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## Taphonomic analysis of late Middle Pleistocene mammal remains from Bucine (Upper Valdarno, Tuscany, Central Italy)

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**KEY WORDS** – *Mammalia, Taphonomy, Late Middle Pleistocene, Tuscany, Central Italy.*

**ABSTRACT** – *The present is a tentative application of a new taphonomic approach proposed by Behrensmeyer (1991), the so-called multivariate pattern, to the renowned mammalian fauna from Bucine (Upper Valdarno, Tuscany, Central Italy). Since the rich fossil collection was assembled during a long period of time, most of the information of the spatial density and arrangement of the specimens is missing; the characteristics of the accumulation are thus deliberately disregarded here. The observations were therefore limited to the assemblage characteristics and to the taphonomic features shown by the fossil assemblage. The obtained results, synthetically presented in graphical form, suggest that the deposit probably formed mostly by attritional processes and was slightly reworked from the original site of accumulation.*

**RIASSUNTO** – [Analisi tafonomica dei resti di mammiferi del tardo Pleistocene medio di Bucine (Valdarno superiore, Toscana, Italia centrale)] – *Il presente studio è un tentativo di applicazione di un nuovo approccio tafonomico, recentemente proposto da Behrensmeyer (1991), il cosiddetto modello multivariato, alla celebrata fauna mammaliana di Bucine (Valdarno Superiore, Toscana, Italia Centrale). Dal momento che la ricca collezione di fossili fu assemblata nel corso di un lungo lasso di tempo, la maggior parte dell'informazione sulla densità spaziale e sulla giacitura degli esemplari è sconosciuta. Perciò le caratteristiche dell'accumulo sono deliberatamente trascurate. Le osservazioni sono state pertanto limitate alle caratteristiche dell'associazione e agli aspetti tafonomici mostrati dall'associazione fossile. I risultati, presentati sinteticamente in forma grafica, suggeriscono che il deposito si sia probabilmente formato in seguito a processi di accumulo progressivo per morte naturale e che sia stato debolmente rielaborato dal sito originale di deposizione.*

### INTRODUCTION

Taphonomy is a newly born science for Italian vertebrate paleontology, the main contributions coming mostly from paleontologists (Villa, 1982; D'Errico & Giacobini, 1985, 1988; Giacobini & Piperno, 1991; Giacobini, 1995; Anconetani *et al.*, 1996; Anconetani & Peretto, 1996a, b; Peretto *et al.*, 1996). In fact, most of the paleontological investigations performed in the past on fossil mammalian remains from Italy disregarded the taphonomic aspects of the assemblages. Many historical collections may thus be revisited under this perspective, but most of the bones were collected randomly with slight consideration for their spatial distribution. This inevitably caused the loss of a great deal of information. This is a tentative application of new methodologies to one of these historical collections, the one from Bucine.

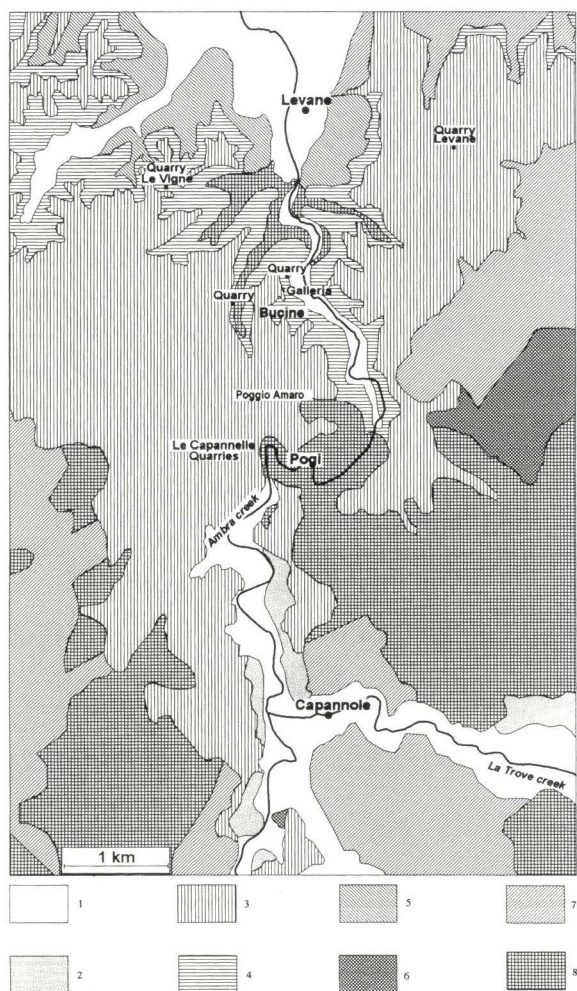
The fossil mammal remains from Bucine actually come from a number of collecting localities (Poggio Amaro, Le Capannelle, Pogi di Bucine, Capannole, Poggio di Bucine, Levane, Galleria di Bucine, Cava Migliorini, Cava di Bucine, Cava Le Vigne, Cava del Rinoceronte) distributed along the Ambra creek, a left-hand tributary of the Arno (Text-fig. 1). Two chert artifacts, found at Poggio Amaro, attest to the occurrence of man.

The first fossils were found in the area in the 40's and are now preserved in the Museum of Paleontology of Montevarchi. Since then, fossil bones were frequently encountered, especially in quarries and gravel and sand pits, and were mostly preserved in the Museum of Geology and Paleontology of Florence and, to a lesser part, in local schools.

The bones were recovered from late Middle Pleistocene yellowish lenticularly stratified fluvial sands and gravels, which lay disconformably on allochthonous Eocene limestones.

### METHOD

The methodologic approach applied here is that recently proposed by Behrensmeyer (1991) and called the multivariate approach. The method is aimed to reconstruct the taphonomic history of an accumulation of fossil remains of terrestrial mammals. This is obtained by a threefold series of observations: assemblage data, which include sample size, number of individuals, number and relative abundance of species, average body size, ages represented, and degrees of articulation of the skeletons; general characters of the accumulation, such as the extent of the recovery area and the spatial arrangement of the bones; surface modification shown by the bones

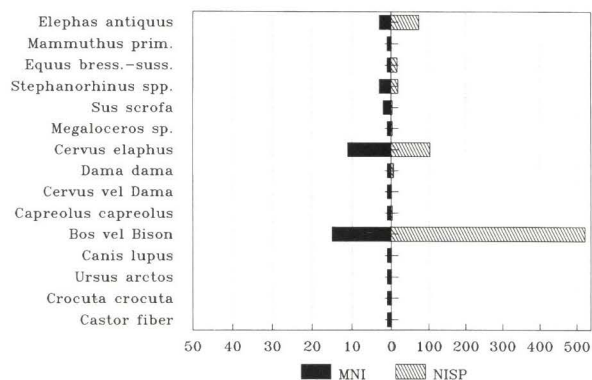


Text-fig. 1 - Schematic geologic map of the study area (survey by the Author). The main sites of recovery of the fossil material recorded from Bucine are shown. 1 - Holocene fluvial deposits; 2 - Recent terraces formed by fluvial sandy clays; 3 - Middle Pleistocene fluvio-lacustrine sands (= Levane Sands); 4 - Middle Pleistocene fluvial limestone conglomerates (= Laterina Conglomerates); 5 - Early Pleistocene lacustrine and fluvio-lacustrine clays (= Terranuova Clays, Ascione Clays, Oreno Clays and Sands); 6 - Oligocene to Early Miocene silty, fine-grained marls and sandstones; 7 - Oligocene to Early Miocene Macigno Formation; 8 - Eocene ? Monte Senario limestones and breccias.

themselves, which consists of breakage, weathering, abrasion/polish, and of carnivore and human activity. The qualitative and quantitative variables are plotted on a diagram (Text-fig. 11). This graphic representation permits a straightforward comparison with curves that depict the characters of selected hypothetical accumulations from recent systems, and thus allows reliable inferences of the factors responsible for the accumulation in study.

For the reasons mentioned above, the lack of information on the spatial distribution of the fossils

#### Fossil-assemblage composition



Text-fig. 2 - Fossil assemblage composition (number of specimens and minimum number of individuals vs. species represented).

of historical collections prevents comparisons of the general characters of the accumulations with present-day examples, as is the case of the faunas from Bucine.

In terms of nomenclature, I here follow Badgley (1986) in calling a *specimen* every identifiable bone fragment and an *element* the bone fragments manifestly coming from a single individual (Holtzman, 1979, made an opposite use of these names).

The methodologic procedure followed here first of all included an anatomical and taxonomic identification of each element and a detailed analysis of the taphonomic evidence. This information was first reported in a number of tables which are synthetically displayed in Tab. 1 and 2 in order to be plotted in the final graphical form. The results are shown in Text-figs. 2-11. The fossil assemblage composition is depicted in Text-fig. 2, where the MNI (minimum number of individuals) is compared to the NISP (number of identified specimens per taxon). The distribution of bones among the most represented taxa, *Bos vel Bison*, *Cervus elaphus* and *Elephas (Palaeoloxodon) antiquus*, is shown in Text-figs. 3-8. The other two histograms show the total percentages of each bone type (Text-fig. 9) and the expected vs. actually found abundances in the most represented taxon, *Bos vel Bison* (Text-fig. 10). The final graph is shown in Text-fig. 11. In the assessment of the number of individuals I followed Badgley (1986) in distinguishing the NISP, which, in accordance with the taphonomic history of the accumulation, may be thought to equate to the number of individuals, from the MNI, which, on the other hand, is assessed by evaluating first the maximum number of left or right long bones and then correcting the results by matching lefts and rights in respect of age and size (Chaplin, 1971).

#### RELATIVE SPECIES ABUNDANCES

Four species diversity indexes were calculated here, in order to meet the different preferences of

|                                | <i>Elephas<br/>(P.)<br/>antiquus</i>        | <i>Mammuthus<br/>primigenius</i> | <i>Stephanorhinus<br/>spp.</i> | <i>Equus</i> gr.<br><i>bressanus-<br/>süssenbor-<br/>nensis</i> | <i>Sus scrofa</i>    | <i>Bos</i> vel.<br><i>Bison</i>              | <i>Cervus<br/>elaphus</i> | <i>Cervus</i> vel<br><i>Dama</i> | <i>Megaloceros</i> sp. | <i>Capreolus<br/>capreolus</i> | <i>Ursus<br/>arctos</i> | <i>Canis<br/>lupus</i> | <i>Crocota<br/>crocota</i> | <i>Castor<br/>fiber</i> |
|--------------------------------|---------------------------------------------|----------------------------------|--------------------------------|-----------------------------------------------------------------|----------------------|----------------------------------------------|---------------------------|----------------------------------|------------------------|--------------------------------|-------------------------|------------------------|----------------------------|-------------------------|
| <b>Assemblage data</b>         |                                             |                                  |                                |                                                                 |                      |                                              |                           |                                  |                        |                                |                         |                        |                            |                         |
| sample size                    | 73                                          | 1                                | 16                             | 14                                                              | 3                    | 522                                          | 103                       | 1                                | 3                      | 3                              | 1                       | 1                      | 1                          | 1                       |
| Number of adult individuals    | 2 (MNI)<br>70 (NISP)                        | 1                                | 2 (MNI)<br>13 (NISP)           | 1 (MNI)<br>14 (NISP)                                            | 1 (MNI)<br>2 (NISP)  | 13 (MNI)<br>506 (NISP)                       | 9 (MNI)<br>98 (NISP)      | 1                                | 1 (MNI)<br>3 (NISP)    | 1 (MNI)<br>3 (NISP)            | 1                       | 1                      | 1                          | 1                       |
| Number of juvenile individuals | 1 (MNI)<br>3 (NISP)                         |                                  | 1 (MNI)<br>3 (NISP)            |                                                                 | 1 (MNI)<br>1 (NISP)  | 2 (MNI)<br>16 (NISP)                         | 2 (MNI)<br>5 (NISP)       |                                  |                        |                                |                         |                        |                            |                         |
| Body size (Kg)                 | 7-8 tonn                                    | about 5 tonn                     | up to 2 tonn                   | 300-400                                                         | up to 250            | 800-1000                                     | 75-340                    | 200                              | 300-800                | 15-50                          | 150-600                 | 30-75                  | 70-80                      | 15-20                   |
| Age spectrum (% of juvenilis)  | 33.3%-4.1%                                  |                                  | 33.3%-18.7%                    |                                                                 | 4.5%-0.4%            | 13.3%-3%                                     | 18.1%-4.8%                |                                  |                        |                                |                         |                        |                            |                         |
| Bone articulation              | isolated + dispersed (+ 1 partial skeleton) | isolated                         | isolated + dispersed           | associated + dispersed                                          | isolated + dispersed | isolated + dispersed (+ 4 partial skeletons) | isolated + dispersed      | isolated                         | isolated + dispersed   | isolated + dispersed           | isolated                | isolated               | isolated                   | isolated                |
| Skeletal parts                 | unsorted                                    |                                  | unsorted                       | unsorted                                                        | unsorted             | unsorted                                     | unsorted                  |                                  | unsorted               | unsorted                       |                         |                        |                            |                         |
| <b>Bone modification</b>       |                                             |                                  |                                |                                                                 |                      |                                              |                           |                                  |                        |                                |                         |                        |                            |                         |
| Breakage                       | 20.5%                                       | broken                           | 68.7%                          | unbroken                                                        | 50%                  | 47.7%                                        | 88%                       | broken                           | 66.6%                  | 33.3%                          | broken                  | unbroken               | broken                     | unbroken                |
| Weathering                     | Stages 0-3                                  | Stage 0                          | Stages 0-3                     | Stage 0                                                         | Stage 0, 4           | Stages 0-3                                   | Stages 0-3                | Stage 3                          | Stages 0-3             | Stages 0-3                     | Stage 3                 | Stage 2                | Stage 0                    | Stage 0                 |
| Abrasion/polish                | 8.2%                                        | not abraded                      | 25%                            | not abraded                                                     | not abraded          | 6.7%                                         | 17.4%                     | abraded                          | 100%                   | 33.3%                          | not abraded             | not abraded            | not abraded                | not abraded             |
| Surface marks                  | none                                        | none                             | none                           | none                                                            | none                 | present (rare)                               | present (rare)            | none                             | none                   | none                           | none                    | none                   | none                       | none                    |

Tab. 1 - Synthesis of the values for taphonomic variables in the fossil assemblage from Bucine. *Sample size*: includes pieces identifiable to one of the recognized species. *Number of individuals*: NISP= number of identified specimens per taxon; MNI= minimum number of individuals, assessed by evaluating the maximum number of left or right long bones and then correcting the results by matching lefts and rights in respect of age and size. *Relative abundance*: All indexes tell that the Bucine assemblage is characterized by low diversity. *Body size*: individual weight per species. *Age spectrum*: percentage of juvenile vs. adult individuals.

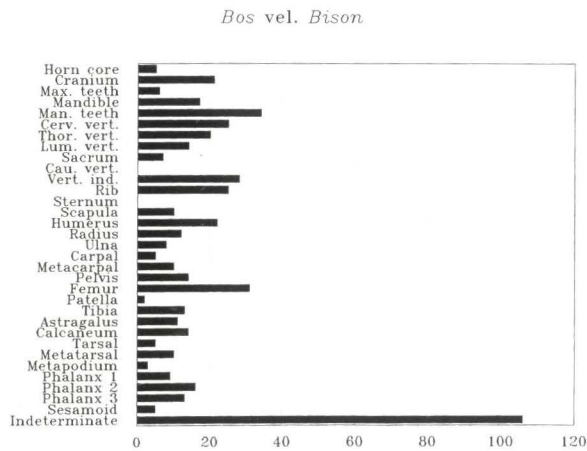


Fig. 3

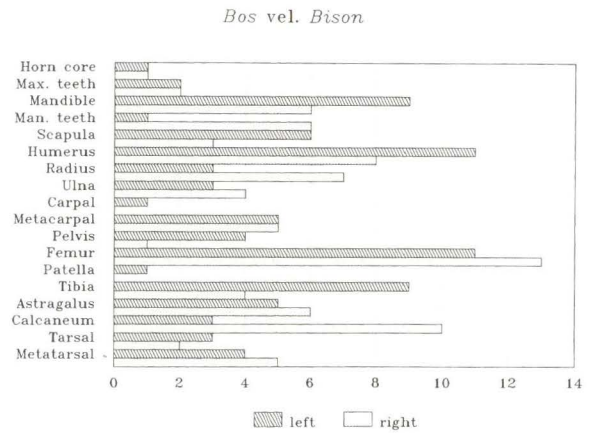


Fig. 4

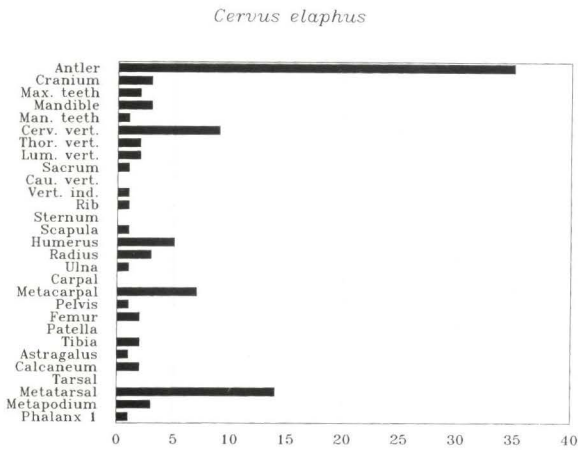


Fig. 5

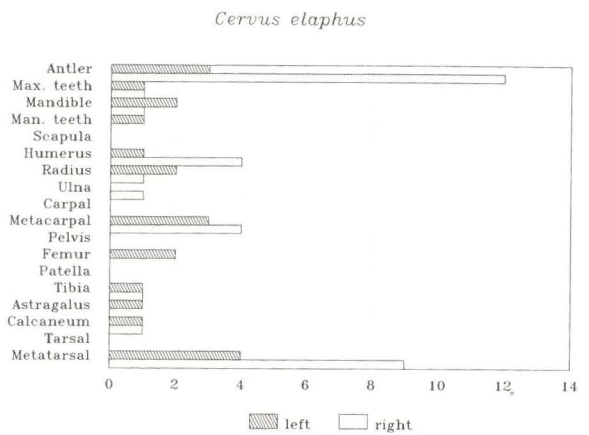


Fig. 6

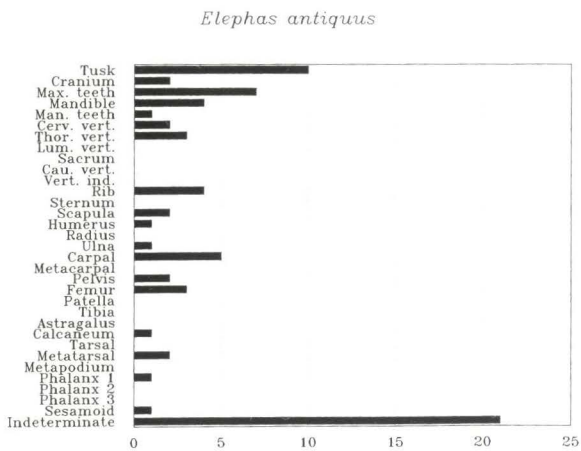


Fig. 7

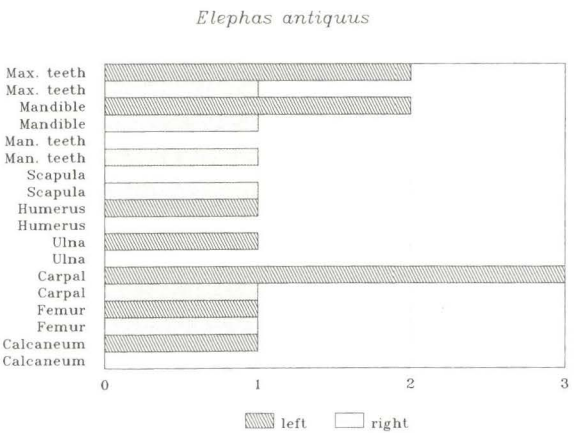


Fig. 8

Text-figs. 3-8 - Number of skeletal elements of *Bos vel Bison* (figs. 3-4), *Cervus elaphus* (figs. 5-6) and *Elephas (Palaeoloxodon) antiquus* (figs. 7-8). Indeterminate specimens in figs. 3, 7 and 9 are fragments of long bone diaphyses, morphologically attributable to the specified species but not surely ascribable to a specific long bone.

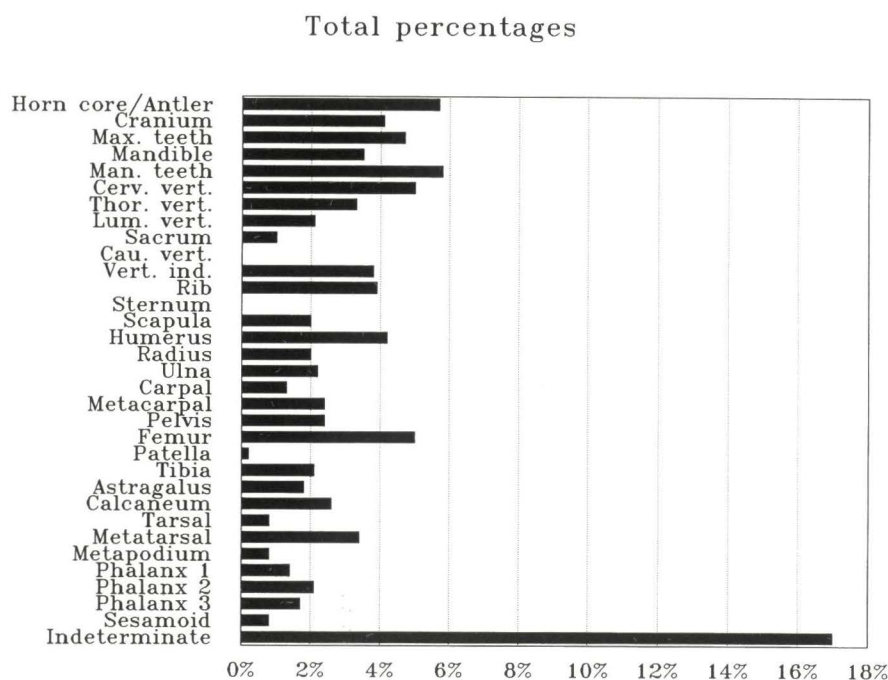
readers: the Shannon-Wiener index ( $SW = \sum P_i \log_e P_i$ , where  $SW$  = Shannon-Wiener index;  $P_i$  = proportion of each species represented in the community); the Margalef's (1957) index ( $M = (S-1)/\log_e N$ , where  $M$  = Margalef's index;  $S$  = number of species;  $N$  = number of individuals); the Whittaker's (1975) index ( $W = S/\log_e N$ , where  $W$  = Whittaker's index;  $S$  = number of species;  $N$  = total number of individuals) (the values of the Margalef and Whittaker indexes reported in Table 2 were calculated on the mean number of individuals between MNI and NISP) and the Simpson's (1949) index ( $SI = \sum (n^2 - n)/(N^2 - N)$ , where  $SI$  = Simpson's index;  $n$  = number of individuals in a species;  $N = \sum n$ ). The Shannon-Wiener index is one of the most used indexes. It is a measure of equitability, because it considers diversity as dependent on both richness and equitability and reaches its highest values when all the species are equally represented, while it is 0 when only one species is represented in the sample. Margalef's (1957) and Whittaker's (1975) indexes are meant to reduce considerably the effects of sample size in assessing the richness of species. Margalef's index is 0 in case of absolute dominance. Finally, Simpson's (1949) index, also known as the index of concentration, is a measure of the dominance of species. It does not depend on a log-series or other kinds of abundance distribution. Nei & Roychoudhury (1974) proved that the index is also sample-size independent. It ranges from 0, in case of absolute equitability, to 1, when all the individuals belong to a single species. The Simpson's index calculated on the means between MNI and NISP values

for the single species represented was plotted in Text-fig. 11. This index was preferred to the others because it readily provides an immediate idea of the relative proportion of the species present in a sample and because of its sample-size independence, which is particularly important in dealing with old collections of fossils.

#### BODY SIZE, AGE SPECTRUM, SKELETAL-PART COMPOSITION AND BONE MODIFICATIONS

The body size calculated here is an average of the sizes of the adult individuals in each size group represented. Estimating the body size of the different species was not too complicated because most of the species encountered are still living today, or have living relatives. The age spectrum is given by an average of the percentages of young individuals present for each species. The skeletal-part composition was estimated by calculating Behrensmeyer's (1975) tooth/vertebra ratio and by assessing the percentages of each bone (Text-fig. 9). A reliable assessment of the eventual sorting of the skeletal parts represented was prevented by the fact that most of the specimens are recorded generically from "Bucine", with no further specification of the exact locality of discovery.

Bone modifications, such as breakage, abrasion/polishing and surface marks are expressed in average percentages, while the range of the most represented weathering Stages (*sensu* Behrensmeyer, 1978) is reported.



Text-fig. 9 - Total percentages of each skeletal element of all the species represented at Bucine.

## RESULTS

The assemblage from Bucine is manifestly biased by the lack of micromammal remains, which is certainly due to the fact that the material was collected in a time when very slight importance was given to these faunal components, so that their occurrence was disregarded. This weights considerably on the diversity counts and therefore also on the paleobiological inference on the assemblage.

## TAPHONOMIC INFORMATION

The fossil-assemblage composition histogram shows a disproportionate abundance of *Bos* vel *Bison* remains and a relatively rich amount of *Cervus elaphus* and *Elephas antiquus*; the other faunal components are poorly represented (Text-fig. 2). The fairly low equitability of the Bucine fauna is also shown by the species diversity indexes (Tab. 2, Text-fig. 11). All the indexes denote a moderate degree of dominance when they are calculated on the MNI, due especially to the abundances of *Bos* vel *Bison* and *Cervus*, while they confirm a considerable dominance when they are calculated on the NISP, given the significant increase of the named taxa and the additional contribution of *Elephas*. The Simpson's index value plotted in Text-fig. 11 still indicates a fairly high dominance.

The average body size of the Bucine mammalian community falls in the 5-100 kg range, the estimated value being very close to the upper limit. The age spectrum is dominated by adult and old-aged individuals. The bones studied were mostly recovered as isolated and randomly dispersed specimens; only five incomplete disarticulated skeletons were found. Four of these, accounting for 80 elements, belong to *Bos primigenius* and one, accounting for 30 elements, belongs to *Elephas (Palaeoloxodon) antiquus*. The histogram of the total percentages (Text-fig. 9) shows that there are a large number of fragments of cranial structures, lower teeth, vertebrae, especially cervical, ribs, stilopodial bones and metatarsal bones. Least represented are the sacrum, patella, tarsal bones and sesamoids. The curve of the expected vs. actually found numbers in *Bos* vel *Bison* (Text-fig. 10), shows a good correspondence in the cranial bones, vertebrae and ribs and a marked disproportion in the limb bones. Basipodial bones, with the exclusion of calcanea, astragali, and sesamoids are very much depleted, while stilopodial bones are over-represented. The tooth/vertebra ratio, which gives an indication on fluvial winnowing, is 0.61, a considerably low value. This is suggestive of a low depletion of vertebrae and, therefore, that the lag components of the assemblage are less represented than the dispersed ones. This seems consistent with the relatively low representation of basipodial and sesamoid bones. Low values for these generally characterize assemblages from channel margin and crevasse-splay facies (Badgley, 1986).

**Assemblage data**

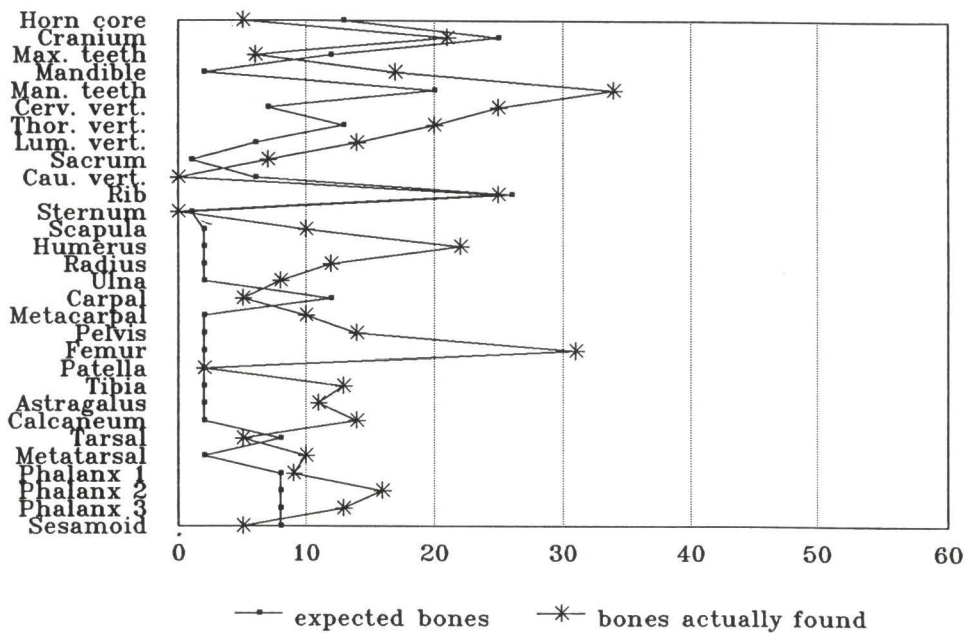
|                              |                                                                                                                                                                                                                                   |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| sample size                  | 743 + 200 indetermined specimens                                                                                                                                                                                                  |
| Number of individuals        | 43 (MNI)<br>743 (NISP)                                                                                                                                                                                                            |
| Number of species            | 14                                                                                                                                                                                                                                |
| Relative abundance           | SW = - 2.017 on MNI<br>SW = - 0.2816 on NISP<br>M = 3.456 on MNI<br>M = 1.966 on NISP<br>W = 3.722 on MNI<br>W = 2.117 on NISP<br>SI = 0.1848 on MNI<br>SI = 0.5297 on NISP<br>SI = 0.4968 on mean values<br>between MNI and NISP |
| Body size (Kg)               | 95.58                                                                                                                                                                                                                             |
| Age spectrum (% of juvenile) | 15.9%-3.7% (mean 9.8)                                                                                                                                                                                                             |
| Bone articulation            | most isolated + dispersed                                                                                                                                                                                                         |
| Skeletal parts               | most unsorted                                                                                                                                                                                                                     |
| <b>Bone modification</b>     |                                                                                                                                                                                                                                   |
| Breakage                     | 49.59%                                                                                                                                                                                                                            |
| Weathering                   | most in Stages 0-3                                                                                                                                                                                                                |
| Abrasion/polish              | 10.16%                                                                                                                                                                                                                            |
| Surface marks                | rare                                                                                                                                                                                                                              |

Tab. 2 - Overall synthesis of the data of tab. 1. SW= Shannon-Wiener index; W= Whittaker index; M= Margalef index; SI= Simpson index.

Almost half of the identifiable specimens are broken. Spiral fracturing is uncommon in long bones (0.01%). Most of the specimens are in the weathering Stage 0-3, but a considerable number are also in Stage 4. Longitudinal fissuring and mosaic fracturing, the latter affecting especially short bones and the epiphyses of long bones, as well as wide open dissection cracks and patches of fibrous textures, are commonly observed. Therefore, most bones apparently underwent prolonged exposure. A small number of specimens show evidence of transportation, consisting of abraded and polished surfaces and rounded edges. Surface marks are rare. Sure evidence of carnivore activity is shown by a cervical vertebra and left tibia of *Bos primigenius* and a left radius of *Cervus elaphus*. Several scratches on a neural spine of a vertebra of *Cervus elaphus* may be possibly interpreted as scrape marks due to human butchering activity, such as carcass filleting, or to trampling.

## COMPARATIVE ANALYSIS

The comparison of the curve representing the characters of the Bucine fossil association with the hypothetical examples illustrated by Behrensmeyer (1991) suggests it is similar, in several respects, to the one attributed to attritional, large tetrapod assemblages. The two curves differ in the number of individuals and species, which are lower in Behrensmeyer's example, and in the species diversity and body size, which, on the contrary, are higher than in

*Bos vel Bison*

Text-fig. 10 - Expected vs. actually found abundances in *Bos vel Bison*. The curve of expected abundances depicts the pattern of relative abundances of bones in one skeleton. The cranium includes all the main parts it is composed of (occiput, parietal bones, frontal bone, etc.). Upon horizontal scale the numbers of specimens are reported.

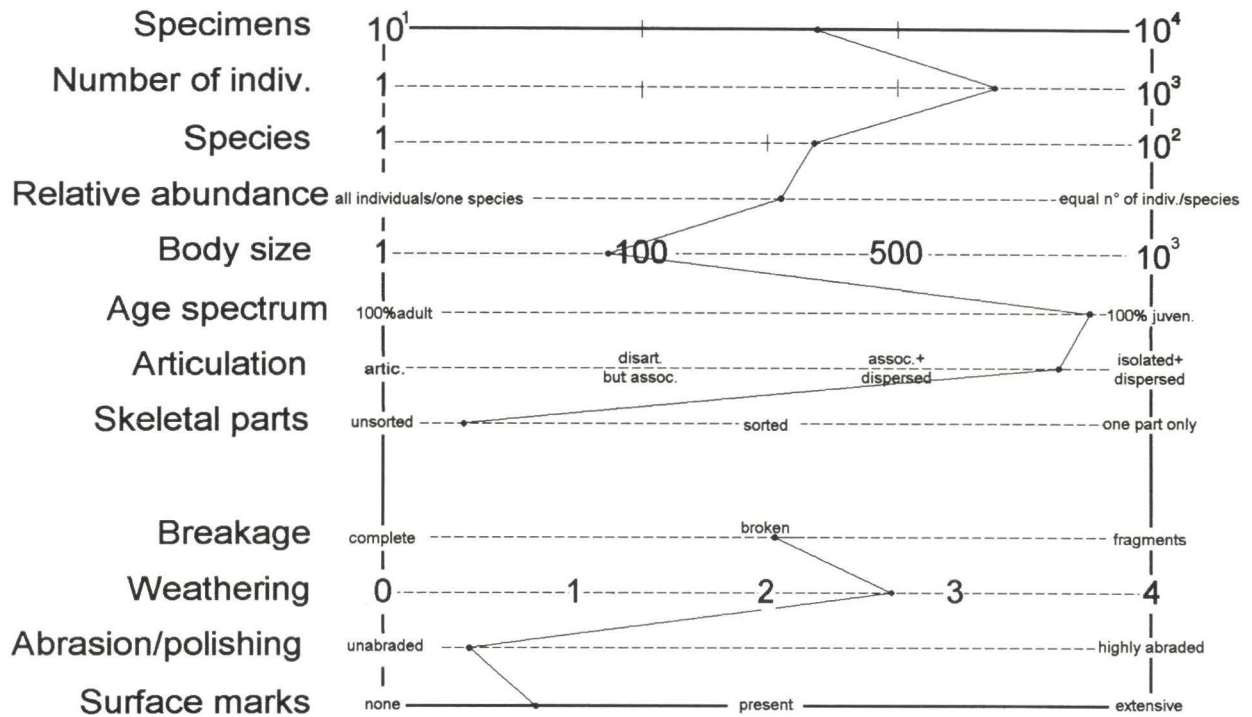
the Bucine assemblage. Breakage is also slightly lower in the Bucine fauna, while the other bone modification parameters are approximately the same. In the relative number of individuals and species, the curve of the Bucine assemblage shows a slight resemblance with the curve relative to a collection of prey by a single predator, although, as mentioned above, this contrasts with the very poor evidence of carnivore activity shown by the bones.

## CONCLUSIONS

The accumulated information from the taphonomic analysis of the Bucine fossil assemblage and the sedimentologic features of the deposits which provided the fossil material suggest that the Bucine assemblage is confidently a time-averaged land surface accumulation of mammal remains, mostly originated by attritional processes, removed by local fluvial bank erosion and re-deposited after limited transportation. The taphonomic analysis therefore suggests that the fossil bones from Bucine derive from carcasses progressively accumulated in the course of a given lapse of time; the assemblage thus seems to be formed by natural causes. A major question is to define the time-span embraced by the Bucine fauna. Possible solutions to this question may be found establishing whether the dominance of bovids at Bucine is a true representation or rather a consequence of a relatively higher rate of accumulation of carcasses through time with respect to the other faunal components. Behrensmeyer *et al.* (1979;

Behrensmeyer & Dechant Boaz, 1980) have observed that at Amboseli (East Africa) species representation is body-size dependent, the carcasses of small-sized extant mammals (between 1 and 100 kgs) found on the surface being underrepresented relative to larger mammals (over 100 kgs). This is due to the fact that smaller bones are subject to complete destruction by carnivore activity, surface weathering and trampling. Carcasses of large-size ungulates at Amboseli are recorded in greater than expected frequencies, basing on the known turnover rates of the species represented. Crucial in these analyses is knowing the population densities and species turnover rates, two characters unfortunately precluded to us in the case of the bovids from Bucine. The dominance of these ungulates at Bucine may therefore be the misleading consequence of the fact that the carcasses of these animals resisted longer to predepositional taphonomic processes than did the carcasses of smaller-sized species. In this case the fossil assemblage might have even formed in a fairly long lapse of time. On the other hand, one cannot rule out the possibility that the dominance of bovids is a true representation, since it is generally assumed that opportunistic species, such as oxen and bison, tend to prevail in unstable environments, where the food supply is not constant and discontinuous. The Bucine fauna may have actually lived under severe climatic conditions, in consideration of the fact that the fossils come from late Middle Pleistocene levels, possibly referable to the Saalian cycle. Bovid may have reacted to a possibly enhanced turnover rate increasing their popula-

### Bucine fossil assemblage graphic representation of data



Text-fig. 11 - Graphical representation of the results of the taphonomic analysis. Relative abundance is based on Whittaker's (1975) index. Sample size includes number of pieces identifiable to one of the recognized species. The number of individuals is the average between MNI and NISP values.

tion density. Present-day bison and wild large-sized representatives of the genus *Bos*, such as the yak, gaur and banteng, do form large herds. In these condi-

tions, even a normal-rate attritional accumulation of carcasses would have produced, in a reasonably short time span, a high number of bones liable to fossilize.

#### EXPLANATION OF PLATE 1

- Fig. 1 - *Bos primigenius*, proximal half of left metacarpal bone (IGF 1887V) in palmar view, showing longitudinal crackings and removal of parts of outer bone surface in the form of long thin flakes. Weathered compact bone exposed. Advanced weathering Stage 2 of Behrensmeyer (1978). About 1/2 nat. size.
- Fig. 2 - *Bos primigenius*, diaphysis of right tibia (uncatalogued) in dorsal view. Remnants of the outer bone surface are visible in the lowest part of the specimen, which is in most part characterized by a fibrous texture resulting from the exposure of the homogeneously weathered compact bone. Behrensmeyer's (1978) Stage 3. About 1/2 nat. size.
- Fig. 3 - *Cervus elaphus*, diaphysis of right metatarsal bone (IGF 1754V) in lateral view, showing longitudinal crackings and patchy removal of outer bone surface where weathered compact bone is exposed. Advanced weathering Stage 2 of Behrensmeyer (1978). About nat. size.
- Fig. 4 - *Bos primigenius*, left astragalus (uncatalogued), in dorsal (4a) and plantar (4b) view, deeply abraded and polished by prolonged transportation. Grooves on the plantar face may be either scars due to transportation or evidence of carnivore activity. Outer bone surface removed in several points. About nat. size.
- Fig. 5 - *Bos primigenius*, incisive corpus of juvenile right hemimandible (uncatalogued) in lingual view, showing scars due to carnivore activity. About nat. size.
- Fig. 6 - *Cervus elaphus*, fragmental left radius (uncatalogued) in dorsal view, showing a scar due to carnivore activity. About nat. size.
- Fig. 7 - *Cervus elaphus*, particular of the distal end of the fragmental left radius shown in Fig. 6. The small white triangle indicates the point at which impact or pressure was applied, presumably by a carnivore tooth, such as a premolar of a hyena, to cause the fracture.
- Fig. 8 - *Cervus elaphus*, fragmental neural spine of a vertebra in lateral view showing scratches which may be interpreted as scrape marks due to human butchering activity such as carcasses filleting.



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