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SEX DIFFERENCES OF PELVIS AND SEX DETERMINATION IN PALEOANTHROPOLOGY

ABSTRACT. — The study deals with the revision of sex diagnosis in some fossil pelvic remains using the discriminant function of the ischium and pubis measurements. The ischiopubic segment of the pelvis may be most suitable for pelvis sexing of the hominids since it is less influenced by hominization. Since the original bones are not available, the author used the published documentation and the results compared with the diagnoses published by authors working with the original skeletons. 1. The European Neanderthal man "La Ferrassie I." is defined by the discriminant function as a male, supporting thus Heim's view (1972); 2. In the SW-Asian Neanderthal man "Tabun I.", the female value is to such a degree beyond the limits of variability of the recent population, that it supports not only sexing, but it upholds also the view that such a long os pubis need not be necessarily a sex character (Stewart, Trinkaus); 3. Although in the skeleton "Skhul IX." the diagnosis agrees with the original sexing, i.e., that it is a male, but the value is within the zone of overlapping, so that it might be also the pelvis of a hypofeminine female; 4. In "Skhul IV." we disagree with the original sexing (McCown and Keith, 1939). The discriminant function points to female, but for the same reason as in "Skhul IX.", it could be also a hypomasculine male. The purpose of this paper is to cast some light on the new methods of pelvis sexing.

KEY WORDS: Pelvis sexing — Fossil remains — Discriminant analysis.

The problem of sex differences and the sex determination ("sexing", sex diagnosis) is of importance even in the investigation of human phylogeny. From the evolutionary antecedents of man only fragments have been preserved (mostly of teeth and of the skull); parts of the postcranial skeleton including sufficiently large parts of pelvis are scare. Eminent is the importance of this problem when discoveries are evaluated, classified taxonomically and ordered according to the system of ideas about the phylogenic evolution of man — anthropogeny.

An ideal classification of fossil finds would be the classification according to affinity. However, the classification according to similarity has to come first. Comparative studies on one hand suffer from the lack of the available material, on the other from the variety of forms of the fragmentary specimens. The problem of the role played there by the variability of sexual dimorphism has to be suspended for the time being (Jelínek, 1972). The attempts to determine the sex of fossil finds are based mostly on skulls, on the robustness of parts of the postcranial skeleton, etc. Erroneous results can be obtained in this way, since only isolated fragmentary finds are involved, without the possibility to study whole series of skeletons of whole populations. Intersexual variability of the evolutionary ancestors of man is not particularly known. Interindividual sexual dimorphism thus makes it difficult to evaluate morphologically the

total interindividual variability. This also makes it difficult to discover evolutionary trends and to determine the limits of classification of individual taxons, especially during the periods of evolutionary transitions.

No *Propliopithecus, Aegyptopithecus, Dryopithecus,* nor *Ramapithecus* pelvic remains have been preserved. (Lately Fleagle et al., 1979, reported an anatomy of the bony pelvis in Parapithecid Primates.)

The evolution of the so-called "second hominization complex" (Vlček) — i.e. rebuilding of the pelvis and the lower limb — forms the key features of hominids. This most complicated evolution of the locomotor system took place in the Miocene epoch. Unfortunately, in that epoch there are for some 4 or 6 millions of years no fossil finds documenting the evolution of pelvis. From finds of other parts of the skeleton, however, it follows that in the middle Pliocene the size of the body of prehominid forms was increased in the two sexes. This may be related to the continuing adaptation of the female pelvic canal to the head of newborns, possessing already a considerable cranial capacity (see e.g. Campbell, 1970).

Features of the second hominization complex express the adaptation to the verticalization of the body — erect posture and bipedal locomotion. In *Australopithecus* they are already completely developed (Dart, 1949). Australopithecus was an efficient biped already in the Middle Pliocene (see e.g. Vančata, 1980). Fossil finds suggest a distinctly human character of the vertebral column and pelvis. There is even some evidence of sexual dimorphism. Little is known about sexual differences in the body build, however, there are known varieties in the build of the skull, its total size and weight. In the same population there are both larger and smaller skulls, the larger ones possessing more robust relief, suggesting rather the masculine sex. It is not known whether the ancestors of the Australopithecus displayed sexual differences analogous to those of the recent anthropoid apes; as far as the whole size of the body and its robustness is concerned it appears to be improbable. General sexual differences obviously diminish during the following evolution since they lose their protective character — only the sexual dimorphism related to reproduction is preserved. In the case of skeleton it applies to the pelvis in full extent.

Deeper insights into these problems may be result from the rich fossil finds of the early forms of hominids (from Laetolil in Tanzania and Hadar in Ethiopia, 1972—1977), representing remains of several tens of individuals, of which, e.g. the discovery (A. L. 288—1) of a mature individual of obviously feminine sex ("Lucy") represents 40 % of the complete skeleton, including the reconstructed left pelvic bone. This early primitive form of hominid *(Australopithecus afarensis)* is already characterized by a substantial sexual dimorphism (Johanson and White, 1979).

Fossil pelvic remains of *Homo erectus* have also been preserved. The new finds in the Arago Cave (France) included among others a part of the pelvis (de Lumley, 1979).

Early stages of *Homo sapiens* have been documented by the some pelvic bones. The pelvic morphology of, for instance, *H. sp. neanderthalensis,* is already very similar to that of modern man. As far as details are concerned, however, the attention was drawn, e.g., by Weidenreich (1913) to the fact that the classical Neanderthal man had extraordinarily expressed *incisura ischiadica major* — the dorsal part of the ilium is so pronouncedly bent down that it goes under the level of the pelvic inlet by 20° more caudally than in an average recent woman and by 13° more that in an average man. The expressiveness of this notch may be related to the relatively greater weight of the individual and may be possibly a sign of the uncompensated adaptation to the bipedal locomotion (see also "La Chapelle-aux-Saints", Boule, 1911).

The following table summarize the best known pelvic fossils of hominids according to "Catalogue of fossil hominids" (Oakley, Campbell, Molleson, 1979) and many papers of McHenry et al., (e.g., 1975) and Zihlman et al., (e.g. 1979).

Australopithecus	
Robust form	
(A. robustus):	Swartkrans (SK 50) (SK 3155) Kromdraai (TM 1905)
Gracile form	
(A. africanus):	Sterkfontein (STS 14) (STS 65) Makapansgat (MLD 7) (MLD 8) (MLD 25)
(A. afarensis):	Hadar (AL-288-1)
Homo erectus	
	Olduvai Gorge (OH 28) [1]ARAGO XLIV ? Broken Hill (E 719) (E 726)
Homo sapiens	
Neanderthals:	[2]Prince (Grimaldi) [3]Hortus La Chapelle-aux-Saints La Ferrassie Neanderthal Krapina Teshik-Tash [4]Kiik-Koba Shanidar Amud Mugharet et-Tabun
Modern man:	Mugharet es-Skhul Cro-Magnon Oberkassel Afalou Natchez... etc.

(Note: 1 = see Lumley and Lumley, 1979, 2, 3 = see Lumley, 1972, 4 = see Vlček, 1973.)

A review of the preserved pelvic fragments of the Neanderthal man and of co-existing form of the modern man, where even significant metric analysis of the sexual dimorphism can be carried out, was given by Trinkaus (1976), as follows: In Europe: La Ferrassie I. (Heim, 1974) and Krapina 208/210 (Gorjanović—Kramberger, 1906). In the above discovery from Krapina the sex was not yet determined. In SW-Asia: Amud I. (Endo and Kimura, 1970), Shanidar I., III., IV. (Stewart, 1960) und Tabun I. (McCown and Keith, 1939). Preserved are also fragments of the hominids Skhul IV. and IX. (McCown and Keith, 1939).

Problems involved in sex differences of pelvis and in the sex determination are perhaps at best illustrated by the discovery of a specific form of the superior pubic rami in the skeletons Tabun and Shanidar (McCown and Keith, 1939, Stewart, 1960): *ramus superior ossis pubis* is there delicate and plate-like in comparison with the stout and rounded form in the Skhul skeletons and in all the modern samples. Moreover, these bones are relatively elongated. According to the investigation of Trinkaus (1976), the European and Southwest Asian Neanderthal pubic remains, in relation to the Skhul remains and those of anatomically modern Homo sapiens, possess thinned and elongated superior pubic rami. (This morphological complex is present in all of the known European and SW-Asian Neanderthals.) Hence it is tempting to regard all these fossil finds as women, since relatively long *os pubis* is typical of the feminine sex (see Washburn, 1948). Despite the obvious bias among paleoanthropologists to refer to fossil hominids as males (Genovés, 1954, 1959), it is difficult, assuming some degree of sexual dimorphism among these fossil hominids, to consider all of the remains as female (see Stewart, 1960 and Genovés, 1969). Probably only a few of these skeletons may be feminine (see Trinkaus, 1976). So specific elongation of the pubis in the above-mentioned skeletons is a feature so far observed neither in the other fossil finds, nor in the recent populations. Explanations of the Neanderthal pubic morphology based only on either sexual dimorphism or some biomechanical alteration of the skeleton are very difficult to maintain.

The above example shows a completely open sphere of the research of sexual differences on the pelvis of man.

PRINCIPLES OF SEX DETERMINATION FROM THE BONY PELVIS

Identification of sex in unknown skeletal remains is a difficult problem in general, not only in paleoanthropology.

Human embryo is potentially bisexual and hence the characters originating on the skeleton are neither exclusively masculine, nor exclusively feminine. A simple analysis of sex differences shows always an overlapping of the two sexes, although a normal human is either a man or a woman. Theoretically there is a contradiction between the discrete classification of individuals according to their genetic sex and the continuous transitions of somatic sexual characters of the fenetic sex (see e.g. Scharf, 1979). That is why it is difficult to elaborate a method that would completely divide a given population to males and females, i.e., that would determine correctly the sex of an unknown skeleton.

Earlier analytical summative and descriptive concepts of the sex diagnosis do not take into account that sexual characters have different weight or relevance, according to their position in the system of sexual dimorphism. A more modern, so-called s y s t e m s a p p r o a c h stresses the contemporary investigation of historical, functional and structural aspects of the studied problem, with the aim to create a picture of the phenomenon as a whole, as far as both its nature and its complexity is concerned (see e.g. Novotný, 1982, for review).

Investigation of the individual and the ethnical variability of sexual characters, of their phylogenetical and ontogenetical evolution and of causal factors, both internal and external, results in construction of the system of the somatic sexual dimorphism. This is reflected also in methods of the sex determination, where these methods respect biological nature of the sexual dimorphism as well as principles of objectivity, validity, reliability and significance. The multivariate discriminant analyses can be seen here as a useful tool (Novotný, 1975). We have already worked out some identification methods within the framework of the "Workshop of European Anthropologists" (Novotný, 1971, 1972, 1975): the results of several years of the work have been already codified and included in the so-called "Recomendations for sex and age diagnosis of skeletons" (see e.g. "Empfehlungen . . ., HOMO, 30. Bd., 2. Hft., 1979.)

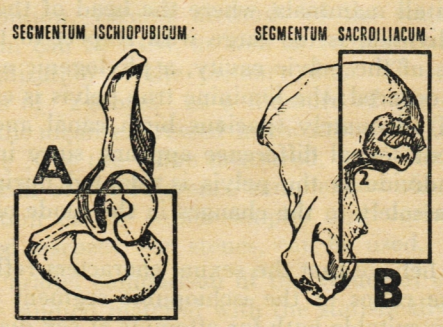

Fig.1

The most conspicious sex differences of the skeleton are in pelvis, in which two relatively independent segments can be distinguished. S a c r o i l i a c s e g m e n t reflecting sexually differentiated processes of hominization, i.e. adaptation to the verticalization of the body and bipedal locomotion. Dorsal extension and downward shift of ilium advanced in males further than in females, in which necessary dimensions of the true pelvis (pelvic cavity) as of the birth canal have to be preserved. Owing to the higher weight and stronger musculature of males the greater sciatic notch *(incisura ischiadica major)* is still more expressed with the downward tendency of the ilium. In females it remains at a lower developmental stage, forming sometimes only a flat arch. Thus a representative character of the substantial sex differences in the hominization processes of the pelvis is the conspiciously sexually differentiated i n c i s u r a i s c h i a d i c a m a j o r. The characteristic shape of the

notch seems to be under direct genetic control, but the degree of its expression is influenced by some local factors (see Coleman, 1967). (See Fig. 1. — B, 2.) Ischiopubic segment reflecting the different role of the two sexes in the reproduction. Representative character of the minor pelvis is the ratio of the sizes (longitudinal dimensions) of the *os pubis* and *os ischii* — ischiopubic index (or ischium-pubis index). The ontogenetic development of this segment is controlled by hormones; the sexual difference is caused by remodelling of the feminine minor pelvis into the birth canal during puberty. (See Fig. 1. — A, 1.)

Combination of the substantial parameters of these two evolutionary, functionally and causally different subsystems of pelvis, which are relatively independent in the system of the sexual dimorphism is not only necessary but also sufficient for a discriminant analysis. Such a discriminant analysis separates completely the two sexes in a given recent population with 1 % risk of error (Novotný, 1975).

From the phylogenic, ontogenic and causal, i.e. biological analysis of the sex differences of pelvis it follows that the sacroiliac segment is closely related to the sexually differentiated process of hominization, whereas the sex differences of the ischiopubic segment are not exclusively human — they are related above all to the evolutionary changes of the mechanical conditions of the parturition. In all mammals, where the head of the newborn individual is too large with respect to the dimensions of the pelvic cavity, a phylogenic adaptation has occured: the feminine true pelvis is extended to an adequately spacious birth canal and thus a clean-cut sexual difference appears, since in masculine individuals the pelvis is adapted during the evolution solely to the changes in the mode of locomotion.

We believe that the sexual characters reflecting just these ratios of the ischiopubic segment of the pelvis are suitable both for attempts at sex diagnosis of skeletal remains of direct antecedents of man, since this segment should not be too affected by the process of hominization, and for the sex diagnosis of fossil hominids with a completely developed sexual dimorphism, when the sacroiliac part of pelvis is missing, or when the sexual differences of the two segments are to be combined.

AUTHOR'S OWN OBSERVATIONS AND DISCUSSION

The representative metric characters of the sex differences in the ischiopubic segment of the pelvic bone are the longitudinal dimensions of pubis and ischium, and these in combination with the sexually differentiated dimensions of the acetabulum can serve as key marks even for the sex identification of the whole skeleton.

The determination of the lengths of the two bones was modified in such a way that it was not necessary to find out their common point (A), i.e. point of fusion of the ischium, pubis and ilium in the acetabulum, which is not distinct on a mature pelvis.

The relatively longer pubis with respect to the short ischium in females and inverse relation in males — expressed by the ischiopubic index — determine the sex in about 85 % of individuals in recent European populations. The discriminant function of the dimensions of the ischiopubic index then determines the sex in recent populations in approximately 90 % (Novotný, 1975; Novotný and Brůžek, 1983). For this reason we have tried to find out whether the discriminant function of the modified ischiopubic index measurements could be used also in sex determination of fossil finds in the cases in which it can be applied.

Since the original fossil finds or their casts have not been available, we used for this purpose the documentation and the data published by authors who themselves processed suitable fossil material. Naturally, our purpose could not have been a real sex identification, but rather an examination of the possibilities to use our methods in sex determination of fossil pelvic fragments.

An experimental test of sex diagnosis has been carried out in some known finds of the fossil hominids: La Ferrassie I., Tabun I., Skhul IV. and Skhul IX., since in these cases it was possible to use the documentation of pelvic fragments for quite probable estimation of the longitudinal dimensions of the pubis, ischium and acetabulum. All photographs and drawings represented the reconstructed ischiopubic segments of pelvic bones, in anteriorlateral view oriented always in the pubo-acetabular plane, with designation of the original and reconstructed parts and with an absolute scale attached. It was thus possible to transform the determined dimensions into absolute lengths, which could have been compared with evaluated material of recent origin and known sex.

a) *Pubis—dimension:* a distance from the superior point of the pubic symphysis or *facies symphysialis ossis coxae* (point C) to nearest *acetabulum* border — corresponds to our dimension (PU-M).

b) *Ischium—dimension:* a distance from the point B where axis of ischium *(ramus superior ossis ischii)* crosses ischial tuberosity *(tuber ischiadicum)* to the far border of the *acetabulum* — corresponds to our dimension (IS-M). (See *Fig. 2.*)

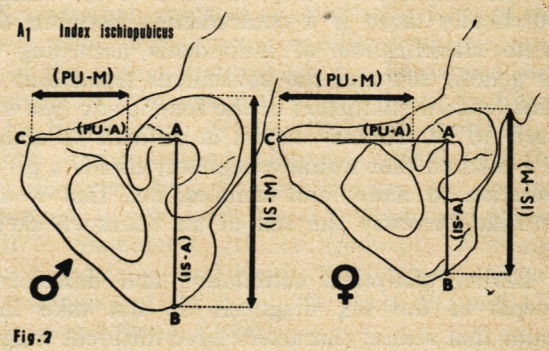

Fig.2

In order that it would not be necessary to determine the point of contact of the two bones in the acetabulum (A), which is quite unclear there, the pubis length is reduced and the ischium length is enlarged always by a corresponding part of the acetabulum; the dimension (PU-M) of the relatively shorter *os pubis* of males is thus shortened more than the analogous dimension in females, which is relatively longer. With *os ischii* the situation is just the opposite — the dimension (IS-M) of the relatively longer male ischium is in this way elongated more than the analogous, relatively shorter, dimension in females; the male acetabulum is namely larger than the female one. The sex difference following from the ischium/pubis ratio is preserved thanks to the use of the dimensions of the acetabulum.

Sexual characters examined: 1. the *ischiopubic index* (PU-M) × 100 : (IS-M) and 2. the value of the *discriminant function* for a redefined ischiopubic index measurements y = (IS-M) × 7,600 — (PU-M) × 4,730.

The basis for the estimation of the sex diagnosis was a comparison with our original (reference) sample of known sex.

Characteristics of the original series of pelvic bones of known sex from the Institutes of Anatomy in Prague and Brno, of German and Czech origin, 19th to 20th century, socially underprivileged classes.

(PU-M)	F	M	*(IS-M)*	F	M
	n = 117	n = 115		n = 118	n = 115
	$\bar{x}$ = 7.262	$\bar{x}$ = 7.069		$\bar{x}$ = 9.455	$\bar{x}$ = 10.954
	s = 0.481	s = 0.427		s = 0.450	s = 0.585
	t = 3.243			t = 21.800	

(PU-M) × 100 : (IS-M)	F	M	*(IS-M) × 7.600 − (PU-M) × 4.730*	F	M
	n = 117	n = 115		n = 115	n = 109
	$\bar{x}$ = 76.890	$\bar{x}$ = 64.620		$\bar{x}$ = 37.530	$\bar{x}$ = 49.840
	s = 3.458	s = 3.713		s = 3.217	s = 3.793
	t = 14.900			t = 12.300	

(F = females; M = males; n = number of cases; $\bar{x}$ = arithmetic mean; s = standard deviation; t = t-value of the Student's test)

Principle of evaluation: each determined dimension, value of the index or value of the discriminant function can be related:

a) to the significance of the sex differences of the examined character in general, which allows us to find whether the values increase or decrease in the direction to hypermasculinity and hypofemininity, or, on the contrary, to hyperfemininity and hypomasculinity;

b) to the arithmetic means of males and females of the comparative (reference) sample respectively;

c) to the statistically induced distribution of the values of the comparative sample of males and females simultaneously.

Each value can thus be ranked either 1. with the interval of plus one or minus one standard deviation ($\bar{x} \pm 1.$ s), which together include approximately 68 % of the values of all males and females, i.e. each of them always about 34 % males and females, above or below the mean of the given character *(masculine* or *feminine zone),* or 2. with the intervals between the first and second standard deviation at the two sides of the arithmetic mean ($\bar{x} \pm 1.$ s to 2. s), encompassing always approximately 14 % of all males and females, with respect to the given character either above or below the mean (according to the masculinity or femininity trend of the sex difference these zones are called *hypermasculine* and *hypomasculine* zone, or *hyperfeminine* and *hypofeminine* zone); or 3. with the intervals between the second and third standard deviation from the arithmetic mean at the two sides ($\bar{x} \pm 2.$ s to 3. s), which encompass already only about 1.5 % of all males and females (according to the trend of masculinity and femininity this corresponds to the *ultrahypermasculine* and *ultrahypomasculine* or *ultrahyperfeminine* and *ultrahypofeminine* zones).

For a more exact estimation of what frequency of the determined value is to be expected in the whole population of males and females and what is the number of cases in a definite interval of the measured values when the character has a normal distribution, various methods of the statistical induction can be used, as well as standardization and normalization of the primary data. Thus, e.g. the values of "z-scores" as a measure of the deviation from the mean expressed in the units $z = (X - \bar{x}) : s$ (where X = the value measured, $\bar{x}$ = the arithmetic mean of the reference sample, s = the standard deviation of the same sample) and various transformed z-scores, e.g. stenes, can be used.

Parallel comparison of the values of characters of the studied material with the statistically induced zones of males and females makes it possible, depending on the importance of the character, i.e. depending on its own sex difference, to infer about masculinity or femininity of the examined pelvis with a certain probability (i.e. with the given risk of errors). To the sex diagnosis, however, only such value can contribute, which is located already outside the interval of variability ($\bar{x} \pm 3$ s) of the values of the opposite sex and which practically cannot be observed in the whole population in the opposite sex.

These theoretical statements display a number of limitations:

1. they are valid only for the multivariate discriminant functions of sexual characters meaningfully selected from the two evolutionary, functionally and causally different subsystems of pelvis, which represent sex differences of the pelvis as a whole, since one cannot avoid the system laws of the whole with respect to its parts. Thus, e.g., female pelvis makes possible the parturition as a whole: eventual reduction of the ischiopubic segment, which then acquires a masculine character, limits the capacity of the true pelvis, which is usual-

ly compensated by extension of the sacroiliac segment and vice versa. This sometimes results in erroneous sex diagnosis based on the analysis of a single subsystem of the pelvis only. Still greater caution is required, when simple indices and single dimensions are considered.

2. Multivariate discriminant analyses determine the sex with a given probability in the population which was the source of the sample that served for elaborating the method. The expression of sexual dimorphism is relatively similar for all varieties of man. The shape of the bimodal curves describing sexually varying characters within populations will be approximately the same. The location of these curves on a scale of absolute size will vary for different ethnic groups — such relations to antecedents of modern man are not known. (See also Thieme and Schull, 1957.)

In spite of these limitations we believe that it is feasible to try to introduce the metric analysis of the ischiopubic segment of the pelvis into sex diagnostics of fossil materials and confront it with different approaches, especially with the morphoscopic ones.

A. PELVIC FRAGMENT OF THE NEANDERTHAL MAN FROM DORDOGNE, FRANCE – "LA FERRASSIE I." (HEIM, 1974)

To obtain corresponding dimensions a photograph of reconstructed ischiopubic segment of the left pelvic bone was used (Trinkaus, 1976).

The *pubis-dimension* (PU-M) is estimated at about 7.6 cm. This value is greater by 0.53 cm than the masculine mean ($z = +1.24$) and 0.34 cm greater than the feminine mean ($z = +0.70$). Thus it belongs to the hypomasculine zone and at the same time to the feminine zone. Such value can be expected in about 10 % of all males and at the same time in about 15 % of all females. The absolute pubis length displays significant but very small difference in the recent population and the value in the interval of values common to the two sexes thus does not contribute to the identification of sex.

The *ischium-dimension* (IS-M) is estimated at about 11 cm. This value practically coincides with the masculine mean ($z = +0.07$), but it is 1.55 cm greater than the feminine mean ($z = +3.43$), which makes it to fall in the centre of the masculine zone and at the same time it is already beyond the limit of the ultrahypofeminine zone, i.e. outside the whole induced range of variability of our whole population of females. Such a value can be hardly expected in the feminine sex (only in approximately 0.26 %), which itself would suggest the masculine sex.

The value of the *ischiopubic index* = 69.09 is 4.47 higher than the masculine mean ($z = +1.19$) and 7.8 lower than the feminine mean ($z = -1.56$), which makes this value fall into the hypomasculine zone. At the same time we can expect always approximately 9 % of such values in the two sexes. The value in the interval of overlapping does not itself contribute to the identification of the sex.

The value of the *discriminant function* = 47.65 is 2.19 lower than the masculine mean ($z = -0.57$) and 12.36 higher than the feminine mean ($z = +3.16$), which makes it fall on one hand into the masculine zone and on the other hand already beyond the ultrahypofeminine zone (or closely to its boundary). Since we cannot assume this value in females (only in 0.26 %), it would suggest with a high probability the masculine sex.

B. PELVIC FRAGMENT OF SOUTHWEST ASIAN NEANDERTHAL MAN FROM MOUNT CARMEL, ISRAEL – "TABUN I." (Mc COWN AND KEITH, 1939)

To obtain the necessary dimensions the reduced copies of drawings of the anterior lateral view of a reconstructed ischiopubic segment of the left pelvic bone have been used. The original drawings (McCown and Keith, 1939) vere modified (Stewart, 1960; Trinkaus, 1976).

The *pubis-dimension* (PU-M) is estimated at about 8.2 cm. This length is 1.4 cm greater than the masculine mean ($z = +2.65$) and 0.9 cm greater than the feminine mean ($z = +1.95$), and therefore it falls into the ultrahypomasculine zone and at the same time at the boundary between the hyper- and ultrahyperfeminine zone. Since such ultrahyperfeminine value can be expected in less than 1 % of males, it suggests in itself feminine sex. (N.B.: os pubis of this length is rare in recent population quite exceptional; in the sample of feminine pelvic bones from Prague and Brno our pubis-dimension (which is less than the real length of the bone) occured in values from 8.2 to 8.8 cm only three times in 117 cases (which corresponds to the expected 2.5 %) and in the French sample only once in 98 cases (i.e., only in about 1 %). (Cf. Novotný and Brůžek, 1983).

The *ischium-dimension* (IS-M) is estimated at about 7.9 cm. This length is 3.5 cm lower than the masculine mean ($z = -5.22$!) and 1.5 cm lower than the feminine mean ($z = 3.45$!), and thus it falls far beyond the boundary of the ultrahypomasculine zone as well as ultrahyperfeminine zone. Such low values have no parallel in the recent material. The position beyond the ultrahyperfeminine zone would in itself and purely from the point of view of sex diagnosis suggest unambiguously feminine sex.

The value of the *ischiopubic index* = 103.79 is 39.17 higher than the masculine mean ($z = +10.46$!) and higher by 26.9 than the feminine mean ($z = +7.78$!), which is in the both cases far beyond the boundaries of the variation intervals ($\bar{x} \pm 3$ s) of the distribution of the values of this character in recent population. The shift beyond both the ultrahypomasculine and the ultrahyperfeminine limits would suggest exclusively feminine

sex purely from the point of view of sex diagnosis; at the same time, however, the index also shows (with relation to the short ischium) an especially elongated pubis.

The value of the *discriminant function* = 21.25 is lower by 28.89 than the mean of recent males (z = −7.56) and 16.23 lower than the feminine mean (z = −3.21), and thus it falls far beyond the ultrahypomasculine limit and at the same time beyond the ultrahyperfeminine limit, which on one hand would suggest unambiguously f e m i n i n e sex, but on the other hand it appears that such a relative long *os pubis* in this case really need not be only a sexual character (Stewart, 1960; Trinkaus, 1976).

C. PELVIC FRAGMENT OF THE FIND FROM MOUNT CARMEL, ISRAEL – "SKHUL IX." (EARLY FORM OF MODERN MAN, STEWART, 1960)

The reduced copies of drawings of the anterior lateral view of the reconstructed left pelvic bone oriented in the pubo-acetabular plane have been used to obtain the dimensions required (McCown and Keith, 1939, in Stewart's modification, 1960).

The *pubis-dimension* (PU-M) is estimated at about 7.6 cm. This value is greater by 0.53 cm than the masculine mean (z = +1.24) and 0.34 cm greater than the feminine mean (z = +0.70), and thus it falls both into the masculine and the feminine zone.

The *ischium-dimension* (IS-M) is estimated at about 10.5 cm. This value being lower by only 0.45 cm than the masculine mean (z = −0.53) and 1.45 cm higher than the feminine mean (z = +2.32) falls into the masculine zone and, at the same time, into the ultrahypofeminine zone. Such value can be expected to occur in only approximately 2.5 % of females, which suggests rather the masculine sex.

The value of *ischiopubic index* = 72.38 is 7.76 lower than the masculine mean (z = −2.07) and lower by 4.51 than the feminine mean (z = = −1.30). Thus it falls approximately at the boundary of the hypo-and ultrahypomasculine zone, and at the same time, at the boundary of the feminine and hypofeminine zone. Such a value can be expected in approximately 3 % of males and 10 % of females; hence it belongs to the interval common to the two sexes.

The value of the *discriminant function* = 43.85 is lower by 6 than the masculine mean (z = −1.58) and 6.37 higher than the feminine mean (z = = +1.98), thus it falls into the centre of the hypomasculine zone and, at the same time, into the hypofeminine zone being, however, more close to the ultrahypofeminine limit. This value can be expected in approximately 7 % of males and 3 % of females. The dividing value (= cutting point) of this discriminant fuction (♀ < 43.68 < ♂) just favours the m a s c u l i n e sex.

D. PELVIC FRAGMENT OF THE FIND FROM MOUNT CARMEL, ISRAEL – "SKHUL IV." (EARLY FORM OF MODERN MAN, STEWART, 1960)

The necessary dimensions were obtained from the same sources as with "Skhul IX."

The *pubis-dimension* (PU-M) is estimated at about 7.0 cm. This value is lower by only 0.07 cm than the masculine mean (z = −0.16), thus it is practically identical to this value and 0.26 lower than the feminine mean (z = −0.54), therefore it falls both into the masculine and the feminine interval.

The *ischium-dimension* (IS-M) is estimated at about 9.7 cm. This value is lower by 1.25 cm than the masculine mean (z = −1.46) and 0.24 cm higher than the feminine mean (z = +0.54) and thus falls into the hypomasculine and the feminine zone. Such a value can be expected in approximately 17 % of females, but also in approximately 8 % of males.

The value of the *ischiopubic index* = 72.16 is 7.54 higher than the mean of males (z = +2.01) and lower by 4.73 than the mean of females (z = −1.36), thus it falls into the hypomasculine zone and, at the same time, into the hypofeminine one. Such value can be expected in approximately 3 % of males, but also in 8 % of females, hence it is located in the interval of overlapping values common to the two sexes.

The value of the *discriminant function* = 40.61 is lower by 9.23 than the masculine mean (z = = −2.44) and 3.31 higher than the feminine mean (z = +0.97), thus it falls into the ultrahypomasculine zone, but, at the same time also into, or close to the boundary of, the hypofeminine one. Such value can range from 9 to 15 % of females, but also between about from 1 to 3 % of males. It is thus situated in the zone of overlapping, even if the dividing value (cutting point) of the discriminant function (♀ < 43.68 < ♂) puts this value already to the side of the feminine sex. (See *Fig. 3.*)

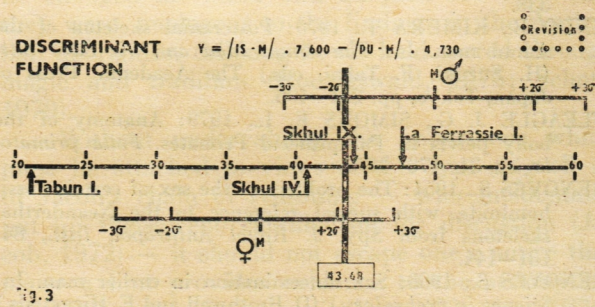

Fig. 3

CONCLUSION

1. The European Neanderthal man "La Ferrassie I." is determined by our discriminant analysis as a male, by which Heim's (1974) opinion is supported;

2. the Southwest-Asian Neanderthal man "Tabun I." gives a feminine value so far beyond the limits of the variability of the recent population that for example such a relative long os pubis is not necessarily a sex character only (Stewart, 1960; Trinkaus, 1976); we are in agreement with the original sex diagnosis;

3. in the "Skhul" group we agree in the case of the skeleton IX. with the original diagnosis a male, however, its value of discriminant function is located in the zone of overlapping, so that the find might also correspond to the pelvis of a hypofeminine female;

4. in the case of the skeleton "Skhul IV." we do not agree with the original diagnosis of the masculine sex (McCown and Keith, 1939), however, from the same reasons as in the preceding case, the skeleton might belong to a hypomasculine male.

The quantitative analysis of morphometric characters aiming at the sex diagnosis of fossil finds is not easy to apply in a broad extent especially since the finds are fragmentary and damaged; we suppose, however, that these methods will also contribute to the analysis of fossil finds when the evolution of man is investigated.

The principal purpose of this contribution has been to draw attention to these methods of the sex identification of pelvis, because it would be interesting to make an attempt of the r e a l r e v i s i o n of the sex diagnosis, applying this method on the original bones or casts.

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