution of centroids and fossil specimens based on raw data, this shape analysis does not place the fossils separately from the modern centroids. On PC1, Weidenreich's and Tattersall's reconstructions exhibit approximately the same positions between Chinese, Indonesians and sub-Saharan Africans. Upper Cave 103 but also 101 and Liujiang are closest to sub-Saharan Africans, Australo-Melanesians and Polynesians, whereas Upper Cave 102 lies near the North African centroid.

PC2 is largely determined by two variables describing the projection of the face. Compared with PC1, the 95% confidence ellipses show even stronger overlap between the recent groups. The greatest differences appear between the Australo-Melanesian and Inuit populations.



**Fig. 50** PCA based on log shape data of 9 measurements taken on nine modern populations and six Chinese fossils. The 95% ellipses are shown. PC1 represents 59.5% and PC2 14.6% of the total variance.



**Fig. 49** The same PCA as illustrated in Figure 49, only two 95% ellipses are shown here.

The Liujiang and Upper Cave 101 specimens show close affinities to the South Americans. Also, the Upper Cave 103 individual is close to South Americans as well as to Indonesians for this component. Quite remarkable are the positions of the *Homo erectus* specimens which differ from the East Asian groups and are much closer to sub-Saharan Africans and Australo-Melanesians. This is also true for Upper Cave 102.

It has been expected by the proponents of the Multiregional model that the Chinese fossils have affinities to their suggested 'descendants' as a reflection of a gradual evolutionary lineage. In this study, this assumption could not be supported. All fossils are scattered and mostly closer to other populations than to the modern Chinese. Therefore, it is difficult to see that the Chinese fossils show typical 'Mongoloid' features as shown by the modern Chinese. The Principal Components Analysis did not indicate that there is an evolutionary continuity from Chinese *Homo erectus* to modern people of the region.

# Chapter 5

## Discussion and conclusions

### 5.1 Regional approach to regional continuity

The basic argument of the Multiregional Evolution model is: „The conditions associated with the initial migrations of humans from Africa, approximately one million years ago, created the central and peripheral contrasts that affected the early establishment of regional features at the peripheries of the human range. The persistence of these peripheral distinctions, referred to as ‚regional continuities‘, through much of the remainder of the Pleistocene was a consequence of long lasting clines maintained by a balance of gene flow, often from center toward the edges, and local selection and in some cases drift“ (Wolpoff 1992: 26, see also Thorne and Wolpoff, 1981; Wolpoff et al., 1984; Wolpoff and Thorne, 1992; Frayer et al., 1993, 1994). These conditions imply that every population will later have specific characteristics which distinguish them from others. In other words, there are differences *between* populations in different regions; and there is relative homogeneity *within* them (Wolpoff, 1999). Thus, according to the Multiregional Evolution model, such ‚homogeneity and differences‘ should occur in each population including the Chinese. Whether this phenomenon can in fact be applied to the Chinese, will be discussed in the following section. The discussion is given in the framework of the Multiregional hypothesis, following Weidenreich’s suggestion that assumes this model as a network of vertical lineages of regional changes and horizontal interregional connections by gene flow between Africa, Europe and East Asia (see Frayer et al., 1993, Figure 1).

#### 5.1.1 Chinese internal morphological variability

To explain that homogeneity can be found within populations as a result of regional continuity, Wolpoff (1999: 42) argues: „...not every specimen is identical and each of these features varies in the sample, but *most of the combination* of features characterizes all of the specimens. Most of these features appear in the African early *Homo sapiens* remains as well, but the sample is much more variable in each of them and they are never found all together“.

In order to assess the ‚degree of homogeneity within populations‘ as defined above, eighteen suggested regional continuity features of the face were reassessed (see chapters 3 and 4). These eighteen characters are believed by the proponents of the Multiregional model to be characteristic for the Chinese and therefore, these should distinguish them from other populations.

Reassessing the occurrence of the eighteen suggested East Asian regional continuity features in this study, the modern Chinese can be regarded as being highly variable. Especially with regard to non-metrical features, there is no single character as proposed by the Multiregional model that can be identified in this study (cf. chapter 3): Sagittal keeling on the frontal is supposed to occur with a distinct/strong expression. In this study, the „distinct“ category was absent. Thus, the occurrence of keeling was determined only in three categories: „absent“, „weak“ and „moderate“. Of these, the category moderate occurs mostly in Chinese. The modern Chinese do not exhibit the expected „protruding“ zygomatic process of the maxilla. This category was totally absent. Instead, the zygomatic process among the modern Chinese is „receding“ and „transverse“ in approximately similar frequencies. Most of the recent Chinese exhibit a „rounded“ and „even (levelled)“ infero-lateral margin of orbit. However, these categories do not occur with the expected frequencies. The shape of the orbits was not assessed as a single character, such as „rectangular“ or „spherical“ since this is an inadequate simplification. Following Lahr’s method, the recent Chinese exhibit mostly a vertical superior-lateral margin, an oblique inferior margin, and various inclinations of the superior margin. However, these categories occur only in low frequencies. A ‚ridge-like‘ (‚very large“) malar tuberosity does not occur with high frequency. Instead, this tuberosity is mostly absent in China and if present at all, it appears only in a slight form. The horizontal orientation of the lower border of the zygomatic process of the maxilla occurs in all modern samples. The recent Chinese do not exhibit the expected „distinct“ incisura malaris. The „distinct“ category is totally lacking. Instead, an absence of the incisura malaris is more frequent. An expected „protruding“ frontal process of the maxilla occurs only in low frequency. In contrast, most of the recent Chinese exhibit a depressed frontal process of the maxilla. Most modern samples frequently show a nasal profile with ‚no difference in breadth between the middle and upper part of nasal bones‘. A flat nasal root is an expected feature of the Chinese. In this study, this feature does not only occur in China but also frequently in other populations. The frontosphenoidal process is not frontally oriented, but identified as an acute angle. The junction of the zygomatic process of the maxilla and zygomatic bone is not angular in shape. The course of the nasofrontal and frontomaxillary sutures is not horizontally oriented. Instead, the modern Chinese show a distinct curve formed by both sutures. The recent Chinese are not the only population that exhibits an obtuse Simotic angle implying a flat nasal region. The Australo-Melanesian and particularly sub-Saharan African populations also have flat nasal bones. Only with regard to the Zygomaxillary angle and Nasio-frontal angle do the Chinese differ from other populations (cf. Wolpoff et al. 1984; Frayer et al., 1993; Wu, 1992, 1995; Wolpoff et al., 1994)

Thus, in general, the greater majority of the features does not occur in the modern Chinese. It can be seen that the major combinations are also not present in China. In

contrast, these features are geographically widespread with very different frequencies or with very different values. Based on the results of the present study, the hypothesis proposed by the advocates of the Multiregional model (Wolpoff, 1999: 42) who say that „most of the combination of features should characterize all of the specimens“ cannot be supported. In this study, only two of the eighteen features show some tendency in modern Chinese which is too little to be regarded as evidence for homogeneity. In contrast the other 16 features do not occur as supposed by the Multiregional Evolution model.

According to the Multiregional model, regional features that occur in modern populations (*Chinese*) can be traced back to the fossil hominids as the impact of gradual evolution (Wolpoff et al., 1984; Thorne and Wolpoff, 1992; Frayer et al., 1993; Wolpoff, 1999). Therefore, the two features specific to recent Chinese (a relatively less projected middle and upper face) were examined in the Chinese fossils to clarify whether they also occur there. The results show that both features vary strongly among the fossils (see chapter 4). Recent Chinese have an average Zygomaxillary angle of  $131.67^{\circ} \pm 5.55^{\circ}$ . This angle expresses the degree of projection of the middle face. The values of three early modern Chinese (Upper Cave 102, 103 and Liujiang) fall into this range of variation. However, Upper Cave 103 has a much lower value ( $112.87^{\circ}$ ), as have the *Homo erectus* reconstructions by Weidenreich and Tattersall ( $120.21^{\circ}$  and  $121.97^{\circ}$ , respectively). Therefore, they fall outside of the recent Chinese range of  $\bar{x} \pm 1sd$ . The Chinese have a Nasio-frontal angle of  $145.28^{\circ} \pm 4.94^{\circ}$ , which determines the projection of upper face. *Homo erectus* as reconstructed by Weidenreich and Tattersall, Liujiang and Upper Cave 101 fall within the recent Chinese range of  $\bar{x} \pm 1sd$  ( $144.34^{\circ}$ ,  $145.33^{\circ}$ ,  $142.7^{\circ}$  and  $144.04^{\circ}$ , respectively). Upper Cave 102 shows the lowest value ( $134.12^{\circ}$ ), whereas Upper Cave 103 exhibits the most obtuse angle ( $151.67^{\circ}$ ). Both individuals fall outside the range of  $\bar{x} \pm 1sd$  of the recent Chinese and other recent samples.

Do the Chinese fossil hominids have East Asian features? A reassessment of the fossils by using three further features which occur in marked expressions in the Inuit reveals that these three features vary strongly in the fossils, so that the pattern suggested by the proponents of the Multiregional Evolution model cannot be found. A non-depressed nasal root is not present in any of the fossils. The protruding zygomatic process occurs only in Weidenreich's reconstruction and Upper Cave 101, whereas the other fossil individuals show a different pattern. In terms of the projection of the malar facies and frontosphenoidal process, most Chinese fossils show an obtuse angle, which enhances facial flatness.

With respect to the special likeness between modern Chinese and Chinese fossil hominids, recent studies also show that the latter exhibit no special degree of similarity with the recent populations. Kamminga and Wright (1988) have studied the ,Old Man-

Upper Cave 101' for which Weidenreich suggested a direct affinity with the modern Chinese. Using PCA in their study, Kamminga and Wright found that Upper Cave 101 is not characterised by the 'Mongoloid' features they examined. According to Kamminga, the 'Old Man' has a long, low and narrow cranium, with a high value for nasal breadth. Furthermore, Kamminga found that Upper Cave 101 is closer to the Ainu than to the 'Mongoloid' group. Wright (1995) concluded that Upper Cave 101 is so unlike other 'Mongoloid' samples in shape that it is misleading to label it as being 'proto-Mongoloid'. Neves et al. (1998, 1999) found almost the same results as the present study. According to Neves et al. Upper Cave 101 does not show any morphological affinity with the 'Mongoloids'. However, the authors found some affinities between Upper Cave 101, 103, and the first Americans, and also between the Upper Cave hominids and South Pacific and African populations. Recently, Stringer (1999) found that the Upper Cave specimens Liujiang and Minatogawa 1 do not seem to be related closely to recent populations of the region. Upper Cave 101 mostly resembles Australian, native American or African crania. Upper Cave 103 resembles Australian or Andamanese crania and Liujiang is close to African and some East Asian crania.

Do the East Asian Late Pleistocene crania show homogeneity? The five features examined do not occur as a complex or combination of features in individual fossils. Stringer (1999) also reveals that "Mongoloid" metrical features are not developed as a complex in the Chinese fossil crania. Only in the anterior projection of the frontosphenoidal process all individual fossils except Upper Cave 102 show a similar pattern. However, such a projection of the frontosphenoidal process is not present in recent Chinese. Instead, the recent Chinese generally show a more acute angle.

#### **5.1.1.1 From fossil to modern humans: a gradual evolution?**

Is there a gradual evolution in China? The results show that there is no indication of special similarities between fossil and modern Chinese. The features that occur in modern Chinese and even in Inuit cannot be identified in any of the fossils (see also chapter 4). In other words, a gradual evolution in China cannot be recognized.

The Principal Components Analysis based on log shape data also shows that an affinity between individual fossils and modern Chinese crania cannot be found. The individual fossils are scattered and not close to the recent Chinese. Instead, early modern human specimens from Liujiang and Upper Cave 101 are closer to the South American population than to the Chinese. Upper Cave 103 is also close to this modern population, and this individual is even placed at a more intermediate position among recent populations. An intermediate position is also shown by Tattersall's reconstruction. *Homo erectus pekinensis* reconstructed by Weidenreich is closer to sub-Saharan Africans, while

Upper Cave 102 is close to the North African populations. Thus, based on the PCA, affinities to recent Chinese cannot be identified among the fossils.

Such patterns of affinity have been also identified by some specialists (Kamminga and Wright, 1988; Wright, 1995; Neves and Pucciarelli, 1998). They found little evidence for an 'ancestor-descendant link' between the Upper Cave specimens and modern 'Mongoloid' populations (*Chinese*). In particular, the study from Neves and Pucciarelli supports the present study. The authors revealed that they did not find morphological affinities between Upper Cave specimens and modern 'Mongoloids' or between first Americans and 'Mongoloids'. However, the authors found some affinities between the Upper Cave hominids (Upper Cave 101 and 103) and the first Americans, and between the Upper Cave hominids and South Pacific and African populations.

On the basis of the features suggested by the Multiregional model, it cannot be said that there is an 'ancestor-descendant' relationship between *Homo erectus* and modern humans in China. As shown in PCA and other analyses, the homogeneity between *Homo erectus*, archaic and early modern *Homo sapiens* is minimal. Besides, all early modern human fossils such as Liujiang, Upper Cave 101, 102 and 103 show differences from recent Chinese their potential 'descendants'. The results of all the comparisons indicate that the morphology of the recent Chinese evolved very recently or that there were other Pleistocene hominids present in China. A similar pattern has been identified by Brown (1999: 120-121). In his study, he found that Liujiang and Upper Cave 101 are not similar to recent or Neolithic East Asians. These fossils fall outside the recent East Asian range of variation. Facial height, orbital shape, malar morphology and relative fault dimensions exclude both fossils from East Asians. Brown reveals that during the early Holocene and late Pleistocene, human crania tended to have low, rectangular orbits, a longer and lower cranial vault and greater curvature in the occipital region. The presence of some of these features in Liujiang, Upper Cave 101 and Minatogawa 1 shows that they are not like recent crania from the regions in which they were found. The Chinese specimens from earlier Holocene times were not examined in the present study, but according to Brown, the recent Southern Chinese are closest in their craniofacial size and shape to crania with an age of 3500 years than to those dating to about 4500 years and finally to 6500-5500 year old specimens. Brown explains that there is a gradual change, primarily in tooth size, prognathism and facial breadth dimensions from 6500-5500 years BP towards the present. Stringer (1999) states that the true origins of the present day peoples of eastern Asia remain unknown. In his study he shows that none of the Chinese fossils he examined is affiliated with the modern Chinese. Instead, they are closer to other modern populations. Furthermore, Stringer pointed out that in dental and metric characters the 'Mongoloid' cranial form is very derived. Finally, he says that this morphology of the modern Chinese

either evolved very recently or that the immediate Pleistocene ancestors of most East Asian peoples remain to be identified in the fossil record.

### **5.1.2 China: an intermediate position**

Are the modern Chinese distinguishable from other recent samples? According to the Multiregional scenario, China should show differences from other samples. For this, Wolpoff (1999: 42) gives an illustration: “An example of the heterogeneity found between peripheral samples is in the face. The Sangiran faces have cheeks beginning well to the rear of the upper jaw, their base positioned over the anterior molars, and their sides angle backwards so that they do not face anteriorly. The Gongwangling (Chinese Early Pleistocene) face is quite different, the base of the cheeks being much more anterior, just behind the nose, and their angulation quite forward, producing extreme facial flatness”.

This study has yielded the following results on the 18 features of the face used:

The antero-lateral surface of the zygomatic process facing more forward (no. 4) and facial height reduction (no. 6) are features that occur in all samples. In other words, all samples show a similar pattern. The occurrence of the horizontal orientation of the nasofrontal and frontomaxillary sutures (no. 10) and the expression of the shape of orbit (no. 15) vary strongly. No population shows any certain pattern in these features. The course of the nasofrontal and frontomaxillary sutures describes a clear curve, while the shape of orbit does not occur in a few separate conditions as for example „rectangular“ or „spherical“. The broad ‚Mongoloid‘ group (Chinese, South Americans and Inuit, as well as Indonesians) shares features such as: sagittal keeling on the frontal (no. 1); pronounced frontal orientation of the malar facies and the frontosphenoidal process of the zygomatic bone (no. 2); middle part of the face is not very protruding (no. 8) and large naso-malar angle (no. 18). The broad ‚Mongoloid‘ populations share some features with the Africans: in anteriorly facing frontal process of the maxilla (no. 3); angular junction of the lower margins of the maxilla and the zygomatic bones (no. 5); non-depressed nasal root (no. 12); and flatness of the nasal bone (no. 11). The orientation of the lower border of the zygomatic process of the maxilla (no. 7) and the lack of anterior facial projection and low degree of prognathism (no. 9) are the features that occur in the Chinese, Africans and Europeans. The Chinese share ‚no difference between upper and middle part of the nasal bones‘ (no. 13) with the Africans, Europeans and Oceanians. Finally, the broad ‚Mongoloid‘ group shares features indicating robustness with the Africans and Oceanians i.e. the presence of the incisura malaris (no. 14); a rounded infero-lateral margin of the orbit (no. 16); and the presence of the malar tuberosity (no. 17).

In fact, most of the features regarded as typical for the ‚Mongoloid‘ morphology are found in wide areas of the world, particularly in Greenland (Inuit). The sub-Saharan

Africans exhibit a number of East Asian features which are shared with Indonesians, Australo-Melanesians, and Polynesians. On the other side, the Inuit show a number of East Asian features, some of them with high frequencies or pronounced expression, even compared to the Chinese.

Similar results were obtained by Lahr (1994, 1996) who examined eleven East Asian regional continuity traits: sagittal keeling, mandibular exostoses, horizontal course of naso-frontal and fronto-maxillary sutures, profile of nasal saddle and nasal roof, rounded frontals, orbital shape, M3 agenesis, reduced posterior dentition, facial flatness (prognathism), lateral facial flatness and rounding of the infero-lateral margin of the orbit. Lahr found that sagittal keeling did not only occur in the Chinese but also in the Australian population. For the course of the nasofrontal and frontomaxillary sutures, the Chinese even exhibited a curved condition for both sutures. The variation in profile of the nasal saddle and nasal roof is great among the Chinese, in which flat nasals occur in only 26.8%, whereas they occur more frequently in sub-Saharan Africans (34%). The orbital shape also varies strongly, so that no particular shape appears to consistently characterize the East Asians. Another trait - the lack of facial prognathism - was most pronounced among Europeans.

The answer to the question at the beginning of this section concerning the interregional affinities and differences is that the morphological basis does not support the hypothesis of regional continuity. The features occur widely in different regions.

#### **5.1.2.1 Chinese Pleistocene population**

With respect to the Chinese fossils, it has been shown in the previous section that no indication of homogeneity has been found. The Principal Components Analyses show that the fossil hominids are widely scattered with regard to the recent centroids. Actually, Weidenreich (1943) had already detected this phenomenon. Weidenreich saw that Upper Cave 102 and 103 resemble Australoid and Eskimoid, respectively. Only Upper Cave 101 was regarded to be affiliated with the recent Chinese and was believed to be a direct ancestor of modern Chinese. This view has been strongly criticized by Wu (1995; see also Wolpoff et al., 1984). Wu stated that all Zhoukoudian Upper Cave crania show affinities with recent Chinese. The facts that were seen by Weidenreich based on his observations on the Zhoukoudian Lower and Upper Cave crania and the results of this study support the view that during the Middle and Late Pleistocene there was a great variability in the ancient Chinese population. As mentioned above, many specialists have also found the phenomenon that there is little affinity between early anatomically modern *Homo sapiens* and recent Chinese (Howells, 1993; Wright, 1995; Neves and Pucciarelli, 1998; Stringer, 1999; Brown, 1999).

Various specialists also found that some Chinese fossils show mixtures of features. Etler (Li and Etler, 1991; Etler, 1996) has studied *Homo erectus* from Yunxian. He found that the Yunxian specimens not only show ‚Mongoloid‘ but also ‚Western archaic‘ features. The Western archaic features, including large cranial and facial dimensions, lack of well-expressed ectocranial buttressing features, elevation of the upper margin of the temporal squama, swept-back orientation of the supraorbital tori, and reduced postorbital constriction appear together with many features common for *Homo erectus*. Another specialist pointed out that the features shown by archaic *Homo sapiens* from Maba and Jinniushan are problematic (Pope, 1992). Jinniushan is the most northerly located specimen of all Chinese archaic *Homo sapiens*. It is said to even exhibit Neandertal affinities e.g. in its thin cranial bones that also occur in Steinheim. The Maba specimen from southern China, displays a spherical shape of orbit that would be completely consistent with the Neandertal morphology (see also Wolpoff et al. 1984, Wu and Poirier, 1995). Pope (1992: 287) argues: „It could well have been in „Maba“ times that individuals with rounder orbits entered the Chinese clade. If the Maba had been recovered in Europe, it would have been classified as a Neandertal“. However, Pope added, that this fact seems biogeographically illogical, but on chronophenetic grounds it is an accurate observation.

In 1988, a nearly complete hominid skeleton was discovered in Laishui, Hebei and dated to 28.000 years ago (Etler, 1996). Bräuer (in press) argues that the Laishui hominid could represent the first evidence that around 30.000 or 40.000 years ago archaic humans were still living in China and possibly co-existing with early anatomically moderns. According to Etler (1996), this material helps to fill in the gap between late premoderns such as Xujiayao and early moderns, such as the Upper Cave specimens. However, as already mentioned, the affinities of the Upper Cave specimens to recent Chinese are dubious. Therefore, a detailed study of the Laishui hominids would be of great interest.

According to the Multiregional model, the heterogeneity among the fossil hominids would be interpreted as resulting from local differentiation (Wolpoff et al., 1984; Wolpoff, 1999). Based on the results of this study and reinforced by other recent research, it may be interpreted that during the Middle and Late Pleistocene the populations were highly variable. This variability within ancient Chinese might be due to contact between eastern and western populations (Eurasian and North Asian), when the Mode 2 (bifacial tradition) was introduced to the most northeastern populations in China (Foley and Lahr, 1997: 23). Based on his archaeological study, Olsen (1999; see also Velichko, 1999) argues that Siberia may have been witness to substantially more complex demographic movements in the Middle and Late Pleistocene in agreement with Foley and Lahr. During this time there were separate population migrations through this region, indicating that this area can be described as a „cross-road“.

If the results from studies of both ancient and recent Chinese populations are combined, it can be seen that the Chinese populations are rather heterogenous. A gradual evolution can hardly be demonstrated. China seems to be a „meeting place“ for the different waves of migration. Applying Lahr’s multiple dispersal model as an explanation for this situation indicates that the populations that migrated to China might have derived from different waves of migration and from different regions with their own characters. Thus, the results of the present study appear to be in agreement with an extra-regional origin of the modern Chinese population, as suggested by the Out-of-Africa model. The process of differentiation of the first humans is explained by Harpending et al. (1993) who proposed ‚The Weak Garden of Eden‘ theory, in which they suggest that modern humans spread into separate regions from a restricted source around 100.000 years ago, at which time they passed through population bottlenecks. Around 50.000 years ago, modern human populations were dispersed in Africa and later migrated to Eurasia and East Asia. Lahr and Foley (1998: 167) explain that the ancestral modern population was not homogenous for long, as population expansion, subdivision, and contraction subsequently took place. Depending on the balance of ancestral polymorphisms throughout the range of the ancestral population prior to subdivision, the pattern of synapomorphism among subdivided groups may have been very different.

Climate changes play a big role for the process of differentiation. An explanation for such differentiation is proposed by Ambrose (1998: 623), who suggests that climatic and geological changes provide an alternative hypothesis for Late Pleistocene population bottlenecks and expansions. Furthermore he said: „The last glacial period was preceded by one thousand years of the coldest temperatures of the Later Pleistocene (71-70 ka), apparently caused by the eruption of Toba, Sumatra, that was known as the largest explosive eruption of the Quaternary“. Furthermore, Ambrose reveals that the end of the bottleneck could have occurred either at the end of this hypercold phase, or 10.000 years later, at the transition from cold oxygen isotope 4 to warmer stage 3. According to Ambrose, Toba’s volcanic winter could have decimated most modern human populations, especially outside of isolated tropical refugia. The largest populations surviving through this bottleneck should have been found in the largest tropical refugia, and thus in equatorial Africa.

It is likely that the evolution of the ancient populations in China was influenced by migrations from outside. Nevertheless, the „archaic Chinese“ developed some characters in response to the process of local adaptation, selection, drift and gene flow which led to a morphology different from Neandertals and archaic Africans.

### 5.1.3 The Inuit Problem

Perhaps it is not unexpected that the Inuit (Greenland) show many similarities with the „Chinese“ population. Other studies have shown similar results (Thoma, 1964; Wolpoff, 1999). What is interesting in the present study is that this population exhibits more suggested East Asian regional continuity features than do the modern Chinese who were supposed to be the center of „Mongoloid“ populations. Of the eighteen suggested East Asian features examined, eight are present in the Inuit with pronounced expressions or highest frequencies. These features are: sagittal keeling on the frontal; pronounced frontal orientation of the malar facies and the frontosphenoidal process of the zygomatic bone; antero-lateral surface of the zygomatic process faces more forward; junction of the lower margins of the maxilla and the zygomatic bones is more angular in shape; middle part of the face is not very protruding; non-depressed nasal root; and large Naso-malar angles (see also Table 38, chapter 3). Compared to the Chinese who exhibit only two features or even tendencies of features, which both also occur with pronounced expression in the Inuit, it seems that the latter show a more specialized „Mongoloid“ morphology than the Chinese. How can this phenomenon be explained?

It is generally accepted that the Inuit have an ultimate Asiatic origin and are related to Asian Mongoloids. Their ancestral population migrated from Siberia along the southern coast of the Bering Land Bridge (Cavalli-Sforza et al., 1994; see also Greenberg et al., 1986). Greenberg et al. (1986) suggested that the Greenland Inuit represent a third migration of the Eskimo-Aleut, who kept their Arctic and sub-Arctic habitats. The differentiation of the two major populations of Aleuts and Eskimos from linear and continuous ancestral chains of isolates began fairly early, some 9000 to 10.000 years ago. The Aleuts then occupied the Aleutian islands and the Eskimos occupied Alaska and the northern coast of North America, spreading later as far as Greenland. Thus, Greenland is a terminal refugium for the Inuit and the Inuit were the first and only human occupants of Greenland (Laughlin et al., 1979; Ubelaker and Jantz, 1986; Cavalli-Sforza et al., 1994; see also Shields, 1993).

At this time (Holocene), the Chinese features were not yet established so that these people cannot be called „Mongoloid“. Some authors call the East Asian features that occur at this time „proto-Mongoloid“ (Coon, 1962; Brown, 1999). It is also possible that a part of the present Northeast Asian features may have appeared during the Late Pleistocene, some 11.000-25.000 years ago or more (Hanihara, 1994: 418). This is the period (30 -10 kya) in which there is a gap between Liujiang/Upper Cave and the Holocene Chinese. During this period the „proto-Mongoloid“ peoples of the Asian mainland spread out over the continent and crossed the Bering Sea, and from there reaching Greenland. Therefore, an explanation for the presence of even more pronounced

East Asian features in the Inuit than in the modern Chinese could be special adaptation and drift effects.

### **5.1.3.1 Inuit features: an impact of climate adaptation?**

As in most „Mongoloids“ of Siberia, the lower margin of the orbit lies further forward and the zygomatic bones protrude forward and laterally in the Inuit, generating the characteristic appearance of „high cheek bones“. The nasal bridge is usually low and flat (Cavalli-Sforza et al., 1994: 316). Lahr (1995: 74) also pointed out that Eskimo skulls are very distinctive. Their particular features are a generally dolichocephalic vault, pronounced sagittal keeling, gracile supraorbital morphology, large orbits, small nasal apertures and nasal bones, pronounced facial flatness, large faces with tall and broad malars, high temporal lines, thick tympanic bones, palatal tori and M3 agenesis. Wolpoff (1999: 42) mentioned that flat Asian faces are strongly expressed in the Inuit.

The Eskimo morphology has been interpreted as resulting from climatic adaptations or from biomechanical adaptations to hard chewing. However, a number of recent studies (see Lahr, 1994) have shown that the Eskimo cranial morphology is not particularly adapted and that there is relatively little selective pressure from frostbite acting on arctic populations, while mechanisms of generation and dissipation of large biting forces could account for the development of the features observed (Lahr, 1995: 174). Furthermore, Lahr compared the Inuit with the Fuegian population living in high altitude in South America. Based on discriminant analysis, she came to the conclusion that the pattern of similarities, especially presence of sagittal keeling, suggests that the Eskimo and Fuegian morphologies reflect common adaptations not to cold conditions (they do not share either facial flatness or nasal breadth dimensions) but to biomechanical stress. Figure 49 (see chapter 4) shows a Principal Components Analysis, with the first component representing ‚breadth‘ dimensions and the second component facial projection. Both PC1 and PC2 do not separate the Inuit from the Chinese and the Indonesian populations. Although the Indonesians are more intermediate in position among the modern populations, on the basis of the PCA this population groups together with the Chinese and the Inuit. If facial flatness can be interpreted as an adaptation to cold climate in the Chinese and Inuit, this does not hold true for Indonesians, who live in a temperate (warmer) zone. Thus, facial flatness, in terms of flatness of the middle and upper face is unlikely to result mainly from a cold climate.



**Fig. 51** Comparison: Recent Chinese (left) and Greenland-Inuit (right). (7.685-Chinese, AM 10.856-Inuit, housed in Natural History Museum, London)

## 5.2 Is there regional continuity in East Asia?

The Multiregional Evolution model proposes that modern populations evolved in different geographic areas from already differentiated ancestral groups of archaic *Homo sapiens* (or *Homo erectus*). The hypothesis is based primarily on anatomical features that appear to indicate genetic continuity across the archaic/modern human boundary throughout the Pleistocene in Europe as well as in Africa and particularly in the Far East. The hypothesis stemmed from attempts to relate the morphological differences seen in *Homo erectus* remains from northern and southern portions of East Asia to the morphological differences between the present day populations from these regions. To some extent, the geographical distribution of human variation reflects the immediate consequences of the dispersals and population movements towards the end of the Early Pleistocene. It has long been recognized that differences between populations are inevitable when a species is widespread, especially when populations occupy different habitats. This is a consequence of isolation by distance (Wolpoff et al., 1984: 447; Smith et al., 1989a: 39; Thorne and Wolpoff, 1992: 77; Wolpoff, 1999). The proponents of this model assume that the evidence of the fossil records in East Asia and Australasia supports their model. Thorne (1981, see also Thorne and Wolpoff, 1981) suggested that this pattern applies to human populations from the Early Pleistocene, after the first colonizations out of Africa. He proposes that:

Centre and edge: The human fossil populations sampled at what were the peripheries of the range at that time, places such as Central Java, were far more homogenous than samples from the center (eastern Africa where *Homo sapiens* first was successful). Early populations in various peripheral regions had quite different combinations of relatively

homogenous features, often different character states of the same anatomy. Some of the homogenous features at the peripheries that differed from place to place could be linked to common characteristics found in populations from the same areas today (Wolpoff, 1999: 42). The differences between populations in different regions and the relative homogeneity within them are a consequence of this process.

Regional continuity: The maintenance of the contrasting pattern of central and peripheral variation for a long period of time. Furthermore, Wolpoff (1999: 42) explains that, as the more peripheral regions were colonized, populations were subject to harsher conditions and climatic fluctuations of greater magnitudes than at the centre. Numerous local extinctions and recolonizations from nearby areas created a population structure in which broad regional continuity could be expected.

Over the last two decades many attempts to assess the correctness of the Multiregional Evolution model have been undertaken (Howells, 1973, 1989, 1993; Kamminga and Wright, 1988; Groves, 1989; Smith, 1989; Pope, 1991, 1992; Bräuer, 1984, 1992; Habgood, 1992; Stringer, 1992, 1999; Wu, 1992, 1995, 1997; Lahr, 1994, 1996; Etlér, 1991; 1996; Neves and Pucciarelli, 1998). Most of the results of these studies criticized the Multiregional model strongly, particularly the morphological evidence. It is argued that there is a gap for 100.000 years between archaic specimens like Dali, Maba and Jinniushan; and early modern *Homo sapiens* like Longtanshan, Liujiang and Upper Cave (Bräuer, 1992). Moreover, the Upper Cave specimens and Liujiang have been recently reexamined. The results indicate that these fossils do not show morphological affinities to recent Chinese. Instead, these early modern humans were found to be closer to Africans, Australo-Melanesians and South Americans. The presence of regional continuity features among the recent Chinese is also problematic. A number of both East Asian and Australasian regional features which are supposed to characterize these regions were not supported by recent studies. The majority of these features are not present in these regions. Instead, these features occur geographically widespread, so that they cannot be regarded as characteristic for these regions.

More criticism came from recent dating evidence. Swisher et al. (1996) and Grün et al. (1999) presented very recent dates of around 40.000 years for Ngandong (Java) and dates of around 50.000 for the gracile modern skeleton from Lake Mungo 3, Australia. If the new dates are correct, Ngandong can hardly be an ancestor of recent Australians which would be even older. This and other evidence (Bräuer and Stringer, 1997) makes the Multiregional Evolution view more and more problematic.

The current results concerning the genetic evidence mostly support the Out-of-Africa model. Studies of mtDNA and nuclear DNA generally show that Africa is the likely place of modern human origin (Cann et al, 1987; Cavalli-Sforza, 1994; Horai, 1995; Nei, 1996).

However, the supporters of the Multiregional Evolution model argue that if modern humans arose first in Africa and then spread out of Africa and replaced the populations that already existed, including those in China, a similar lithic tradition should also be found in this region (Fruyer, et al., 1993). As has been mentioned by Lahr and Foley (1997, see also Schick and Zhuan, 1993), archaeological evidence is widely lacking in China. One explanation why the archaeological evidence in China is relatively small might be the so-called 'Bamboo barrier' (Pope, 1989, see also Foley and Lahr, 1997). It is supposed that modern humans could exploit bamboo as an alternative material for making tools which, however, are not preserved. Klein (2000: 23) proposes: "By 600 to 500 ky ago, the Acheulean occupied a vast area, from the southern tip of Africa to England and from Spain to India. However, it failed to penetrate eastern Asia. One possibility is that the first east Asians were Oldowan people who expanded from Africa 1.8 to 2 my ago, before the Acheulean emerged. A better-substantiated possibility is that the first east Asians arrived much later, near 1 my ago, but abandoned classic handaxe manufacture early on and subsequently developed their own distinctive artifact tradition. This centered on flakes and a range of relatively informal core tools, perhaps supplemented by novel tools in bamboo. In keeping with archaeological separation from the West by 1 my ago, eastern Asia also seems to have nurtured its own distinctive human lineage or lineages, which persisted from 1 my ago or before until 50 ky ago or later". Furthermore, Klein argued that, compared to Europe, Africa, and the west Asian bridge that links them, eastern Asia is archaeologically poorly known.

Turning to the evidences of regional continuity in East Asia, some specialists see great problems in the morphological basis. Gradual evolution can not be demonstrated for China (see Stringer, 1992; Bräuer, 1992, 1993; Stringer and Bräuer, 1994; Bräuer and Stringer, 1997; Groves, 1989; Habgood, 1992; Lahr, 1994, 1996; Brown, 1999). As explained above, the present study shows that nearly all of the regional features supposed to be characteristics for Chinese cannot be regarded as convincing. Moreover, the suggested East Asian regional features occur in other modern populations from different parts of the world, often in higher frequencies. Only two tendencies can be seen as recent Chinese or „broad Mongoloid“ features, but these cannot be traced back to the fossils. Moreover, the fossils themselves are separated from recent Chinese and closer to other populations. It is also evident that there is great heterogeneity among the fossils.

Is there regional continuity in China? On the basis of the current results, a gradual evolution or regional continuity from *Homo erectus* to modern humans in China can hardly be shown. The Chinese Pleistocene population was strongly variable (Pope, 1992; Hanihara, 1994; Etlar, 1996; Lahr and Foley, 1994). Nevertheless, we can assume that specimens like Liujiang and Upper Cave 101, 102 and 103 belonged to the gene pool from which during the last 20.000 years evolutionary changes towards the morphology of the

recent Chinese and other East Asian populations took place. This process was most likely the result of local adaptation, admixture, genetic drift, absorption and other factors (see also Bräuer, 1992; Hanihara, 1994). Moreover, Hanihara (1994: 436) suggests: “A few Neolithic samples from North China tended to show a craniofacial morphology similar to the recent Chinese samples; this may reflect the possible long-term historical-biological connection resulting from the population movements in the northern part of China at an earlier time”. In his most recent study, Brown (1999) assumed that the recent Chinese morphological pattern has evolved during the Holocene period. This would mean that the recent Chinese morphology was established very recently, as has also been suggested by Stringer (1999).

## Chapter 6

### Summary

The Multiregional Evolution model suggests for East Asia that modern humans evolved gradually from regional *Homo erectus*. This hypothesis is based on the fossil record from China and Australasia that is said to show regional continuity. Thus, according to this model, early modern *Homo sapiens* in each area of the world should strongly resemble recent populations of the same region. The proponents of the Multiregional model believe that high frequencies of 'regional continuity features' distinguish these regions from others.

The aim of the present study was to examine whether this suggestion can be supported for China on the basis of eighteen regional continuity features of the face. These features of the face were selected because the suggested 'Chinese characteristics' are centered in the face, particularly in the middle and upper face (Pope, 1991). The eighteen assumed regional features are: presence of sagittal keeling on the frontal; pronounced orientation of the malar facies and frontosphenoidal process of the zygomatic bone; anteriorly facing frontal process of the maxilla with distinct paranasal inflation; anterior surface of the zygomatic process faces more forward; junction of the lower margins of the maxilla and the zygomatic bones is more angular in shape; facial height reduction; lower border of the zygomatic process of the maxilla is oriented horizontally; middle part of the face is not very protruding; lack of anterior facial projection and low degree of prognathism; horizontal course of the nasomaxillary and frontomaxillary sutures; flatness of the nasal saddle; non-depressed nasal root; no difference between upper and middle parts of the nasal bones; presence of the incisura malaris; shape of orbits; rounded infero-lateral margin of the orbit; presence of malar tuberosity; and large naso-malar angle. If the suggestion of the Multiregional Evolution model is correct, these features, or most of them, should occur with high frequency or with pronounced expression in China, and would distinguish the Chinese from other populations. Second, it should be possible to trace back these features to archaic *Homo sapiens* and *Homo erectus*.

The occurrence of the suggested East Asian regional features was examined in nine samples from different geographic regions of the world. These include Chinese, Indonesians, Inuit, South Americans, Australo-Melanesians, Polynesians, sub-Saharan Africans, North Africans and Europeans. 256 adult and well-preserved recent crania were studied by examining 18 suggested East Asian regional features of the face which were determined through 25 metrical variables and 11 non-metrical variables. The data were

then analysed statistically by using Anova, Chi-square, and Principal Components Analysis based on raw and log-shape data.

The results can be summarized as follows:

### **1. The regional continuity features cannot be identified in the modern Chinese sample**

The eighteen suggested East Asian regional continuity features occur geographically widespread. An exclusive occurrence of any of these features in China cannot be identified. Moreover, 16 of the features studied do not show the pattern of occurrence or expression as claimed by the Multiregional hypothesis. Only two of the eighteen features show a tendency to occur with pronounced expression as postulated by the Regional Continuity model, although the occurrence of these features in China is not significantly different from that in other populations. These features are the degrees of flatness of the middle and upper face determined by the Zygomaxillary angle and Nasio-frontal angle, respectively.

### **2. The Inuit are in some features more „East Asian“ than the recent Chinese**

Some of the eighteen suggested East Asian regional continuity features are present in Inuit with higher frequencies or with more pronounced expression. These features are: sagittal keeling on the frontal; anterior orientation of the zygomatic process of maxilla; middle part of the face is not very protruding; large Naso-malar angle; pronounced orientation of the facies malaris and frontosphenoidal process of the zygomatic bone; non-depressed nasal root; low degree of prognathism. A possible explanation of these conditions is a fairly recent adaptation to biomechanical stress.

### **3. The expression of the regional continuity features in the fossil hominids is variable**

According to the Multiregional model, the features that occur in modern East Asians can be traced back to the fossil hominids of that region. Therefore, as a first step, the two features that occur with relatively pronounced expression in recent Chinese crania (Zygomaxillary angle and Nasio-frontal angle) were examined in the Chinese fossils. The conditions of both features in the fossil crania are variable. Although there is great overlapping between sub-Saharan Africans and Chinese and other samples for the

Zygomaxillary angle, the *Homo erectus pekinensis* skulls fall with lower values outside the 95% ellipses of the recent Chinese, with lower values. The Upper Cave 103 specimen falls outside the recent populations, whereas Upper Cave 102 lies at the periphery of the sub-Saharan African 95% confidence ellipse. Liujiang and Upper Cave 101 lie in the overlapping zone. For the Nasio-frontal angle, both *Homo erectus* specimens fall in the zone of overlap between Chinese, sub-Saharan Africans and other populations, as do Liujiang and Upper Cave 101. In contrast, Upper Cave 102 and Upper Cave 103 are at opposite poles and marginal to sub-Saharan Africans and Chinese, respectively.

The examination of the fossils was further extended using three features that are present with higher frequencies in Inuit. These features are: non-depressed nasal root; pronounced orientation of the malar facies and frontosphenoidal process of the zygomatic bone; and anterior orientation of the zygomatic process of maxilla. With regard to the degree of nasal root depression and orientation of the zygomatic process of the maxilla the fossils are highly variable. Concerning the anterior orientation of the malar facies and frontosphenoidal process of the zygomatic bone, all specimens except that of Upper Cave 102 show similar conditions (rather obtuse angles 78°-88°).

#### **4. No affinities between fossil and recent Chinese crania**

Multivariate methods used to analyse the affinities between fossil and modern Chinese specimens show that all fossils are widely scattered. Based on a PCA using log-shape data, no individual fossil is closest to the Chinese centroid. The early modern specimen from Liujiang is closer to South Americans and sub-Saharan Africans than to modern Chinese. Upper Cave 102 is closer to North and sub-Saharan Africans, and *Homo erectus pekinensis* reconstructed by Weidenreich is closer to sub-Saharan Africans as well. *Homo erectus* reconstructed by Tattersall shows an intermediate position among the modern samples.

#### **5. Chinese features were most likely established recently**

As shown in this study, no gradual evolution could be found between *Homo erectus*, early modern *Homo sapiens* and recent Chinese. It is assumed that the morphology exhibited by early modern humans such as the Upper Cave and Liujiang specimens changed towards that of recent Chinese during the last 30.000 years. In other words, the recent Chinese might have evolved from the early modern Chinese populations. The origin of these early modern Chinese, however, seems to be located outside this area.

The above results show that the morphological basis for the Multiregional Evolution model is dubious and should be further reviewed. The results of the present study support previous studies that already pointed to the weak basis of this model. In agreement with Lahr's suggestion (1996; see also Bräuer and Stringer, 1997), the definition of many features needs also to be revised in order to reach worldwide agreement.

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## 8 List of individuals included in this study

### China (N=41)

7.6932 Batavia	7.6921 Borneo
7.6422 Amoy	7.694 Sandwich Island
FC.691-6 Suriname	7.6302 Shanghai
7.6304 Shanghai	7.631 Shanghai
7.6102 Peking	7.6306 Shanghai
7.308 Shanghai	7.6121 Peking
7.6101 Peking	7.6122 Peking
7.6305 loc. unknown	7.6322 Shanghai
7.635 Chekiang	7.6502 Canton
7.6381 Ningpo	7.6335 Shanghai
7.6386 Ningpo	7.6503 Canton
7.6383 Ningpo	7.6333 Shanghai
7.6531 Macao	7.6567 Hongkong
7.6572 Hongkong	7.6981 loc. unknown
7.6993 loc. unknown	7.699 loc. unknown
7.685 loc. unknown	7.6991 loc. unknown
7.6984 loc. unknown	4211 Suriname
As.21.0.2 Kowloon	As.21.0.1 Kowloon
1760 loc. unknown	1759 loc. unknown
1761 loc. unknown	As.21.0.7 Kowloon
As.21.0.3 Kowloon	

### Indonesia (N=24)

IM.60.768 Borneo	IM.60.769 Borneo
IM.60.773 Borneo	IM.60.771 Borneo
IM.50.463 Java	IM.90.777 Mollucas
IM.11.463 Malaya	IM.11. 466 Malaya

8.401 Bali	IM.11.467 Malaya
8.441 Bima	8.4045 Bali
8.445 Timor	8.415 Kupang
8.5203 Ambon	8.5202 Ambon
8.6202 Makasar	8.5204 Ambon
8.2035 Batak	8.2055 Lampung
8.3739 Java	8.3732 Java
8.399 Madura	8.3987 Madura

**Inuit (N=16)**

AM.10.836 Edgesminde	AM.10.837 Edgesminde
AM.10.838 Edgesminde	AM.10.840 Sermersuit
AM.10.842 Sermersuit	AM.10.844 Sermersuit
AM.10.854 loc. unknown	AM.10.856 loc. unknown
AM.10.853 loc. unknown	91.12.18.2 Nunivok
AM.10.845 Sermersuit	AM.10.847 Rodebay
BD.1191 loc. unknown	FC.816 Upernavik
FC.814 Upernavik	FC.810 loc.unknown

**South America (N=19)**

AM.70.962 Peru	AM.70.982 Peru
AM.70.977 Peru	AM.70.977 Peru
AM.70.963 Peru	AM.70.983 Peru
AM.70.950 Peru	AM.71.971 Peru
AM.80.964 Peru	BD.1342 Paraguay
FC.addn.1024.12 Patagonia	99.4.27.2 Patagonia
8.8.17.1 Patagonia	BMNH 1848.10.12.23 Peru
FC.946 Peru	BD.1344 Argentina
FC.935 Peru	BD.1318 Peru
FC.973 Peru	FC.979 Peru

**Australia (N=27)**

Aus.50.532 South Australia	Aus.50.994 South Australia
Aus.60.57 Western Australia	Aus.60.1004 West Australia
Aus.60.1007 West Australia	Aus.60.1006 West Australia
Aus.60.2 West Australia	Aus.60.3 west Australia
Aus.30.437 New South Wales	Aus.30.442 New South Wales
Aus.30.984 New South Wales	Aus.20.973 Quensland
Aus.30.436 New South Wales	Aus.30.438 New South Wales
Aus.30.439 New South Wales	Aus.80.5 Tasmania
Aus.80.59	Aus.50.533 South Australia
Aus 635 Loc. unknown	Aus.1009 loc. unknown
Aus.1011 Loc. unknown	Aus.80.60 Tasmania
Aus.1016-c Loc. unknown	Aus.446 Tasmania
1911.11.14.5 Loc. unknown	1968.8.8.69 Loc. unknown
1917.10.29.1 Tasmania	

**Melanesia (N=9)**

Mel.70.1 Papua Newguinea	Mel.70.1029 Papua Newguinea
Mel.50.3 Solomon	Mel.30.63 Fiji
9.0622 Papua Newguinea	9.0624 Papua Newguinea
9.0751 Papua Newguinea	9.0752 Papua Newguinea
1790 New Ireland	

**Polynesia (N=11)**

Pol.10.448 New Zealand	Pol.10.813 New Zealand
Pol.10.815 New Zealand	Pol.10.450 New Zealand
Pol.10.73 New Zealand	Pol.10.529 New Zealand
Pol.10.829 New Zealand	6012 New Caledonia
6009 New Caledonia	6010 New Caledonia
6006 New Caledonia	

**South Africa (N=15)**

Af.61.1053 Zulu	Af.61.400 Bantu
Af.61.397 Bantu	Af.61.87 Zulu
Af.61.403 Bantu	Af.61.38 Zulu
Af.61.404 Bantu	Af.63. 1072 Khoisan
Af.61.407 Bantu	Af.63.418 Khoisan
Af.61.1066 Basuto	Af.61.395 Tambuki
Af.61.396 Tambuki	

**East Africa (N=15)**

Af.50.2 Lake Nyasa	Af.51.428 Mozambique
Af.50.8 M'bena	Af.50.9 Uganda
Af.21.0.45 Teita	Af.21.0.52 Teita
Af.50.10 Uganda	Af.21.0.16 Teita
Af.53.434 Mauritius	Af.21.0.48 Teita
Af.21.0.13 Teita	Af.21.0.50 Teita
Af.21.0.5 Teita	1904.2.6.46 Angkole
Af.21.0.18 Teita	

**West Africa (N=15)**

Af.22.263 Nigeria	Af.20.269 Timmanis
Af.22.13 Hausa	Af.22.265 Mandingo
Af.23.131 Ibo	Af.23.293 Ibo
Af.23.299 Ibo	Af.23.119 Ibo
Af.23.294 Ibo	Af.23.110 Ibo
Af.22.266 Mandingo	Af.23.295 Ibo
Af.22.15 Ogoja	Af.20.265 Kounga
Af.20.385 Loc. unknown	

**North Africa (N=15)**

Af.11.4.434 Egypt, Abydos dynasty	Af.11.6.16 Egypt, Sorab dynasty
Af.11.3.159 Egypt, El Amrah dynasty	Af.11.6.17 Egypt Sorab dynasty
Af.11.4.426 Egypt, Abydos dynasty	Af.11.4.432 Egypt, Abydos dynasty
Af.11.6.2506 Egypt, Shekh Ali dynasty	Af.11.4.435 Egypt, Abydos
Af.11.5.604 Egypt, Regagnah dynasty	Af.11.3.511 Egypt, Shekh Ali dynasty
Af.11.6.14 Egypt, Sorab dynasty	Af.11.6.2514 Egypt, Shekh Ali, dynasty
Af.11.5.606 Egypt, Regagnah dynasty	Af.11.5.601 Egypt, Regagnah dynasty
Af.11.5.605 Egypt, Regagnah dynasty	

**Europe (N=49)**

HL.50. 1557 Lübeck	HL.50.1776 Lübeck
HL.50. 1780 Lübeck	HL.50.1355 Lübeck
HL.50.1734 Lübeck	HL.50.1600 Lübeck
HL.50.1589 Lübeck	HL.50.1992 Lübeck
HL.50.1702 Lübeck	HL.50.2077 Lübeck
HL.50.1496 Lübeck	HL.50.1614 Lübeck
HL.50.1779 Lübeck	HL.50.1497 Lübeck
HL.50.1545 Lübeck	HL.50.1552 Lübeck
HL.50.1508 Lübeck	HL.50.1546 Lübeck
HL.50. 1601 Lübeck	HL.50.1526 Lübeck
HL.50.1654 Lübeck	HL.50.1555 Lübeck
HL.50. 1554 Lübeck	HL.50.1567 Lübeck
HL.50. 1564 Lübeck	HL.50.1568 Lübeck
HL.50. 1533 Lübeck	HL.50. 1569 Lübeck
HL.50. 1610 Lübeck	HL.50. 1628 Lübeck
HL.50. 1606 Lübeck	HL.50. 1608 Lübeck
HL.50. 1636 Lübeck	HL.50. 1616 Lübeck
HL.50. 1625 Lübeck	HL.50. 1637 Lübeck
HL.50. 1635 Lübeck	HL.50. 1595 Lübeck

HL.50. 1859 Lübeck	HL.50. 1860 Lübeck
HL.50 1857 Lübeck	HL.50. 1858 Lübeck
HL.50. 1861 Lübeck	HL.50. 1855 Lübeck
HL.50. 1519 Lübeck	HL.50. 1514 Lübeck
HL.50. 1518 Lübeck	HL.50. 1516 Lübeck
HL.50. 1926 Lübeck	

## Erklärung

Hiermit versichere ich, dass ich die vorliegende Arbeit selbständig verfaßt habe. Ich habe keine anderen als die angegebenen Quellen und Hilfsmittel benutzt und diese als solche kenntlich gemacht.

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