

Why mammal study collections and vouchers are needed in Italy

Spartaco Gippoliti

Società Italiana per la Storia della Fauna "G. Altobello", Viale Liegi, 48. I-00198 Roma.
E-mail: spartacolobus@hotmail.com

Gaetano Aloise

Museo di Storia Naturale della Calabria ed Orto Botanico, Università della Calabria, Via Savinio, Edificio Polifunzionale. I-87036 Rende (CS). E-mail: gaetano.aloise@unical.it

"... Da tutto questo risulta che la questione ha orizzonti molto più ampi che la discussione sull'opportunità o meno di introdurre nuovi nomi, il cui valore è puramente relativo e privo in parte di significato in sé, e che dall'accurata suddivisione tassonomica si risale alla sintesi di fenomeni grandiosi e di interesse generale"

Gianbattista Dal Piaz, Studio sulle arvicole trentine, Studi Trentini 1924: 2

ABSTRACT

In the last century, taxonomy has been neglected within the scientific community leading to an irreversible decline of natural history collections in Italy as well in other countries. In this paper, some examples are presented concerning the effects of poor collecting activities over the study of alpha taxonomy and geographic distribution of Italian mammals. The situation is even worse in Southern Italy and we discuss some taxa mainly restricted to Calabria, a region now recognized as a refuge for several endemic vertebrates. Here thanks to two collections (one public and one private) the hypodigma of several mammal taxa is increasing allowing a finer taxonomic work. This can have positive consequences for future ecological monitoring and conservation activities aimed at preserving the unique evolutionary lineages found in Calabria.

Key words:

taxonomy, specimens-based research, Calabria, biodiversity.

RIASSUNTO

Perché abbiamo bisogno di collezioni di studio di mammiferi e voucher?

Negli ultimi cento anni gli studi tassonomici sono stati spesso denigrati in seno agli studi biologici e ciò è all'origine del declino scientifico dei musei naturalistici in Italia, ma non solo. Nel presente lavoro vengono presentate alcune delle difficoltà che l'abbandono della gestione scientifica delle collezioni comportano per la comprensione della diversità tassonomica dei mammiferi italiani e della loro distribuzione territoriale. Il caso particolare della mammalofauna calabra permette di evidenziare quanto siano ancora ampie le nostre carenze conoscitive anche a causa della povertà dei reperti disponibili per lo studio. Le conseguenze per il monitoraggio e la conservazione sono discusse.

Parole chiave:

tassonomia, ricerca basata sugli specimen, Calabria, biodiversità.

We wish to dedicate the paper to Prof. Mauro Cristaldi (1947-2016), naturalist and teacher, who, although dedicated most of his late researches to biomonitoring and human health, always supported the existence of museum facilities for basic research, taxonomy and education.

INTRODUCTION

It is not our scope here to review the historical and scientific reasons that led to dismissal of the scientific value of mammal study collections particularly in Western Europe (Kryštufek & Dunnum, 2012; Gippoliti & Groves, 2012). Instead,

our goal is, as mammalogists and conservation practitioners, to show that the abandonment of scientific collecting in Italy had (and still has) severe consequences for the knowledge of alpha taxonomy and, consequently, for the monitoring, management and conservation of mammal diversity (Gippoliti &

Museum Collection	NMNH	AMNH	MNHN	ISPRA	MSNF
Total (skins/skulls)	5 (4/5)	2 (0/2)	3 (2/1)	2 (2/1)	6 (6/5)

Tab. 1. Vouchers of *Lepus corsicanus* available to Palacios (1996).

NMNH – National Museum of Natural History (London); AMNH – American Museum of Natural History (New York); MNHN – Muséum National de Histoire Naturelle (Paris); ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale, (Ozzano Emilia, Bologna); MSNF - Museo di Storia Naturale dell'Università degli Studi di Firenze, Sezione di Zoologia "La Specola" (Firenze).

Amori, 2002). While this trend is known all over Western Europe (Gippoliti & Groves, 2012) in Italy such a situation has a particularly negative consequences owing to 1) lack of a national centre repository under the form of a National Museum of Natural History; 2) the highly fragmented status of historical collections and 3) the periodical abandonment and general scarce resources allocated to maintenance and care of the several medium or small-sized collections spread over the country (Andreone et al., 2014). Although a first census of Italian mammalogical collections has been realised (De Marinis et al., 2007), this aspect is not high among the priorities of the national scientific community. It should also be noted that recently it has been proposed to establish a national reference mammal collection in the Museo di Storia Naturale dell'Università di Firenze (Gippoliti et al., 2014). While most enlighten vertebratologists recognize the value of specimens and local collections to document objectively distributional ranges (faunistic data), it is often overlooked the need to revise materials from a broad geographic range for taxonomic research and to establish range limits of taxa. This is especially important in regions already recognized as refuge or centers of endemism.

SOME EXAMPLES

Several examples may illustrate some of the problems encountered due to poor collecting. While criticizing some taxonomic decisions taken on the study of Bovidae skull morphology, Zachos et al. (2013) stressed the importance of sample size for the validation of statistical analyses (a point already raised by the Italian zoologist Filippo Cavazza in several of his papers at the beginning of 20th Century). Effectively, the American school of mammalogy has a long tradition of studying geographic variability and making taxonomic revisions on the bases of abundant materials, yet the most famous mammal taxonomists do not refrain to describe new taxa from single specimens (i.e. Thomas, 1906; Miller, 1909) but after comparison with sizeable collections. In some cases relating to Italian mammals, taxonomic reevaluation have been based on re-analysis of published data extracted from abundant historical samples, as has been done in the case of *Rupicapra* (Lovari & Scala, 1980) thanks

to previous efforts by Lorenzo Camerano and Marcel Couturier (Camerano, 1914; Couturier, 1938). Generally, we should expect that current population samples available to modern research would be more numerous than those available would at the beginning of 20th Century. This however is not always true. In the case of the Calabrian black squirrel (*Sciurus meridionalis* Lucifero, 1907), Amori et al. (2014) confirmed its distinctiveness from other Italian squirrels re-analyzing the data of Cavazza (1913) who had at his disposal a mere five specimens from Calabria. Cavazza was a pioneer in the utilization of statistical methods in biology and adopted a species concept similar to modern evolutionary biologists (the Biological Species Concept), yet he apparently lacked a training in classical taxonomy. Actually, measurements of Cavazza's specimens cannot be easily reassessed, as he did not indicated the place of deposition of studied specimen.

More important, no sizeable samples of Calabrian black squirrels have been added to Italian public collections during the last Century additional to the small Cavazza's sample. The Calabrian black squirrel exemplify the fact that most Natural History Museums in Italy are found in the northern regions, and very rarely they had nationally-broad research and collecting programs (but see the Natural History Museum in Verona for a recent exception under the leadership of the late Sandro Ruffo). As a result, the Central-Southern regions have relatively smaller samples. Modern evolutionary research needs to have a broader knowledge of processes involved with the present pattern and this should only been obtained through complete geographic sampling. Furthermore, conservation measures can be postponed by the impossibility to describe new taxa that has been genetically detected but are not available in modern museum's collections. It is the case of the recently discovered Italian Peninsular cryptic taxa allied to *Myotis nattereri* (Salicini et al., 2012).

INTRASPECIFIC VARIABILITY

As you can see from table 1, taxonomic reevaluation of endemic Italian taxa, such as *Lepus corsicanus* De Winton, 1898, has often been realized with very limited available materials. In this specific case, of

the 18 available specimens (all except two taken before 1935), 10 are housed in foreign museums. If we exclude the six specimens from Corsica, where the species has been introduced historically, this leaves 12 specimens (11 skins and 10 skulls) from the entire Italian range (Palacios, 1996). It is possible that a few more specimens exist scattered in other museums. In the Museo Civico di Zoologia in Rome there is mounted skin of a completely white specimen originating from the Campagna Romana and taken in 1895 that certainly belongs to this species. Admittedly, this is a poor sample to assess intraspecific variability. Despite this, more recent morphometric and genetic analyses evidenced a geographic sub structuring in the species, with the Sicilian population that it is clearly distinct from the continental populations (Riga et al., 2001; Mengoni et al., 2015). Although it is often impractical or costly to maintain vouchers of all individuals sampled, the discovery of two introgressed *Lepus europaeus* with *Lepus corsicanus* (Mengoni et al., 2015) in Calabria demonstrate the importance to maintain vouchers for a later re-analysis. This issue of assuring vouchers long-term maintenance seems more emphasized overseas than in Europe. Vouchers are essential for clarifying unexpected results, which may be due to convergence, to misinterpretation of morphological or other data, or - perhaps most commonly - to misidentification. As such, vouchers are the basis of reproducibility, an essential part of the scientific method (Ruedas et al., 2000; Funk et al., 2005). As shown by the work of Filippo Cavazza, already at the beginning of 20th Century the necessity to indicate the exact origin and the placement of studied specimens was often overlooked by modern biologists. In agreement with the general low appeal of classical taxonomy among researchers, Cavazza sent himself no obliged to fix holotypes and to list the type series for some of the taxa he described such as *Putorius nivalis monticola* Cavazza, 1908, *Putorius ermineus minimus* Cavazza, 1912, *Martes martes notialis* Cavazza, 1912.

VALUE OF HISTORICAL SPECIMENS

As urgent as continuing collecting of new material is the acquisition and preservation of old specimens anymore available today owing to the environmental changes and population extinctions that occurred in the last century in Italy. This is especially true for large mammals. It is well known that the original populations have often been extirpated from the whole or part of Peninsular Italy and Sicily before being studied or even only sampled with traditional museum methods. To our knowledge, there has not been systematic attempts to recover or at least census old specimens of species that formerly were subject to heavy hunting

practices and probably often preserved as hunting trophy. So with the excellent exception of Giuseppe Altobello's collection from Abruzzo and Molise, rarely any specimens from Southern Italy of species such as wild boar, red deer, roe deer, Italian hare, wolf, otter have found the way in a major Natural History Museum in Italy. Research in Spain showed that searching old specimens of a threatened species such as the Iberian lynx *Lynx pardinus* could be very rewarding (Casas-Marce et al., 2012).

HISTORICAL DATA

In several museums, even if collections persisted, much information about specimens is lost. For instance, De Marinis and Lapini (1994) listed a number of Italian museums that have mustelids vouchers without supplementary information. The importance of archival and historical research has been often ignored in recent decades, but it can lead to a significant increase of the scientific value of collections (Gippoliti & Bruner, 2007; Gippoliti & Amori, 2011). If we consider the ermine *Mustela erminea* distribution in Italy as a case-study, Cavazza (1912) cites the fact that some old museum specimens he saw were said to originate from the Parma Apennine, a fact he said, has not been confirmed at the beginning of XX Century. Another apparently overlooked record is represented by the capture of an ermine male in winter coat in the Tuscany Apennine (S. Giovanni d'Asso), with this specimen then prepared in Siena by the famous naturalist Brogi (Brogi, 1898). This specimen is certainly still maintained in an Italian museum among the many information-deficient vouchers identified by De Marinis & Lapini (1994). Regrettably, the scientific value of museum collections was often so negligible to their staff that in several museums original labels have been replaced by labels, which contained general information over the exhibited species

THE CASE OF THE CALABRIAN SMALL MAMMALS

Before the Second World War, we are aware of only three attempts to build up representative study collections of small mammals of the entire national territory of Italy. These were led by Immanuel Forsyth-Mayor (specimens often deposited in Pisa and Florence museums), by Enrico Hyllier Giglioli (collezione centrale dei vertebrati) at the Zoological Museum of Florence University, and by Lorenzo Camerano (Collezione dei vertebrati italiani) at the Zoological Museum of Turin University. Obviously, specimens from the lesser-known regions of the country (southern Italy and islands) were actively searched but the number of obtained specimens of small mammals was very low, and this was especially

true for the Calabria Region. In his classic work on little-known Italian vertebrates, Forsyth Major (1877) recorded from Calabria a single mole he identified as *Talpa caeca* and some *Microtus savii* all from a single locality (Arena di Calabria). Apart the important but less than satisfactory work of Lucifero (1905-1909), it is not surprising that major contributions to the knowledge of Calabrian small mammals and adjoining regions originated from a few specimens deposited in foreign museums. Some of the most talented mammalogists of the time studied a few critical specimens (Barrett-Hamilton, 1899; Thomas, 1906; Miller, 1909) comparing them with the extensive collections stored at the then British Museum (Natural History). After the Second World War, the first modern collections with adequate sampling of local populations was done by Ernest Von Lehmann for the Bonn Zoological Museum (Lehmann 1961, 1964, 1973, 1977). One consequence is that typical series of newly-described taxa are mostly found in the Bonn Zoological Museum (Hutterer & Peters, 2010), while materials stored in Italy are scarce and, often, unstudied. In the last decades the Department of Ecology of the University of Calabria and one of the present author (GA) established two scientific collections of Calabrian mammals (see Aloise et al., 1990; De Marinis et al., 2007). In table 2, we summarized the achievements of both the Gaetano Aloise Calabrian Mammal Collection and University of Calabria. For almost all Calabrian mammal taxa, the increase of available vouchers is relevant. For *Sciurus meridionalis* hypodigm has more than doubled. These collections are critical for any study aimed to verify the validity of the many described taxa and their exact distribution and phyletic relationship.

Here are some examples;

Erinaceus europaeus consolei Barret-Hamilton, 1900 is generally considered an endemic Sicilian form, but Wettstein (1941), cited it for Calabria too. Genetic data confirm the distinctiveness of the Sicilian form while *Erinaceus* from central Calabria cluster with Italian hedgerows (Santucci et al., 1998). There is no available data from the southern tip of Calabria (Aspromonte Massif) and, further, no morphological study has tested validity of *consolei* with a richer material (e.g Toschi, 1959).

Neomys fodiens, recently reported for the first time from the Calabria region (Sila Massif), based on a single specimen, this represents the southernmost occurrence throughout the range of the species (Aloise et al., 2005). Genetically, the Calabria sample is allied to the Pyrenean population and distinct from all other European populations. The Spanish and southern Italian haplotypes share four substitutions with respect to the central Italian haplotype; the Calabrian haplotype has accumulated five additional substitutions (Castiglia et al., 2007).

Both genetic and morphological studies are needed to fully understand the status of the cryptic Calabrian *Neomys* cf. *fodiens* taxon.

Still less clear is the taxonomic status of members of the genus *Myodes* in Calabria. Two taxa has been described from the Region; *ballucalis* Thomas, 1906 from the Aspromonte massif in the southern tip and *curcio* von Lehmann, 1961 from the Sila Massif. A first molecular study showed a considerable genetic distance between Calabria samples (including the Pollino massif) and the rest of Italy (Colangelo et al., 2012), and *ballucalis* was raised at species level by Gippoliti (2013). A through revision of *ballucalis* is in dire need to highlight further differentiation and contribute to undercover the palaeobiogeography of the region.

CONCLUSIONS

Modern phylogeographic studies mainly based on mtDNA studies have revealed a complex genetic structure found in Calabria vertebrate populations, that are very often clearly distinct from the rest of peninsular Italy (for mammals see Castiglia et al., 2007; Grill et al., 2009; Canestrelli et al., 2010; Colangelo et al., 2012; Mouton et al., 2016). This is certainly due to the complex Quaternary paleogeographic history of Calabria, an Archipelago for much of its history (Bonfiglio et al., 2002). It should be stressed that the use of a single measure, such as a genetic divergence of cytochrome *b*, as a taxonomic tool has been criticized (Ferguson, 2002). There have been calls for an integrative approach to taxonomy (Dayrat, 2005; see also Wauters et al., in press). Collections are often undervalued in European mammalogy but morphological studies and classic taxonomy can add valuable data to genetic research and serve as a guide for an effective genetic sampling strategy that emphasize visible differentiation often recognized by subspecific identification (Cotterill, 2016). According this author's tentelism thesis, (combining the Latin roots *Tena* - to hold, with *Tela* - a web) specimens inform biodiversity sciences; specimen preservation maintains the fecundity, fidelity and veracity of both existing and future knowledge. Natural science collections in museums preserve tentelic specimens as the focal sources of scientific verification and innovation. Considering the huge gap in our knowledge of biota in Italy and the pressing threats to its biodiversity, it is time that taxonomic infrastructures are considered essential for understanding of Italian mammals real taxonomic diversity and for conservation planning.

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Taxon	Locus typicus	Where the holotype is deposited	Distribution in Italy	Specimens in Calabrian Collections	Calabrian specimens preserved in other Collections	Notes
<i>Eriacus europaeus consolei</i> Barret-Hamilton, 1900	Palermo, Sicily	NHML n° 1898.10.6.1	Sicily and, according Wettstein 1941, Calabria	CGA: 1	-	Individuals from Central Calabria grouped genetically with those from Central Italy. No samples has so far been available from Southern Calabria. Considered a distinct species by Gippoliti (2013).
<i>Talpa romana adamoi</i> Capolongo e Panasci, 1976	Favazzina (RC), Calabria	MSNF - (ex n° 245 Coll. D. Capolongo)	Southern Calabria	MSNC: 1 + 2 skulls from raptor pellets CGA: 159	ZFMK: 2* MZUF: 4 MACUR: 35 CMLC: 3	Considered a distinct species by Gippoliti (2013) * A specimen of Tiriolo (CZ) attributed by Lehmann (1977) to <i>T. r. stankovici</i> .
<i>Sorex antinorii silanus</i> von Lehmann, 1961	Camigliatello silano (CS), Calabria	ZFMK - n° 60.339	Central and Southern Calabria	MSNC: 46 + 4 skulls from raptor pellet CGA: 10	ZFMK: 8	Possible range Northern Calabria and Lucania
<i>Sorex minutus lucanici</i> Miller 1909	M.te Sirino, Lagonegro (PZ), Lucania	NHML n° 1908.9.1.5	Campania, Lucania and Calabria	MSNC: 123 CGA: 11	ZFMK: 4	Vega et al. (2010) in a study of <i>Sorex minutus</i> found a distinct Central-Southern Italian clade also with a Calabrian subclade. Given species rank by Gippoliti (2013).
<i>Neomys fodiens</i> (Pennant, 1771)	Berlin		Italian Peninsula	MSNC: 1	-	The only known Calabrian specimen is genetically closer to the Pyrenees population. Thus the Calabria <i>N. fodiens</i> is a cryptic taxon that deserve further study.
<i>Crocidura suaveolens bruecheri</i> Lehmann, 1977	Tiriolo (CZ), Calabria	ZFMK - n° 77.665		MSNC: many skulls from raptor pellet CGA: many skulls from raptor pellet	ZFMK: 13 CMLC: 19	Generally not accepted as a valid taxon.
<i>Sciurus meridionalis</i> Lucifero 1907	Sila Massif, Calabria	MSNF - n° 11481	Calabria and Southern Lucania	MSNC: 8 CGA: 18	MSNM: 5 MZUF: 10 MSG: 9	Raised at species level by Gippoliti (2013) and Wauters et al. (2016).
<i>Dryomys nitedula aspromontis</i> Lehmann, 1964	Gambarie d'Aspromonte (RC), Calabria	ZFMK - n° 63.510	Calabria and Southern Lucania	MSNC: 7 CGA: 9	ZFMK: 6 MACUR: 4	
<i>Muscardinus speciosus</i> (Dehne, 1855)	Tursi (PZ), Lucania	Apparently lost in Dresden	Central and Southern Italy	MSNC: 7 + 305 skulls from raptor pellet CGA: 3 + 22 skulls from raptor pellet	ZFMK: 2 CMLC: 66 MZUF: 10	Gippoliti (2013) considers <i>speciosus</i> a distinct Italian endemic species. Two distinct subclades exist along the Italian Peninsula, one composed from individuals of Sicily and Calabria (Mouton et al. 2016). Lehmann (1969) cites <i>pulcher</i> (= <i>speciosus</i>) for the Picentini Mts. (Campania).
<i>Arvicola italicus</i> Savi 1839 (1)	Pisa nearby, Tuscany		Central and Southern Italy	MSNC: 3 + 59 skulls from raptor pellets CGA: 1 + 5 skulls from raptor pellets	ZFMK: 7 MZUF: 1 MSG: 6	Raised at species level by Gippoliti (2013) and Castiglia et al. (2016). There is a genetic clade composed of Central and Southern Italian individuals. (1) Lehmann (see Toschi, 1965) believed a new subspecies occurred on Sila Mts. he refrained to formalize it because his 12 specimens were not completely adult.
<i>Microtus brachycercus</i> Lehmann, 1961	Camigliatello silano (CS), Calabria	ZFMK - n° 60.379	Southern Italy	MSNC: 221+ many skulls from raptor pellets CGA: 50+ many skulls from raptor pellets	ZFMK: 17 CMLC: 165 MZUF: 9	
<i>Myodes glareolus hallucalis</i> (Thomas 1906)	S. Eufemia d'Aspromonte (RC), Calabria	NHML n° 1906.8.4.9	Southern Calabria	MSNC: 11 + 6 skulls from raptor pellets CGA: 2	ZFMK: 36	The Calabrian population appears clearly distinguished from the rest of the Italian peninsula (Colangelo et al., 2012). Raised at species rank by Gippoliti (2013).
<i>Myodes glareolus curcio</i> von Lehmann, 1961	Camigliatello silano (CS), Calabria	ZFMK - n° 60.379	Central and Northern Calabria	MSNC: 100 + 17 skulls from raptor pellets CGA: 5	ZFMK: 10	See <i>Myodes glareolus hallucalis</i>

Tab. 2. Current knowledge of available hypodigm for a selected number of mammal taxa with exclusive or significant distribution in Calabria. Subspecific identification based on geographic origin. MSNC - Museo di Storia naturale della Calabria, Università della Calabria, Rende (CS); CGA - Collezione Gaetano Aloise, Frumefreddo Br. (CS); CMLC - Collezione Microterologica L. Contoli, Museo Civico di Zoologia, Roma; CDC - Collezione Domenico Capolongo, Museo di Storia Naturale dell'Università degli Studi di Firenze, Sezione di Zoologia "La Specola", Firenze; MSNG - Museo Civico di Storia Naturale Giacomo Doria, Genova; MSNM - Museo civico di storia naturale, Milano; MZUF - Museo di Storia Naturale dell'Università degli Studi di Firenze, Sezione di Zoologia "La Specola", Firenze; MACUR - Museo di Anatomia Comparata "G. B. Grassi", Università di Roma "La Sapienza", Roma; ZFMK - Zoological Museum Alexander Koenig, Bonn NMIH - National Museum Natural History, London.

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