

New records of *Testacella scutulum* Sowerby, 1821 (Gastropoda, Pulmonata, Testacellidae) from Southern Italy and Sicily

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ABSTRACT In the present paper we report on *Testacella scutulum* recently recorded for a few regions of Southern Italy and Sicily. An updated distribution map, anatomical remarks and feeding behaviours of collected specimens are related in order to extend and improve general knowledge on these terrestrial molluscs.

KEY WORDS terrestrial molluscs, semi-slugs, *Testacella scutulum*, Southern Italy, Sicily.

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INTRODUCTION

The family Testacellidae Cuvier, 1800 comprises the only genus *Testacella* Cuvier, 1800 with Euro-mediterranean distribution extending up to Macaronesia (Giusti et al., 1995; Schileyko, 2000; Rinaldi, 2003a; Bank, 2011). *Testacella* spp. specimens are carnivorous and mostly feed on earthworms actively hunted in the subsoil and, sometimes, on molluscs (Benoit, 1857; Paulucci, 1879; Webb, 1893; Quick, 1960). Such a particular mode of life is likely to be the main reason of the relative difficulty in sampling these organisms.

In Italy three *Testacella* species, distinguishable only by anatomical inspection, have been reported, *T. haliotidea* Draparnaud 1801, confirmed by anatomical data, from a single station in the northwestern Italy (Piedmont, Collina di Torino); *T. gestroi* Issel 1873, endemic of Sardinia and southern Corsica; and *T. scutulum* Sowerby, 1821 reported for some areas of the peninsula and Sicily (Manganelli et al., 1995). In North-central Italy the presence of *T. scutulum* was documented (by anatomical data) only for Liguria and Tuscany (Pollonera, 1889; Wagner, 1915; Colosi, 1919; Giusti 1968, 1970,

1976; Giusti & Mazzini, 1970); recently it was reported also for Abruzzo (Rinaldi, 2003a, b).

In Southern Italy, the genus *Testacella* was recorded (although without any anatomical analyses) only in three localities. In particular it was reported in Campania on the island of Capri (Costa, 1840; Bellini, 1915; Petraccioli et al., 2005) where Bourguignat (1861), based on morphological shell characters, described *T. drymonia*; such a taxon was successively accepted as valid by Pilsbry (1885) and Bellini (1915) whereas, a few decades later, Alzona (1971) suggested it to be a synonym of *T. haliotidea trigona* Gassies & Fischer, 1856. In the end, Petraccioli et al. (2005) attributed this population to *T. scutulum*. In Basilicata, Degner (1927) recorded *Testacella* sp. for Lagonegro (locality Mala Mogliera) and Paulucci (1878, 1879) indicated the occurrence of *Testacella* sp. in Calabria, Scilla (locality Grotte di Tremusa).

In Sicily, the genus *Testacella* has been recorded for the island of Ustica and surroundings of Palermo. In particular, Pirajno di Mandralisca (1842) reported that the malacologist A. Bivona collected a few specimens of *T. haliotidea* in Ustica (Palermo, Sicily), whereas Testa (1842) and Calcara (1842, 1845) and, some years later, Benoit

(1857) reported the same taxon for Monte Cuccio (Palermo) and Palermo surroundings. Alzona (1971) agreed in attributing the populations from Sicily and Ustica to *T. haliotideae*; on the contrary, Manganelli et al. (1995) considered the sicilian populations as *T. scutulium*.

In the present paper we report on 28 extant specimens of *T. scutulium* collected in Campania, Calabria and Sicily (Fig. 1), the reproductive systems of which are described and illustrated in details for the first time. Moreover a few notes on feeding behavior are added including an illustrative video (http://www.biodiversityjournal.com/video/BJ_video1.avi).

MATERIALS AND METHODS

All *Testacella* specimens were collected by sight on the soil or under the rocks. Observations on ecology of these organisms and their feeding behavior were made both directly in the field and in captivity by keeping the animals inside a terrarium.

In order to study and illustrate genital organs, highly informative at the specific level, individuals were drowned and fixed in 75% ethanol.

Reproductive apparatus was extracted by means of scalpel, scissors and needles. Photographs were taken with a digital camera. Height and maximum diameter of the shell along with some parts of genitalia were measured (in millimeters) by a digital gauge. Illustrations of genitalia were sketched using a camera lucida. Voucher specimens were stored in collections indicated below. Toponyms (place-names) are reported following the Portale Cartografico Nazionale (PCN, <http://www.pcn.minambiente.it/PCN/>), Map IGM 1:25,000. Each locality and/or collection site is named in the original language (Italian).

Studied material, except from when indicated in a different way, has been collected by the owner of the collection where it is stored.

Examined material:

Abbreviations: Collection F. Liberto, Cefalù (CL); Collection W. Renda, Amantea (CR); Collection I. Sparacio, Palermo (CS).

Campania: Benevento, Monte Taburno, 800 m, 30.X.1993, one specimen (CS).

Calabria: Melia, nearby Grotte di Tremusa, 550 m, legit W. Renda, 24.XI.2007, one specimen (genitalia in 75% Ethanol, CL), (shell, CR).

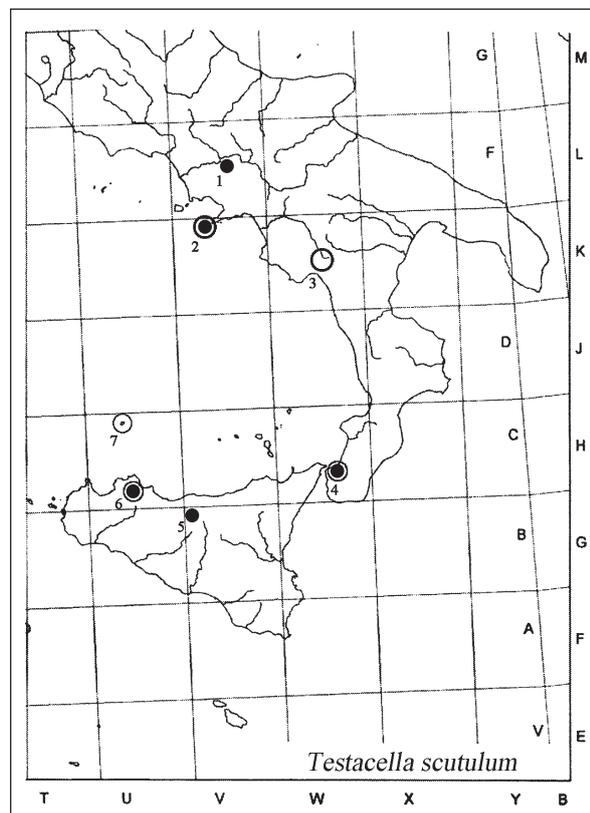


Figure 1. Distribution map showing the location of past and recent records of *Testacella scutulium* in Southern Italy and Sicily; blank circle, past records (before 1950), black dot, recent records (after 1950), circle with dot inside, past records confirmed by recent data. Localities: Benevento, Monte Taburno (1); island of Capri (2); Lagonegro, Mala Mogliera (3); Scilla, Grotte di Tremusa (4); Isnello, Vallone Madonie (5); Palermo, Ponte delle Grazie and Molara (6); island of Ustica (7).



Figures 2-5. Shells of *Testacella scutulum* from Campania, Benevento, Monte Taburno, h 7 mm, D 4.1 mm (Fig. 2), Calabria, Scilla, Grotte di Tremusa, h 4.7 mm, D 2.8 mm (Fig. 3), Sicily, Isnello, Vallone Madonie, h 6 mm, D 3.5 mm (Fig. 4), Sicily, Palermo, Ponte delle Grazie, h 5.7 mm, D 3.4 mm (Fig. 5).

Sicilia: Palermo, by the Oreto river bank, at Ponte delle Grazie, 77 m, 8-15.XI.1993, six specimens (in 75% Ethanol, CS); same place X/XI.1995, twelve shells (CS), three specimens and two shells, legit I. Sparacio (CL). Palermo, Molara, 140 m, 7.III.2011, one specimen, legit B. Massa (CS). Isnello, Vallone Madonie, 1130 m, 1.XI.2009, one specimen (CL); same place 14.XI.2010, one specimen (CL).

RESULTS AND DISCUSSION

Based on results of the analysis of reproductive apparatus, *Testacella* specimens investigated in the present study were attributed to *T. scutulium*. Such a species is characterized by a cylindrical penis, without flagellum and dilatations, with the retractor muscle originating from the apex of the penis, side by side with the point at which the vas deferens ends (Colosi, 1919; Quick, 1960; Giusti, 1968, 1976; Giusti & Mazzini, 1970; Giusti et al., 1995).

T. haliotidea differs from *T. scutulium* for the presence of a long penial flagellum and a short penial diverticulum situated level with where vas deferens ends (Giusti et al., 1995; De Mattia, 2006); whereas *T. gestroi* is characterized by both an appendix near the apex of the penis and a bifid retractor muscle, one branch of which is inserted on the penial apex and the other one on the appendix (Wagner, 1915; Giusti, 1970).

Shells of specimens examined in the present study were quite variable both in size and morphological characters (Figs. 2-5).

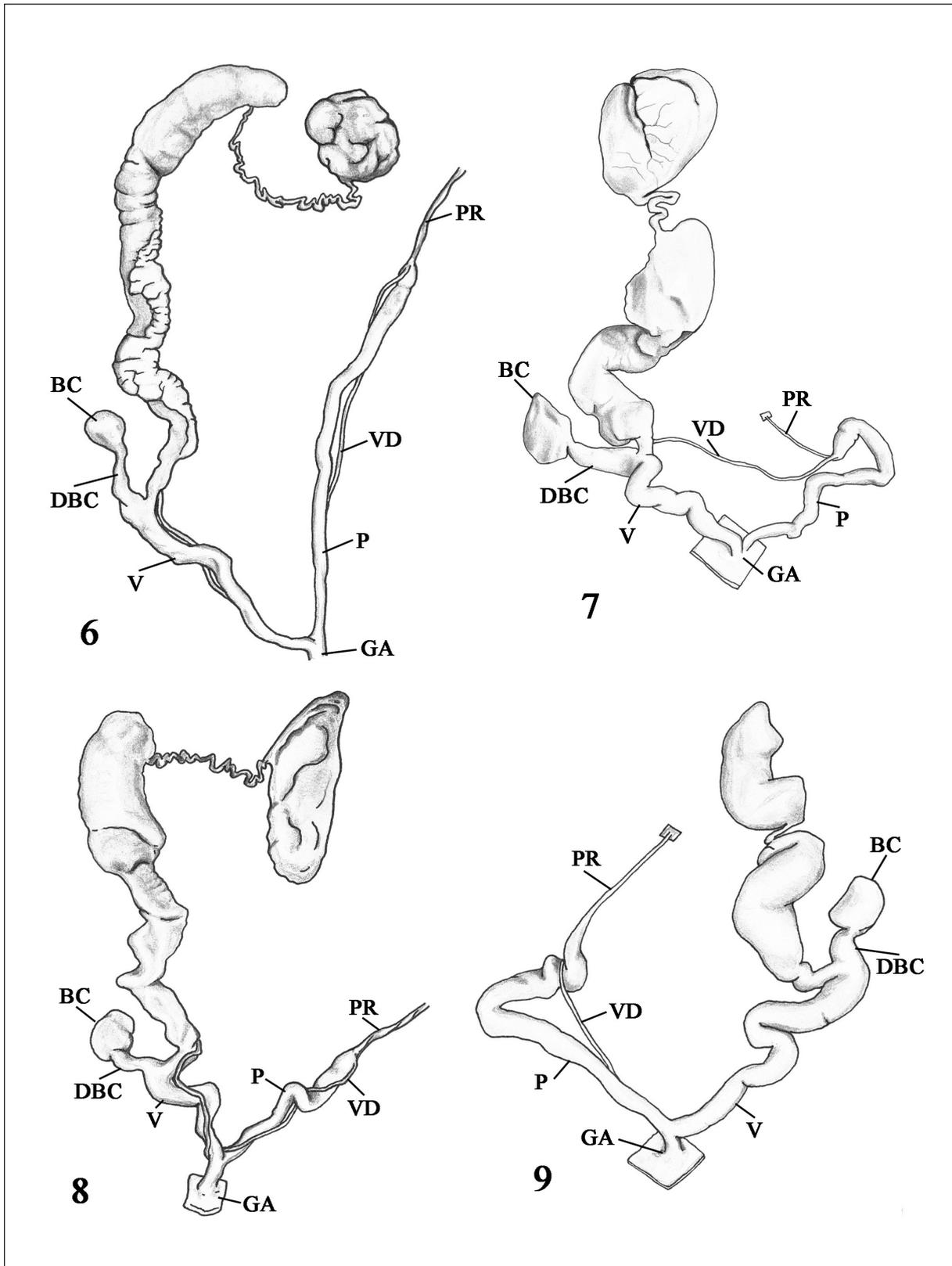
The specimen from Monte Taburno (Benevento) and those from Calabria and Sicily show the same structure of genitalia as that described for *T. scutulium*, with a more or less evident constriction of the proximal end of the penis, probably due to a contraction of the penis itself, and a retractor muscle sometimes very wide and more spanned on the penis apex (Giusti, 1970) (Figs. 6-9). Among all investigated animals, genitalia of the specimen from Monte Taburno were the most developed, while those of Sicilian samples were undersized with respect to the others.

From the ecological point of view, the specimen from Monte Taburno was collected under a rock in a natural environment comprising a meadow richly interspersed with shrubs at the edge of a group of

oaks (*Quercus pubescens* Willd.); the specimen from Calabria, found in the same place as that reported by Paulucci (1878, 1879), was collected in the day-time on a rock covered with a rich vegetation. *Testacella* caught at Ponte delle Grazie (Palermo) were found in activity on the fields, in the night-time. They were observed either in natural environments by the Oreto river banks with typical riparian vegetation or in the neighboring citrus plantations. *T. scutulium* (one specimen) picked up in Palermo (locality Molara) was recovered under the soil during ploughing time (B. Massa, *in verbis*) within a field bordered by citrus plantations and gardens. The two specimens from Isnello (Vallone Madonie) were found in the day-time under large stones not far from a stream. The environment was characterized by reforestation with alder-trees, *Alnus cordata* (Loisel.) Desf., a native species from southern Apennines in association with *Ulmus*, *Fraxinus*, *Salix* and *Populus* (Schicchi, 1998).

From the biological point of view, *Testacella* are molluscs particularly specialized in being predators and carnivours. The buccal mass is very developed and endowed with powerful muscles and a radula with hooked teeth. The shell, reduced in size, is located at the posterior region of the body. The body, which at rest is wider in the posterior region, during locomotion appears worm-like (Fig. 10). Such a features facilitate *Testacella* specimens in pursuing, capturing and swallowing preys in the subsoil cracks. Several authors (Lacaze-Dutiers, 1887; Webb, 1893; Barnes, 1950; Quick, 1960) supplied information on biology of these mollusks and, moreover, a very detailed analysis of the anatomy and method of functioning of the buccal mass of *T. maugei* Férussac, 1819, was provided by Crampton (1975), with particular attention to prey capture and feeding process. The sequence of events during feeding seems to include two major phases, the first of these is the seizure of a worm and the drawing of the first part of the body through the mouth; the second is the ingestion of the remainder of the worm.

In the first phase *Testacella* protract the odontophore far outside the mouth, so that the radular teeth are erect. The worm is caught by the hooked teeth on the leading edge of the odontophore and contraction of the radular retractor follows rapidly. The body of the worm is pulled into the odontophoral concavity and,



Figures 6-9. Genitalia of *Testacella scutulum* from Campania, Benevento, Monte Taburno (Fig. 6), P 28 mm, V 15.8 mm, CBC 5.4 mm, CBC+BC 8.3 mm; Calabria, Scilla, Grotte di Tremusa (Fig. 7), P 17 mm, V 9 mm, CBC 4.8 mm, CBC+BC 6 mm; Sicily, Isnello, Vallone Madonie (Fig. 8), P 12.5 mm, V 8 mm, CBC 3.2 mm, CBC+BC 5.5 mm; Sicily, Palermo, Ponte delle Grazie (Fig. 9), P 12.4 mm, V 12 mm, CBC 2.9 mm, CBC+BC 3.8 mm. Abbreviations: GA, genital atrium; BC, bursa copulatrix; DBC, duct of the bursa copulatrix; P, penis; PR, penial retractor muscle; V, vagina; VD, vas deferens.



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Figures 10-15. Living specimens. *Testacella scutulum* (Fig. 10). Sequence of events in the feeding process (Figs. 11-14). Phase of regurgitation of the worm (Fig. 15).

because the sides of the radula now collapse inwards, the worm is gripped on three sides by radular teeth. The buccal sphincter also contracts so that the worm is held firmly within the buccal vestibule and the buccal cavity.

The second phase is carried out without further protraction of the odontophore outside the mouth. Swallowing occurs by a combination of suction and odontophoral movements. Contraction of the buccal sphincter increases pressure within the buccal cavity and, as the oesophagus is opened the worm is partially sucked into this. Swallowing also necessitates active participation by the radula to release the prey. As the worm is held by the teeth, a forward movement of these effectively releases it to the oesophagus. Relaxation of the buccal sphincter muscle occurs at this point and now the radula underlies a more anterior portion of the worm and is rapidly retracted by the radular retractor muscles, drawing more of the worm in through the mouth. Interactions between odontophore, buccal sphincter and walls of the buccal cavity continue with a ratchet-like mechanism until the whole worm has been ingested. Usually, the worm is caught at one or other extremity or, alternatively, laterally (http://www.biodiversityjournal.com/video/BJ_video1.avi). In the last case, since the worm is ingested after having been folded, *Testacella* remarkably widens its mouth (Figs. 11, 12). It has also been observed that *Testacella* may swallow only a portion of the worm and then cut, without eating, the remaining part (Figs. 13-14). Generally capturing and feeding may take up to one hour. Ingested worm is digested by gastric juices (=digestive fluids) without being broken into pieces; this hypothesis is corroborated by the observation that in case of regurgitation the worm only shows superficial lacerations (Webb, 1893; present work, Fig. 15).

CONCLUSIONS

Records reported and discussed in the present paper result from researches on the field carried out for about twenty years in Sicily and Southern Italy. Description and illustration of genitalia of these population are given herein for the first time. These studies led us either to ascertain the occurrence of *T. scutulium* including a few localities never being reported up to now for this species, i.e. Benevento (Monte Taburno) and

Isnello (Vallone Madonie), or to confirm the persistence of the populations of Scilla (Grotte di Tremusa) and Palermo (Ponte delle Grazie). From the ecological point of view, collection sites resulted quite variegated, being natural (Monte Taburno, Grotte di Tremusa, Ponte delle Grazie); semi-natural and partially anthropized (surroundings of Ponte delle Grazie, Molaro), or still characterized by reafforestation within highly natural environments (Vallone Madonie). Because of their subterranean mode of life, *Testacella* are really useful in biogeographic studies (Giusti et al., 1995), and, for this reason, either deeper analyses by molecular genetic techniques in order to evaluate the real taxonomic status of some *T. scutulium* populations living in apparent isolation, or additional field investigations to ascertain the real distribution of the species are therefore desirable. Examples of anthropic passive transport of *Testacella* are, however, known for several geographic areas; New Zealand (Barker, 1999), South Africa (Quick, 1960), Australia (Smith & Kershaw, 1979; Smith, 1992), U.S.A. (Hanna, 1966; Branson, 1976; Thomas et al., 2010) hence, for some of the herein examined populations, a possible allochthonous origin cannot definitely be ruled out.

REFERENCES

- Alzona C., 1971. Malacofauna italiana. Catalogo e bibliografia dei molluschi viventi, terrestri e d'acqua dolce. Atti della Società italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano, 111: 1- 433.
- Bank R.A., 2011. Fauna Europea: Gastropoda, Helicidae. Fauna Europea version 1.1. <http://www.faunaeur.org>. Last access: 19.01.2011.
- Barker G.M., 1999. Naturalised terrestrial Stylommatophora (Mollusca: Gastropoda). Fauna of New Zealand, 38. Manaki Whenua Press, Canterbury, New Zealand, 254 pp.
- Barnes H.F., 1950. Worm eating slugs in Bedford gardens. Bedfordshire Naturalist, 4: 24-26.
- Bellini R., 1915. I molluschi extramarini dei dintorni di Napoli. Bollettino della Società di Naturalisti in Napoli, 27: 149-194.
- Benoit L., 1857. Illustrazione sistematica critica iconografica de' testacei estramarini della Sicilia Ulteriore e delle isole circostanti. Stabilimento Tipografico del Cav. Gaetano Nobile, Napoli, XIV + 52 pp.
- Bourguignat J.R., 1861. Notice sur les espèces vivantes et fossiles du genre *Testacella*. Revue et Magazin de Zoologie Pure et Appliquée, 13: 513-524.

- Branson B.A., 1976. *Testacella haliotidea* (Draparnaud) free living in Pennsylvania. *Sterkiana*, 62: 20.
- Calcara P., 1842. Esposizione dei molluschi terrestri e fluviatili dei contorni di Palermo. Roberti & Clamis, Palermo, 14 pp.
- Calcara P., 1845. Esposizione dei molluschi terrestri e fluviatili dei dintorni di Palermo. Atti dell'Accademia di Scienze e Lettere di Palermo, N.S., 1: 1-46.
- Colosi G., 1919. Testacellidi conservati nel R. Museo Zoologico di Firenze. *Monitore Zoologico Italiano*, 30: 57-63.
- Costa O. G., 1840. Statistica fisica ed economica dell'isola di Capri. Molluschi. Esercitazioni accademiche degli aspiranti naturalisti, 2: 1-140.
- Crampton D. M., 1975. The anatomy and method of functioning of the buccal mass of *Testacella maugei* Férussac. *Proceedings malacological Society of London*, 41: 549-570.
- De Mattia W., 2006. New records of *Testacella scutulum* Sowerby, 1821 and *Paralaoma servilis* (Shuttleworth, 1852) (Gastropoda: Pulmonata: Testacellidae et Punctidae) from Istria, Kvarner and Dalmatia (Italy, Slovenia and Croatia). *Malakologische Abhandlungen*, 24: 121-127.
- Degner E., 1927. Zur Molluskenfauna Unteritaliens. Mitteilungen aus dem Zoologischen Staatsinstitut und Zoologischen Museum Hamburg, 43: 39-124.
- Giusti F., 1968. Notule malacologiche V. Le isole di Gorgona, Capraia e Giglio. *Atti della Società Toscana di Scienze Naturali, Memorie, Serie B*, 75: 265-324.
- Giusti F., 1970. Notulae Malacologicae, X. *Testacelloides* Wagner e *Testacella (Testacelloides) gestroi* Issel, un buon sottogenere ed una buona specie della Sardegna. *Atti della Società Toscana di Scienze Naturali, Memorie, Serie B*, 77: 55-66.
- Giusti F., 1976. Notulae Malacologicae, XXIII. I molluschi terrestri, salmastri e di acqua dolce dell'Elba, Giannutri e scogli minori dell'Arcipelago Toscano. Conclusioni generali sul popolamento malacologico dell'Arcipelago Toscano e descrizione di una nuova specie. (Studi sulla Riserva naturale dell'Isola di Montecristo, IV). *Lavori della Società italiana di Biogeografia (N.S.)*, 5: 99-355.
- Giusti F., Manganelli G. & Schembri P.J., 1995. The non-marine molluscs of the Maltese Islands. *Monografie Museo Regionale Scienze Naturali, Torino*, 15: 1-607.
- Giusti F. & Mazzini M., 1970. Notulae malacologicae XIV. I molluschi delle Alpi Apuane. Elenco delle specie viventi con descrizione di una nuova specie: *Vitrinobranchium baccettii* n. sp. *Lavori della Società italiana di Biogeografia (N.S.)*, 1: 202-335.
- Hanna G.D., 1966. Introduced mollusks of western North America. *California Academy of Sciences Occasional Papers*, 48:1-108.
- Lacaze-Duthiers H. De., 1887. Histoire de la Testacelle. *Archives de Zoologie expérimentale et générale*, 5: 459-596.
- Manganelli G., Bodon M., Favilli I. & Giusti F., 1995. *Gastropoda Pulmonata*, In: Minelli A., Ruffo S. & La Posta S. (eds.), *Checklist delle specie della fauna d'Italia*, 16, 60 pp.
- Paulucci M., 1878. *Materiaux pour servir a l'étude de la faune malacologique terrestre et fluviatile de l'Italie et de ses îles*. Librairie F. Savy, Paris, IV + 54 pp.
- Paulucci M., 1879. Escursione scientifica nella Calabria 1877-78. *Fauna malacologica, specie terrestri e fluviatili*. Tipi dell'arte della stampa, Firenze, 223 pp.
- Petraccioli A., Barattolo F., Crovato P., Cretella M., Maio N. & Aprea G., 2005. Guida pratica al riconoscimento dei macro-gasteropodi terrestri attuali e fossili dell'isola di Capri. *Bollettino sezione Campania ANISN*, 29: 19-48.
- Pilsbry H.A., 1885. In: Tryon G.W. & Pilsbry H.A., *Manual of Conchology, structural and systematic*. With the illustrations of the species. Second series: Pulmonata, 1: 1-364.
- Pirajno E., 1842. Nota di talune specie di Molluschi terrestri e fluviatili di Sicilia. *Giornale di Scienze Lettere e Arti per la Sicilia*, 77: 156-163.
- Pollonera C., 1889. Osservazioni intorno ad alcune specie di *Testacella*. *Bollettino dei Musei di Zoologia ed Anatomia comparata della Regia Università di Torino*, 4: 1-6.
- Quick H.E., 1960. British slugs (Pulmonata; Testacellidae, Arionidae, Limacidae). *Bulletin of the British Museum (Natural History), Zoology*, 6: 103-226.
- Rinaldi A.C., 2003a. Note a proposito di *Testacella* Cuvier, 1800 (Gastropoda, Pulmonata, Testacellidae). *La Conchiglia*, 35: 47-54.
- Rinaldi A.C., 2003b. New records of *Testacella* (Gastropoda, Pulmonata, Testacellidae) from Abruzzo and Sardinia, Italy. *Bollettino Malacologico*, 39: 203-206.
- Schicchi R., 1998. Spontaneizzazione di *Alnus cordata* (Loisel) Desf. (Betullaceae) sulle Madonie (Sicilia). *Il Naturalista Siciliano*, 22: 447-455.
- Schileyko A.A., 2000. *Treatise on recent terrestrial Pulmonate molluscs*. Part. 6. Rhytididae, Chlamydephoridae, Systrophiiidae, Haplotrematidae, Streptaxidae, Spiraxidae, Oleacinidae, Testacellidae. *Ruthenica, Supplement 2*: 731-880.
- Smith B.J., 1992. Non-marine mollusca. In: Houston, W.W.K., Editor *Zoological Catalogue of Australia* 8, CSIRO Publishing, Canberra, 405 pp.
- Smith B.J. & Kershaw R.C., 1979. *Field guide to the non-marine Mollusca of South-Eastern Australia*. Australian National University Press, Canberra, 285 pp.
- Testa D., 1842. Osservazione sopra alcune conchiglie. *La Cerere*, 31: 1.
- Thomas A.K., Mc Donnell R.J., Paine T.D. & Harwood J.D., 2010. *A Field Guide to the Slugs of Kentucky*. Lexington, 34 pp.
- Webb W.M., 1893. On the manner of feeding in *Testacella scutulum*. *The Zoologist*, 17: 281-289.
- Wagner A.J., 1915. Beiträge zur Anatomie und Systematik der Stylomatophoren aus dem Gebiete der Monarchie und der angrenzenden Balkanländer. *Denkschriften der kaiserlichen Akademie der Wissenschaften mathematisch-naturwissenschaftlichen Classe*, 91: 429-498.