STUDYING FOSSIL HORSES

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Volume I: Methodology

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FOREWORD

Volume I of the "New York Hipparion Conference" is mostly dedicated to methodology; it proposes a standardized system to be used by all students in equids.

The usefulness of a standardized system, internationally applied, speaks for itself: when there is such an amount of material all around the world, no single person can collect data on the whole of it. At the same time, a geographically and chronologically broad knowledge is a prerequisite to understand phylogenetic relations and therefore also to propose reasonable correlations and biostratigraphies. The only way to acquire it is to compare one's own data with data published by other people. But the data must need be comparable, i.e. concern the same points observed in the same ways.

To construct such a system was the aim of a lot of more or less formal discussions among european "equid people" during the seventies. It culminated at the New York International Hipparion Conference sponsored by the National Science Foundation (Grant EAR 8110870), in November 1981, when 18 people from 8 countries accepted the invitations issued by R. H. Tedford, J. A. Van Couvering, M. O. Woodburne and P. Y. Sondaar and met at the American Museum to discuss and practise the system elaborated in Europe. At the end of the Conference, some modifications were proposed and it was also agreed that the ultimate system—as it is published here—was to be recommended for international use as a *minimum* set of measures and observations.

Everyone present at the Conference (see list on next page) participated to the discussions and the elaboration of the system here presented, and everyone agreed on the final version presented here. The persons entrusted with the redaction are however responsible for the texts and illustrations as well as for the personal comments they may introduce.

During the Conference, the system in course of elaboration was tested: the same material (one cranium, one mandible, one central metacarpal, one central metatarsal) were measured by every participant. In this way we hoped to check the consistency of the measures and, in consequence, their reliability. A quarry sample of Clarendonian horses was also observed, measured and discussed by all the participants. These data and their interpretations will be published in the next volume.

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INTRODUCTION

The present methodological system for the study of *Equus* and *Hipparion* bones and teeth is intended for people who need not be convinced of the usefulness of morphometry, and who agree that there is no real opposition nor mutual exclusion between "observing" and "measuring". These points were discussed at some length in a previous paper (Eisenmann 1986) and we will not come back to them.

Since at the basis of this new system lies an original "european" system that had been in use for more than 10 years, we should perhaps explain how, and what for, it was initially elaborated, and why it differs from another push at standardization, namely the "Guide to the measurements of animal bones" by A. von den Driesch (1976). The second point is easy: when the "Guide" was published, some of us had already been accumulating data for several years and could not switch to another system. Even so, a lot of measures are common to both systems and we noted them in tables of correspondence for each bone.

The other questions need a longer developement. In the foreword to A. von den Driesch "Guide", there is a sentence with which we deeply agree: "If they (the measurements) are useful, use them; if they are not, change them". But what is "useful"? In our opinion, a useful measurement is one which helps to express a visible difference between morphologies, compared at a particular time by a particular worker, for a particular purpose.

This definition implies that it is more important to try to quantify differences *one can see*, even if the measures are difficult to define and variable, than be content with precise but not diagnostic measurements. For example, when one looks at *Equus* first phalanges, one can see that anterior and posterior phalanges differ in the relative position of the supraarticular tuberosities. One of the best ways to discriminate anterior and posterior first phalanges of *Equus* (Eisenmann & De Giuli, 1974b; Dive & Eisenmann, in press) is to use this observation, although the relevant measures are *not* precise and have very high coefficients of variation. Our definition implies also that there is no "absolute" usefulness of a measurement. For example, the height of the zygomatic arc under the orbit is very useful to distinguish between skulls of Mountain and Plain Zebras (Eisenmann & De Giuli, 1974a); it is not very useful when comparing skulls of other species of *Equus* (Eisenmann, 1980). For this reason, the elaboration of a system is never really finished. For any particular worker, new materials bring new problems that need to be addressed by new observations and measures.

On the other hand, the particular worker is not alone. When he begins to work with (for example) equids, he is usually aware that other people have done so before. These people may have already found that some points were interesting; and they may have published data on them. If the new worker wants to use this experience and these data, he has naturally to take the same measurements other people take, or took. For this reason, any methodological system is usually composed of previously recommended measurements (or observations) and "new" ones, designed to answer some "new" specific questions. Since no one can accept as basis *all* the measurements that have ever been recommended, one usually takes as basis one particular system and modifies it according to his whims and his aims.

Concerning the postcranial skeleton, the "european system" emerged after discussions with P. Y. Sondaar who had worked on *Hipparion* limb bones (Sondaar, 1968), from the system of measurements published by Gromova (1963). After some minor additions during the next years, this system was applied first to *Equus*, then to *Hipparion*. At the moment, no one was aware that another system was

being elaborated in Archaeozoology (von den Driesch, 1976) and still another in North America (Willoughby, 1948, 1974). Our *Equus* system was integrally published in Eisenmann dissertation (1979a) and in the volume consecutive to the International symposium on equids held in 1982 at Tübingen (1986). Partial publications date from 1974b (Eisenmann & De Giuli) to "in press" (Dive & Eisenmann).

The cranial "system" emerged much in the same way, on the basis of the papers published by Osborn (1912), Motohashi (1930), Hooijer (1949) and (mostly) Gromova (1949), as well as on the basis of qualitative characters noted by Azzaroli (1966); again the system recommended by von den Driesch was not considered because it was not yet published. The first publication of our system dates to 1974a (Eisenmann & De Giuli); the last additions (Eisenmann, 1981b) were made after concertation with M. T. Alberdi, C. De Giuli, P. Sondaar and U. Staesche.

The teeth methodology was also the result of discussions using as basis Gromova observations and measurements (1949, 1952) and those of Alberdi (1972-1974), Cooke (1950), Forstén (1968), Gabunia (1959), Hooijer (1975), Petit (1939), Prat (1968), Sondaar (1961), Stirton (1941), Van Hoepen (1940), and probably others. The applications to *Equus* have been published by Eisenmann (1976, 1979b, 1980, 1981a). At that moment, we did not know the paper of Skinner & Hibbard (1972), in which are given observations very similar to those of Gromova, but with another terminology ("isthmus" for "stem" of the double knot in the lower cheek teeth, for example).

In short, the initial system was based mostly on the publications of Gromova, and it was reworked in the aim of comparing first Zebras, then other *Equus* species, then (much later) *Hipparion* species. It was empirically constructed with new measurements added "in disorder" to old ones whenever it seemed necessary. It has been "tested" by 10 years of practice on modern and fossil bones and teeth and submitted to multivariate analyses (Eisenmann & Turlot, 1978; Eisenmann & Karchoud, 1982; Dive & Eisenmann, in press). In doing so, not only something was found about the interspecific differences inside the genus *Equus*, but also about the relative "usefulness" of the measurements employed to express these differences. It was also made clear that, in many cases, a few measurements are not sufficient to correctly discriminate bones. For example, the gracility index usually employed to characterize metapodials is indeed important, but often it is not enough to achieve a specific determination.

The present system differs in several ways from the original one: 1) the order in which the measurements are proposed try to be practical and logical. For example, the first 15 skull measurements can all be taken on the ventral face of the skull; most of limb bones measurements are equivalent (numbers 1 and 2 deal with maximal and internal lengths, numbers 3 and 4 with diaphyseal breadth and depth, etc.). 2) The system has been modified to adapt not only to *Equus* but also to *Hipparion*; measures were added for the preorbital fossa of the skull (Woodburne & Bernor, 1980; Woodburne, MacFadden and Skinner, 1981), for the depth of the narial opening (Eisenmann, 1981b), as well as for lateral metapodials and phalanges (Sondaar, 1968). 3) The "usefulness" of some new measurements has not yet been tested. According to the wish of the majority of the participants, several "old" measurements were changed or even suppressed even though they seemed "good" to a minority. Some comments on the differences between the systems will be found in the next chapter ("General remarks on terminology, definitions, and equivalences of measurements").

GENERAL REMARKS ON TERMINOLOGY, DEFINITIONS, AND EQUIVALENCES OF MEASURES

Besides defining the measurements of equid bones and teeth as they were recommended by the New York Hipparion Conference, the aim of this paper is also to make these measurements easily recognizable and reproducible, even by little experienced people. Great emphasis is therefore laid on a clear presentation of the measurements by drawings. These figures and their captions constitute the main part of the paper. But some complementary explanations concerning the terminology used in describing bones and their orientations are also needed, although they cannot find room inside the captions, as well as some general comments on the definitions of measurements and their equivalences.

Terminology

There is a general agreement on the nomenclature of bones and their components (Barone, 1966; von den Driesch, 1976). When different names may be used, as for carpals and tarsals, we have tried to give the list of synonyms. Priority has been given to the names more usual in English.

Since we deal with equids alone (especially *Hipparion* and *Equus*), i.e. a selected and homogeneous group of Mammals, we need not consider the problems that may arise when dealing with various differently specialized animals. Even though, the terminology applied to the orientation of bones and definition of measurements is not quite uniform nor evident. Directions and orientations are in general named by reference to the living animal (or the mounted skeleton). Let us specify that *lateral* refers to the outer sides of an animal; *medial*, at the opposite, is near the plane of symmetry. By reference to the long axis of the body, are *anterior* the structures looking to the front and *posterior*, those looking to the rear. *Caudal* refers to a part closer to the tail, *cranial* to a part closer to the head; thus cranial may be a synomym for anterior and caudal for posterior. In the skull, structures looking upwards, and downwards, are named, respectively, *dorsal*, and *ventral*. In a limb or in any long limb bone, the *proximal* part is the one nearer the attachment to the trunk while the *distal* part is the one nearer the free end of the limb.

Definitions

For limb bones, measurements follow the three main spatial directions. The *length* is usually the greatest dimension and more or less proximo-distal. It is usually measured along the long axis of the bone. In some cases, a proximo-distal measurement may be called *height*. *Breadth*, width, and transverse diameter are synonyms; they qualify dimensions perpendicular to the length and medio-laterally oriented. *Depth* qualify dimensions perpendicular to length and breadth, and oriented in a antero-posterior direction; depth is naturally synonym of antero-posterior diameter. Length, breadth and depth were prefered because the same terms are used by von den Driesch "Guide" (1976) and in the book edited by R. H. Meadow and H. P. Uerpmann after an international symposium on equids (Eisenmann, 1986). For measurements which cannot fit any of the three main directions, the term *diameter* may be used, for example for the dimensions of some articular facets. It may happen also that breadths and widths are not exactly perpendicular to each other, nor to the length, or not exactly medio-laterally or antero-posteriorly oriented. Mention is made of such discrepancies when it seems necessary to avoid confusion. In most of these cases, one of the dimensions is defined between prominent points; such points are indicated on the figures by small black triangles.

Equivalences of the measurements

For most bones of *Hipparion* and *Equus*, measurements are identical. When necessary (skull, lateral metapodials and phalanges), additional figures and recommendations are given.

The equivalences to the most complete recent system (von den Driesch, 1976) and to the "old" system are given in short tables for most bones. In these tables, the proposals of this paper are referred to as "PP" (Present Paper), those of von den Driesch as "AVD", and those of Eisenmann as "VE".

Comments on the differences between the "new" and the "old" system will be made at the beginnings of the main chapters (Skull and Mandible, Teeth, Limb Bones).

For paired structures (limbs and teeth), it is the left ones that are always figured.

SKULL AND MANDIBLE

On the whole, the present methodology for the skull improves on the old one. The order of the measurements is easier to follow; some measures are defined in a more logical way (alveolar lengths instead of occlusal for the cheek teeth); several indifferent or redundant measures were suppressed; probably useful ones (palatal width, 2 occipital diameters, 8 measures for the preorbital area, etc.) were introduced. Some people may however regret the suppression of the measures for the diastema length, the cranial width, and 2 facial heights (numbers 6, 15, 26 and 27 in Eisenmann, 1986). For the mandible also, there is a general improvement, mostly by additions of new heights, but again the suppression of the diastema's length measure may be regretted.