

# The quick and the sad fate of the Harvest mouse *Micromys minutus* (Pallas, 1771) of the Lake Trasimeno

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## ABSTRACT

This contribution contains a summary of information relating to the discovery, decline and apparent extinction in Umbria (central Italy) of an isolated population of the Harvest mouse *Micromys minutus*, located in the southern reed beds of Lake Trasimeno (Perugia). The species was discovered by chance in March 1999 during a study session on micromammals led inside the lake, at Sant'Arcangelo. The destiny of the Harvest mouse of Lake Trasimeno is linked to the very rapid reduction and disappearance of its vital area, the reed strip with *Phragmites australis*.

Key words:

*Micromys minutus*, Lake Trasimeno (Umbria, central Italy), biogeography, extinction.

## RIASSUNTO

*Il veloce e triste destino del Topolino delle risaie Micromys minutus (Pallas, 1771) del Lago Trasimeno*

Nel presente contributo sono riportate le sommarie informazioni relative alla scoperta, al declino e all'apparente estinzione in Umbria (Italia centrale) di una popolazione isolata di Topolino delle risaie *Micromys minutus*, localizzata nei canneti meridionali del Lago Trasimeno (Perugia). La specie venne scoperta per caso nel marzo 1999 durante una sessione di studio sui micromammiferi condotta all'interno del lago, presso Sant'Arcangelo. Il destino del Topolino delle risaie del Lago Trasimeno è collegato alla velocissima riduzione e scomparsa della sua area vitale, la fascia di canneto a *Phragmites australis*.

Parole chiave:

*Micromys minutus*, Lago Trasimeno (Umbria, Italia centrale), biogeografia, estinzione.

## INTRODUCTION

The Harvest mouse *Micromys minutus* is a small Eurasian murid with distribution between central-western Europe and Japan. The preservation of this declining species is subordinated to interventions aimed at the protection of the species itself and of the wetlands, at the limitation of the use of agricultural poisons as well as at a targeted study of the populations (Bulgarini et al., 1998). In Italy, until the early 1990s, it was considered exclusive to the Po Valley. Subsequently, its presence was also ascertained in Tuscany (Marshes of Fucecchio-Firenze, lakes of Chiusi and Montepulciano-Siena) and in Umbria, while for Campania its historical presence was confirmed through reinterpretations of old museum material (Agnelli, 2008).

In Umbria the species was detected in the Regional Park of the Lake Trasimeno (Perugia) in March 1999, during control of the presence/absence of the Italian water vole *Aroicola italicus* (Paci & Bertarelli, 1999; Nappi, 2004; Paci & Romano, 2007). On that occasion, two of the authors (A.M. Paci, C. Romano) placed some live traps near the

village of Sant'Arcangelo (see Paci et al., 2022b), among the reeds of the Trasimeno Valley Oasis (Municipality of Magione). Surprisingly, 5 individuals of *M. minutus* were captured and, in September of the same year, a nest was found (Paci & Bertarelli, 1999; Paci & Romano, 1999). At the end of 1999, Ragni and Chiappini (2000) found other skulls of the species in Barn owl *Tyto alba* food remains, collected at the ornithological ringing center "La Valle" (see Paci et al., 2022b) near the village of San Savino (Chiappini & Ragni, 1998). In January 2010 the skull of a specimen was extracted from a pellet of Tawny owl *Strix aluco*, still collected in Sant'Arcangelo from one of the authors (A.M. Paci) (Gaggi & Paci, 2014), even if in the meantime the conditions of the vital area had dramatically worsened due to the inexorable decline of vast portions of reeds, attributable above all to the phenomenon known as "Common Reed Die-Back", a complex and irreversible syndrome which in less than a decade can devastate a mature reed bed until it disappears completely (cf. Gigante et al., 2011; Gigante & Venanzoni, 2012; Lastrucci et al., 2017).

Further specimens of *M. minutus*, again from Barn owl pellets, were found in another part of the Lake Trasimeno, at the site Podere Caporalino (Municipality of Castiglione del Lago), from Manganelli et al. (2001) but, probably, the animals could have been preyed on among the reed beds of the neighboring Tuscan Lake of Chiusi and indirectly arrived on Umbrian soil.

Before 2010 *M. minutus* was considered very localized in Umbria and in danger of extinction (EN) (Angelici et al., 2008); in 2014 the regional atlas of small mammals warned of the critical danger of extinction (CR) due to the sudden dissolution of the habitat (Gaggi & Paci, 2014), while other sources did not map the populations of central Italy (including those of the neighboring Tuscan district of Chiusi and Montepulciano) already in 2011 (Aulagnier et al., 2011). Despite the considerably compromised situation from the time of discovery and, on the other hand, the apparent ease of approaching this otherwise elusive and enigmatic species, local investigations into its ecology were never carried out. The present contribution therefore has the aim both to update its regional status and to constitute a compendium of the present knowledge about this exclusive population.

## METHODS AND RESULTS

The trapping session aimed at establishing the presence/absence of *Arvicola italicus* was carried out to the lake near Sant'Arcangelo, inside the Trasimeno Valley Oasis, an inlet of about 500 hectares in the south-eastern sector of the lake including the localities of San Feliciano, San Savino (nearby "La Valle" ornithological ringing center, 257.33 meters above sea level) and Sant'Arcangelo (see Paci et al., 2022b), the most valuable Lake Trasimeno naturalistic area and in which the reeds reached their maximum concentration and extension. On the 16th of March 1999, seventeen live traps for the capture of small rodents were placed in the middle of a reed bed of *Phragmites australis*. Seven of these were of the "box" type built entirely of sheet metal, measuring 23 cm x 9 cm x 9 cm, with a spring-loaded closure of the front door and a rear entrance closed by a fixed inspection net with a 0.5 cm x 0.5 cm mesh (see Paci et al., 2022b). The other ten ones were of the same size, but of the "cage" type entirely in 1.2 cm x 1.2 cm mesh. They were baited with crusty bread and randomly distributed on the ground within an area of about 10 m<sup>2</sup>. On the 17th of March 1999 five *Micromys minutus* were found in the "box" traps and two wild mice *Apodemus sylvaticus* in the "cage" ones. Four traps of the latter model were closed, but free and without bait (later it was found that the harvest mice could easily get out through the meshes of the net). Three of the five individuals of *M. minutus*, one sub adult male and two sub adult females, were found dead; the two alive, together with the wild mice, were photographed and immediately released. On the 26th of September 1999,

during a second and last inspection in the same place, an old summer nest anchored to a stem of *P. australis* of about 6.5 mm in diameter was found 90 cm from the ground and close to the water. The three dead specimens and the nest were measured, prepared and at first included in the "Gaggi-Paci" mammal collection (Paci et al., 2022a), subsequently donated to museums ("La Specola" Zoological Museum, University of Florence; Museum of Ecology and Natural History, Marano sul Panaro-MO). In particular, the male was prepared as taxidermy mount, padded with wadding with the skull in situ, and mounted next to the nest, which was in turn disinfected with nitro solvent and fixed with opaque transparent varnish; the two females as study skins with separate skulls; the hemi-jaw found in 2010 is still in "Gaggi-Paci" private collection (the images of these finds are reported in Paci et al., 2022b). All the finds collected in the Sant'Arcangelo station have been ordered in table 1 and integrated with all samples found in the San Savino station, preserved in the "Bernardino Ragni" zoological collection (Museum of Science and Territory, Spoleto, PG) (L. Brustenga e M. Capitani, pers. com.); the few references relating to gender, age and biometrics are shown in table 2, integrated with six of seven samples found in the San Savino station extrapolated from the literature (Ragni & Chiappini, 2000).

## DISCUSSION AND CONCLUSIONS

Some aspects, relating to the biometric and ecological parameters for the Harvest mouse of the Lake Trasimeno, agree with what reported by Agnelli (2008) for Italy:

- average head-to-body length = 54.66 mm
- average tail length = 53.66 mm
- average back foot length = 15.00 mm
- average jaw length = 9.96 mm
- average row length of upper molars = 2.99 mm
- average row length of lower molars = 2.79 mm
- nest-site = among *Phragmites australis* at an altitude <300 m s.l.m.
- nest = in a marginal position <100 cm above the ground, hung on stems of medium diameter <7 mm
- predators = *Tyto alba* (87.50%), *Strix aluco* (12.50%).

Another important parameter, also reported by Agnelli (2008), is the high small mammal's diversification characterizing its area of diffusion, punctually recorded also in the Trasimeno Valley by Chiappini & Ragni (1998). Interspecific interactions in the trapping site occurred with *Apodemus sylvaticus* and with the Brown rat *Rattus norvegicus* (Gaggi & Paci, 2014; Vercillo et al., 2019), while among the medium and large mammals sharing the habitat and often being responsible for the devastation of large reed beds, there were certainly the Coypu *Myocastor coypus* (Paci & Romano, 2007) and probably the Wild boar *Sus scrofa*, as ascertained by A. Benocci (pers. com.) for Lake of Montepulciano (Tuscany).

Specimen	Typology	Locality	Date	Acquisition	Source	Place of collection
1	Taxidermy mount	Sant'Arcangelo	17.03.1999	Live trap	"Gaggi-Paci" p.c., cod. MM01	"La Specola" Zool. Mus., Florence
2	summer nest	Sant'Arcangelo	26.09.1999	Found in environment	"Gaggi-Paci" p.c., cod. MM01bis	"La Specola" Zool. Mus., Florence
3	skin + skull	Sant'Arcangelo	17.03.1999	Live trap	"Gaggi-Paci" p.c., cod. MM02	"La Specola" Zool. Mus., Florence
4	skin + skull	Sant'Arcangelo	17.03.1999	Live trap	"Gaggi-Paci" p.c., cod. MM03	Mus. Ec. Nat. Hist. Marano s./P. (MO)
5	skull	Sant'Arcangelo	10.01.2010	<i>Strix aluco</i> pellet	"Gaggi-Paci" p.c., cod. MM04	"Gaggi-Paci" private collection
6	skull	San Savino	XI 1999	<i>Tyto alba</i> pellet	"B. Ragni" p.c., cod. /	Mus. Sc. Terr., Spoleto (PG)
7	skull	San Savino	XI 1999	<i>Tyto alba</i> pellet	"B. Ragni" p.c., cod. 7	Mus. Sc. Terr., Spoleto (PG)
8	skull	San Savino	XI 1999	<i>Tyto alba</i> pellet	"B. Ragni" p.c., cod. 7B	Mus. Sc. Terr., Spoleto (PG)
9	skull	San Savino	XI 1999	<i>Tyto alba</i> pellet	"B. Ragni" p.c., cod. 7C	Mus. Sc. Terr., Spoleto (PG)
10	skull	San Savino	XI 1999	<i>Tyto alba</i> pellet	"B. Ragni" p.c., cod. 8A	Mus. Sc. Terr., Spoleto (PG)
11	skull	San Savino	XI 1999	<i>Tyto alba</i> pellet	"B. Ragni" p.c., cod. 8B	Mus. Sc. Terr., Spoleto (PG)
12	skull	San Savino	XI 1999	<i>Tyto alba</i> pellet	"B. Ragni" p.c., cod. 8C	Mus. Sc. Terr., Spoleto (PG)
13	photo	Sant'Arcangelo	17.03.1999	Live trap	"C. Romano" p.a.	"C. Romano" p.a.
14	photo	Sant'Arcangelo	17.03.1999	Live trap	"C. Romano" p.a.	"C. Romano" p.a.

Tab. 1. All finds collected in the Sant'Arcangelo station integrated with all samples found in the San Savino station (p.c.=private collection; p.a.= private archive).

However, in total contrast with what is known, were the extreme ease of the capture during the trapping session at the Lake Trasimeno and the related indices, both calculated solely on the 7 "box" traps (those actually producing reliable data) and on all 17: respectively Catch Index (CI = n. samples / n. trap-nights x 100 trap-nights) 71.42 and CI 29.41 (the latter figure could have been higher, considering the traps occupied by *Apodemus sylvaticus* and the fact that the four closed and empty ones were not taken into account). Conversely, several authors such as Osella & Montolli (1986) or Vogel & Gander (2015) point out the difficulty in obtaining harvest mice with traps and the data collected by Dickman (in Vogel & Gander, 2015) for the city of Oxford (GB) would confirm it: CI 0.10 (4 samples for 3858 trap-nights although the Author had found at least 26 nests in his study area). An important role in the case of Umbria could have been played by the presence of a good density of hungry animals, still present on the ground at the end of winter, and the ideal catching formula adopted (trap type + bait type + trap positioning site), however fortuitous. In the recent work by Vogel & Gander (2015), it is recommended to place live traps on the ground during the autumn-winter period, while in the repro-

ductive season they should be suspended on platforms of reeds or leaves set up among the vegetation; Darinot (2020) reports capture successes in summer with both ground and aerial traps, however underlining the greater success with the latter, which allowed captures in every seasons and even in the flooding periods of the reed bed. Moreover, according to the experience of these Authors, a large opening of the trap, even if it is non-selective and enabling intrusion of different species, would not in any case induce in the Harvest mouse neophobia for structures with wide accesses. The last part of the discussion focuses on the main cause of the disappearance of the species from the Lake Trasimeno attributable, as mentioned, to the Common Reed Die-Back, the death of the reed bed due to permanent immersion of the stems and other contributing causes deriving from this such as, for example, excessive accumulation of organic matter from overproduction of self-generated litter by the straw itself, absence of starch in the root tips, proliferation of endo-parasitic fungi inside the leaf and root cells, growth of reeds into bushes. The trigger would have been at the end of the 1950s when, to avoid swamping of this large laminar lake (surface of the lake mirror of 124 km<sup>2</sup>, perimeter of the banks of 53.1 km, 6.5 meters of maximum depth) at

Specimen	Gender	Age	Ltc	Lco	Lpp	Lmb	Ums	Lms	Source
1	♂	sub ad.	55.00	53.00	15.00	\	\	\	"Gaggi-Paci" p.c., cod. MM01
3	♀	sub ad.	52.00	59.00	16.00	9.50	2.78	2.58	"Gaggi-Paci" p.c., cod. MM02
4	♀	sub ad.	57.00	49.00	14.00	9.50	3.20	3.00	"Gaggi-Paci" p.c., cod. MM03
6	\	\	\	\	\	10.40	\	\	Ragni & Chiappini (2000)
7	\	\	\	\	\	10.30	\	\	Ragni & Chiappini (2000)
8	\	\	\	\	\	10.00	\	\	Ragni & Chiappini (2000)
9	\	\	\	\	\	10.00	\	\	Ragni & Chiappini (2000)
10	\	\	\	\	\	10.00	\	\	Ragni & Chiappini (2000)
11	\	\	\	\	\	10.00	\	\	Ragni & Chiappini (2000)

Tab. 2. The references relating to gender, age and biometrics, integrated with six of seven samples of the San Savino station (ad = adult; sub ad. = sub adult; Ltc = head-to-body length; Lco = tail length; Lpp = rear foot length; Lmb = jaw length; Ums = upper molar row length; Lms= lower molar row length; p.c.=private collection).

that time completely devoid of significant tributaries, it was decided to have the waters of four streams flow into the artificial canal Anguillara, created on purpose, which then flowed into the lake itself. Here they would have been kept at the levels suitable to avoid the flooding hazard of lakeside towns by means of the artificial emissary, thanks to which the exceeding waters could be let flow if needed into the Caina stream, hence into the Nestore river and then into the Tiber river. In those years the cane thicket in the Valley with an off-shore extension of several hundred meters, found itself suddenly in excessively deep waters for its ecological needs. Afterwards with the small surface of its catchment basin (309 km<sup>2</sup>), it underwent prolonged flooding seasons alternate with significant drops in level, due to particularly dry periods (fig. 1): "[...] its closed lake nature and the high variability of rainfall inevitably imply a strong variation in its level on an annual and multi-annual scale" (Dragoni, 2007). At the end of the 20th century, the extension of the cane thicket in the

Trasimeno Valley, although considerably withdrawn (see Paci et al., 2022b), still constituted 10% of the entire surface (Chiappini & Ragni, 1998). Concurrently with the last phase characterized by levels near or superior to the hydrometric zero (emissary's overflow quota) occurred from 2014 and 2017 (data Region Umbria Hydrographic Service) this sector of reed beds, which if compared to the other bank strips was particularly subject to the die-back, quickly resumed its systematic reduction and disappeared almost completely in 2017 (see Paci et al., 2022b). The disappearance of the reedbeds in the Trasimeno Valley has then caused problems to the vegetable and animal organisms, even rare and threatened, connected to it in various ways. Recent local searches for the Harvest mouse, carried out after 2020 (Mori et al., 2022), found no more traces of this isolated and probably relict population, located at the southern limits of the currently known Italian range and separated from the other ones present in the northern part of the Peninsula, substantially decla-

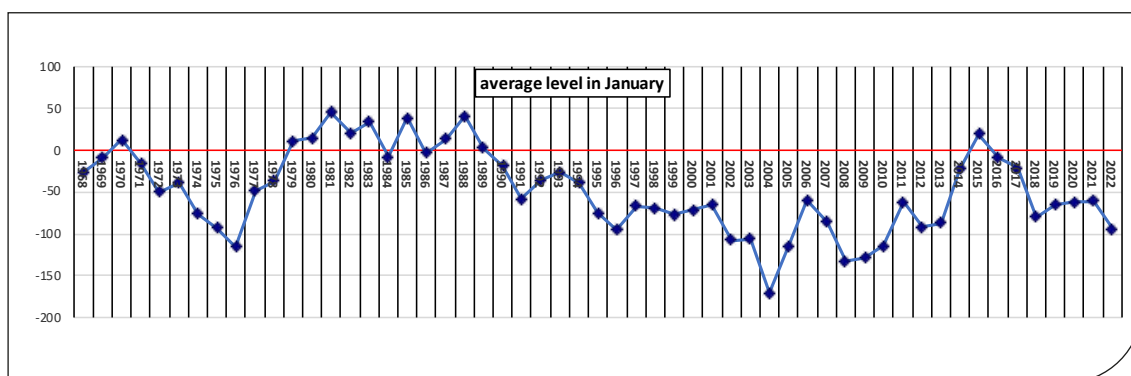


Fig. 1. Trend in the lake's level in the month of January, expressed as the relative height of the lake surface compared to the emissary's overflow quota (hydrometric zero, indicated by the horizontal axis). Respectively from 1968 to 2022: -27 cm, -9, 13, -15, -50, -39, -76, -92, -115, -48, -36, 10, 14, 45, 20, 34, -7, 39, -4, 14, 41, 3, -19, -58, -36, -27, -38, -75, -95, -67, -70, -77, -71, -65, -108, -106, -170, -116, -60, -86, -133, -128, -114, -62, -92, -87, -22, 19, -9, -21, -80, -65, -62, -61, -94 (Data Region Umbria Hydrographic Service).

ring its extinction at the regional level (RE) (Paolucci & Bon, 2022). So, if the absence of surviving nuclei should be indeed confirmed for the future in this as well as other possible wetlands of the region, the finds collected between Sant'Arcangelo and San Savino would constitute the only physical and genetic trace of the transient presence in Umbria of this discreet and very delicate species. The reported experience once again underlines the extreme importance of the preservation of local scientific materials as keepers of unique records, precious pieces of natural history of a territory essential to know it and pass the knowledge to future generations.

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