

## ***Asoriculus burgioi* sp. nov. (Soricidae, Mammalia) from the Monte Pellegrino faunal complex (Sicily).**

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**Abstract.** A morphometric and taxonomic study of a large shrew (Soricidae, Soricinae) found at the Monte Pellegrino POC site has been carried out. All the Soricinae from the western Mediterranean islands were formerly described as belonging to the genus *Nesiotites*, but morphometrics proved to be a rather poor method for discrimination between this genus and the continental *Asoriculus*, if other factors than size were taken into consideration. Multivariate analyses permit us to regard *Asoriculus* as small *Nesiotites* or vice versa; also the overall geological, paleobiogeographical and chronological body of data on the evolution of the Perityrrhenian region, rules out the hypothesis of close phylogenetic relationships between the Sicilian shrew and the Balearic and Sardinia-Corsican *Nesiotites*. These results allowed us to describe the new taxon as *Asoriculus burgioi*. This Early Pleistocene shrew must have originated by way of a long lasting endemisation process from its continental ancestor of unknown geographic origin. *Asoriculus* was in fact present both in continental Italy and in the Maghreb.

**Key words:** Plio-Pleistocene, Soricidae, Morphometrics, Paleobiogeography, Sicily.

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### **I. INTRODUCTION**

Fossil vertebrates recovered from the continental deposits outcropping at various sites of Monte Pellegrino (Palermo) represent the oldest endemic faunal complex of Sicily. This fauna is characterised by an assemblage of mammals – the mustelid *Mustelercta* (= *Pannonictis*) *arzilla* (DE GREGORIO, 1886), leporid *Hypolagus* sp., ctenodactylid *Pellegrinia panormensis* (DE GREGORIO, 1886), mouse *Apodemus maximus* (THALER 1972), and dormouse *Maltamys* cf. *gollcheri* (DE BRUJIN, 1966) – showing different degrees of endemisation, and is unique among other Sicilian Quaternary faunas. The age of this fauna is still poorly defined; it was formerly to be of generic Plio-Pleistocene age by THALER (1972); but BURGIO & FIORE (1997) restricted its chronological distribution to the Early Pleistocene on the basis of the morphological affinities between *Pannonictis arzilla* and the other *Pannonictis* species, found in the late Villafranchian localities of the Italian Peninsula (cf. ROOK 1995).

Among the elements of this fauna, BURGIO & FIORE (1988) recorded the presence of a fairly well preserved large soricid skull collected in 1986 during excavation carried out in the western

slope of Monte Pellegrino (POC site). This find was an important new element, not only to the Monte Pellegrino assemblage, but also to the whole Sicilian Pleistocene fauna. The occurrence of fossil shrews, other than Crocidurinae, was in fact unknown to Sicily; the oldest form, so far recorded from the Middle Pleistocene Spinagallo faunal complex and from younger deposits, was the endemic *Crocidura esuae* (KOTSAKIS 1986, SARÀ 1995). In the present work the Monte Pellegrino POC specimen is subjected to morphological and taxonomic analyses.

**A c k n o w l e d g m e n t s.** Dr. Barbara RZEBIK-KOWALSKA, permitted the study of material stored at the Polish Academy of Sciences in Krakow. and, as a referee, provided important remarks on our work. Prof. Augusto AZZAROLI kindly read the manuscript and gave constructive criticisms and suggestions. Laura ZANCA and Flaviano FANFANI kindly drew Fig. 2 and 3, respectively.

## II. MATERIALS AND METHODS

The specimen has been determined by the taxonomic keys and the current diagnostic literature on fossil Soricidae (BATE 1945, REPENNING 1967, REUMER 1984); it was also compared with fossil *Nesiotites* and *Asoriculus* (= *Episoriculus*) specimens and with living *Neomys* spp. (Italian, France, German and Polish specimens stored in the theriological collection at the Zoological Museum of Palermo University). Twenty-four metric variables were measured, as proposed by REUMER (1984) and RZEBIK-KOWALSKA (1988a) using a stereo-microscope fitted with micrometric lenses (Fig. 1). These metric variables were measured directly on 6 Operational Taxonomic Units (OTUs): the Monte Pellegrino skull, *Nesiotites hidalgo*, *N. corsicanus*, *N. similis*, *Asoriculus maghrebiensis* and *A. gibberodon*. A further set of 14 variables (P4-M2) of Hungarian *A. gibberodon* were redrawn from REUMER (1984). The origin, age and sample composition of the material examined are presented in Table I. To arrange the OTUs in multivariate space a principal coordinate analysis (PCoA) and a principal component analysis (PCA) were carried out by the SYN-TAX IV program

Table I

List of taxa considered for morphometrics and qualitative analysis. (a) = according to BURGIO & FIORE 1997; (b) = uncertain stratigraphy (cf. REUMER 1980a)

Taxon	Age	Biochronological unit	Locality
<i>Asoriculus burgioi</i>	Early Pleistocene (a)		Monte Pellegrino – Palermo
<i>A. maghrebiensis</i>	Plio-Pleistocene		Irhoud Ocre – Morocco
<i>A. gibberodon</i>	Late Pliocene	Early Villafranchian	Layna – Spain
<i>A. gibberodon</i>	Early Pliocene	Early Ruscianian	Podlesice – Poland
<i>A. gibberodon</i>	Early Pliocene	Early Ruscianian	Osztramos 9 – Hungary
<i>A. gibberodon</i>	Early Pliocene	Early Ruscianian	Osztramos 1 – Hungary
<i>A. gibberodon</i>	Plio-Pleistocene	Late Ruscianian	Osztramos 7 – Hungary
<i>A. gibberodon</i>	Late Pliocene	Late Ruscianian	Csarnáta 2 – Hungary
<i>Nesiotites similis</i>	Mid-Late Pleistocene		Silanus – Sardinia
<i>N. similis</i>	Mid-Late Pleistocene		S. Giovanni – Sardinia
<i>N. corsicanus</i>	Mid-Late Pleistocene		Teppa di Lupino – Corsica
<i>N. hidalgo</i>	Mid-Late Pleistocene ? (b)		Cava de Son Bauzr – Mallorca

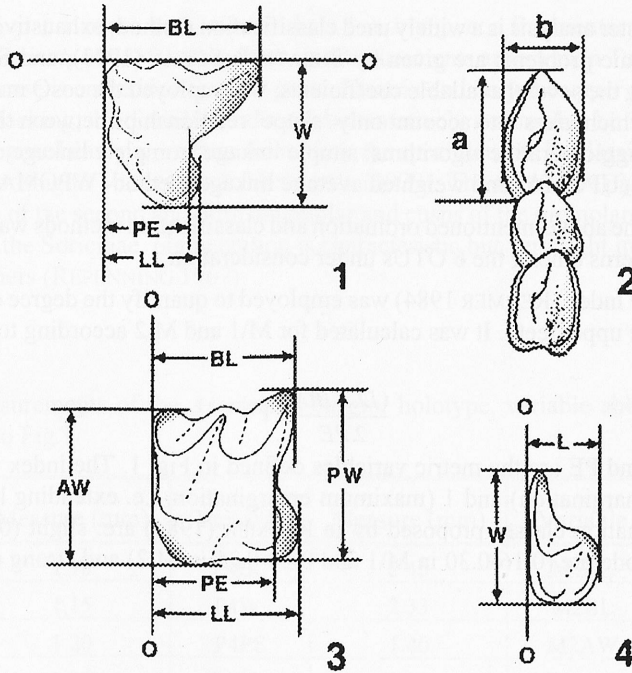


Fig. 1. The metric variables (approximation to 0.05 mm) taken on the specimens in occlusal view. 1 – fourth premolar (P4); 2 – antemolars (A1-A4), the fourth not shown; 3 – molars (M1-M2), the second not shown; 4 – third molar (M3). BL = P4, M1 and M2 buccal length; PE = P4, M1 and M2 length to the posterior emargination; LL = P4, M1 and M2 lingual length; W = P4 and M3 width; L = M3 length; a = A1, A2, A3 and A4 length; b = A1, A2, A3 and A4 width; AW = M1 and M2 anterior width; PW = M1 and M2 posterior width.

(PODANI 1990) and a hierarchical cluster analysis by the SPSSPC+ 4.01 statistical program. Given the scant degree of integrity and the general state of the fossils, it was possible to carry out the analyses only on the average of each metric variable. This allowed also a comparison with the variable means of Hungarian *Asoriculus gibberodon* reported in REUMER (1984).

PCA is a widely used technique for summarising most of the variation resulting from a multivariate data set in fewer dimensions. The first principal component (PC1) is the direction axis which accounts for the maximum variance; subsequent components are the directions of the total residual variance subject to being orthogonal (i.e. not correlated) to all preceding axes. According to JOLICOEUR & MOSIMANN (1960), the PC1 often corresponds to the general factor expressing 'size'. This general factor is thus given by a linear combination of all the variables being considered, rather than by a single directly measurable variable, such as total length or weight. There are many ways to define this general factor (see BOOKSTEIN 1989). Here, we apply the most common definition which describes it as the first eigenvector obtained from a PCA of the variance-covariance matrix of log-transformed metric variables.

PCoA is a method for providing a geometrical representation of the distance or association between OTUs. The Gower coefficient was chosen from among several distance coefficients available, because it is capable of running with some data missing. This permitted of introducing OTUs lacking the third upper molar (M3).

Hierarchical cluster analysis is a widely used classification method; exhaustive reports on its application to taxonomic problems are given by SNEATH & SOKAL (1973), and SOKAL & SNEATH (1963). From among the several available coefficients, we employed the cosQ metric, a measure of overall similarity, which takes into account only 'shape' relationships between the OTUs, coupled with four different agglomerative algorithms: simple linkage, complete linkage, unweighted average linkage method (UPGMA) and weighted average linkage method (WPGMA).

The purpose of the above-mentioned ordination and classification methods was to give evidence of groupings or patterns among the 6 OTUs under consideration.

The PE bivariate index (REUMER 1984) was employed to quantify the degree of posterior emargination of the large upper teeth. It was calculated for M\1 and M\2 according to the formula:

$$\frac{(LL + BL)}{2PE} - 1$$

where LL, BL and PE are the metric variables defined in Fig. 1. The index values can lie between 0 (lack of emargination) and 1 (maximum emargination, i.e. extending halfway along the tooth). The emargination classes proposed by in REUMER (1984) are: slight (0-0.15 in M\1 and 0-0.13 in M\2) – moderate (0.16-0.30 in M\1 and 0.14-0.25 in M\2) and strong (0.30 in M\1 and 0.25 in M\2).

### III. RESULTS

#### Systematic part

Order: Insectivora

Family: Soricidae FISCHER VON WALDHEIM, 1817

Subfamily: Soricinae FISCHER VON WALDHEIM, 1817

Tribe: Neomyini, MATSCHIE, 1909

Genus: *Asoriculus*

Species: *Asoriculus burgioi* sp. nov.

**H o l o t y p e:** partial skull, stored at the Vertebrate Collection of the G. Gemmellaro Geo-Paleontological Museum, Palermo University. Only the holotype is known.

**T y p e l o c a l i t y:** continental deposit of site POC (Western slope) of Monte Pellegrino (Palermo, Sicily).

**A g e:** Early Pleistocene.

**D e r i v a t i o n o m i n i s:** the species is named in honour of the author's friend and colleague Dr. Vincenzo BURGIO, Curator of the G. Gemmellaro Geo-Paleontological Museum, Palermo University in recognition of his significant contributions to the vertebrate palaeontology in Sicily.

**D i a g n o s i s:** a very large sized *Asoriculus*, comparable in size to the largest Mediterranean *Nesiotites hidalgo*: total braincase length is greater than 23.30 mm, upper tooth-row length exceeding 11.34 mm. Wide first and second antemolars, provided with a lingual flange pronounced in occlusal direction. Greatly reduced P\4, M\1 and M\2 with moderate posterior emargination; large, sub triangular M\3, with pronounced protocone and hypocone.



**Description of the holotype:** a fragmentary skull of a large soricid, lacking the incisors and left antemolars; its measurements are given in Table II. The lower portion of the braincase is embedded in a red-ground matrix and only the upper part is exposed. Since the mandible is lacking, the dental formula can be tentatively assumed to be 1-5-3/1-?-3. The antemolar cusps are more heavily worn than the molars, the specimen can be classified as an adult of age class III-IV according to VESMANIS & VESMANIS (1979). The teeth lack pigmentation except for light orange tips of the second and third antemolar and cusps of the premolars. In the Neomyini, as in general in all the Soricinae, pigmentation is characteristic but very light in some genera and absent in a few others (REPENNING 1967).

Table II

Measurements of the *Asoriculus burgioi* holotype, variable abbreviations according to Fig.1

Variable	Measure (mm)	Variable	Measure (mm)	Variable	Measure (mm)
A1a	1.18	P4BL	2.45	M1LL	2.26
A1b	1.15	P4W	2.33	M2BL	1.98
A2a	1.20	P4PE	1.40	M2AW	2.48
A2b	1.00	P4LL	1.71	M2PW	2.00
A3a	1.02	M1BL	2.26	M2PE	1.70
A3b	0.96	M1AW	2.34	M2LL	1.90
A4a	0.36	M1PW	2.60	M3L	1.13
A4b	0.48	M1PE	1.91	M3W	1.75

The first and second antemolars are large and wide, provided with a lingual flange pronounced in occlusal direction; the antemolar row, in labial view, is packed and high, with the tip of A2 reaching about the half height of A3; A4 is very much reduced. P4 is more emarginated posteriorly than are the first two molars; it has a poorly developed hypoconal flange, the parastyle is less protruding in the occlusal direction than the protocone. M3 is large, subtriangular, with a pronounced protocone and hypocone (Fig. 2). M1 and M2 have a moderate posterior emargination. The skull has a deep, rounded and dorsally narrow snout, a long interorbital area and a moderately large preorbital foramen; in dorsal view the skull expands abruptly immediately behind the interorbital area.

**Closely related taxa and qualitative comparisons.** The Monte Pellegrino POC fossil has already been correctly included in the Soricidae by BURGIO & FIORE (1988). The available characters such as light pigmentation, the dental formula and the molar structure permitted its inclusion in the Neomyini tribe (MATSCHIE, 1909),

The classification and phylogenetic relationships between the taxa included in the Neomyini are rather problematic (cf. BATE 1945, REPENNING 1967) and call for reconsideration, as suggested by HUTTERER (1994) and RZEBIK-KOWALSKA (1994). The tribe includes several living and fossil species from Eurasia. However, given the geographic location and the age of the Monte Pellegrino fossil, we focused attention on three genera only, *Nesiotites*, *Asoriculus* and *Neomys*, which could have been potential ancestors to the Sicilian shrew or at least had close phylogenetical relationships with it.

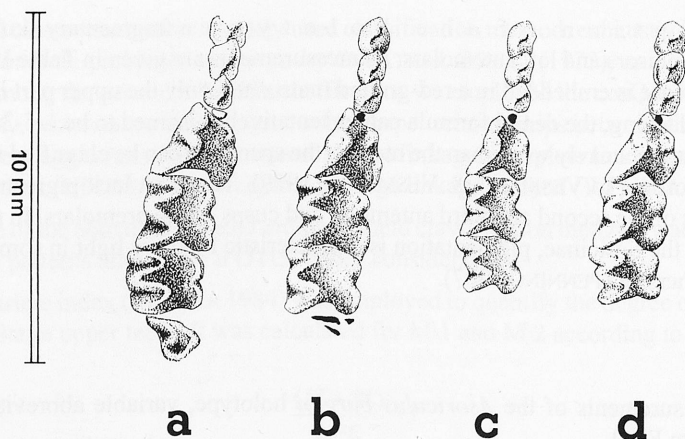


Fig. 2. Right upper tooththrow of: a, the Monte Pellegrino specimen; b, *Nesiotites similis*; c, *N. corsicanus*; d, *N. hidalgo*.

So far, *Nesiotites* is the only taxon of the Soricinae known from the Plio-Pleistocene of the western Mediterranean islands, where it survived up to the Holocene. It was present in Sardinia: *N. similis* (HENSEL 1855), Corsica: *N. corsicanus* (BATE 1945) and the Balearics (Mallorca and Menorca): *N. ponsi*, *N. ex. interc. ponsi-hidalgo* (REUMER 1979), and *N. hidalgo* (BATE 1945, REUMER 1980a, 1980b, 1981, 1982). REUMER (1984) considered *Nesiotites* as a form derived from *Asoriculus*, while RZEBIK-KOWALSKA (1988, 1994) suggested a morphological relationship to *Neomys*.

As pointed out by HUTTERER (1994), the European fossil species previously referred to *Episoriculus* are actually not congeneric with this extant south-eastern Asiatic taxon and be referred to *Asoriculus* KRETZOI 1959. *Asoriculus* was present in Europe at least from the Late Miocene, with *A. cf. gibberodon* (Brisighella – Italy, Late Messinian, MN13; DE GIULI et al. 1988) and *Asoriculus* sp. (Salobreña – Spain, Messinian, MN13, pre-evaporitic phase; CROCHET 1975). This shrew was relatively common in the Pliocene and Early Pleistocene from Europe to Turkey (cf. REUMER 1984, RZEBIK-KOWALSKA 1994). Findings from France, Romania and Croatia document its occurrence until the early Middle Pleistocene (cf. CLOT et al. 1976, RZEBIK-KOWALSKA 1994).

These specimens were usually grouped within a single species, *A. gibberodon*, except for *Asoriculus thenii*, a larger form from the ex-Yugoslavian Republic; according to GERAADS (1995) also *A. kubinyii* should be considered a separate species. A specimen referred to *A. aff. gibberodon* was reported from the Late Pliocene of Sardinia (Nuraghe su Casteddu, ESU & KOTSAKIS 1979). The species *A. maghrebiensis* has been eventually described from the Plio-Pleistocene of North-Africa (Irhoud Ocre, RZEBIK-KOWALSKA 1988b, Ahl Al Oughlam, GERAADS 1995).

*Neomys*, the water shrew, which seems closely related to *Asoriculus*, appears in the fossil documentation of the Late Pliocene of Russia. It is, however, rather an uncommon fossil until the Middle Pleistocene (REPENNING 1967, GEORGE 1986, RZEBIK-KOWALSKA 1994). We feel that, even though the derivation of *Nesiotites* from *Neomys* might be inferred on the morphological basis, the younger stratigraphic distribution of *Neomys* in western Europe in relation to the *Nesiotites* forerunners renders it rather problematic.

Apart from its very large size, the most distinctive features of the Sicilian shrew, when compared with those of related taxa, are its short deep snout, the shape and disposition of the first three antemolars, reduced P4, and large, subtriangular M3. Except for the P4 reduction, which may be

considered to be an autoapomorphy of the Sicilian species, all the other features of the dentition are commonly found in *Asoriculus* and distinguish this last taxon from both *Nesiotites* and *Neomys* (Fig. 3). RZEBIK-KOWALSKA (1994) has pointed out that the features of the antemolars are the most discriminant characters in the upper dentition between *Asoriculus* and the other two genera.

M3, a tooth which is indeed unfrequently found and described in fossil and extant specimens, is much more reduced in *Nesiotites* and in *Neomys* than in both the Monte Pellegrino shrew and the *Asoriculus* species, at least in the few cases in which it is figured (Fig. 3).

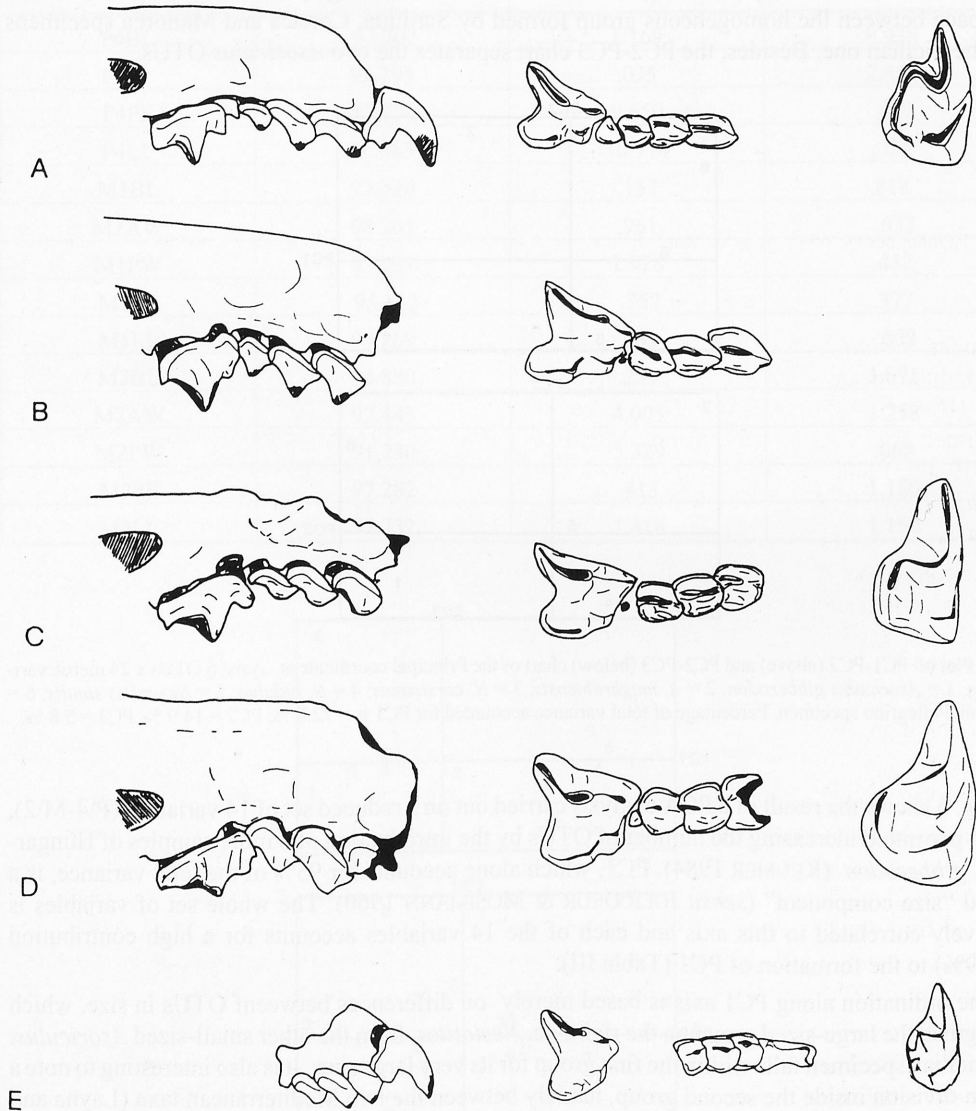


Fig. 3. Right upper P4 to I1, labial and occlusal views and M3, occlusal view of: A, *Neomys fodiens*; B, *Nesiotites similis*; C, *N. hidalgo*; D, the Monte Pellegrino specimen; E, *Asoriculus gibberodon* (redrawn from REUMER, 1984).

## Morphometrics

PCoA (Fig. 4) made it possible to show the ordination chart of the 6 OTUs on the first three axes (PC1-PC3). The variance explained by the PC1-PC2 axes comes to 69% of the total and separates the two *Asoriculus* specimens from the three *Nesiotites* ones plus the Sicilian specimen. Among these latter, the Sicilian specimen appears relatively distant from the others. Considering PC3, the total variance explained reaches 85% and determines a higher distinction in the multivariate space between the homogeneous group formed by Sardinia, Corsica and Mallorca specimens and the Sicilian one. Besides, the PC2-PC3 chart separates the two *Asoriculus* OTUs.

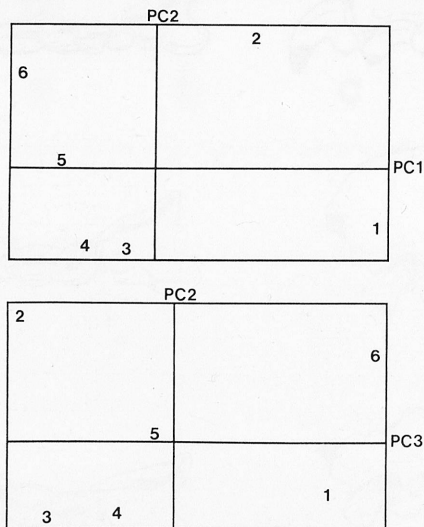


Fig. 4. Plot of PC1-PC2 (above) and PC2-PC3 (below) chart of the Principal coordinate analysis; 6 OTUs x 24 metric variables. 1 = *Asoriculus gibberodon*; 2 = *A. maghrebiensis*; 3 = *N. corsicanus*; 4 = *N. hidalgo*; 5 = *Nesiotites similis*; 6 = Monte Pellegrino specimen. Percentage of total variance accounted for PC1 is = 72.8 %; PC2 = 14.9 %; PC3 = 5.8 %.

Fig. 5 shows the result of a PCA analysis carried out on a reduced set of 14 variables ( $P\sqrt{4-M/2}$ ), which permitted increasing the number of OTUs by the introduction of 6 more samples of Hungarian *A. gibberodon* (REUMER 1984). PC1, which alone accounts for 95% of the total variance, is a typical "size component" (*sensu* JOLICOEUR & MOSIMANN 1960). The whole set of variables is positively correlated to this axis and each of the 14 variables accounts for a high contribution (86-99%) to the formation of PC1 (Table III).

The ordination along PC1 axis is based merely on differences between OTUs in size, which distinguish the large-sized group on the right, i.e. *Nesiotites*, from the other small-sized *Asoriculus*. The Sicilian specimen falls within the first group for its very large size. It is also interesting to note a certain division inside the second group, namely between the two Mediterranean taxa (Layna and Irhoud Ocre) and the other European forms. The Spanish and Moroccan *Asoriculus* taxa prove to be relatively larger than their Hungarian or Poland counterparts.

The PC2-PC3 chart (Fig. 5, below), which displays an OTUs ordination based on a residual total variance (3.5%) not related directly to size, shows a vague distinction between *Asoriculus* and *Nesiotites* and a proximity of the Sicilian specimen to *A. maghrebiensis*. Along the PC2 axis, the OTUs are ordered by a higher contribution of the second antemolar (i.e.  $A\sqrt{2a}$  and  $A\sqrt{2b}$ ) and hypoconal



Table III

Percentage of variance of variables accounted for by each component (PC1-PC3) in a PCA of 12 OTUs and 14 metric variables (see Fig. 5). All the component correlations on the PC1 are positive. Variable abbreviations according to Fig.1

Variables	PC1	PC2	PC3
P4BL	97.202	1.169	0.938
P4W	95.793	.035	2.853
P4PE	87.770	9.650	.072
P4LL	86.063	10.714	.322
M1BL	97.320	.137	.818
M1AW	98.265	.961	.033
M1PW	97.221	1.928	.452
M1PE	95.112	.757	.377
M1LL	99.269	.001	.002
M2BL	93.880	.239	1.671
M2AW	92.443	4.003	1.258
M2PW	91.230	5.329	.068
M2PE	97.282	.413	1.180
M2LL	95.732	1.416	1.150

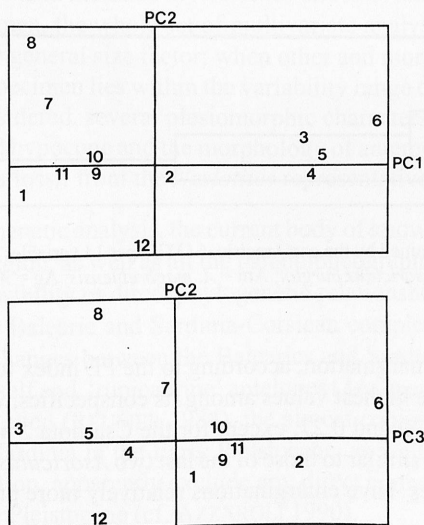


Fig. 5. Plot of PC1-PC2 (above) and PC2-PC3 (below) chart of the Principal component analysis; 12 OTUs x 14 metric variables. 1 = *A. gibberodon* (Podlesice, Hungary); 2 = *A. maghrebiensis* (Irhoud Ocre, Morocco); 3 = *N. corsicanus* (Teppa di Lupino, Corsica); 4 = *N. hidalgo* (Son Bauzà, Mallorca); 5 = *N. similis* (Silanus, San Giovanni, Sardinia); 6 = Monte Pellegrino specimen; 7 = *A. gibberodon* (Osztramos 9, Hungary); 8 = *A. gibberodon* (Osztramos, Hungary); 9 = *A. gibberodon* (Osztramos 7/a, Hungary); 10 = *A. gibberodon* (Osztramos 7/b, Hungary); 11 = *A. gibberodon* (Csarnáta 2, Hungary); 12 = *A. gibberodon* (Layna, Spain). Percentage of total variance accounted for PC1 is = 94.6 %; PC2 = 2.6 %; PC3 = 0.8 %.

flange variables (i.e. P\4PE and P\4PL). According to this interpretation, the OTUs marshal irrespective of their taxonomic position, within the range of *A. gibberodon* variability; from the Osztromos1 form with a larger second antemolar and a reduced hypoconal flange to that from Layna with these characters reversed. A similar line of evidence orders the OTUs along the PC3 axis, between two extremes represented by *N. corsicanus* and *A. maghrebiensis*. The A\1b, P\4PE, and the reduction of the first molar (M\1BL, M\1AW) are the variables which account for the highest contribution to this latter axis.

In conclusion, the PCA result shows a clear separation of the *Nesiotites* from the *Asoriculus* OTUs only by the general size factor, whereas the remaining factors (shape plus size) do not confirm the taxonomic distinction between them.

A similar result is achieved if single teeth are separately taken into account, as in the case of the PCAs run on the premolar or on the variable of the first and second molars (not reported). In all these cases, a reduction in variables (4 for P\4; 5 for M\1 and M\2) provides an increase in the number of specimens (30 for P\4; 34 for M\1 and 22 for M\2), and permits a slightly more robust check of the morphometric variability of the involved OTUs. In all these ordinations, PC1 is always a size-component, i.e. the *Nesiotites* teeth are larger than those of *Asoriculus*; but an overlap of specimens occurs along the PC2-PC3 axes.

A cluster analysis (Fig. 6) showed a stable classification for all the 4 methods chosen. For example, in the reported case (WPGMA with *A. maghrebiensis* and without M\3), the North-African OTU lies internal to the *Nesiotites* cluster showing a contradictory separation of these two genera from each other. The Monte Pellegrino OTU is placed in the *Nesiotites* group and shows a great similarity to *N. hidalgo* and *N. similis*, whereas *N. corsicanus* presents a lower similarity level and *A. gibberodon* is the furthest of the OTUs.

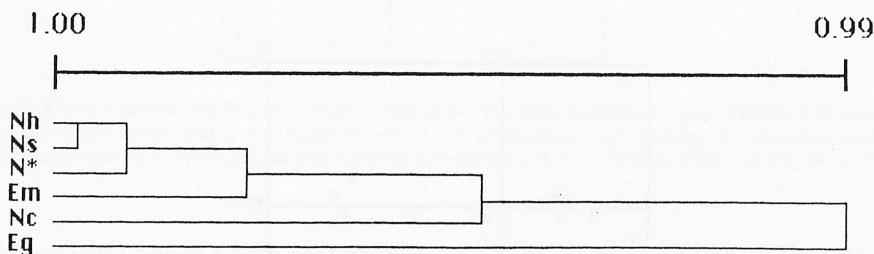


Fig. 6. The WPGMA dendrogram obtained by the cosQ metric; 6 OTUs per 14 variables. Nh. = *Nesiotites hidalgo*; Ns = *N. similis*; Nc = *N. corsicanus* N\* = *Asoriculus burgioi*; Am = *A. maghrebiensis*; Ag = *A. gibberodon*;

As regards the degree of emargination, according to the PE index for M\1 M\2 (Fig. 7), *A. gibberodon* from Layna shows the highest values among its conspecifics, which have moderate emarginations and vary between 0.20 and 0.27, except for the Csarnota 2 and Osztromos 7/a samples. The Sicilian sample has values similar to those of the last two *Asoriculus*, whereas *Nesiotites* of Sardinia, Corsica and the Balearics have emarginations relatively more pronounced.

#### IV. DISCUSSION AND CONCLUSIONS

The use of different multivariate approaches (PCoA, PCA and cluster analysis) and of the univariate PE index can in a certain way by-pass the problem of the small sample size of each OTU. All

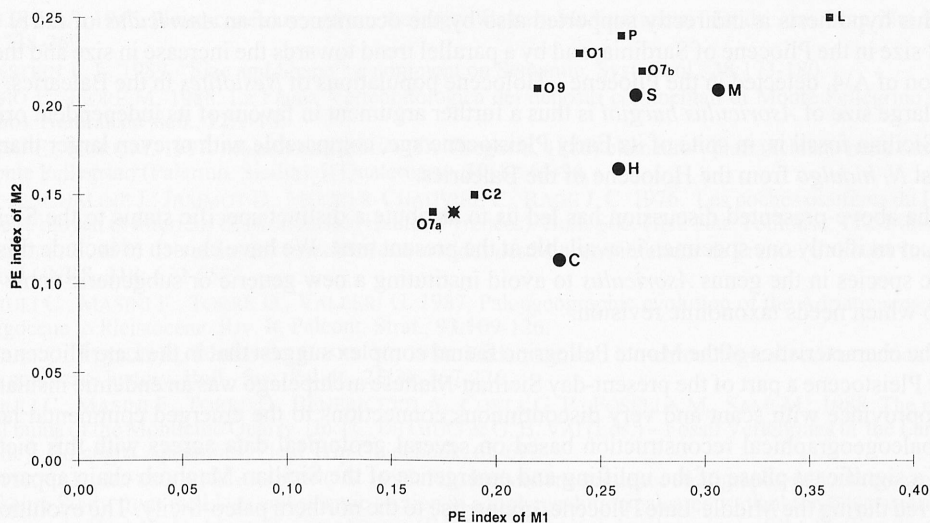


Fig. 7. The PE index plot of different *Asoriculus* and *Nesiotites* samples. P = *A. gibberodon* (Podlesice, Hungary); M = *A. maghrebiensis* (Irhoud Ocre, Morocco); C = *N. corsicanus* (Teppa di Lupino, Corsica); H = *N. hidalgo* (Son Bauzà, Mallorca); S = *N. similis* (Silanus, San Giovanni, Sardinia); \* = Pellegrino Monte specimen; O9 = *A. gibberodon* (Osztramos 9, Hungary); O1 = *A. gibberodon* (Osztramos 1, Hungary); O7a = *A. gibberodon* (Osztramos 7/a, Hungary); O7b = *A. gibberodon* (Osztramos 7/b, Hungary); C2 = *A. gibberodon* (Csarnáta 2, Hungary); L = *A. gibberodon* (Layna, Spain).

the results of morphometrics are not concordant with the taxonomic classification of these forms, which appear to be separated only by size. For this reason we agree with those who call for a taxonomic reconsideration of the taxa included in *Nesiotites* and *Asoriculus*. As regards the position of the Monte Pellegrino specimen, the whole set of multivariate analyses show its inclusion in *Nesiotites* only on the basis of the general size factor; when other and more informative taxonomic characters are considered, this specimen lies within the variability range of *Asoriculus*. Moreover, when qualitative features are considered, several plesiomorphic characters (large third upper molar with an unreduced protocone and hypocone and the morphology of antemolars) are shared with *Asoriculus* and separate the Sicilian fossil from the *Nesiotites* representatives.

In agreement with the phenetic analysis, the current body of knowledge on the geological evolution of the Perityrrhenian region, as well as all the paleobiogeographical, evolutionary and chronological data rule out the possibility of direct phylogenetic relationships between the Sicilian shrew and *Nesiotites* living in the Balearic and Sardinia-Corsican complexes. Even if the possibility of Plio-Pleistocene faunal exchanges between the Balearics and Sardinia-Corsica, based also on the concurrence of *Nesiotites* itself and 'rupicaprine' antelopes (*Myotragus* in the Balearics, *Nesogoral* in Sardinia), has been suggested (REUMER 1984), the almost completely different composition of fauna between Sicily and Sardinia in the Early Pleistocene, as well as the lack of geological evidence of land bridge formation, apparently exclude any direct connection between the two islands during the Pliocene and the Pleistocene (cf. AZZAROLI 1990).

These statements, and the results of morphometrics and qualitative analysis, would support the hypothesis that the Monte Pellegrino shrew was the product of the endemisation of an *Asoriculus* population, distinct from those which probably originated *Nesiotites* in the Balearics and in the Sardinia-Corsica islands. In view of the foregoing the large size and other characters they have in common (i.e. reduced A/4) are the result of parallel evolutions.

This hypothesis is indirectly supported also by the occurrence of an *Asoriculus* of fairly 'normal' size in the Pliocene of Sardinia, and by a parallel trend towards the increase in size and the reduction of A\4, detected in the Pliocene – Holocene populations of *Nesiotites* in the Balearics. The very large size of *Asoriculus burgioi* is thus a further argument in favour of its independent origin. The Sicilian fossil is, in spite of its Early Pleistocene age, comparable with or even larger than the largest *N. hidalgo* from the Holocene of the Balearics.

The above-presented discussion has led us to attribute a distinct specific status to the Sicilian form, even if only one specimen is available at the present time. We have chosen to include this endemic species in the genus *Asoriculus* to avoid instituting a new generic or subgeneric name in a group which needs taxonomic revision.

The characteristics of the Monte Pellegrino faunal complex suggest that in the Late Pliocene and Early Pleistocene a part of the present-day Sicilian-Maltese archipelago was an endemic insular paleobioprovince with scant and very discontinuous connections to the emerged continental lands. The paleogeographical reconstruction based on several geological data agrees with this picture, since a significant phase of the uplifting and emergence of the Sicilian-Maghreb chain apparently occurred during the Middle-Late Pliocene, giving rise to the northern paleo-Sicily. The evolution of the hypothetical lineage which produced *Asoriculus burgioi* could be thus the result of an endemisation process lasting for a relatively long time span. This hypothesis should, however, be taken with caution, since changes in morphology and size in insular environments do not follow linear patterns in time, and are determined by several ecological factors (e.g. the presence and the number of predators and competitors, the availability of food resources) and by the area of the island (see also DE GIULI et al. 1987 and 1988, MEZZABOTTA et al. 1995). These factors are far from being stable through geological time and their variations are difficult to determine.

The age and the provenance of the dispersal that gave rise to *A. burgioi* still remain poorly defined. *Asoriculus* was in fact rather a widespread shrew in the Italian peninsula through the Late Miocene to the late Early Pleistocene and was also present in the Maghreb region during the Late Pliocene-Early Pleistocene period. The concurrence of elements characteristic of both the Middle Pliocene-Early Pleistocene European (i.e. *Hypolagus* and *Pannonictis*) and African paleobioprovinces (i.e. *Pellegrinia*) in the Monte Pellegrino faunal complex suggests indeed a possible double route of dispersal.

The hypothesis of an earlier dispersal from north Africa followed by a later arrival from the European continent (*Hypolagus*, *Pannonictis*) becomes plausible, if we assume that, from among the previously quoted mammals, only *Pellegrinia* and *Asoriculus* are characterised by a relatively higher degree of endemic modifications. The very large *Apodemus maximus* could have had the same African origin. Data on the paleogeographic evolution of the Sicilian-Tunisian platform (DI STEFANO et al. 1993) suggest that suitable conditions for dispersal may have occurred in the Late Pliocene and Early Pleistocene (Emilian sub stage).

An alternative, but in our opinion, more remote hypothesis can consider *A. burgioi* as a survivor of the Messinian mammalian fauna, documented in Sicily by the fully non-endemic assemblage of Gravitelli (Messina). Unfortunately fossils from this site, collected at the beginning of the century, do not include small vertebrates. In such a case *Asoriculus burgioi* should have survived in the insular domain until the Early Pleistocene time.

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