Cainozoic Research, 4(1-2), pp. 61-65, February 2006

A Miocene molluscan faunule from Caucagua (Miranda State, Venezuela), with the description of a new species of *Tryonia* (Mollusca, Gastropoda)

F.P. Wesselingh[1,2] & O. Macsotay[3]

[1] *Nationaal Natuurhistorisch Museum, Postbus 9517, 2300 RA Leiden, the Netherlands; e-mail: wesselingh@naturalis.nl*
[2] *Biodiversity Centre, University of Turku, SF 20014 Turku, Finland*
[3] *Urb. El Trigal Norte, Ave. Atlantico, no. 155-61 B, Valencia, 2001, Venezuela*

Received 2 August 2003; revised version accepted 1 October 2003

A molluscan faunule from the Miocene Cumaca Formation of the western margin of the Tuy Basin (Venezuela) is described. The fauna yields two species of freshwater snails and a single terrestrial snail species. *Tryonia vivasi* nov. spec. is described from the fauna, and its biogeographical significance is discussed.

KEY WORDS: Miocene, Venezuela, Gastropoda, *Tryonia*, new species, Cumaca Formation.

Introduction

North-western South America has abundant non-marine Neogene mollusc faunas. A review in the seminal work of Nuttall (1990) of these faunas showed biogeographical affinities between Miocene Amazonian faunas and contemporaneous faunas from the northern Andes. However, non-marine faunas from Venezuela, apart from the faunas described by Palmer (1945) from the Pliocene Las Piedras Formation, are little known, hampering the evaluation of biogeographical affinities. Here, we report on a very small faunule (three species only) from the western margin of the Tuy Basin, containing amongst others a new species of *Tryonia*. The biogeographical significance of this occurrence is discussed.

The Tuy Basin is a pull-apart basin located along the major fault zone separating the South American and Caribbean plates. The Cumaca Formation crops out in the western margin of the Tuy Basin between Caucagua and Araguita (Figure 1). Northeast of Araguita a clay quarry is exploited for the production of tiles. The quarry is at the Alfareria Caribe, and is located along the road that connects the main Caracas-Barcelona road in the northwest and the town of Araguita in the southwest. The quarry is approximately 3 km south of the Caracas-Barcelona road (Figure 1). The outcropping deposits are part of the Cumaca Formation, a Middle Miocene intramontane fresh-water depositional unit (Macsotay *et al.*, 1998).

The outcrop comprises approximately 60 metres of predominantly dark grey-green clay-silt stones with alternating yellowish and light greyish green (carbonaceous) sand layers.

Two levels were found to contain molluscan fossils (Figure 2, levels 1101 and 1102). The lower of these (level 1101, located c. 14 metres stratigraphically below the top of the outcrop) was a decimetre thick layer of partially consolidated clays with tectonically deformed (cracked) specimens of *Tryonia* spec. Level 1102, the second fossiliferous level, located c. 8 metres below the stratigraphical top of the outcrop, contained abundant, mostly undeformed, fossil shells. In this level the three species listed below were found. The sediments in which the fossils occur are grey silty clays containing dispersed organic matter, ostracod, fish remains and molluscs.

The succession of clays and silts probably reflects lacustrine deposits alternated with tempestites.

Macsotay *et al.* (1995) refer to the Cumaca Formation deposits as inland fresh-water molasse deposits. Age of the outcrop, based on the occurrence of the chinchillid rodent *Prolagostomus* spec. is estimated to be Middle Miocene (Macsotay *et al.*, 1995). Shells from level 1102 are well preserved (no dissolution-holes and seldom any abrasion marks), but fragile. Apart from whole shells, also small sharp-edged fragments (of c. 1-2 mm) are common, possibly pointing to avian or fish-predation on these snails. Fish scale- and bone fragments are common in this level. The concentration of delicate fish skeleton remains may indicate that the fauna was deposited in or nearly in situ, and did not suffer substantial reworking.

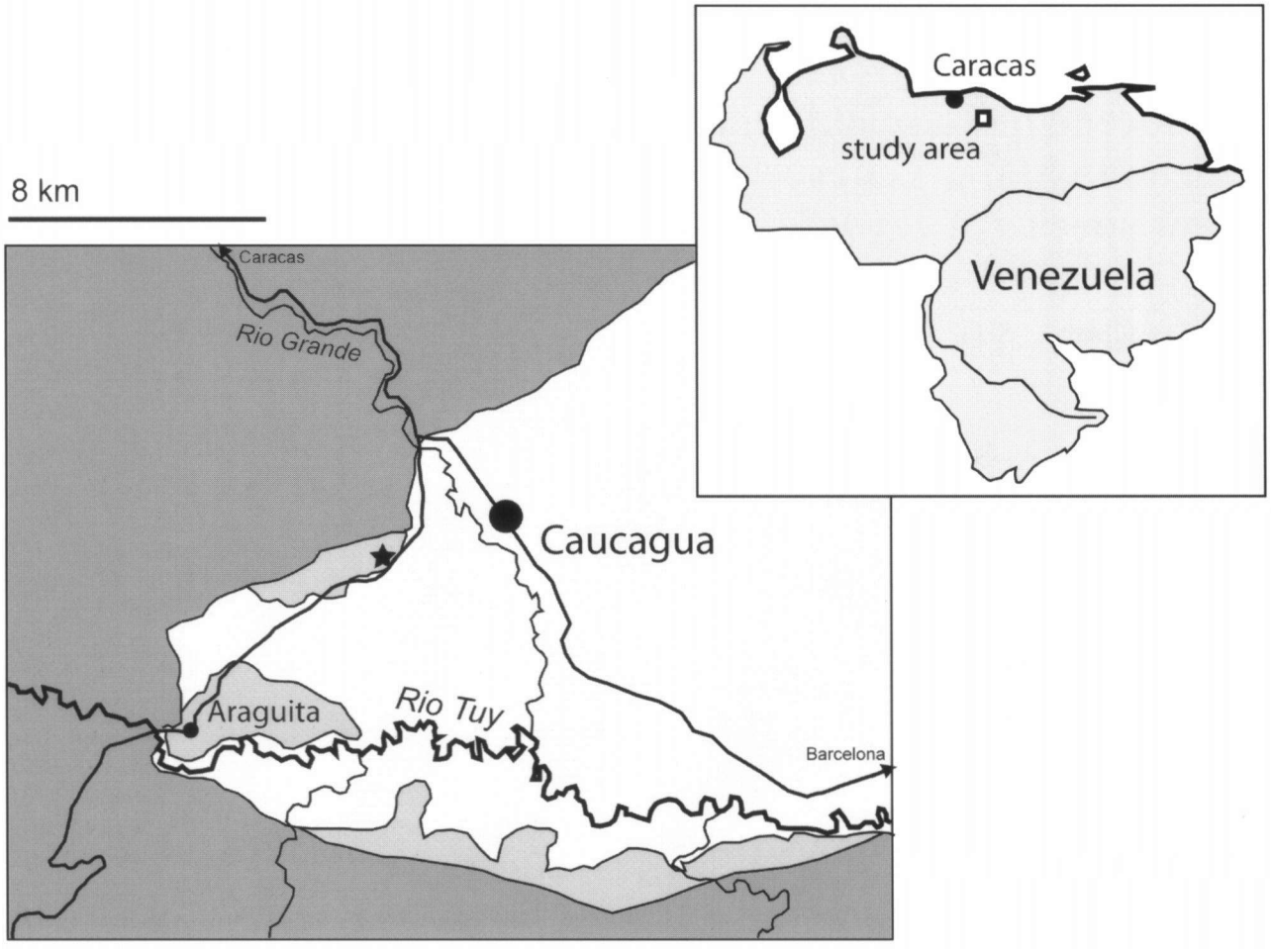

Figure 1. Location of the outcrop at the Alfareria Caribe (star). Dark grey refers to basement, intermediate grey to the Miocene Cumaca Formation, light grey to post Miocene fluviatile deposits.

Only three species were encountered in the studied samples: the ampullariid *Marissa* spec. indet. (RGM 456157: a single severely damaged specimen from level 1102), the bulimulid ?*Eudolichotis* (s.l.) spec. indet. (RGM 456158: numerous fragments belonging to a single shell from level 1102) and *Tryonia vivasi* nov. spec. described below.

Systematic palaeontology

Abbreviations – Below, the following abbreviations are used:

RGM Nationaal Natuurhistorisch Museum, Leiden, the Netherlands, Palaeontology department, division of Cainozoic Mollusca (formerly Rijksmuseum voor Geologie en Mineralogie)
UCV Universidad Central de Venezuela, Caracas, department of Geology
H height
HAP height of aperture
W width
n number of whorls
Dimensions in mm

Family Cochliopidae Tryon, 1866
Genus *Tryonia* Stimpson, 1865

Type species – *Tryonia clathrata* Stimpson, 1865, Colorado Desert, southern Nevada, USA (Hershler & Thompson, 1992: 110); original designation.

Remarks – from studies of extant *Tryonia* it has emerged that shell characteristics are often insufficient for the attribution of shells to this genus (Hershler *et al.*, 1999). The shortcomings of shell characteristics for the generic attribution mainly apply to the smooth endemic species commonly found in isolated springs in the SW United States. The typical predominant axial ornament as well as the more or less continuous presence of gastropod species attributed to *Tryonia* in the Neogene of the tropical America's (see Discussion below) are reasons for assigning the Venezuelan species described below to *Tryonia*.

Tryonia vivasi nov. spec.
Figures 3a-c

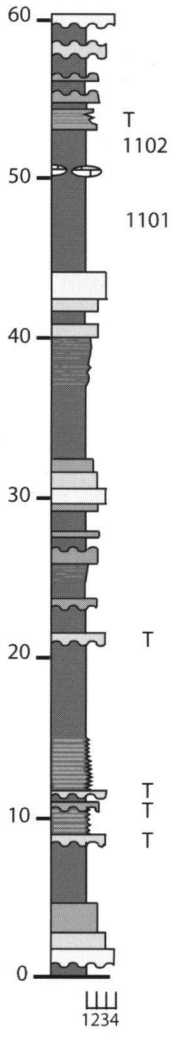

Figure 2. Lithostratigraphic section of the outcrop, and location of fossiliferous layers. T tempestites. 1 clay/silt, 2 fine-grained sand, 3 medium-grained sane, 4 coarse-grained sand. Height in m.

Types – Holotype: RGM 456150, level 1102, Quarry Alfareria Caribe, W of the road linking the Caracas-Barcelona Road and the town of Cumaca, ca. 3 km S of the junction with the former, Miranda dept., Venezuela.
Leg. O. Macsotay & F.P. Wesselingh, 1996. Middle Miocene, Cumaca Formation. Paratypes: RGM 456151-456155 (5 specimens from the same locality) and UCV n.n. (5 specimens from the same locality).
Other material studied – RGM 456156, level 1102, ca. 1000 specimens (almost all severely damaged); RGM 456159- RGM 456166 (8 samples containing slabs with numerous deformed specimens), level 1101, from the same locality.

Diagnosis – Intermediate (maximum H 9 mm), thin-shelled, elongate, highly variably ornamented *Tryonia*; ornamentation ranging from axially ribbed to reticulate to smooth or nearly smooth; sutural ramp especially well developed on earlier whorls; whorls rounded to slightly biconvex or carinate, early whorls sometimes strongly shouldered; regular axial intersections at the shoulder produce in some specimens a coronate sculpture; fine spiral threads (usually over 20 on the body whorl); umbilicus narrowly rimate; aperture semicircular, adnate; growth-lines prosocline.

Description – (holotype) The protoconch is smooth. The protoconch-teleoconch boundary (P/T boundary) is located at 1.6 whorls. Just before this boundary that is marked by a fine axial thread, numerous ill-defined axial (growth?) lines appear. Within a very short distance after the P/T boundary four spirals develop almost simultaneous. The upper spiral at ca. two-thirds of the whorl height, is the most prominent, and bounds a well-defined sutural ramp above. Numerous fine, slightly sigmoid growth lines appear on the first teleoconch whorl. From the second teleoconch whorl on more or less regularly spaced broad and low axial ribs are present. The axials and spirals develop together in a kind of (sub) reticulate ornament. On the upper spiral on early teleoconch whorls at intersections with the axials, slightly produced tubercles develop, that fade on the last two teleoconch whorls. The axial ribs do not extend to the upper and lower suture. Up to 8 spirals develop (on the penultimate whorl), and on the last two whorls up to 8 very fine spirals develop on the sutural ramp as well, that becomes progressively poorly defined. On the body whorl prominent spirals are restricted to the zone between half and three-quarters of the whorl height. Above and below fine spirals are present. The axial ribs may disappear on the last two whorls, but not so on the holotype. The shell is slightly shouldered on the first four teleoconch whorls. The suture is well defined. The aperture is ovate, apertural margins are not thickened. The outerlip and innerlip margins of the holotype are slightly damaged, and bent outward. The aperture is adnate, bounding a rimate umbilicus.
The paratypes represent morphological variation of this species. The P/T boundary of the paratypes is located between 1,2 and 1,6 whorl. RGM 456151 has a rather flat apex. The onset of the teleoconch ornament is variable. In this specimen directly after the P/T boundary the upper spirals form, followed within half a whorl by three lower spirals. The apex of RGM 456152 is missing. In RGM 456153 three spirals appear after the P/T boundary at the base, one-third and two-thirds of the whorl height respectively, followed by a fourth spiral within half a whorl. RGM 456154/456155 develop a very strong keel after the P/T boundary at ca. three-fifths of the whorl height, soon followed by a basal keel. On these latter two specimens broad axial folds develop within the first teleoconch whorl, that produce tubercles at their junctions with the upper spiral, resulting in a coronate appearance that lasts on the first three teleoconch whorls. In all specimens the number of spirals increases on subsequent whorls. The central part of the whorl yields the most prominent spirals, and the lower quarter and, progressively the sutural ramp yield fine spirals. On the penultimate whorl 17-34 spirals are present. Axial folding/ ribbing shows a wide variation. On RGM 456151 axial ribs are very poorly developed, and absent on most of the later teleoconch.

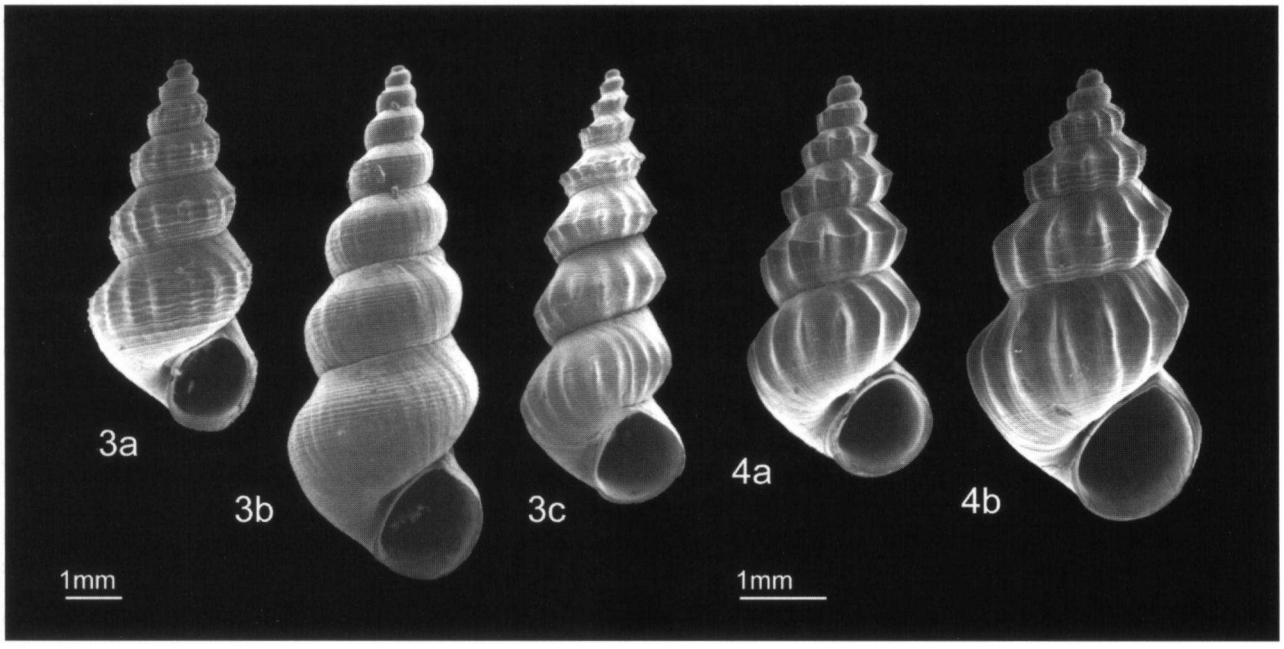

Figure 3. *Tryonia vivasi* nov. spec. Level 1102, Outcrop Alfereria Caribe (see details in text). Miocene, Cumaca Formation. Leg. Macsotay & Wesselingh, 1996.
3a. RGM 456150, holotype, frontal view (H 6.5); 3b. RGM 456151 paratype, frontal view (H 9.2); 3c. RGM 456154 paratype, frontal view (H 7.8).

Figures 4. *Tryonia spiralistriata* Wesselingh, 1996. Carboneras, Itzabal dept., Guatemala, Herreria Formation, Pliocene, leg. H.-J Gregor, 1994: 4a RGM 394312 holotype, frontal view (H 4.7); 4b RGM 394313 paratype, frontal view (H 5.4).

On RGM 456152, on the other hand, well developed axial ribs, straight on early teleoconch whorls, irregular inverted C-shaped on later teleoconch whorls, are present. Axial ribs usually do not extend to the upper and lower sutures, but occasionally do so. On the last two whorls axial ornamentation becomes subdued or disappears. The penultimate whorl yields ca. 17 axials. The sutural ramp also becomes progressively less-defined and disappears on the last two whorls. In four of the paratypes a subsutural ridge is seen. The sutural ramp (sometimes obsolete, but usually prominent) is flat, and can be slightly concave on later whorls. Growth-lines are slightly prosocline in all material. Whorl profile varies from generally rounded to carinate.

Dimensions (mm) –

	H	HAP	W	n
RGM 456150	6.5	1.9	2.9	7.1
RGM 456151	9.2	2.2	3.3	8.2
RGM 456153	6.5	2.1	2.7	7.0
RGM 456154	7.8	1.7	2.7	8.1
RGM 456155	7.8	1.7	2.9	8.3

Variability – This species is characterised by a high degree of morphological variation. Specimens can be coronate, like *Pyrgophorus* spp., others show predominantly axial ribbing, and others show a predominant reticulate or spiral ornament. Although two extreme variants appear to exist, a coronate variant (*e.g.* Figure 3c) and a predominantly spirally ribbed variant (cf. Figure 3b), all kinds of intermediates exist, pointing to intraspecific variation.

Differentiation – *Tryonia vivasi* nov. spec. from the Cumaca Formation is larger and thinner-shelled than Miocene *Tryonia* species from the Pebas Formation of western Amazonia (listed in Nuttall, 1990 under *Liris*). The species bears some resemblance to *Tryonia* spec. from the Tumbatu Formation of the Chota Basin of Ecuador (Nuttall, 1990). The age of this formation has been established as Early Pliocene (S. Tobler, pers. comm.). The Ecuadorean *Tryonia* is a bit smaller and more robust, axial ornamentation is better developed, and coronate specimens lack in the Ecuadorean material. *Tryonia spiralistriata* Wesselingh, 1996 (Figures 4a, b) from the Pliocene of Eastern Guatemala is smaller. Spirals can develop in the latter but are not as numerous as on the Cumaca specimens. Also, the Guatemalan species contain exclusively shouldered specimens. *Tryonia semituberculata* (Nuttall, 1990) from the Early Miocene La Tagua Beds of Southern Colombia also resembles the Cumaca species. The La Tagua specimens are in general smaller, higher spired and are less regularly coiled and characterised by fewer spirals. *Tryonia semituberculata* lacks the strongly developed shoulder seen in various specimens of the Cumaca *Tryonia*.

Derivatio nominis – Named after Dr. Victor Vivas, in honour of his extensive research work on the sedimentary geology of Venezuela.

Discussion and Conclusions

Of the three gastropod species, *Tryonia vivasi* and *Marissa*

spec. are aquatic. *Eudolichotis* spec. is a terrestrial pulmonate. The oligospecific character of the fauna is comparable to *Tryonia* dominated faunas from the Pliocene Chota Basin (Ecuador), the Pliocene Itzabal Basin (Guatemala), as well as the modern fauna of Laguna Itzen-Peten in Northern Guatemala (Nuttall, 1990; Wesselingh *et al.*, 1996), and modern spring fauna's from the US Western Interior (*e.g.* Hershler & Sada, 1987). These monospecific or oligospecific *Tryonia* fauna's appear(ed) to characterise comparatively isolated inland basin water bodies. The sediments of the Cumaca Formation (bluish silty clays with dispersed organic matter) point to a lacustrine depositional environment.

The occurrence of *Tryonia* in the Miocene of northern Venezuela has interesting biogeographic implications. During the Middle Miocene, *Tryonia* was widely distributed in Western Amazonia (Peruvian, Colombian and Brazilian Amazonia). *Tryonia* occurred in the Ecuadorian Chota Basin and in Eastern Guatemala during the Pliocene. There are also Miocene and Pliocene records of *Tryonia* from the southwestern USA (R. Hershler, pers. comm.). Therefore, during the Neogene, *Tryonia* had an essentially neotropical distribution, ranging from the southern US to western Amazonia. Nowadays, the hydrobiid faunas from Venezuela and the Amazon region are very different. *Tryonia* is lacking alltogether (it is restricted to the southern USA, Mexico and Guatemala: Hershler, 2001). The present day Venezuelan faunas are dominated by *Aroapyrgus* and *Pyrgophorus* species. The latter genus is absent in the Amazonian region, whereas Amazonian species formerly assigned to *Aroapyrgus* also should be transferred to other genera (see Wesselingh, 2000). Therefore, both regions nowadays yield a very different hydrobiid fauna. The presence of *Tryonia* in Miocene deposits indicates a closer biogeographic affinity of northern Venezuela and western Amazonian faunas during the Middle Miocene.

Acknowledgements

Prof. W. Winkler and S. Tobler (ETH Zürich, Switzerland) and D. Hungerbühler (Hillegom, the Netherlands) for making available *Tryonia* material from the Chota Basin and for providing age estimates of the Tumbatu Formation. Prof. J. Salo (UTU Turku, Finland) for funding the research. R. Hershler (USNM, Washington D.C., USA) for providing information on fossil occurrences of *Tryonia* in the USA. W. Renema (NNM, Leiden, the Netherlands) for REM photo's. Suggestions from J. Jagt (NHM Maastricht, the Netherlands), A. Janssen (Xewkija, Malta) and R. Hershler (USNM, Washington D.C., USA) greatly improved the manuscript.

References

Hershler, R. 2001. Systematics of the North and Central American aquatic snail genus Tryonia (Rissoidea: Hydrobiidae). *Smithsonian Contributions to Zoology* 612, 1-53.

Hershler, R. & D.W. Sada 1987. Springsnails (Gastropoda: Hydrobiidae) of Ash Meadows, Amargosa Basin, California-Nevada. *Proceedings of the Biological Society, Washington* 100, 776-843.

Hershler, R. & Thompson, F.G. 1992. A review of the aquatic gastropod subfamily Cochliopinae (Prosobranchia: Hydrobiidae). *Malacological Review, Supplement* 5, 1-140.

Hershler, R., Liu, H.-P. & Mulvey, M. 1999. Phylogenetic relationships within the aquatic snail genus *Tryonia*: implications for biogeography of the North American Southwest. *Molecular Phylogenetics and Evolution* 13, 377-391.

Macsotay, O., Peraza, T. & Wehrmann, M. 1995. Grupo Cubagua Ciclo molasico Marino (III) de edad Mioceno Tardio-Plioceno Temprano de Venezuela Nor-oriental. *Boletino Geologico, Publicacion Especial* 11, 164-176.

Macsotay, O., Vivas, V., Wehrmann, M., Hartenberger, J.L. & Chachati, B. 1998. Tectonosedimentary molassic cycles along Northern Venezuela and Trinidad. *Transactions of the 3rd geological conference of the Geological Society of Trinidad and Tobago and the 14th Caribbean Geological Conference* 1, 584-593.

Nuttall, C.P. 1990. A review of the Tertiary non-marine molluscan faunas of the Pebasian and other inland basins of northwestern South America. *Bulletin British Museum Natural History (Geology Series)* 45, 165-371.

Palmer, K. von Winkle 1945. Fossil fresh-water Mollusca from the State of Monagas, Venezuela. *Bulletins of American Paleontology* 31, 1-34.

Stimpson, W. 1865. Diagnoses of newly discovered genera of gasteropods, belonging to the subfam. Hydrobiinae, of the family Hydrobiidae. *American Journal of Conchology* 1, 52-54.

Troschel, F.H. 1857. Das Gebiss der Schnecken zur Begründung einer natürlichen Classification. Volume 1. Nicolaische Verlagsbuchhandlung, Berlin. 252 p.

Tryon, G.W. 1866. [Review of] researches upon the Hydrobiinae and allied forms. *American Journal of Conchology* 2, 152-158.

Wesselingh, F.P. 1996. A Pliocene freshwater molluscan faunule from Guatemala, with implications for Neogene neotropical molluscan dispersal. *Documenta Naturae* 100, 7-22.

Wesselingh, F.P. 2000. On relict hydrobiid species in Brazilian Amazonia (Gastropoda, Prosobranchia, Hydrobiidae). *Basteria* 64, 129-136.