

CONTRIBUTION TO THE FRESHWATER GASTROPODS OF THE ISLAND OF ANDROS IN THE NORTHERN CYCLADES (AEGEAN ISLANDS, GREECE)

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ABSTRACT: New data on the freshwater gastropods of the island of Andros (Northern Cyclades, Greece) are presented. We surveyed the gastropod fauna of 27 freshwater springs, rivulets and water reservoirs located mainly in the central part of the island. Six gastropod species were identified. At least two more species of the genera *Pseudamnicola* and *Bythinella* were also recorded. Although all the gastropod species are known from mainland Greece, *Theodoxus fluviatilis* (Linnaeus, 1758), *Haitia acuta* (Draparnaud, 1805), *Planorbis atticus* (Bourguignat, 1852) and *Galba truncatula* (O. F. Müller, 1774) are reported for the first time from Andros. Literature records, material examined, taxonomic remarks, and ecological information such as altitudinal ranges and habitat preferences are given for each species. Illustrations and distribution maps are provided; the history of the fauna is briefly discussed.

KEY WORDS: Aegean archipelago, distribution, Greece, new records, habitat preferences, taxonomy

INTRODUCTION

Freshwater gastropods from Greece have been recorded by various authors in the last two centuries (e.g. CLESSIN 1878a, b, BOETTGER 1889, SCHÜTT 1980, REISCHÜTZ et al. 2008). BANK (2006) published a comprehensive catalogue of freshwater molluscs, including distribution records and references. Since then, many notable works have added to our knowledge of freshwater gastropods of Greece with exploration of new localities, description of new species and genetic analyses (e.g. GLÖER et al. 2010, ALBRECHT et al. 2012, FALNIOWSKI et al. 2012, RADEA et al. 2013a, b, SZAROWSKA et al. 2016a, b). So far, only few Greek islands have been surveyed for freshwater gastropods (e.g. RÄHLE 1980, SCHÜTT 1980, 1982, 1986, REISCHÜTZ 1985, BANK 1988, SEIDL 2001, RADEA et al. 2016, SZAROWSKA et al. 2016a, b), whereas in older studies mainly general information, for example prefecture names and spe-

cies lists from collecting trips, was provided (e.g. CLESSIN 1878a, b). Contemporary works, fortunately, provide detailed information on localities and very often adopt a comprehensive approach to species delimitation, including genetic and morphological analyses (e.g. RADEA et al. 2016, SZAROWSKA et al. 2016a, b). These works often focus on single species or species-groups (e.g. FALNIOWSKI et al. 2012, SZAROWSKA et al. 2014, RADEA et al. 2016).

According to BANK (2006) five freshwater gastropod species have been recorded from Andros (Northern Cyclades) so far: *Ancylus fluviatilis* (O. F. Müller, 1774), *Bythinella charpentieri* (Roth, 1855), *Melanopsis buccinoidea* (Olivier, 1801), *Pseudamnicola macrostoma* (Küster, 1853) and *Theodoxus saulcyi* (Bourguignat, 1852). *A. fluviatilis* and *M. buccinoidea* were first mentioned by BOETTGER (in STUSSINER & BOETTGER 1886) and MARTENS (1889), respectively.



B. charpentieri, *P. macrostoma* and *T. saulcyi* were studied by SCHÜTT (1980, 1986). Only recently, the phylogeographical study of the hydrobiid genera *Bythinella* and *Pseudamnicola* in the Aegean islands showed that the populations of Andros were distinct from those in mainland Greece and other Aegean islands, reflecting the complex geological history of the Cycladic area and the Late Pleistocene colonisation events, respectively (SZAROWSKA et al. 2016a, b).

Andros is the northernmost island of the Cyclades in the central Aegean Sea; it is located about 12 km southeast of Evvoia Island and approximately 55 km east of mainland Greece (Attica). With its area of ca. 379 km², it is the second largest island of the Cyclades after Naxos. It is mainly mountainous, with the highest altitude at 994 m (Mount Petalo, peak of Kouvara). Andros has the highest annual precipitation in the Cyclades, and holds a richness of vascular plants consisting mainly of maquis, phrygana and forests (POLEMIS et al. 2012). It is also one of

the richest Cycladic islands in terms of freshwaters, partly due to its geographical position and geological relief (BROGGI 1996). The central part of the island is rich in small rivulets and freshwater springs. Several wetlands exist in its northern part (BROGGI 1996). Andros was isolated from the mainland around 30 to 18 kya BP (LYKOUSIS 2009), and was completely detached from the other Cycladic islands around 8 to 6 kya BP (KAPSIMALIS et al. 2009). Archaeological excavations show that the earliest human presence on the island was during the Mycenaean times or even earlier (LIRITZIS 2010).

Here, we provide new distribution data on the freshwater gastropods of Andros with notes on their taxonomy and habitat preferences. There is a need for modern and integrative work (genetic and morphological) regarding several freshwater gastropod species to disentangle their biogeographic history and to serve conservation purposes.

MATERIAL AND METHODS

Samples were collected along the central valley of the island (Messaria), located between Mount Petalo (994 m) in the north and Mount Gerakonas (720 m) in the south, on the 22nd–24th August 2014, 14th May 2015 (1 site), and 28th–31st August 2015. The 27 surveyed localities included freshwater springs, ephemeral waters, tanks, natural pools, ditches and rivulets/streams between 0 (site 9) and 663 m (site 21) a.s.l (Figs 1–27, Table 1). The specimens were collected by hand from fallen leaves, spring walls and floor and submerged vegetation.

All specimens were preserved in spring water and subsequently in 70% ethanol. They were identified based on shell and/or anatomical characters, using a ZEISS Discovery.V20 stereomicroscope and photographed with the attached AxioCam MRc5 using the stacking module of the software ZEISS AxioVision SE 64 4.9 to obtain focused images (Figs 28–44).

The material is deposited in the Malacological Collection of the 3rd Zoological Department at the Natural History Museum of Vienna (NHMW).

RESULTS

“Previous records” refer to previously recorded occurrences of the species on the island of Andros. “Distribution and IUCN status” is provided for the species when available from the IUCN Red List.

Class: Gastropoda Cuvier, 1795

Family: Neritidae Rafinesque, 1815

Subfamily: Neritinae Poey, 1852

Genus: *Theodoxus* Montfort, 1810

***Theodoxus fluviatilis* (Linnaeus, 1758)**

Figs 28, 45

1986 *Theodoxus saulcyi* (Bourguignat, 1852) – SCHÜTT: 284, figs 12–14. [non *Theodoxus saulcyi* (Bourguignat, 1852)]

1988 *Theodoxus saulcyi* (Bourguignat, 1852) – FRANK: 82. [non *Theodoxus saulcyi* (Bourguignat, 1852)]

Material examined: Site 8, Apoikia, village entrance, on road curve, stream with flowing and stagnant water, 295 m a.s.l., 37°50'44.9"N, 24°54'21.8"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111854/1 in ethanol); Site 16, Pitrofos, fountain by bus station, 297 m a.s.l., 37°48'44.64"N, 24°52'34.84"E, leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111880/18 in ethanol); Site 16a, Pitrofos, fountain by bus station, 297 m a.s.l., 37°48'44.64"N, 24°52'34.84"E, leg. GEORGOPOULOU & SIMAIKIS, 24.08.2014 (Mollusca NHMW 111912/14 in ethanol); Site 17, Menites, Lions fountain, 222 m a.s.l., 37°49'21.37"N, 24°53'45.74"E, leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111883/40 in ethanol); Site 17a, Menites, Lions fountain, 222 m a.s.l.,



Table 1. List of surveyed sites and their coordinates. The name of the closest village or settlement is given

Site No.	Description	Coordinates
Site 1	Ano Menites, concrete water tank on roadside	37°49'30.35"N, 24°53'53.94"E
Site 2	Strapouries, fountain Metoxi-Ipsilou and concrete tank next to it	37°50'05.64"N, 24°54'25.29"E
Site 3	Ipsilou, traditional Ipsilou-Doubli fountain and mud puddles on roadside	37°50'19.42"N, 24°55'07.01"E
Site 4	Lamira, rivulet with flow	37°49'36.46"N, 24°54'44.60"E
Site 5	Paraporti, rivulet near traditional bridge	37°49'37.89"N, 24°55'48.45"E
Site 6	Livadia, small fountain near village	37°49'20.32"N, 24°55'52.26"E
Site 7	Apoikia, pipe leak under concrete tank, next to Agios Spiridonas church	37°50'50.66"N, 24°54'21.68"E
Site 8	Apoikia, village entrance, on road curve, stream with flowing and stagnant water	37°50'44.90"N, 24°54'21.80"E
Site 9	Nimporio, rivulet with concrete banks, by beach	37°50'37.86"N, 24°56'04.49"E
Site 10	streamlet behind Pera Chorion-Aladou fountain	37°47'36.57"N, 24°53'10.65"E
Site 11	Sasa, village entrance, artificial pool on roadside	37°47'58.97"N, 24°53'37.05"E
Site 12	Aladinou, stream under bridge	37°48'34.94"N, 24°54'00.04"E
Site 13	Gianniseo (Stavros), water-filled tank, running water and spring	37°46'57.00"N, 24°55'34.90"E
Site 14	Plaka, on road to beach, natural pool	37°46'22.14"N, 24°53'32.99"E
Site 15 (15a)	Pitrofos, Kasaba fountain	37°48'48.88"N, 24°52'35.62"E
Site 16 (16a)	Pitrofos, fountain by bus station	37°48'44.64"N, 24°52'34.84"E
Site 17 (17a)	Menites, Lions fountain	37°49'21.37"N, 24°53'45.74"E
Site 18	Evrousies, stagnant waters on roadside	37°50'15.05"N, 24°53'04.72"E
Site 19	Evrousies, natural pools	37°50'07.36"N, 24°52'54.09"E
Site 20	Evrousies, on road to Chora, water pipe with quick flow	37°50'18.82"N, 24°53'58.98"E
Site 21	Vourkoti, village entrance, on road curve, Varidi stream	37°51'24.86"N, 24°53'04.95"E
Site 22	Achla crossroad to Arnas, Voris stream	37°51'45.13"N, 24°51'29.42"E
Site 23	Revmata, stream	37°51'53.25"N, 24°50'11.83"E
Site 24	Ano Pitrofos, Pano Rema fountain, and stream by fountain	37°49'00.92"N, 24°52'26.09"E
Site 25	Melida, end of asphalt road, stream with rocks on roadside	37°48'38.89"N, 24°51'26.48"E
Site 26	Zaganiaris to Kochylou, small tank	37°46'42.53"N, 24°53'40.22"E
Site 27	Agios Georgios, artificial pool	37°46'36.37"N, 24°53'27.67"E

37°49'21.37"N, 24°53'45.74"E, leg. GEORGOPOULOU & SIMAIAKIS, 24.08.2014 (Mollusca NHMW 111915/22 in ethanol); Site 23, Revmata, stream, 185 m a.s.l., 37°51'53.25"N, 24°50'11.83"E, leg. GEORGOPOULOU & SIMAIAKIS, 30.08.2015 (Mollusca NHMW 111864/4 in ethanol); Site 24, Ano Pitrofos, Pano Rema fountain and nearby stream, 441 m a.s.l., 37°49'00.92"N, 24°52'26.09"E, leg. GEORGOPOULOU & SIMAIAKIS, 31.08.2015 (Mollusca NHMW 111896/1 in ethanol); Site 25, Melida, end of asphalt road, stream with rocks on roadside, 412 m a.s.l., 37°48'38.89"N, 24°51'26.48"E, leg. GEORGOPOULOU & SIMAIAKIS, 31.08.2015 (Mollusca NHMW 111900/11 in ethanol).

Previous records: This is the first record from Andros.

Habitat notes: The species was collected from six localities between 185 and 441 m a.s.l. The snails were attached to rocks or concrete walls of usually

fast flowing waters. In site 17 (and 17a), the species was abundant.

Distribution and IUCN status: *T. fluviatilis* is a Western Palaearctic species, ranked as Least Concern (IUCN 2016).

Family: Melanopsidae H. et A. Adams, 1854

Subfamily: Melanopsinae H. et A. Adams, 1854

Genus: *Melanopsis* A. Férussac, 1807

***Melanopsis buccinoidea* (Olivier, 1801)**

Figs 31, 46

1889 *Melanopsis praerosa* (L.) var. *ferussaci* Roth, 1839 – MARTENS: 184.

1936 *Melanopsis* (*Melanopsis*) *praemorsa buccinoidea* Olivier – FUCHS & KÄUFEL: 542.

Material examined: Site 8, Apoikia, village entrance, on road curve, stream with flowing and stagnant water, 295 m a.s.l., 37°50'44.9"N, 24°54'21.8"E, leg.



Figs 1–27. The surveyed localities. Site numbers correspond to those in Table 1



GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111853/31 in ethanol); Site 9, Nimporio, rivulet with concrete banks, by beach, 0 m a.s.l., 37°50'37.86"N, 24°56'04.49"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111856/5 in ethanol).

Previous records: The species was recorded from Andros as *Melanopsis praerosa* (L.) var. *ferussaci* Roth, 1839 by MARTENS (1889), who in the same work synonymised *Melanopsis praerosa* (L.) with *buccinoidea* Oliv. Also, FUCHS & KÄUFEL (1936) reported *Melanopsis praemorsa buccinoidea* from Andros.

Habitat notes: The species was found in Sites 8 and 9, between 0 and 295 m a.s.l., on submerged *Platanus* leaves in flowing water.

Distribution and IUCN status: According to the IUCN Red List, *M. buccinoidea* is distributed in the eastern Mediterranean and is a Least Concern species (IUCN, 2016).

Superfamily: Planorboidea Rafinesque, 1815

Family: Physidae Fitzinger, 1833

Subfamily: Physinae Fitzinger, 1833

Genus: *Haitia* Clench et Aguayo, 1932

Haitia acuta (Draparnaud, 1805)

Figs 33, 47

Material examined: Site 5, Paraporti, rivulet near traditional bridge, 14 m a.s.l., 37°49'37.89"N, 24°55'48.45"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111846/1 dry + Mollusca NHMW 111845/96 in ethanol).

Previous records: This is the first record from Andros.

Habitat notes: The species was found only in site 5, attached to large pebbles, submerged in flowing water.

Distribution and IUCN status: *H. acuta* is distributed throughout Holarctic and is regarded as Least Concern (IUCN, 2016).

Family: Planorbidae Rafinesque, 1815

Subfamily: Planorbinae Rafinesque, 1815

Genus: *Planorbis* O. F. Müller, 1773

Planorbis atticus (Bourguignat, 1852)

Figs 32, 48

Material examined: Site 1, Ano Menites, concrete water-filled tank on roadside, 275 m a.s.l., 37°49'30.35"N, 24°53'53.94"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111831/13 in ethanol); Site 4, Lamira, rivulet with flow, 102 m a.s.l., 37°49'36.46"N, 24°54'44.60"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca

NHMW 111841/2 dry + Mollusca NHMW 111840/3 in ethanol); Site 5, Paraporti, rivulet near traditional bridge, 14 m a.s.l., 37°49'37.89"N, 24°55'48.45"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111847/5 in ethanol); Site 7, Apoikia, pipe leak under concrete tank, next to Agios Spiridonas church, 335 m a.s.l., 37°50'50.66"N, 24°54'21.68"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111849/3 dry + Mollusca NHMW 111850/2 in ethanol); Site 9, Nimporio, rivulet with concrete banks, by beach, 0 m a.s.l., 37°50'37.86"N, 24°56'04.49"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111855/12 in ethanol); Site 11, Sasa, village entrance, artificial pool on road-side, 238 m a.s.l., 37°47'58.97"N, 24°53'37.05"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111866/8 in ethanol); Site 12, Aladinou, stream, under bridge, 93 m a.s.l., 37°48'34.94"N, 24°54'00.04"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111870/8 in ethanol); Site 13, Gianniseo (Stavros), water-filled tank, running water and spring, 405 m a.s.l., 37°46'57.00"N, 24°55'34.90"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111872/2 in ethanol).
Previous records: This is the first record from Andros.

Habitat notes: The species was found in eight sites between 0 and 405 m a.s.l., on concrete walls at and below the water table, in mud, and attached to rocks and submerged fallen leaves.

Distribution and IUCN status: *P. atticus* is known from Greece and regarded as Least Concern species (IUCN, 2016).

Genus: *Ancylus* O. F. Müller, 1774

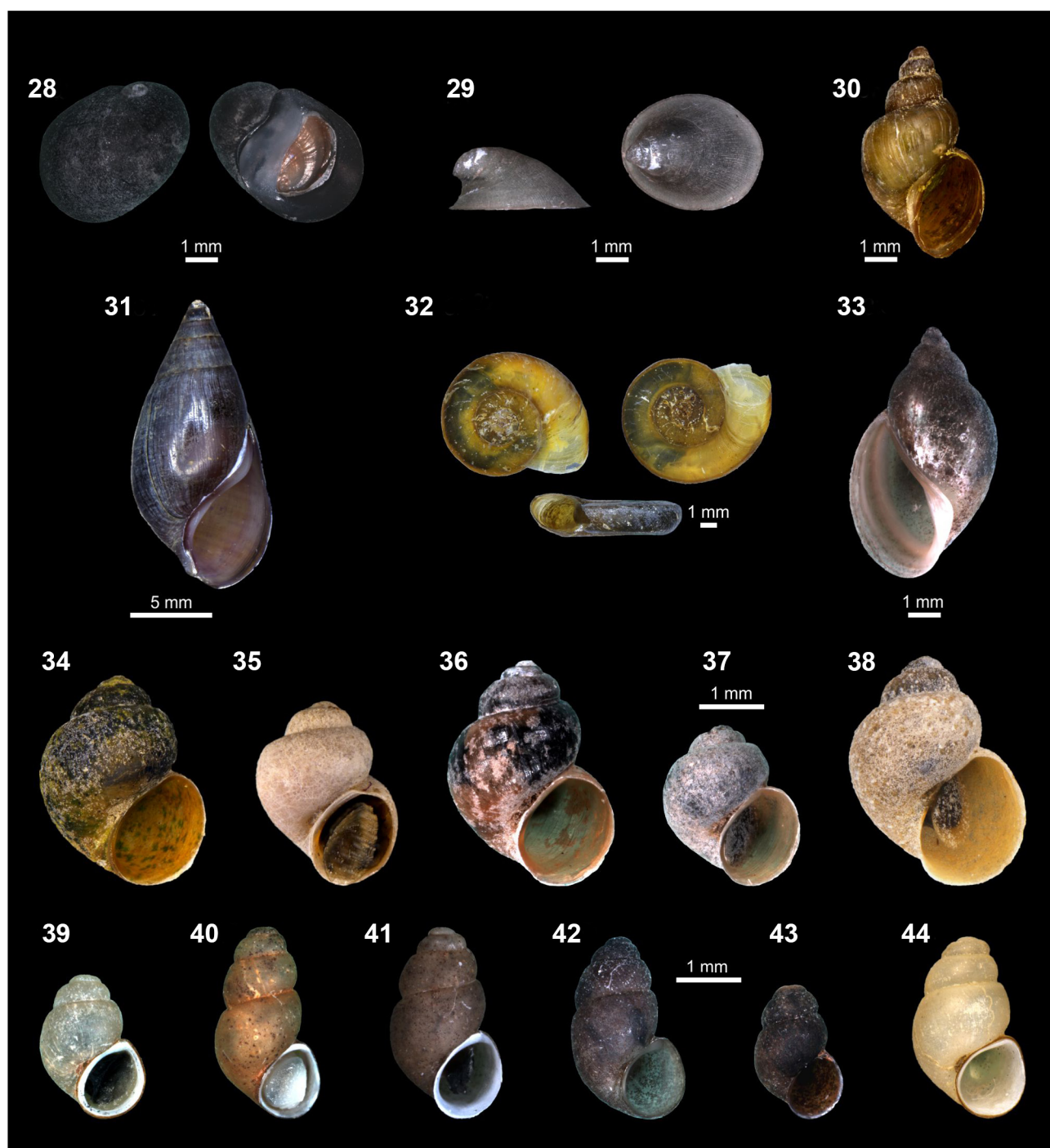
Ancylus fluviatilis O. F. Müller, 1774

Figs 29, 49

1886 *Ancylus* (*Ancylastrum*) *fluviatilis* (Müller) var. *gibbosa* Bourguignat – BOETTGER in STUSSINER & BOETTGER: 64.

1982 *Ancylus fluviatilis* O. F. Müller, 1774 – SCHÜTT: 521.

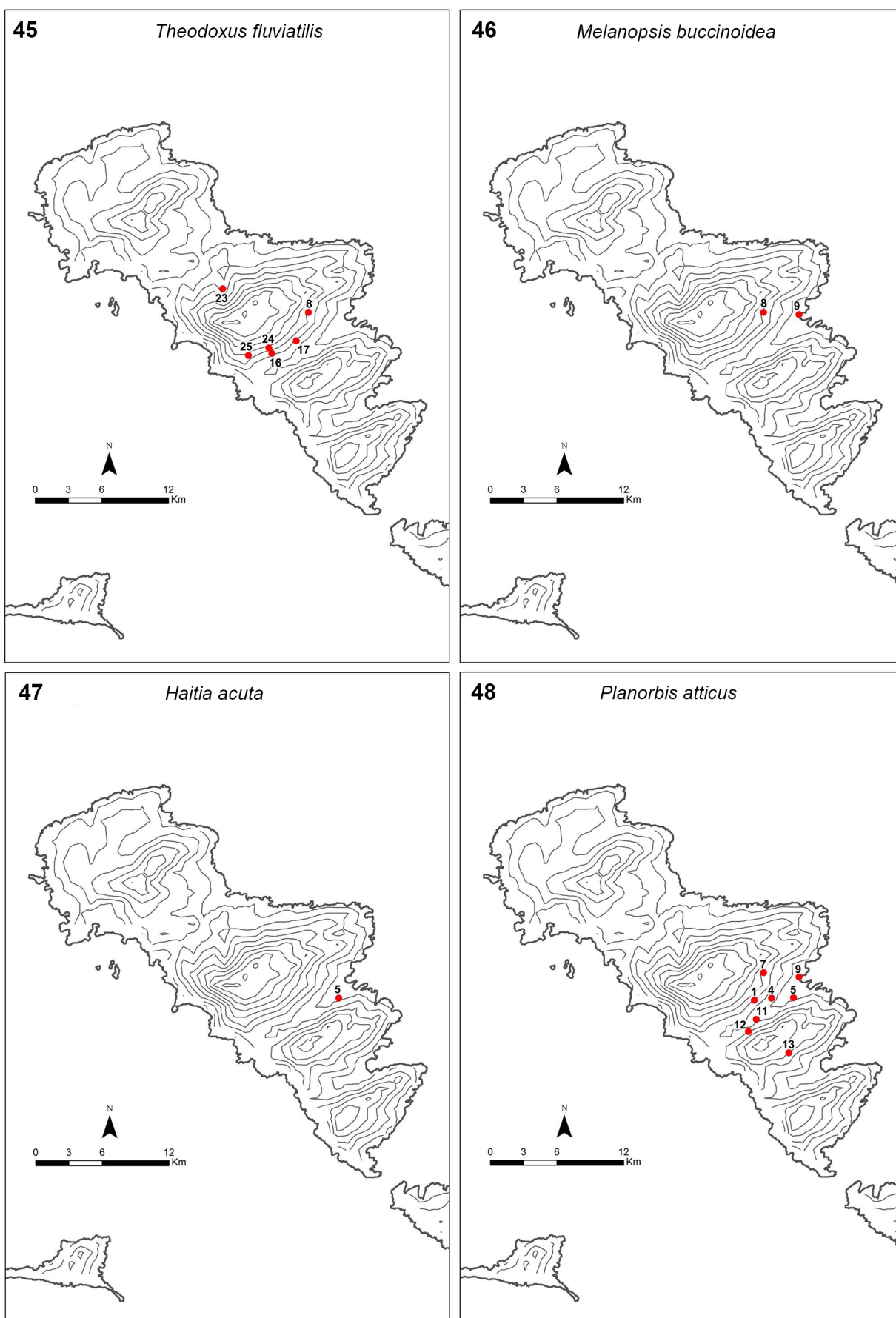
Material examined: Site 4, Lamira, rivulet with flow, 102 m a.s.l., 37°49'36.46"N, 24°54'44.60"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111837/1 dry + Mollusca NHMW 111836/10 in ethanol); Site 5, Paraporti, rivulet at traditional bridge, 14 m a.s.l., 37°49'37.89"N, 24°55'48.45"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111844/21 in ethanol); Site 8, Apoikia, village entrance, on road curve, stream with flowing and stagnant water, 295 m a.s.l., 37°50'44.9"N, 24°54'21.8"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111852/3 dry + Mollusca NHMW 111851/3 in ethanol); Site 10, streamlet behind Pera Chorion-Aladou foun-



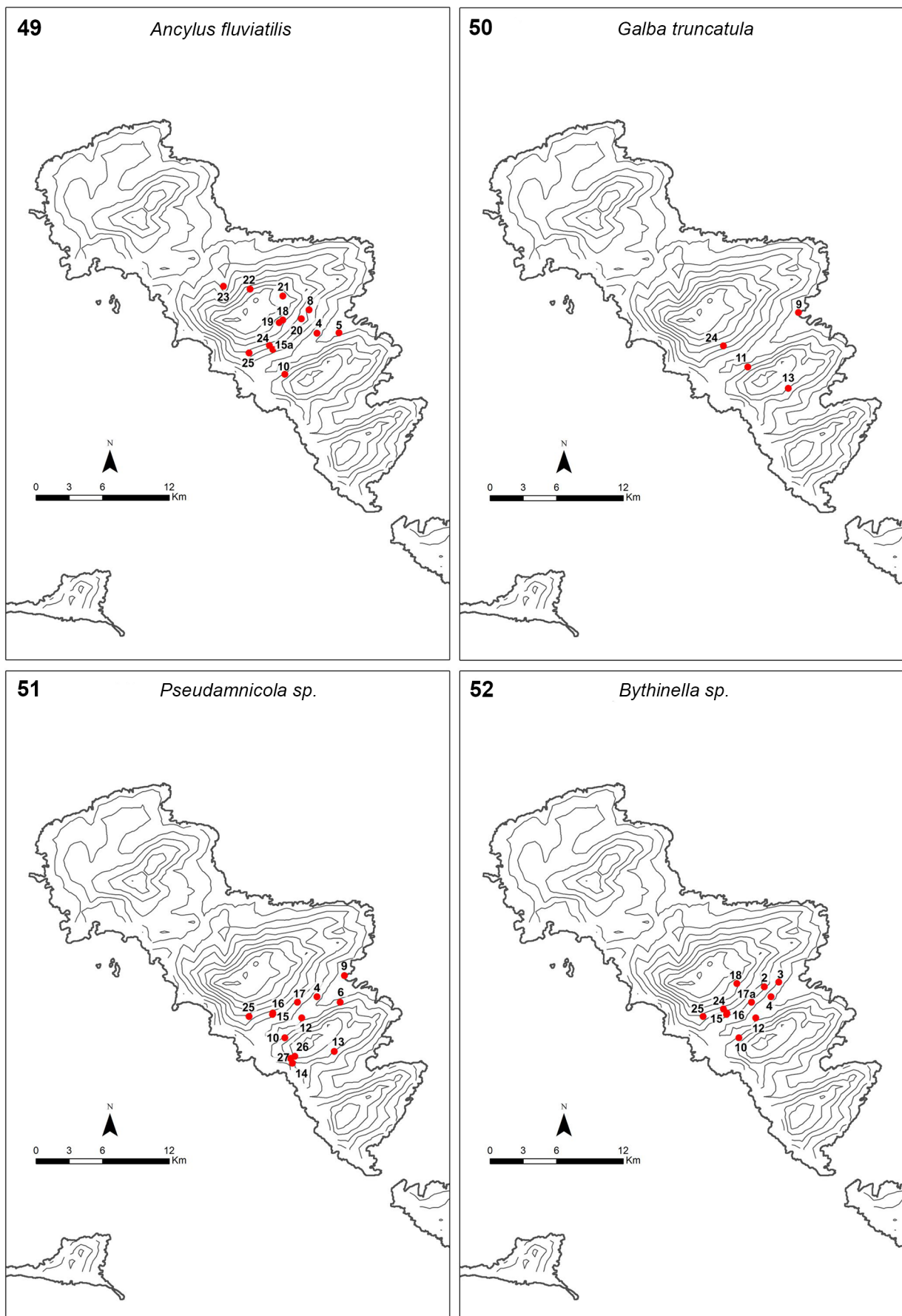
Figs 28–44. Freshwater snails recorded from the island of Andros: 28 – *T. fluviatilis* (site 24), 29 – *A. fluviatilis* (site 4), 30 – *G. truncatula* (site 13), 31 – *M. buccinoidea* (site 8), 32 – *P. atticus* (site 1), 33 – *H. acuta* (site 5), 34–38 – *Pseudamnicola* sp. (sites 13, 17a, 25, 25, 27, respectively), 39–44 – *Bythinella* sp. (sites 2, 3, 3, 10, 18, 15a)

tain, 257 m a.s.l., 37°47'36.57"N, 24°53'10.65"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111862/3 in ethanol); Site 15a, Pitrofos, Kasaba fountain, 340 m a.s.l., 37°48'48.88"N, 24°52'35.62"E, leg. GEORGOPOULOU & SIMAIKIS, 22.08.2014 (Mollusca NHMW 111904/5 dry + Mollusca NHMW 111905/1 in ethanol); Site 18, Evrousies, stagnant water on roadside, 579 m a.s.l., 37°50'15.05"N, 24°53'04.72"E, leg. GEORGOPOULOU

& SIMAIKIS, 30.08.2015 (Mollusca NHMW 111884/8 in ethanol); Site 19, Evrousies, natural pools, 596 m a.s.l., 37°50'07.36"N, 24°52'54.09"E, leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111886/23 in ethanol); Site 20, Evrousies, on road to Chora, water pipe with fast flow, 512 m a.s.l., 37°50'18.82"N, 24°53'58.98"E, leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111887/5 in ethanol); Site 21,



Figs 45–48. Species distributions based on sampling sites



Figs 49–52. Species distributions based on sampling sites



Vourkoti, village entrance, on road curve, Varidi stream, 663 m a.s.l., 37°51'24.86"N, 24°53'04.95"E, leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111889/2 dry + Mollusca NHMW 111888/11 in ethanol); Site 22, Achla crossroad to Arnas, Voris stream, 648 m a.s.l., 37°51'45.13"N, 24°51'29.42"E, leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111891/1 dry + Mollusca NHMW 111890/4 in ethanol); Site 23, Revmata, stream, 185 m a.s.l., 37°51'53.25"N, 24°50'11.83"E, leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111892/14 in ethanol); Site 24, Ano Pitrofos, Pano Rema fountain and nearby stream, 441 m a.s.l., 37°49'00.92"N, 24°52'26.09"E, leg. GEORGOPOULOU & SIMAIKIS, 31.08.2015 (Mollusca NHMW 111893/9 in ethanol); Site 25, Melida, end of asphalt road, stream with rocks on roadside, 412 m a.s.l., 37°48'38.89"N, 24°51'26.48"E, leg. GEORGOPOULOU & SIMAIKIS, 31.08.2015 (Mollusca NHMW 111897/4 in ethanol).

Previous records: BOETTGER (in STUSSINER & BOETTGER 1886) was the first to mention the species from Andros. SCHÜTT (1982) found it in Stenia, Ateni, Revmata, Apikia (Apoikia), Vourkoti and Varidion.

Habitat notes: The species was found in 13 sites with fast to very slow or stagnant water, attached to stones, water pipes and concrete walls of fountains. In site 19, copulation of several pairs was observed.

Distribution and IUCN status: *A. fluviatilis* is a Least Concern species distributed in Europe and North Africa (IUCN, 2016).

Family: Lymnaeinae Rafinesque, 1815

Genus: *Galba* Schrank, 1803

***Galba truncatula* (O. F. Müller, 1774)**

Figs 30, 50

Material examined: Site 9, Nimporio, rivulet with concrete banks, by beach, 0 m a.s.l., 37°50'37.86"N, 24°56'04.49"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111861/2 dry + Mollusca NHMW 111860/59 in ethanol); Site 11, Sasa, village entrance, artificial pool on roadside, 238 m a.s.l., 37°47'58.97"N, 24°53'37.05"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111867/1 in ethanol); Site 13, Gianniseo (Stavros), water-filled tank, running water and spring, 405 m a.s.l., 37°46'57.00"N, 24°55'34.90"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111874/7 in ethanol); Site 24, Ano Pitrofos, Pano Rema fountain and nearby stream, 441 m a.s.l., 37°49'00.92"N, 24°52'26.09"E, leg. GEORGOPOULOU & SIMAIKIS, 31.08.2015 (Mollusca NHMW 111895/2 in ethanol).

Previous records: This is the first record from Andros.

Habitat notes: *G. truncatula* was collected from four sites. It was very abundant in Site 9, where it was attached to the rivulets' concrete walls in dense populations along with *Oxyloma* cf. *elegans* above the water table. In site 13 it was found submerged among freshwater weeds.

Superfamily: Rissooidea Gray, 1847

Family: Hydrobiidae Stimpson, 1865

Subfamily: Hydrobiinae Stimpson, 1865

Genus: *Pseudamnicola* Paulucci, 1878

***Pseudamnicola* sp.**

Figs 34–38, 51

Material examined: Site 4, Lamira, rivulet with flow, 102 m a.s.l., 37°49'36.46"N, 24°54'44.60"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111843/1 dry + Mollusca NHMW 111842/4 in ethanol); Site 6, Livadia, small fountain near village, 104 m a.s.l., 37°49'20.32"N, 24°55'52.26"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111848/11 in ethanol); Site 9, Nimporio, rivulet with concrete banks, by beach, 0 m a.s.l., 37°50'37.86"N, 24°56'04.49"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111859/2 in ethanol); Site 10, streamlet behind Pera Chorion-Aladou fountain, 257 m a.s.l., 37°47'36.57"N, 24°53'10.65"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111865/5 in ethanol); Site 12, Aladinou, stream, under bridge, 93 m a.s.l., 37°48'34.94"N, 24°54'00.04"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111871/1 dry); Site 13, Gianniseo (Stavros), water-filled tank, running water and spring, 405 m a.s.l., 37°46'57.00"N, 24°55'34.90"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111873/89 in ethanol); Site 14, Plaka, on road to beach, natural pool, 247 m a.s.l., 37°46'22.14"N, 24°53'32.99"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111875/11 in ethanol); Site 15, Pitrofos, Kasaba fountain, 340 m a.s.l., 37°48'48.88"N, 24°52'35.62"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111877/16 in ethanol); Site 15a, Pitrofos, Kasaba fountain, 340 m a.s.l., 37°48'48.88"N, 24°52'35.62"E, leg. GEORGOPOULOU & SIMAIKIS, 22.08.2014 (Mollusca NHMW 111909/3 dry + Mollusca NHMW 111908/3 in ethanol); Site 16, Pitrofos, fountain by bus station, 297 m a.s.l., 37°48'44.64"N, 24°52'34.84"E, leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111879/16 in ethanol); Site 16a, Pitrofos, fountain by bus station, 297 m a.s.l., 37°48'44.64"N, 24°52'34.84"E, leg. GEORGOPOULOU & SIMAIKIS, 24.08.2014 (Mollusca NHMW 111911/10 in ethanol); Site 17, Menites, Lions fountain, 222 m a.s.l., 37°49'21.37"N, 24°53'45.74"E,



leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111882/4 dry + Mollusca NHMW 111881/30 in ethanol); Site 17a, Menites, Lions fountain, 222 m a.s.l., 37°49'21.37"N, 24°53'45.74"E, leg. GEORGOPOULOU & SIMAIKIS, 24.08.2014 (Mollusca NHMW 111914/45 in ethanol); Site 25, Melida, end of asphalt road, stream with rocks on roadside, 412 m a.s.l., 37°48'38.89"N, 24°51'26.48"E, leg. GEORGOPOULOU & SIMAIKIS, 31.08.2015 (Mollusca NHMW 111899/30 in ethanol); Site 26, Zaganiaris to Kochylou, small tank, 518 m a.s.l., 37°46'42.53"N, 24°53'40.22"E, leg. GEORGOPOULOU & SIMAIKIS, 24.08.2014 (Mollusca NHMW 111902/16 dry); Site 27, Agios Georgios, artificial pool, 371 m a.s.l., 37°46'36.37"N, 24°53'27.67"E, leg. SIMAIKIS, 14.05.2015 (Mollusca NHMW 111903/76 in ethanol).

Previous records: *P. macrostoma* was first mentioned from Apikia (Apoikia) by SCHÜTT (1980) and later by FRANK (1988). SZAROWSKA et al. (2016b) collected *Pseudamnicola* spp. from six localities [Pitrofos, S of Lamira, Aghios Georgios Faralis church (Agios Georgios), Amoniakleon, Livadhia (Livadia), Koumari].

Habitat notes: *Pseudamnicola* sp. was collected from 13 localities in fountains, natural and artificial pools/tanks.

Family: Bythinellidae Locard, 1893

Genus: *Bythinella* Moquin-Tandon, 1856

Bythinella sp.

Figs 39–44, 52

Material examined: Site 2, Strapouries, fountain Metoxi-Ipsilou and concrete tank, 302 m a.s.l., 37°50'05.64"N, 24°54'25.29"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111833/23 in ethanol); Site 3, Ipsilou, traditional Ipsilou-Doubli fountain and mud puddles on roadside, 176 m a.s.l., 37°50'19.42"N, 24°55'07.01"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111835/1 dry + Mollusca NHMW 111834/26 in ethanol); Site 4, Lamira, rivulet with flow, 102 m a.s.l., 37°49'36.46"N, 24°54'44.60"E, leg. GEORGOPOULOU & SIMAIKIS, 28.08.2015 (Mollusca NHMW 111839/1 dry + Mollusca NHMW 111838/5

in ethanol); Site 10, streamlet behind Pera Chorion-Aladou fountain, 257 m a.s.l., 37°47'36.57"N, 24°53'10.65"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111863/6 in ethanol); Site 12, Aladinou, stream, under bridge, 93 m a.s.l., 37°48'34.94"N, 24°54'00.04"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111869/1 in ethanol); Site 15, Pitrofos, Kasaba fountain, 340 m a.s.l., 37°48'48.88"N, 24°52'35.62"E, leg. GEORGOPOULOU & SIMAIKIS, 29.08.2015 (Mollusca NHMW 111876/14 in ethanol); Site 15a, Pitrofos, Kasaba fountain, 340 m a.s.l., 37°48'48.88"N, 24°52'35.62"E, leg. GEORGOPOULOU & SIMAIKIS, 22.08.2014 (Mollusca NHMW 111907/8 dry + Mollusca NHMW 111906/9 in ethanol); Site 16, Pitrofos, fountain by bus station, 297 m a.s.l., 37°48'44.64"N, 24°52'34.84"E, leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111878/9 in ethanol); Site 16a, Pitrofos, fountain by bus station, 297 m a.s.l., 37°48'44.64"N, 24°52'34.84"E, leg. GEORGOPOULOU & SIMAIKIS, 24.08.2014 (Mollusca NHMW 111910/53 in ethanol); Site 17a, Menites, Lions fountain, 222 m a.s.l., 37°49'21.37"N, 24°53'45.74"E, leg. GEORGOPOULOU & SIMAIKIS, 24.08.2014 (Mollusca NHMW 111913/23 in ethanol); Site 18, Evrousies, stagnant waters on roadside, 579 m a.s.l., 37°50'15.05"N, 24°53'04.72"E, leg. GEORGOPOULOU & SIMAIKIS, 30.08.2015 (Mollusca NHMW 111885/55 in ethanol); Site 24, Ano Pitrofos, Pano Rema fountain, and stream by fountain, 441 m a.s.l., 37°49'00.92"N, 24°52'26.09"E, leg. GEORGOPOULOU & SIMAIKIS, 31.08.2015 (Mollusca NHMW 111894/1 in ethanol); Site 25, Melida, end of asphalt road, stream with rocks roadside, 412 m a.s.l., 37°48'38.89"N, 24°51'26.48"E, leg. GEORGOPOULOU & SIMAIKIS, 31.08.2015 (Mollusca NHMW 111898/5 in ethanol).

Previous records: Mentioned from Apikia (Apoikia) by SCHÜTT (1980) as *Bythinella charpentieri* (Roth, 1855). SZAROWSKA et al. (2016a) found *Bythinella* sp. on Andros in five localities [Pitrofos, Aghios Georgios Faralis church (Agios Georgios), Amoniakleon, Ammolochas, Koumari].

Habitat notes: *Bythinella* sp. was collected from 11 localities, mainly fountains, but also streams and mud puddles.

DISCUSSION AND ZOOGEOGRAPHIC REMARKS

The surveyed freshwaters are inhabited by at least eight freshwater gastropod species. The occurrence of *A. fluviatilis*, *M. buccinoidea*, *Bythinella* sp. and *Pseudamnicola* sp. on the island of Andros was confirmed. The newly recorded species include *G. truncatula*, *H. acuta* and *P. atticus*. They were previously reported from other Cycladic islands or Evvoia, but not

from Andros (see BANK 2006 and references therein). *T. fluviatilis*, known so far only from the Greek mainland (see BANK 2006), was found at six sites. The occurrence of *T. saulcyi* (Bourguignat, 1852) (see SCHÜTT 1986) was not confirmed. The opercula illustrated by SCHÜTT (1986: p. 286, figs 12–14) belong to *T. fluviatilis*.



From the zoogeographical point of view, the faunal similarity with mainland Greece is easily explainable by the geographic proximity of Andros to Evvoia and Attica, as well as its recent connection with the mainland during the middle Pleistocene (ca 180 to 140 kya BP; LYKOUSIS 2009). *T. fluviatilis*, *M. buccinoidea*, *P. atticus*, *A. fluviatilis*, *H. acuta* and *G. truncatula* are also distributed on the mainland (BANK 2006, GLÖER & PEŠIĆ 2010). Moreover, all of the above mentioned species and genera except *T. fluviatilis* are known from adjacent Aegean islands (see BANK 2006 and references therein).

The occurrence of *T. fluviatilis* in six sites does not support SCHÜTT's (1986) view that Andros (and possibly other Cycladic islands) was inhabited by *T. saulcyi*. Our findings agree with BUNJE & LINDBERG (2007) who propose that most probably *Theodoxus* spp. from Greece belong to four distinct clades; our specimens fall in the distribution area of *T. fluviatilis* and other clades of *Theodoxus* sp. However, there is urgent need for an integrative taxonomic revision of the genus in Greece as there is no agreement between the existing morphological and phylogenetic findings.

The only record of *H. acuta*, a widely introduced species originating in North America, is a site near the main settlement of the island, including an extensive cultivated land and a bird-reserve wetland; it could be a result of transport by humans or birds. The species is known to be carried by water birds or large mammals (see VAN LEEUWEN et al. 2013 and references therein). The collection of *G. truncatula* from four sites under human influence (e.g., water tanks used for watering livestock) and/or presence of birds (e.g., site 9) indicate similar conditions of arrival to the island as for *H. acuta*.

The specimens of *Bythinella* sp. are morphologically and anatomically similar to *B. charpentieri* and to the distinct clade of Andros presented in SZAROWSKA et al. (2016a). However, species delimitation in *Bythinella* is difficult and the use of molecular data is required (SZAROWSKA et al. 2016a and references therein). Similarly, the systematic posi-

tion of *Pseudamnicola* is currently under investigation by several workers (SZAROWSKA 2006, SZAROWSKA & FALNIOWSKI 2011, RADEA et al. 2013b, 2016, DELICADO et al. 2015). According to RADEA et al. (2016 and references therein) there are eight species of *Pseudamnicola* in Greece: *P. exilis* (Frauenfeld, 1863), *P. negropontina* (Clessin, 1878), *P. brachia* (Westerlund, 1886), *P. chia* (Martens, 1889), *P. macrostoma* (Küster, 1853), *P. pieperi* Schütt, 1980, *P. ianthae* Radea et Parmakelis, 2016 and *P. ilione* Radea et Parmakelis, 2016. Until now, only *P. macrostoma* was known from Andros (SCHÜTT 1980). However, new molecular data reveal the potential existence of two species in Andros one of which may be *P. negropontina* (SZAROWSKA et al. 2016b). Following the suggestions of the previous workers that molecular analyses are necessary in order to identify *Pseudamnicola* species, we refrain from attributing name(s) to the species (for further discussion see RADEA et al. 2013b, SZAROWSKA et al. 2016b).

Our work is a step towards increasing and establishing the knowledge of Greek freshwater gastropods. The results presented here suggest the need for innovative work on multiple species-groups and the need for systematic revisions. For example, the south-eastern Mediterranean (including Greece) is probably inhabited by a separate species in addition to the European *A. fluviatilis* which is so often mentioned in the literature (for discussion see PFENNINGER et al. 2003, ALBRECHT et al. 2006).

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REFERENCES

- ALBRECHT C., HAUFFE T., SCHREIBER K., WILKE T. 2012. Mollusc biodiversity in a European ancient lake system: lakes Prespa and Mikri Prespa in the Balkans. *Hydrobiologia* 682: 47–59.
- ALBRECHT C., TRAJANOVSKI S., KUHN K., STREIT B., WILKE T. 2006. Rapid evolution of an ancient lake species flock: freshwater limpets (Gastropoda: Ancyliidae) in the Balkan lake Ohrid. *Org. Divers. Evol.* 6: 294–307.
- BANK R. A. 1988. Die Molluskenfauna der griechischen Insel Lesbos (= Mytilini). *Basteria* 52: 61–76.
- BANK R. A. 2006. Towards a catalogue and bibliography of the freshwater Mollusca of Greece. *Heldia* 6: 51–86.
- BOETTGER O. 1889. Zur Molluskenfauna von Corfu. *Nachrichtsbl. dtsch. malakozoool. Ges.* 21: 133–138.
- BROGGI M. F. 1996. Wetlands on the island of Andros, their amphibians and hydrophilous reptiles (Amphibia, Reptilia; Cyclades, Greece). *Herpetozoa* 8: 135–144.
- BUNJE P. M. E., LINDBERG D. R. 2007. Lineage divergence of a freshwater snail clade associated with post-Tethys



- marine basin development. *Mol. Phylogenet. Evol.* 42: 373–387.
- CLESSIN S. 1878a. Neue Süßwasser-Rissoiden. *Malakozool.* Bl. 25: 115–122.
- CLESSIN S. 1878b. Aus meiner Novitäten-Mappe. *Malakozool.* Bl. 25: 122–129.
- DELICADO D., MACHORDOM A., RAMOS M. A. 2015. Effects of habitat transition on the evolutionary patterns of the microgastropod genus *Pseudamnicola* (Mollusca, Hydrobiidae). *Zool. Scr.* 44: 403–417. <http://dx.doi.org/10.1111/zoj.12124>.
- FALNIOWSKI A., SZAROWSKA M., GLÖER P., PEŠIČ V., GEORGIEV D., HORSÁK M., SIRBU I. 2012. Radiation in *Bythinella* Moquin-Tandon, 1856 (Mollusca: Gastropoda: Rissooidea) in the Balkans. *Folia Malacol.* 20: 1–10. <http://dx.doi.org/10.2478/v10125-012-0006-2>
- FRANK C. 1888. Über Molluskenfunde von den Inseln Chios, Kreta und Zypern sowie vom griechischen Festland (Thessalien). *Ber. nat.-med. Verein Innsbruck* 75: 81–90.
- FUCHS A., KÄUFEL F. 1936. Anatomische und systematische Untersuchungen an Land- und Süßwasserschnecken aus Griechenland und von den Inseln des Agäischen Meeres. *Zeit. Wiss. Zool. B, Arch. Naturg. N.F.* 5(4): 541–662.
- GLÖER P., FALNIOWSKI A., PEŠIČ V. 2010. The Bithyniidae of Greece (Gastropoda: Bithyniidae). *J. Conchol.* 40: 179–187.
- GLÖER P., PEŠIČ V. 2010. The *Planorbis* species of the Balkans with the description of *Planorbis vitojensis* n. sp. (Gastropods: Planorbidae). *J. Conchol.* 40: 249–257.
- IUCN 2016. IUCN Red List of Threatened Species. Version 2016.2. <www.iucnredlist.org>. Downloaded on 21 September 2016.
- KAPSIMALIS V., PAVLOPOULOS K., PANAGIOTOPOULOS I., DRAKOPOULOU P., VANDARAKIS D., SAKELLARIOU D., ANAGNOSTOU CH. 2009. Geoarchaeological challenges on the Cyclades shelf (Aegean Sea). *Z. Geomorph. N.F.* 53:169–190. <http://dx.doi.org/10.1127/0372-8854/2009/0053S1-0169>.
- LIRITZIS I. 2010. Strofilar (Andros Island, Greece): new evidence for the cycladic final neolithic period through novel dating methods using luminescence and obsidian hydration. *J. Archaeol. Sci.* 37: 1367–1377
- LYKOUSIS V. 2009. Sealevel changes and shelf break prograding sequences during the last 400 ka in the Aegean margins: Subsidence rates and palaeogeographic implications. *Cont. Shelf Res.* 29: 2037–2044.
- MARTENS E. VON 1889. Griechische Mollusken. Gesammelt von Eberh. von Örtzen. *Arch. Naturgesch.* 55: 169–240.
- PFENNINGER M., STAUBACH S., ALBRECHT C., STREIT B., SCHWENK K. 2003. Ecological and morphological differentiation among cryptic evolutionary lineages in freshwater limpets of the nominal form-group *Ancylus fluviatilis* (O. F. Müller, 1774). *Mol. Ecol.* 12: 2731–2745.
- POLEMIS E., DIMOU D., TZANOUDAKIS D., ZERVAKIS G. 2012. Diversity of Basidiomycota (subclass Agaricomycetidae) in the island of Andros (Cyclades, Greece). *Nova Hedwigia* 95: 25–58.
- RADEA C., PARMAKELIS A., MOURIKIS T., TRIANTIS K. A. 2013a. *Isimerope*, a new genus of Hydrobiidae (Caenogastropoda: Rissooidea) from Greece. *J. Mollus. Stud.* 79: 168–176. <http://dx.doi.org/10.1093/mollus/eyt010>.
- RADEA C., PARMAKELIS A., PAPADOGIANNIS V., CHAROU D., TRIANTIS K. A. 2013b. The hydrobioid freshwater gastropods (Caenogastropoda, Truncatelloidea) of Greece: new records, taxonomic re-assessments using DNA sequence data and an update of the IUCN Red List Categories. *ZooKeys* 350: 1–20. <http://dx.doi.org/10.3897/zookeys.350.6001>.
- RADEA C., PARMAKELIS A., VELENTZAS A. D., TRIANTIS K. A. 2016. Systematics of *Pseudamnicola* (Gastropoda: Hydrobiidae): description of two new species from insular Greece and redescription of *P. pieperi* Schütt, 1980. *J. Mollus. Stud.* 82: 67–79. <http://dx.doi.org/10.1093/mollus/eyv031>.
- RÄHLE W. 1980. Land- und Süßwassermollusken von Kephallinia und Zakynthos (Ionische Inseln). *Arch. Molluskenkd.* 110: 199–224.
- REISCHÜTZ P. L. 1985. Ein Beitrag zur Molluskenfauna von Leros (Dodekanes, Griechenland). *Malakol. Abh.* 11: 17–24.
- REISCHÜTZ P. L., FISCHER W., REISCHÜTZ A. 2008. Helleniká pantoía, 19: Zur Molluskenfauna des Aliakmonas, Loudias, Axios und Strymon (Makedonien, Griechenland). *Nachrichtenblatt der Ersten Malakologischen Gesellschaft Vorarlbergs* 15: 25–27.
- SCHÜTT H. 1980. Zur Kenntnis griechischer Hydrobiiden. *Arch. Molluskenkd.* 110: 115–149.
- SCHÜTT H. 1982. Die ostmediterrane Verbreitung von *Ancylus fluviatilis*. *Mitt. dtsch. malakozool. Ges.* 3: 519–523.
- SCHÜTT H. 1986. The dissemination of *Theodoxus* species in Greece including the islands (Moll. Prosobranch.). *Biol. Gallohellenica* 12: 283–290.
- SEIDL F. 2001. Zur Kenntnis der Süßwassermolluskenfauna der Ostägäischen Insel Ikaria. *Mitt. Zool. Ges. Braunau* 8: 95–102.
- STUSSINER J., BOETTGER O. 1886. Malakologische Ergebnisse auf Streifzügen in Thessalien. *Jahrb. dtsch. malakozool. Ges.* 13: 42–73.
- SZAROWSKA M. 2006. Molecular phylogeny, systematics and morphological character evolution in the Balkan Rissooidea (Caenogastropoda). *Folia Malacol.* 14: 99–168. <http://dx.doi.org/10.12657/folmal.014.014>
- SZAROWSKA M., FALNIOWSKI A. 2011. *Pseudamnicola exilis* (Frauenfeld, 1863) in southern Greece: A remnant of a flock of species (Rissooidea: Hydrobiidae)? *Folia Malacol.* 19: 117–129. <http://dx.doi.org/10.2478/v10125-011-0019-2>
- SZAROWSKA M., HOFMAN S., OSIKOWSKI A., FALNIOWSKI A. 2014. *Pseudorientalia* Radoman, 1973 (Caenogastropoda: Rissooidea) on Samos island, Aegean Sea. *Folia Malacol.* 22: 11–20. <http://dx.doi.org/10.12657/folmal.022.001>
- SZAROWSKA M., OSIKOWSKI A., HOFMAN S., FALNIOWSKI A. 2016a. Do diversity patterns of the spring-inhabiting snail *Bythinella* (Gastropoda, Bythinellidae) on the



Aegean Islands reflect geological history? *Hydrobiologia* 765: 225–243. <http://dx.doi.org/10.1007/s10750-015-2415-x>.

SZAROWSKA M., OSIKOWSKI A., HOFMAN S., FALNIOWSKI A. 2016b. *Pseudamnicola* Paulucci, 1878 (Caenogastropoda: Truncatelloidea) from the Aegean Islands: a long or short story? *Org. Divers. Evol.* 16: 121–139. <http://dx.doi.org/10.1007/s13127-015-0235-5>.

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D. H., KLAASSEN M., FIGUEROLA J. 2013. How did this snail get here? Several dispersal vectors inferred for an aquatic invasive species. *Freshwater Biol.* 58: 88–99.

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