

# Considerations about genus *Talpa* (Mammalia, Soricomorpha, Talpidae) in central Italy studying specimens of Gaggi-Paci mammal collection (Città di Castello, PG)

**Armando Nappi**

Museo Civico di Storia Naturale, Via Cortivacci, 2. I-23017 Morbegno (SO). E-mail: armando.nappi@alice.it

**Patrick Brunet-Lecomte**

5, Rue de Palanka. 38000 Grenoble, France. E-mail: patrick.brunet-lecomte@wanadoo.fr

**Luca Convito**

Servizio Foreste, Montagna, Sistemi naturalistici e Faunistica-venatoria, Regione Umbria, Via Mario Angeloni, 61. I-06124 Perugia. E-mail: lconvito@regione.umbria.it

**Angela Gaggi**

**Andrea Maria Paci**

Via dell'Antico Forno, 2. I-06012 Città di Castello (PG). E-mail: angigaggi@libero.it

**Silvana Palanga**

**Carmine Romano**

Via G. Matteotti, 20. I-06028 Sigillo (PG). E-mail: croman97@libero.it

## ABSTRACT

New data about biogeography, ecology, morphology and biometry of *Talpa caeca*, *T. europaea* and *T. romana* in central Italy are reported based on the analysis of 64 specimens of the three Italian species preserved in mammal collection "Angela Gaggi-Andrea Maria Paci". This collection began in 1985 in northern Umbria accumulating during the years a corpus of +3.100 specimens belonging to 53 European mammal species (mostly small mammals), contributing to provide in the proposed study case further information on the genus *Talpa*.

*Key words:*

*Talpa spp., museology, biogeography, ecology, morphological and biometrical data.*

## RIASSUNTO

Considerazioni sul genere *Talpa* (Mammalia, Soricomorpha, Talpidae) nell'Italia centrale attraverso lo studio di esemplari della collezione di mammiferi Gaggi-Paci (Città di Castello, PG)

Si riportano conferme o nuovi elementi riguardo alla biogeografia, ecologia, morfologia e biometria di *Talpa caeca*, *T. europaea* e *T. romana* in Italia centrale, attraverso i risultati di analisi effettuate su 64 reperti relativi alle tre specie italiane, conservati nella collezione teriologica "Angela Gaggi-Andrea Maria Paci". Questa raccolta, nata in Umbria settentrionale nel 1985, ha accumulato negli anni un corpus di oltre 3100 reperti appartenenti a 53 specie di mammiferi europei (soprattutto piccoli mammiferi) contribuendo a fornire, nel caso di studio proposto, ulteriori informazioni sul genere *Talpa*.

Parole chiave:

*Talpa spp., museologia, biogeografia, ecologia, morfologia, biometria.*

## INTRODUCTION

The genus *Talpa* was described for the first time in 1758 in the "Systema naturae" (Linnaeus, 1758). Linnaeus considers as distinctive characters of the genus the "dentes primores", 6 upper ones and eight inferior ones and for the "laniarum" teeth, a bigger one and

4 smaller ones and then the sharp "molares". The "dentes primores", the incisors, are indeed 6 in the genus *Talpa*, both the upper and the lower ones: the two more ones considered by Linnaeus are apparently attributed to canines, that are two, both on the upper and on the lower dental arches. The "laniarum" are to be identified with canines, therefore the four

smaller ones are premolars. It has not always been simple to find a correspondence between the teeth of Soricomorpha and of humans; in Soricidae for instance the more or less sharp teeth ascribed to incisors, canines and premolars have been then generically defined unicuspid teeth (Chaline et al., 1974). In the "Systema naturae" are described two species of the genus *Talpa*: *T. europaea* and *T. asiatica*. Among the distinctive characters of the first one, subject of this article, are the five-finger feet, the longest penis among all animals and the delicate skin. For the distribution areal it is reported generically "in Europa". After 1758, several species of genus *Talpa* have been described and today 12 are acknowledged as valid (Kryštufek & Motokawa, 2018). In Italy the ultimate national checklist of mammals (Loy et al., 2019) reports 3 species: *T. caeca* distributed in continental Italy, *T. europaea* distributed in central-northern Italy

and *T. romana* distributed in central-southern Italy. Globally *T. caeca* is distributed in continental Italy, bordering Swiss and French areas and the Balcanic peninsula (Cassola, 2016); *T. europaea* covers a great part of central-northern Europe (Amori et al., 2017); *T. romana* is endemic in central-southern Italy (Amori, 2016; Amori & Castiglia, 2018; Loy et al., 2019). In a checklist preceding the one of Loy et al. (2019), Gippoliti (2013) reports 4 species for Italy. Beside the 3 already quoted ones, the Calabrian populations of *T. romana*, traditionally ascribed to the subspecies *T. r. adamoii* Capolongo et Panasci, 1976, are acknowledged as good species, a status not subsequently confirmed (Amori & Castiglia, 2018).

In the century following the publication of "Systema naturae", the naturalist Paolo Savi, considering the description of moles by authors and scientists since Aesops, Aristotele and Pliny the Older, hypothesized

Environment typologies	Percentage frequency		
	<i>T. caeca</i> (n = 5)	<i>T. europaea</i> (n = 34)	<i>T. romana</i> (n = 7)
Mountain prairie	-	-	14,28%
Wood and prairie	-	2,94%	-
Beech-wood and mountain prairie	100%	2,94%	-
Oak-wood	-	2,94%	-
Oak-wood and prairie	-	8,82%	-
Oak-wood and traditional farming	-	20,59%	-
Lake riparian wood and pasture	-	2,94%	-
River riparian wood and intensive farming	-	2,94%	-
Conifer reforestation	-	8,82%	-
Traditional farming	-	20,59%	85,71%
Intensive farming	-	11,76%	-
Suburban area	-	14,70%	-

Tab. 1. Percentage frequency of the Umbrian specimens of the genus *Talpa* in the collection Gaggi-Paci for each one of the 12 listed environment typologies; n. = number of data.

Bioclimatic planes	Percentage frequency		
	<i>T. caeca</i> (n = 5)	<i>T. europaea</i> (n = 34)	<i>T. romana</i> (n = 7)
High mountain	20,00%	-	14,28%
Low mountain, humid variant	80,00%	5,88%	-
High hill	-	29,41%	-
High hill, humid variant	-	32,35%	14,28%
Low hill	-	5,88%	-
Low hill, cold variant	-	20,59%	-
Low hill, humid variant	-	-	14,28%
Submediterranean hill	-	-	42,86%
Submediterranean hill, temperate variant	-	-	14,28%
Submediterranean, humid variant	-	5,88%	-

Tab. 2. Percentage frequency of the Umbrian specimens of the genus *Talpa* of the collection Gaggi-Paci in each one of the listed 10 bioclimatic planes; n. = number of data.



Fig. 1. Types of tails of "europaea" (a, TE48) and "romana" (b, TR05) (photo A. Gaggi).

the existence in Europe of two species of moles, one with very small but visible eyes and the other one with skin-covered eyes (Savi, 1822a, 1822b). Further to the analysis of specimens from the Apennines, on which he personally witnessed the existence of skin-covered eyes, he decided to name this species *Talpa caeca* (sic!) (= *Talpa caeca*) (Savi, 1822a).

At the beginning of 1900, analysing two cranes from Ostia and Frascati (province of Rome) preserved at the Natural History Museum, London, Thomas (1902) described a new species: *Talpa romana*, a mole with "colour and proportions about as in *T. europaea*; orbits apparently covered with skin, but this is not absolutely determinable". In comparison to *T. europaea*, Thomas observed a generally stronger cranial structure with bigger teeth, especially the molars, and "second lower molar with a small supplementary external basal cusp at the bottom of the valley

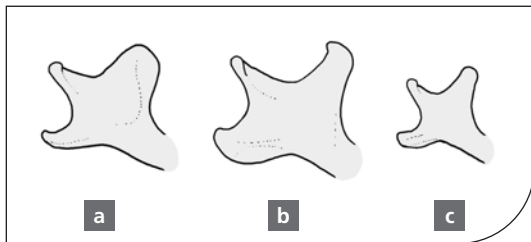


Fig. 2. Coronoid apophysis of *T. europaea* TE07 (a), *T. romana* TR03 (b) and *T. caeca* TC01 (c) (drawing by A. Nappi from photo in Gaggi & Paci, 2014).

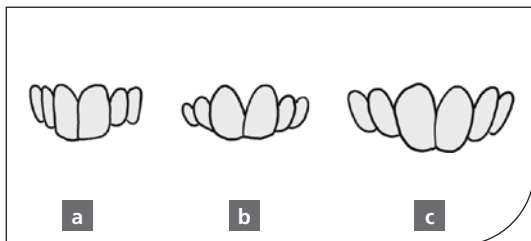


Fig. 3. Upper incisors with the two central longer and larger in a and c; a) *T. caeca* TC01; b) *T. europaea* TE51; c) *T. romana* TR15 (drawing by A. Nappi).

separating the main cusps; last molar with a slight indication of the same cusp, which is not found in *T. europaea* or *caeca*; although very possibly not constant, its presence is noteworthy".

After to their descriptions, the validity of *T. caeca*, *T. europaea* and *T. romana* was confirmed by morphological studies (Capolongo, 1972; Capolongo & Panasci, 1975, 1978; Capanna, 1981; Corti et al., 1985; Capolongo, 1986; Loy & Corti, 1986; Corti & Loy, 1987; Loy et al., 1993, 1996; Rohlf et al., 1996; Loy & Capanna, 1997; Loy et al., 2001, 2005) and by genetic studies (Capanna, 1981; Filippucci et al., 1987; Loy et al., 2001, 2005; Colangelo et al., 2007).

In Italy the presence of three species of the genus *Talpa* is very interesting from a biogeographical and ecological point of view, in order to know their distribution and possibly their sympatric and syntopic relation. Central Italy is the only area for this kind of research, as the three species live in Tuscany, in Umbria and in the Marche.

So, in this work are reported the results of a study on materials from central Italy, actually preserved in the mammals collection Gaggi-Paci (Città di Castello, PG, Umbria). On account of the difficulty of the field research and determination of moles, collections acquire a fundamental role for their geographical, ecological, biometrical, morphological and genetic comprehension.

This collection derives from the union of two small mammals private collections: the collection Andrea Maria Paci was started in 1985 at Montecorona di Umbertide (PG), during a study of Barn Owl's local diet; the collection Angela Gaggi was started in 1994 during researches for a degree thesis in the northern pre-Apennine between Umbria and the Marche (Gaggi, 1996).

The collection has been useful to study the Umbrian small mammals also favouring the exchange of information, materials and experiences with Italian and foreign researchers, with museums and with scientific institutions.

Due to its corpus of +3.100 specimens belonging to 53 European mammal species, mostly small mammals, found in Umbria, in other Italian regions and in other European countries, the collection has been used for several researches including the first data

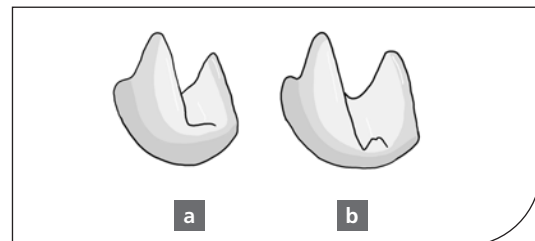


Fig. 4. Second left lower molars of *T. europaea* TE51, without accessory cusp (a) and of *T. romana* TR15, with accessory cusp (b) (drawing by A. Nappi).

on biogeography of genus *Talpa* in Umbria (Paci & Nappi, 2003), the study of teeth morphology of *Microtus savii* group in Italy (Nappi et al., 2006, 2019), the study of taxonomic status of *Microtus (Terricola)* in central Italy (Nappi et al., 2005, 2006, 2012; Nappi, 2014), the Atlas of Umbrian Small Mammals (Gaggi & Paci, 2014), the cranial and dental characters of *Arvicola italicus* (Brunet-Lecomte et al., 2020). Some specimens of this collection were also useful for the iconography of a volume in Fauna d'Italia (Amori et al., 2008).

With regard to Umbrian small mammals, the collection preserves the only known specimens of *Talpa caeca* and *Sorex antinorii* for this region and the four species with a bad status in the regional red list (Gaggi & Paci, 2014): *Neomys fodiens* and *Sciurus vulgaris* (Vulnerable), *Arvicola italicus* (Endangered) and *Microtus minutus* (Critically Endangered, with the only 3 complete samples from the extreme southern distribution of Italian areal) (Agnelli, 2008).

The collection has been catalogued with the model used by the Regional Wildlife Office to census and file Umbrian bat specimens preserved in museum collections (Sergiacomi, 2009). During the years the collection underwent several modifications on account of contacts with researchers, museums and scientific institutes.

## MATERIALS AND METHODS

A number of 64 samples has been considered (8 *T. caeca*, 45 *T. europaea* e 11 *T. romana*), including also missing specimens (specimens that went lost during exchanges with colleagues or during the various translocations of the collection) or specimens donated to the following collections: Museo Civico di Ecologia e Storia Naturale, Marano sul Panaro (MO) (MSP); Museo Universitario di Storia Naturale "La Specola", Firenze (LSF); Università degli Studi di Perugia (UNIPC); collection David Fiacchini (DF); collection Carmine Romano (CR).

The records are updated to March 2020.

For the analysis of regional distribution, only Umbrian specimens have been considered. Some samples from the Marche are considered to show the presence of the three species within the Parco Nazionale dei Monti Sibillini (between Umbria and the Marche), while all *T. caeca* samples are reported to show their typical Apennine distribution.

For the data analysis on habitat, on bioclimatic planes and altitudes only Umbrian samples have been considered in 12 habitat typologies (tab. 1) and in 10 bioclimatic planes (tab. 2), based on the classification of Orsomando et al. (1999).

For the entire material the following morphological and biometrical characters have been examined, without considering sex and age (adult / sub-adult) differences: open or closed eyes, *europaea* or *romana*

tail typology (fig. 1), bifid or non-bifid molars, morphology of coronoid apophysis (Rosi & Brunet-Lecomte, 2004; Gaggi & Paci, 2014) (fig. 2); longer and larger upper central incisors than upper lateral incisors (Corbet & Ovenden, 1985) (fig. 3), the small supplementary external basal cusp at the bottom of the area separating the main cusps in the second lower molar (Thomas, 1902) (fig. 4), caecoid or europoid pelvis typology (Loy, 2008a, 2008b, 2008c, 2008d) (fig. 5).

The reported body length details are: body-head (Tc), tail (Co) and posterior foot (Pp). The skull (Nappi, 2001) and the pelvis (Gaggi & Paci, 2014) measurement are shown in figures 6 and 7.

## RESULTS

The complete list of studied material is shown in the box on page 42. For each sample are indicated the catalogue number, the type of preparation, date of finding, the region, the province (with province code), municipal district, toponym, notes if needed. For some collection code, see "Materials and methods". The collection is overall useful for studies of biometry and morphology. On the contrary less important can be its role in studies of genetics, because of the scarce number of specimens in alcohol.

As for *T. europaea*, not always the species' typical characters have been detected. In particular seven specimens have eyes covered with skin (TE04, LSF21837/2010-1, TE16, TE18, TE44, TE46, MSP632/M), two specimens have an open eye and the other one covered with skin (TE10, TE20), three specimens have a *romana* tail type (TE14, TE33, TE40), two specimens show a *caeca* pelvis (TE05, TE42). The complete analysis of these specimens' characters (see box on page 43) has led us to attribute them to *T. europaea*.

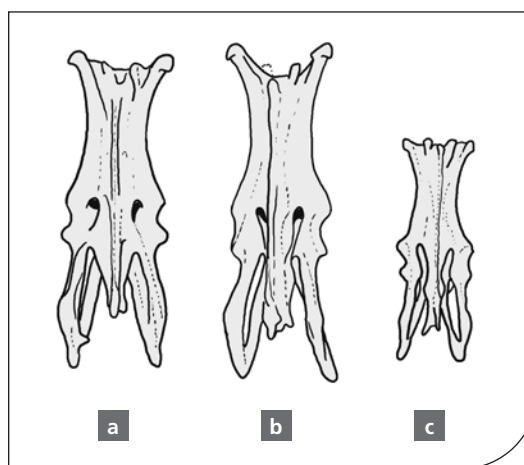


Fig. 5. Europoid (a) and caecoid type (b-c) pelvises, a) *T. europaea* TE07; b) *T. romana* TR02; c) *T. caeca* TC01 (drawing by A. Nappi from photo in Gaggi & Paci, 2014).

## Specimens of the genus *Talpa* of Gaggi-Paci collection

### *Talpa caeca*

TC01, skin+skull+pelvis; 24.IV.2003; Umbria, PG, Sigillo, Monte Cucco.  
TC02, skull+pelvis; 23.V.2007; Umbria, PG, Sigillo, Monte Cucco.  
TC03, pelvis; 23.V.2007; Umbria, PG, Sigillo, Monte Cucco.  
exTC04, sample in alcohol; 1995; Marche, AP, Arquata del Tronto, Passo Galluccio; missing sample.  
TC05, sample in alcohol+pelvis; 04.IV.2013; Umbria, PG, Scheggia-Pascalupo, M.te Motette.  
TC06, sample in alcohol+pelvis; 26.V.2013; Toscana, AR, Chiusi della Verna, Eremito di Verna.  
UNIPG161012, sample in alcohol+skull+pelvis; 12.X.2016; Umbria, PG, Costacciaro, Monte Cucco.  
DF090716, skin+skull+pelvis; 16.VII.2009; Emilia Romagna, RE, Ligonchio-Ventasso, Alta Valle dell'Ozola.

### *Talpa europaea*

TE01, skull; 17.XI.1992; Umbria, PG, Città di Castello, Bonsciano.  
TE02, skin+skull; 30.V.2000; Umbria, PG, Gubbio, Schifanoia.  
TE03, skull; IV.1998; Marche, PU, Apecchio, Casa di Luca.  
TE04, skull; 30.V.1999; Umbria, PG, Gubbio, Castiglione Altobrando.  
TE05, skull+pelvis; 29.VI.2001; Umbria, PG, Città della Pieve.  
TE06, skull+pelvis; 01.VII.2001; Marche, PU, Apecchio, Casa di Luca.  
TE07, skin+skull+pelvis; IV.2002; Umbria, PG, Magione, Sant'Arcangelo.  
TE08, skin+skull+pelvis; 19.IV.2002; Umbria, PG, Pietralunga.  
TE10, skin+skull+pelvis; 12.V.2002; Marche, PU, Apecchio, Casa di Luca.  
TE11, skin+skull; 12.V.1990; Emilia Romagna, MO, Castelnuovo Rangone.  
TE12, skin+skull+pelvis; 05.V.2003; Umbria, PG, Sigillo, Monte Cucco.  
TE13, skin+skull+pelvis; 13.VI.2003; Umbria, PG, Città di Castello, Montemaggiore; a part of this sample is missing.  
TE14, skin+skull; 19.I.2001; Umbria, PG, Magione, Montemelino.  
TE15, skin+skull+pelvis; 15.VI.2003; Umbria, PG, San Giustino, Parnacciano; a part of this sample is missing.  
TE16, skin+skull+pelvis; 27.VIII.2003; Umbria, PG, Pietralunga, Case San Salvatore.  
TE18, skin+skull+pelvis; IV.2002; Umbria, Perugia, Cenerente, Castelgatto.  
TE19, skin+skull+pelvis; 09.V.2001; Umbria, PG, Città di Castello, San Secondo.  
TE20, skull+pelvis; 21.I.2006; Umbria, PG, Gubbio, Castiglione Altobrando.  
exTE22, sample in alcohol; 21.VII.2003; Umbria, PG, Sigillo, Monte Cucco; missing sample.  
exTE23, sample in alcohol; 14.VI.2003; Umbria, PG, Umbertide, Niccone; missing sample.  
exTE24, sample in alcohol; 12.XI.2003; Umbria, PG, Pietralunga, Candeletto; missing sample.  
TE26, skull+pelvis+other bones from pellet of *Strix aluco* pellet; 1994; Umbria, PG, Città di Castello, Scalocchio.  
TE27, skull from pellet of *Strix aluco*; 1995; Umbria, PG, Città di Castello, Scalocchio.  
TE32, skull+pelvis+other bones from pellet of *Tyto alba*; 2010; Umbria, Perugia, Ponte Valleceppi, Ansa degli Ornari.  
TE33, sample in alcohol+skull+pelvis; 20.V.2010; Umbria, PG, Città di Castello, Montesca.  
TE34, skull+pelvis; 01.VI.2010; Marche, AN, Fabriano, Valleremita.  
TE35, skin+skull+pelvis; 03.VI.2010; Umbria, PG, Città di Castello, Scalocchio, Focacciaie; a part of this sample was donated.  
TE40, sample in alcohol+skull+pelvis; 07.V.2011; Umbria, PG, Pietralunga, Pieve de' Sadi.  
TE41, skull+pelvis+other bones from pellet of *Asio otus*; VI.2011; Umbria, PG, Gubbio, Madonna di Colonnata.  
TE42, pelvis; 15.VI.2011; Umbria, PG, Pietralunga, Caifiorda.  
TE44, skull+pelvis; 30.XII.2011; Umbria, PG, San Giustino, Bocca Trabaria, Fontanile.  
exTE45, skin+skull; 25.IX.1992; Umbria, PG, Pietralunga, Candeletto; missing sample.  
TE46, skull+pelvis; XI.2012; Umbria, PG, Montone, Santa Maria di Sette.  
TE48, sample in alcohol; 12.IV.2014; Marche, PU, Apecchio, Chibrardi.  
TE50, skin+skull+pelvis; 29.IV.2014; Umbria, PG, Città di Castello, Sasso.  
TE51, skeleton; VI.2015; Marche, PU, Apecchio, Casa di Luca.  
TE52, skull+pelvis; 19.IV.2019; Marche, MC, Valfornace, Villarella.  
MSP588/M, skin+skull; 11.VI.1994; Umbria, PG, Pietralunga, Candeletto.  
MSP608/M, skin+skull; 03.VI.1995; Umbria, PG, Città di Castello, San Secondo.  
MSP632/M, sample in alcohol+skull+pelvis; VII.1996; Umbria, PG, Pietralunga, Case San Salvatore.  
LSF21837/2010-1, skin+skull+pelvis; 19.IV.2002; Umbria, PG, Pietralunga.  
LSF21838/2010-1, skin+skull+pelvis; 13.IV.2001; Umbria, PG, Città di Castello, Zoccolanti.  
CR030425, skin+skull+pelvis; 25.IV.2003; Marche, AN, Fabriano, Valleremita.  
CR070000, skin+skull+pelvis; 2007; Toscana, SI, Montepulciano, Lago di Montepulciano.  
DF060420, skin+skull+pelvis; 20.IV.2006; Marche, AN, Castelfidardo, San Rocchetto.

### *Talpa romana*

TR01, skin+skull+pelvis; 18.VII.2003; Umbria, TR, Narni, Gualdo; a part of this sample is missing.  
TR02, skull+pelvis; 18.XI.2003; Umbria, Perugia, Poggio Montorio.  
TR03, sample in alcohol+skull+pelvis; 04.IX.2009; Marche, MC, Serravalle di Chienti, Monte Staffolo.  
TR04, pelvis; 25.X.2009; Umbria, TR, Narni, San Pellegrino.  
TR05, sample in alcohol+skull+pelvis; 24.V.2010; Lazio, VT, Ponte di Cetti.  
TR08, skull+pelvis; 29.VII.2010; Umbria, TR, Castelgiorgio.  
TR09, skull+pelvis; 12.VI.2010; Lazio, VT, Acquapendente, San Francesco.  
TR12, sample in alcohol+skull; 16.IV.2011; Umbria, PG, Spoleto, surroundings.  
TR13, skin+skull+pelvis; 16.VII.2010; Umbria, TR, Narni, Treie.  
TR14, sample in alcohol+skull+pelvis; 24.V.2011; Marche, MC, Pieve Bovigliana, Case Fiorentini.  
TR15, skeleton; VIII.2015; Umbria, PG, Norcia, Castelluccio, Capanna Ghezzi.

## Specimens of the genus *Talpa* of Gaggi-Paci collection with unusual characters

All those characters are reported that could be detected on some specimens of *T. europaea* showing elements typical of other species. Measurements are in mm and the codes are reported in captions of tables 5 and 6.

TE04, LSF21837/2010-1, TE16, TE18, TE44, TE46 and MSP632/M with skin-covered eyes; TE10 and TE20 with one open eye and one skin-covered eye; TE14, TE33 and TE40 with *romana* tail type; TE05 and TE42 with *caeca* pelvis type.

**TE04:** Tc 149,0. Co 32,0. Pp 19,5. Lm 36,36. Cb 35,69. Lp 15,73. Ds 12,75. Ac 16,83. Az 13,05. Ap 9,73. Io 8,21. An 4,95. Mb 22,84. Hm 7,72. Skin-covered but visible eyes, *europaea* tail type, large coronoid apophysis, bifid molars.

**LSF21837/2010-1:** Tc 128,0. Co 33,0. Pp 17,3. Lp 14,90. An 4,60. Mb 21,70. Hm 7,20. Lub 19,83. Lab. 9,49. *Europaea* tail type, large coronoid apophysis, europoid pelvis type.

**TE16:** Tc 134,0. Co 30,0. Pp 17,7. Lp 15,20. Ds 12,36. Ap 9,75. An 5,26. Mb 22,22. Hm 7,40. Lub 20,25. Lab 9,09. Skin-covered but visible eyes, *europaea* tail type, large coronoid apophysis, europoid pelvis type.

**TE18:** Tc 147,5. Co 32,0. Pp 19,0. Lm 36,44. Cb 36,07. Lp 15,79. Ds 13,18. Ac 17,10. Ap 9,40. Io 8,37. An 5,15. Hc 10,63. Mb 23,30. Hm 7,75. Skin-covered but visible eyes, *europaea* tail type, large coronoid apophysis, europoid pelvis type.

**TE44:** Tc 134,0. Co 35,0. Pp 18,1. Lp 15,11. Ds 12,36. Ap 10,00. Io 7,56. An 4,91. Mb 21,39. Hm 6,97. Lub 20,84. Lab 8,70. Open eyes, *europaea* tail type, large coronoid apophysis, europoid pelvis type.

**TE46:** Tc 131,0. Co 35,0. Pp 18,1. Lp 16,10. Ds 13,41. Ap 10,23. Io 8,15. An 5,11. Mb 23,32. Hm 7,66. Lab 9,77. Covered eye, *europaea* tail type, large coronoid apophysis, bifid molars, europoid pelvis type.

**MSP632/M:** Lp 14,20. An 4,80. Mb 20,30. Hm 6,80. Lub 19,90. One open and one skin-covered but visible eye, large coronoid apophysis, europoid pelvis type.

**TE10:** Tc 132,0. Co 27,0. Pp 17,5. Lp 13,94. Ds 12,01. Ap 9,48. Io 6,90. An 4,32. Lub 20,36. One open eye and one skin-covered but visible eye.

**TE20:** Tc 136,0. Co 27,0. Pp 17,2. Lp 14,69. Ds 12,34. Ap 9,36. Io 7,26. An 4,84. Mb 22,44. Lub 19,48. Lab 7,70. One open eye and one skin-covered but visible eye, europoid pelvis type.

**TE14:** Tc 139,0. Co 26,0. Pp 16,8. Lp 15,16. Ds 12,61. Ap 9,56. An 4,78. Mb 21,80. Open eyes, *romana* tail type.

**TE33:** Tc 128,0. Co 23,5. Pp 18,3. An 4,76. Hm 7,02. *romana* tail type, large coronoid apophysis, not bifid molars, europoid pelvis type.

**TE40:** Tc 131,0. Co 27,8. Pp 18,1. Hm 7,04. Lub 20,04. Lab 7,64. Open eyes, *romana* tail type, large coronoid apophysis, bifid molars, europoid pelvis type.

**TE05:** Pp 17,8. Cb 36,40. Lp 15,05. Ds 12,73. Ap 9,52. An 4,12. Mb 21,59. Hm 6,85. Large coronoid apophysis, not bifid molars, caecoid pelvis type.

**TE42:** Lab 8,75. Caecoid pelvis type.

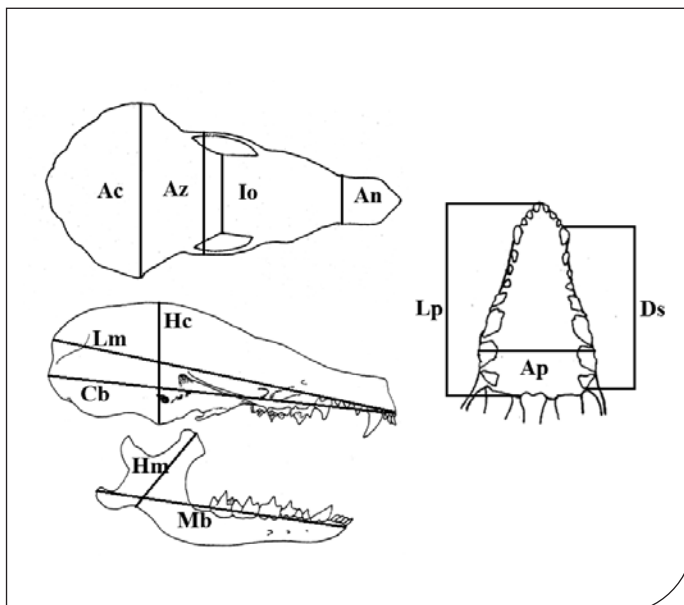


Fig. 6. Method for measuring skull; see table 6 for codes (only skull redrawn by A. Nappi from Paolucci et al., 1987).

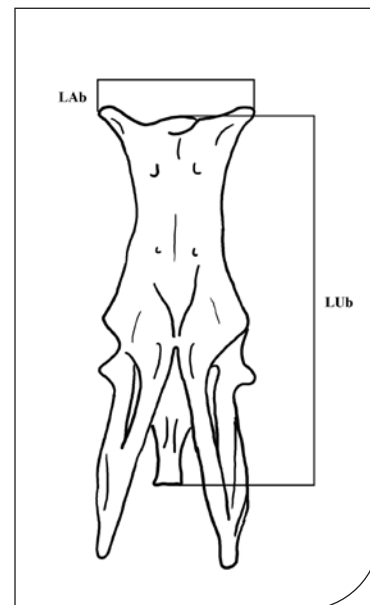


Fig. 7. Method for measuring pelvis; see table 6 for codes (Gaggi & Paci, 2014; drawing by A. Nappi).

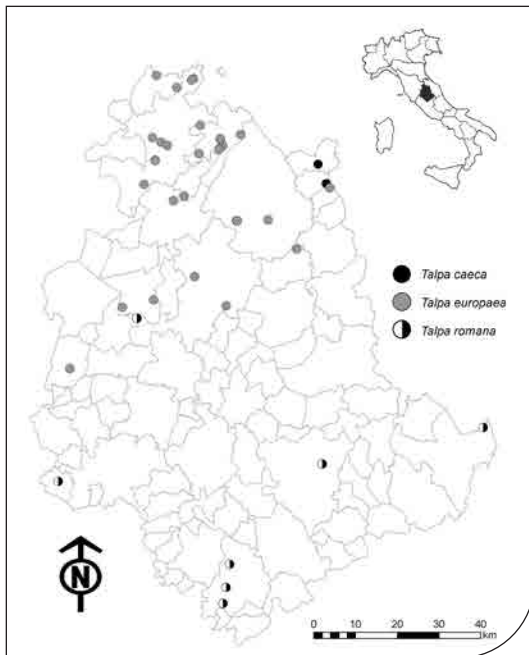


Fig. 8. Localization of the findings of the three species of genus *Talpa* in Umbria (drawing by L. Convito).

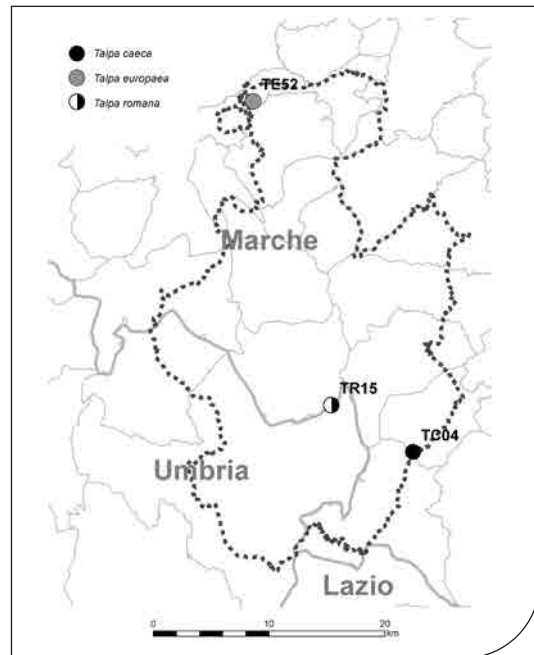


Fig. 9. Localization of three findings of genus *Talpa* within the territory of the Parco Nazionale dei Monti Sibillini, between the Marche and Umbria (drawing by L. Convito).

The Umbrian geographical localization of the listed materials is shown in figure 8. The localization of *T. caeca*, *T. europaea* and *T. romana* within the Parco Nazionale dei Monti Sibillini, between Umbria and the Marche is shown in figure 9. The localization of the *T. caeca* samples in the Apennine mountain area across the regions of Emilia Romagna, Tuscany, Umbria and the Marche is shown in figure 10.

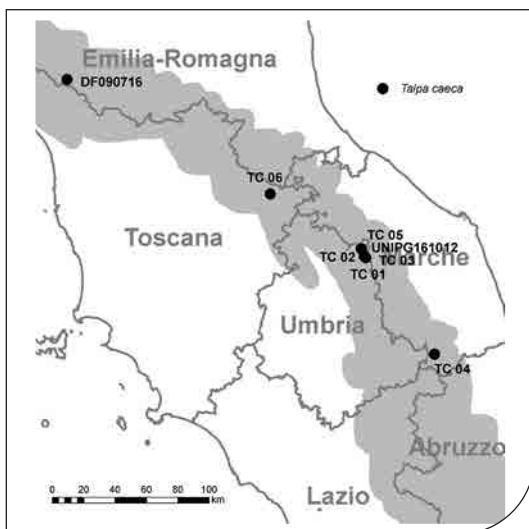


Fig. 10. Localization of all findings of *T. caeca* along the Apennines' ridge, marked in grey; all of them collected near beech woods or in prairie next to beech woods, at altitudes between 1.100 and 1.700 m (drawing by L. Convito).

The data related to environments, bioclimatic planes and altitudes are synthesized in tables 1-3.

In table 4 are reported for each of the three species the type of eyes, of tails, of coronoid apophysis of mandible and of pelvis, as well as the morphology of upper central incisors, the presences of bifid upper molars and of small supplementary external basal cusp at the bottom of the valley separating the main cusps in the second lower molar.

For each one of the three species the values of measurements (mean, standard deviation, median, minimum and maximum) of body, skull and pelvis are synthesized in tables 5 and 6.

## DISCUSSION AND CONCLUSIONS

According to calculations dated March 2020, over a total of 3.157 samples of mammals in the collection Gaggi-Paci, the family Talpidae (represented in Italy only by the genus *Talpa*), is 2,06% (fig. 11). Although the mediocre actual percentage, it is to be considered that no specific collection campaign was performed, but all specimens are animals found dead.

The study on the specimens of genus *Talpa*, considered in the present work, has contributed to clarify the distribution of the species present in Umbria: as for the available information about the dates and places of finding we can in fact state that all specimens can be used for studies on geographical distribution. At present the most updated publication on the biogeography of the genus *Talpa* in Umbria is an atlas of the

regional small mammals (Gaggi & Paci, 2014), where the majority of data derives from this collection. Previously a first update of the regional distribution of *T. europaea* (Paci & Nappi, 2003), had been based firstly on findings preserved in this collection and secondly on bibliographical research (Ragni, 2002; Spagnesi & De Marinis, 2002). The sample of the three Italian species of *Talpa*, besides having ascertained their presence in Umbria, suggests moreover some reflections. For instance the records TE05, TE07, TE14, TE18, TR02 have contributed to individuate an overlap area between *T. europaea* and *T. romana* included in a longitudinal strip between the territories of the Lake Trasimeno (west) and of the Mount Subasio (east) (Gaggi & Paci, 2014), with an already known zone of sympatric contact and of hybridization cases in the surroundings of Assisi (Dupré & Loy, 1995; Palombi, 1996; Loy & Capanna, 1997; Loy et al., 2001).

Also the records TC01, TC02, TC03, TE12, TE22 have ascertained the presence of a parapatric area between *T. caeca* and *T. europaea* at the beech woods of the Mount Cucco, while the records ex TC04, TE52 and TR15 have witnessed the presence of the three species also along the boundary of the Parco Nazionale dei Monti Sibillini including two regions (Umbria and the Marche) and three provinces (Perugia, Macerata, Ascoli Piceno).

All findings of *T. caeca*, come only from the Tuscany-Emilia and Umbria-the Marche Apennines' ridge and they represent a further confirmation of the mainly mountainous distribution of this species in Italy (Loy, 2008b).

The three species prefer open environments and with temperate and moist climate conditions (tabs. 1, 2), all factors favouring the excavation activity (fig. 12). According to the few available data, *T. caeca* appears a strictly mountain species (tab. 1), as it is known in a great part of its areal (Kryštufek & Motokawa, 2018). *T. europaea* results as the most eclectic species in the choice of habitats. It is present in all considered typologies with the exception of mountain prairie (tab. 1). Both *T. europaea* and *T. romana* have been found in big numbers in anthropic contexts preferably with traditional farming practices (tab. 1).

As for the altitudinal data (tab. 3), *T. caeca* has been found only over 1.000 m while the other two species present quite a wide range.

The findings are preserved with the classic methods for small mammals: stuffed skins, skulls, specimens in alcohol, but in many cases it has been decided to preserve also the pelvis, being an important diagnostic element in the species of the genus *Talpa*. Over 64 samples considered here, for 48 the pelvis has been preserved (7 *T. caeca*, 31 *T. europaea*, 10 *T. romana*).

The post-cranial elements are normally disregarded in collections of small mammals, but for the species here considered it would be advisable to preserve always the pelvis. Even if only in small part repre-

Data	<i>T. caeca</i> (n = 6)	<i>T. europaea</i> (n = 34)	<i>T. romana</i> (n = 7)
Mean	1.142	539	504
SD	94	235	486
Median	1.100	544	332
Min	1.100	190	150
Max	1.310	1.050	1.570

Tab. 3. Some data (in meters above sea level) about the altitudinal distribution of the Umbrian specimens of the genus *Talpa* in the collection Gaggi-Paci; n. = number of data.

Morphological characters	<i>T. caeca</i>	<i>T. europaea</i>	<i>T. romana</i>
<b>Eyes, n.</b>	6	30	9
covered by skin	6 (*)	7 (**)	9 (***)
open	/	21	/
other	/	2 (°)	/
<b>Tail, n.</b>	6	28	9
"europaea"	2	25	/
"romana"	4	3	9
<b>Coronoid apophysis, n.</b>	3	29	8
long shape	3	1	8
large shape	/	28	/
<b>Upper central incisors, n.</b>	4	18	6
protuding	3	/	6
slightly protruding	/	7	/
not protruding	/	10	/
other	1°	1°	/
<b>Bifid upper molars, n.</b>	2	18	5
present	2	15	5
absent	/	3	/
<b>Accessory cusp M<sub>2</sub> (°°°), n.</b>	2	22	8
present	/	/	7
absent	2	22	1
<b>Pelvis type, n.</b>	7	30	11
caecoid	7	2	11
europoid	/	28	/

Tab. 4. Typologies of morphological characters detected in the specimens of genus *Talpa* in the collection Gaggi-Paci: \* one of the specimen shows visible eyes under skin; \*\* five specimens show visible eyes under skin; \*\*\* four specimens show visible eyes under skin; ° the same individual shows one open and one skin-covered eye, but anyway visible; °° one incisor is slightly protruding, the other one is not protruding; °°° M<sub>2</sub> second lower molar, the *accessory cusp* is a small supplementary external basal cusp at the bottom of the valley separating the main cusps; n. = number of data.



Data	Tc	Co	Pp
<i>T. caeca</i> , n.	4	6	6
Mean	109,25	19,92	14,03
SD	11,44	2,54	0,70
Median	107,00	20,50	14,15
Min	98	15	13
Max	125	22	15
<i>T. europaea</i> , n.	30	32	33
Mean	135,23	28,38	18,18
SD	8,40	3,62	0,93
Median	134,00	28,00	18,10
Min	116	21	16
Max	156	35	20
<i>T. romana</i> , n.	7	10	10
Mean	138,14	26,88	19,34
SD	5,43	3,28	0,86
Median	140,00	27,15	19,25
Min	131	20	18
Max	145	30	21

Tab. 5. Main body measurements (in mm) of the specimens of genus *Talpa* in the collection Gaggi-Paci. Tc: head-body length; Co: tail length; Pp: posterior foot length; n. = number of data.

sented in the collection Gaggi-Paci, it is advisable to preserve the humerus when preparing Talpidae, that has been useful in studies of palaeontology and of functional morphology, also to understand the evolution of the subterranean lifestyle (Sansalone et al., 2015, 2017a, 2017b, 2019). It is moreover a bone that can be used also in didactic projects.

The main body measurements are available for almost all specimens and the preservation state of skulls allows almost always to take the main measurements and to observe the diagnostic bone and the dental characters.

The biometrical data have not undergone statistic tests on account of the reduced actual sample quantity of *T. caeca* and *T. romana*. One can anyway observe that *T. caeca* shows altogether inferior means than *T. europaea*, and this one shows inferior means than *T. romana*, with the exception of the shorter tail in *T. romana* (26,88 mm) than in *T. europaea* (28,38 mm). Moreover along with the pelvis length (Gaggi & Paci, 2014), also the measurement of pelvis width has been proposed; both proposals are to be considered with attention for future studies as discriminating elements for the three species.

A recent work on modern mammal collections present in Italy has highlighted that particularly for Italian samples, 70% are used for research purposes

Data	Lm	Cb	Lp	Ds	Ac	Az	Ap	Io	An	Hc	Mb	Hm	Lub	Lab
<i>T. caeca</i> , n.	2	2	4	3	2	2	3	2	4	2	4	4	5	6
Mean	29,66	28,85	13,04	11,14	15,61	10,20	8,10	6,62	4,13	9,09	18,45	5,95	16,23	6,56
SD	0,23	0,21	0,31	0,64	1,53	0,20	0,51	0,04	0,18	0,30	0,37	0,17	0,45	0,21
Median	29,66	28,85	13,05	11,31	15,61	10,20	7,85	6,62	4,06	9,09	18,50	5,90	16,50	6,55
Min	29,50	28,70	12,64	10,44	14,53	10,06	7,76	6,59	4,00	8,87	18,01	5,80	15,68	6,31
Max	29,82	29,00	13,40	11,68	16,69	10,34	8,69	6,64	4,39	9,30	18,80	6,20	16,63	6,93
<i>T. europaea</i> , n.	6	10	26	22	6	5	18	13	29	6	27	26	17	18
Mean	35,32	34,74	14,94	12,47	16,56	12,40	9,46	7,82	4,77	10,57	21,97	7,20	20,62	8,60
SD	1,12	1,60	0,50	0,43	0,58	0,43	0,52	0,49	0,37	0,39	1,00	0,46	0,76	0,82
Median	35,50	35,45	14,94	12,40	16,70	12,44	9,54	7,85	4,78	10,62	22,22	7,16	20,36	8,70
Min	33,68	31,60	13,94	11,77	15,76	11,91	8,59	6,90	3,90	10,07	20,25	6,30	19,48	6,60
Max	36,44	36,40	16,10	13,41	17,13	13,05	10,33	8,71	5,41	11,05	23,60	8,30	21,93	9,77
<i>T. romana</i> , n.	3	4	7	7	4	2	7	5	7	4	7	8	6	6
Mean	38,60	37,26	17,06	14,68	18,03	14,44	11,39	8,20	5,53	11,14	25,16	8,67	22,62	8,85
SD	0,78	1,22	0,34	0,34	0,73	0,47	0,25	0,15	0,18	0,42	0,81	0,29	1,00	0,77
Median	38,98	37,47	17,04	14,77	17,89	14,44	11,37	8,18	5,46	11,23	25,42	8,69	22,56	9,01
Min	37,70	35,80	16,60	14,14	17,42	14,11	11,00	8,00	5,34	10,60	24,14	8,22	21,44	7,74
Max	39,11	38,30	17,62	15,15	18,91	14,77	11,78	8,41	5,77	11,50	26,20	9,04	23,73	9,81

Tab. 6. Some cranial and pelvic measurements (in mm) of the specimens of genus *Talpa* in the collection Gaggi-Paci. Lm: maximum cranial length; Cb: basal condyle length; Lp: palate length; Ds: length of the upper dental row; Ac: maximum cranial width; Az: zygomatic width; Ap: palatal width; Io: interorbital narrowing; An: nasal width; Hc: cranial height; Mb: mandible length; Hm: mandible height; Lub: pelvis length; Lab: pelvis width; n. = number of data.

(De Marinis et al., 2007). The collection Gaggi-Paci finds its place in this trend and contributes to the study of different aspects of the genus *Talpa* in central Italy and particularly in Umbria. In a period of economic crisis, the study of small private collections, beside the ones preserved in museums, can offer interesting possibilities of research at not too high costs (Cagnacci et al., 2012).

## ACKNOWLEDGEMENTS

About 30 years ago Claudio Bertarelli, curator of the Vertebrates' collections at Museo di Ecologia e Storia Naturale di Marano sul Panaro (MO), suggested to one of authors (Paci) to plan a specific research on Umbrian moles "...because one could find out some interesting things!". He was right. We would like to thank also the precious collaboration of many friends, who consigned those moles they found dead: L. Beatrici, M. Bellezza, E. Brunelli, G. Cagnucci, L. Coppari, L. Ercoli, D. Fiacchini, G. Forti, S. Laurenti, G. Martinelli, E. e L. Mencarelli, M. Pallottini, A. Palombi, R. Papi, A. Parrini, E. Pauselli, M.D. Rovati, P. Viali. Thanks to Sergio Gentili (Galleria di Storia Naturale, Casalina di Deruta - PG), to Berend Koch (Department of Biology/TU Darmstadt, Germany), to the two anonymous referees, to Roberta Gaggi for reading the English translation.

## REFERENCES

AGNELLI P., 2008. *Micromys minutus* Pallas, 1771. In: Amori G., Contoli L., Nappi A. (a cura di). *Mammalia II. Erinaceomorpha, Soricomorpha, Lagomorpha, Rodentia*. Collana "Fauna d'Italia", vol. XLIV. Edizioni Calderini de Il Sole 24 ORE, Milano, pp. 619-632.

AMORI G., 2016. *Talpa romana*. The IUCN Red List of Threatened Species 2016: e.T41484A2953688 (<https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T41484A2953688.en>).

AMORI G., CASTIGLIA R., 2018. Mammal endemism in Italy: a review. *Biogeographia - The Journal of Integrative Biogeography*, 33: 19-31.

AMORI G., CONTOLI L., NAPPI A. (a cura di), 2008. *Mammalia II. Erinaceomorpha, Soricomorpha, Lagomorpha, Rodentia*. Collana "Fauna d'Italia", vol. XLIV. Edizioni Calderini de Il Sole 24 ORE, Milano, 736 pp.

AMORI G., HUTTERER R., MITSAINAS G., YIGIT N., KRYŠTUFEK B., PALOMO L., 2017. *Talpa europaea*. The IUCN Red List of Threatened Species 2017: e.T41481A22320754 (<https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T41481A22320754.en>).

BRUNET-LECOMTE P., GAGGI A., NAPPI A., PACI A.M., RICCI F., 2020. Observations on cranial and dental morphology of *Arvicola italicus* Savi, 1838 (Mammalia, Rodentia, Arvicolinae). *Bulletin de la Société des naturalistes luxembourgeois*, 122: 83-98.

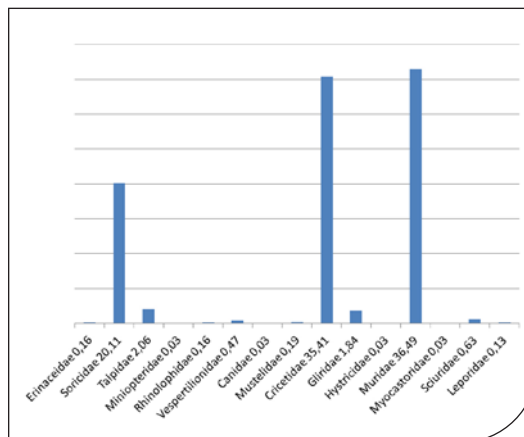


Fig. 11. Percentage composition of the Gaggi-Paci collection, divided per families, updated in March 2020.

CAGNACCI F., CARDINI A., CIUCCI P., FERRARI N., MORTELLITI A., PREATONI D.G., RUSSO D., SCANDURA M., WAUTERS L.A., AMORI G., 2012. Less is more: a researcher's survival guide in times of economic crisis. *Hystrix, the Italian Journal of Mammalogy*, 23(2): 1-7 (doi: 10.4404/hystrix-23.2-8737).

CAPANNA E., 1981. Caryotype et morphologie crânienne de *Talpa romana* Thomas de terra typica. *Mammalia*, 45(1): 71-82.

CAPOLONGO D., 1972. Variabilità ed anomalie in *Talpa romana* (Thomas). *Atti della Società Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano*, 113(1): 37-62.

CAPOLONGO D., 1986. Weitere Untersuchungen über die Gattung *Talpa* (Mammalia: Insectivora) in Italien und den angrenzenden Ländern. *Bonner zoologische Beiträge*, 37(4): 249-256.



Fig. 12. Hypogean and epigeal activity of *Talpa europaea* synthesized in this nice biological micro-diorama prepared in 2019 for the modern exposition of the Department of Biology, Technical University of Darmstadt, Germany (Koch, 2016, courtesy Berend Koch).

- CAPOLONGO D., PANASCÌ R., 1975. Le talpe dell'Italia centro-meridionale. *Rendiconto dell'Accademia di Scienze Fisiche e Matematiche della Società Nazionale di Scienze, Lettere e Arti in Napoli, serie IV*, 62: 104-138.
- CAPOLONGO D., PANASCÌ R., 1978. Ricerche sulle popolazioni di talpe dell'Italia settentrionale e nuovi dati sulle restanti popolazioni italiane. *Annuario dell'Istituto e Museo Zoologia dell'Università di Napoli*, 22: 17-59.
- CASSOLA F., 2016. *Talpa caeca*. The IUCN Red List of Threatened Species 2016: e.T41479A2953438 (<https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T41479A2953438.en>).
- CHALINE J., BAUDVIN H., JAMMOT D., SAINT GIRONS M.-C., 1974. *Les proies des rapaces. Petits Mammifères et leur environnement*. Doin Editeurs, Paris, 141 pp.
- COLANGELO P., LOY A., ANNESI F., KRYŠTUFEK B., ALOISE G., CAPANNA E., 2007. Mitochondrial DNA diversity of the blind mole *Talpa caeca* Savi, 1822. Abstracts V European Congress of Mammalogy. Siena, Italy, 21-26 September 2007. *Hystrix, the Italian Journal of Mammalogy (n.s.)*, suppl.: 199.
- CORBET G. B., OVENDEN D., 1985. *Guida dei Mammiferi d'Europa. Atlante illustrato a colori*. Franco Muzzio, Padova, 288 pp.
- CORTI M., LOY A., 1987. Morphometric divergence in southern European moles. *Bollettino di Zoologia*, 54: 187-191.
- CORTI M., LOY A., AZZAROLI M.L., CAPANNA E., 1985. Multivariate analysis of osteometric traits in Italian moles (genus *Talpa*). *Zeitschrift für Säugetierkunde*, 50: 12-17.
- DE MARINIS A., CAGNIN M., CAGNOLARO L., 2007. A survey of recent mammal collections in Italy. *Hystrix, the Italian Journal of Mammalogy (n.s.)*, 18(2): 137-156.
- DUPRÉ E., LOY A., 1995. Tecniche di radiotelemetria: un'applicazione su *Talpa romana* Thomas. *Supplemento alle Ricerche di Biologia della Selvaggina*, 23: 163-168.
- FILIPPUCI M.G., NASCETTI G., CAPANNA E., BULLINI L., 1987. Allozyme variation and systematics of European moles of the genus *Talpa* (Mammalia, Insectivora). *Journal of Mammalogy*, 68(3): 487-499.
- GAGGI A., 1996. *Caratterizzazione ornitologica dell'alto Tevere umbro*. Tesi di Laurea, Facoltà di Chimica, Fisica e Scienze Naturali, Università degli Studi di Perugia, 99 pp.
- GAGGI A., PACI A.M., 2014. *Atlante degli Erinaceomorfi, dei Soricomorfi e dei piccoli Roditori dell'Umbria*. Regione Umbria, Perugia, 211 pp.
- GIPPOLITI S., 2013. Checklist delle specie dei mammiferi italiani (esclusi Mysticeti e Odontoceti): un contributo per la conservazione della biodiversità. *Bollettino del Museo Civico di Storia Naturale di Verona (Botanica Zoologia)*, 37: 7-28.
- KOCH B., 2016. *Darmstadt: the zoological collection at the Department of Biology/TUDarmstadt: history and present state of the zoological collection*. In: Beck L.A. (ed.), *Zoological Collections of Germany, Natural History Collections*. Springer International Publishing, pp. 245-251.
- KRYŠTUFEK B., MOTOKAWA M., 2018. *Family Talpidae (moles, desmans, star-nosed moles and shrews moles)*. In: Wilson D.E., Mittermeier R.A. (eds.). *Handbook of the Mammals of the World*. Vol. 8. Insectivores, Sloths and Colugos. Lynx Edicions, Barcelona, pp. 552-619.
- LINNAEUS C., 1758. *Systema naturae per Regna tria naturae, secundum Classes, Ordines, Genera, Species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima reformata*. Impensis Direct. Laurentii Salvii, Holmiae, pp. [1-4], 1-824.
- LOY A., 2008a. *Genere Talpa Linnaeus, 1758*. In: Amori G., Contoli L., Nappi A. (a cura di). *Mammalia II. Erinaceomorpha, Soricomorpha, Lagomorpha, Rodentia*. Collana "Fauna d'Italia", vol. XLIV. Edizioni Calderini de Il Sole 24 ORE, Milano, pp. 93-100.
- LOY A., 2008b. *Talpa caeca Savi, 1822*. In: Amori G., Contoli L., Nappi A. (a cura di). *Mammalia II. Erinaceomorpha, Soricomorpha, Lagomorpha, Rodentia*. Collana "Fauna d'Italia", vol. XLIV. Edizioni Calderini de Il Sole 24 ORE, Milano, pp. 101-106.
- LOY A., 2008c. *Talpa europaea Linnaeus, 1758*. In: Amori G., Contoli L., Nappi A. (a cura di). *Mammalia II. Erinaceomorpha, Soricomorpha, Lagomorpha, Rodentia*. Collana "Fauna d'Italia", vol. XLIV. Edizioni Calderini de Il Sole 24 ORE, Milano pp. 106-112.
- LOY A., 2008d. *Talpa romana Thomas, 1902*. In: Amori G., Contoli L., Nappi A. (a cura di). *Mammalia II. Erinaceomorpha, Soricomorpha, Lagomorpha, Rodentia*. Collana "Fauna d'Italia", vol. XLIV. Edizioni Calderini de Il Sole 24 ORE, Milano, pp. 113-121.
- LOY A., CAPANNA E., 1997. A parapatric contact area between *Talpa romana* and *Talpa europaea* in Central Italy. Character displacement investigated through the geometric morphometric of the skull. *Acta Zoologica academiae scientiarum Hungaricae*, 44(1-2): 151-164.
- LOY A., CORTI M., 1986. Le talpe italiane: un approccio morfometrico alle relazioni sistematiche. *Hystrix, the Italian Journal of Mammalogy*, 1(1): 77-82.
- LOY A., CORTI M., MARCUS L.F., 1993. *Landmark data: size and shape analysis in systematics. A case study on Old World Talpidae (Mammalia, Insectivora)*. In: Marcus L.F., Bello E., Garcia-Valdecasas A. (eds.), *Contribution to Morphometrics*. Monografias Museo Nacional Ciencias Naturales, pp. 193-240.
- LOY A., DI MARTINO S., CAPOLONGO D., 1996. Patterns of geographic variation of *Talpa romana* Thomas: preliminary results from a geometric morphometrics approach. *Mammalia*, 60(1): 77-89.
- LOY A., CAPULA M., PALOMBI A., CAPANNA E., 2001. Genetic and morphometric evidence of past introgression between *Talpa europaea* and *Talpa romana* along a parapatric contact zone. *Journal of Zoology*, 254: 229-238.
- LOY A., COLANGELO P., ANNESI F., CAPANNA E., 2005. Origin and evolution of Western European moles (ge-

- nus *Talpa*, Insectivora, Mammalia): a multidisciplinary approach. *Mammal Study*, 30: 13-17.
- LOY A., ALOISE G., ANCILLOTTO L., ANGELICI F.M., BERTOLINO S., CAPIZZI D., CASTIGLIA R., COLANGELO P., CONTOLI L., COZZI B., FONTANETO D., LAPINI L., MAIO N., MONACO A., MORI E., NAPPI A., PODESTÀ M., RUSSO D., SARÀ M., SCANDURA M., AMORI G., 2019. Mammals of Italy: an annotated checklist. *Hystrix, the Italian Journal of Mammalogy*, 30(2): 87-106 (<https://doi.org/10.4404/hystrix-00196-2019>).
- NAPPI A., 2001. *I Micromammiferi d'Italia*. Edizioni Simone, Napoli, 112 pp.
- NAPPI A., 2014. *Quali specie di arvicole sotterranee vivono in Italia centrale?* In: Gaggi A., Paci A.M., Atlante degli Erinaceomorfi, dei Soricomorfi e dei piccoli Roditori dell'Umbria. Regione Umbria, Perugia, p. 143.
- NAPPI A., BRUNET-LECOMTE P., RICCI F., PACI A.M., BERTARELLI C., DE SANCTIS A., PELLEGRINI M., MONTUIRE S., 2005. Sulla presenza di *Microtus (Terricola) multiplex* in Abruzzo: esperienze dall'analisi del primo molare inferiore. Atti V Congresso Italiano di Teriologia. *Hystrix, the Italian Journal of Mammalogy (n.s.)*, suppl.: 45.
- NAPPI A., BRUNET-LECOMTE P., MONTUIRE S., 2006. Intraspecific morphological tooth variability and geographical distribution: application to the Savi's vole, *Microtus (Terricola) savii* (Rodentia, Arvicolinae). *Journal of Natural History*, 40(5-6): 345-358.
- NAPPI A., BRUNET-LECOMTE P., PACI A.M., RICCI F., BERTARELLI C., DE SANCTIS A., PELLEGRINI M., MONTUIRE S., 2012. Considerazioni su alcune morfologie dentarie di arvicole sotterranee *Microtus (Terricola)* (Mammalia, Rodentia, Cricetidae) dell'Italia centrale. *Picus*, 38(73): 119-125.
- NAPPI A., BRUNET-LECOMTE P., MONTUIRE S., 2019. The systematics of *Microtus (Terricola) savii* group: an odonthometrical perspective (Mammalia, Rodentia, Cricetidae). *Journal of Natural History*, 53(47-48): 2855-2867 (<https://doi.org/10.1080/00222933.2020.1758818>).
- ORSOMANDO E., CATORCI A., PITZALIS M., RAPONI M., 1999. *Carta fitoclimatica dell'Umbria, Scala 1:200.000*. Regione dell'Umbria, Università di Camerino, Università di Perugia, S.E.L.C.A., Firenze, 58 pp.
- PACI A.M., NAPPI A., 2003. Aggiornamento sulla distribuzione di *Talpa europaea* in Umbria. Atti IV Congresso Italiano di Teriologia. *Hystrix, the Italian Journal of Mammalogy (n.s.)*, suppl.: 127.
- PALOMBI A., 1996. *Caratterizzazione genetica e ambientale di un'area di contatto parapatrico tra due specie di talpa (Talpa europaea e T. romana) in Italia centrale*. Tesi di Laurea, Università degli Studi "La Sapienza", Roma, 82 pp.
- PAOLUCCI P., 1987. *Micromammiferi della Foresta di Tarvisio. Parte I*. In: Battisti A., Stergulc F., Mezzalira G., Paolucci P. (a cura di). *Vertebrati della Foresta di Tarvisio. I. Saggio faunistico*. Ministero dell'Agricoltura e delle Foreste, Corpo Forestale dello Stato. Gest. ex. A.S.F.D. Ufficio Amministrazione di Tarvisio, pp. 148-225.
- RAGNI B., 2002. *Atlante dei Mammiferi dell'Umbria*. Regione Umbria, Perugia, 223 pp.
- ROHLF F.J., LOY A., CORTI M., 1996. Morphometric analysis of Old World Talpidae (Mammalia, Insectivora) using partial-warp scores. *Systematics Biology*, 45(3): 344-362.
- ROSI R.E., BRUNET-LECOMTE P., 2004. A propos de la présence de taupes taille, *Talpa* species, dans le Préalpes du Dauphiné. *Arvicola*, 26(2): 42-43.
- SANSALONE G., KOTSAKIS T., PIRAS P., 2015. *Talpa fossilis* or *Talpa europaea*? Using geometric morphometrics and allometric trajectories of humeral moles remains from Hungary to answer a taxonomic debate. *Palaeontologia Electronica*, 18.2.42A: 1-17.
- SANSALONE G., COLANGELO P., KOTSAKIS T., LOY A., CASTIGLIA R., BANNIKOVA A. A., ZEMLEMEROVA E. D., PIRAS P., 2017a. Influence of evolutionary allometry on rates of morphological evolution and disparity in strictly subterranean moles (Talpinae, Talpidae, Lipotyphla, Mammalia). *Journal of Mammalian Evolution* (doi: 10.1007/s10914-016-9370-9).
- SANSALONE G., KOTSAKIS T., SCHWERMANN A. H., VAN DEN HOEK OSTENDE L. W., PIRAS P., 2017b. When moles became diggers: *Tegulariscaptor* gen. nov., from the early Oligocene of south Germany, and the evolution of talpid fossoriality. *Journal of Systematic Palaeontology* (doi: 10.1080/14772019.2017.1329235).
- SANSALONE G., COLANGELO P., LOY A., RAIA P., WROE S., PIRAS P., 2019. Impact of transition to a subterranean lifestyle on morphological disparity and integration in talpid moles (Mammalia, Talpidae). *BMC Evolutionary Biology*, 19: 179 (<https://doi.org/10.1186/s12862-019-1506-0>).
- SAVI P., 1822a. Lettera del Dott. Paolo Savi al Sig. Dott. Carlo Passerini conservatore dell'I. e R. Museo di Fisica, Storia Naturale di Firenze. *Nuovo Giornale de' Letterati, Pisa*, 2(3): 264-265.
- SAVI P., 1822b. *Sopra la Talpa cieca degli antichi. Memoria del Dottore Paolo Savi, aiuto dei professori di Storia Naturale e di Botanica della I. e R. Univ. di Pisa*. Presso Sebastiano Nistri, Pisa, 16 pp.
- SERGIACOMI U. (a cura di), 2009. *I Chiroterri umbri nelle collezioni di storia naturale*. I Quaderni dell'Osservatorio, Regione Umbria, Perugia, 157 pp.
- SPAGNESI M., DE MARINIS A.M. (a cura di), 2002. *Iconografia dei Mammiferi d'Italia*. Ministero dell'Ambiente e della Tutela del Territorio – Istituto Nazionale per la Fauna Selvatica "A. Ghigi", 309 pp.
- THOMAS O., 1902. On the mole of the Roman District. *The Annals and Magazine of Natural History, including Zoology, Botany, and Geology (seventh series)*, 10: 516-517.

Submitted: September 8th, 2020 - Accepted: October 6th, 2020  
Published: December 11th, 2020