The Afro-American Biomphalariae

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The reports on the occurrence of African planorbids in South America and of South American species in Africa and Asia are reviewed.

Key words: *Biomphalaria glabrata* - *B. tenagophila* - *B. straminea*

The first report on the occurrence of freshwater molluscs common to South America and Africa was published by Lucena in 1950. Having received a batch of snails collected in the city of Santos, state of São Paulo, and then collecting personally there, he admitted to be dealing with two species, "none of them belonging to any mollusc known by us". He sent specimens to J Bequaert, of the Museum of Comparative Zoology, Harvard College, Cambridge, who identified them as *Biomphalaria alexandrina pfeifferi* [*sic*: this name really applies to two species: *Biomphalaria alexandrina* (Ehrenberg, 1831) and *Biomphalaria pfeifferi* (Krauss, 1848)] and *Bulinus tropicus,* African species that would have been introduced during the slave trade (Bequaert & Lucena 1951, Lucena 1953).

Before that report several authors had recorded the occurrence of planorbids in Santos. Arantes (1923) studied two autochthonous cases of schistosomiasis, collecting a planorbid identified as probably *Planorbis centimetralis* Lutz (now *B. straminea*) by Pirajá da Silva, the discoverer of schistosomiasis in Brazil. Moura (1945) and Pinto (1945) treated it as *Australorbis glabratus*. According to Coutinho (1949a, b) there would be another unidentified species besides *A. glabratus*, reaffirming soon after (Coutinho 1950) that "assuredly *A. glabratus* exists among us and chiefly in Santos".

Prosecuting his investigation, Lucena sent specimens from Santos to several specialists, who had different opinions.

As for the *Biomphalaria*, S. Jaeckel, of the Museum of Berlin, admitted that it was *Australorbis camerunensis* Boettger, of the African Republic of Cameroon, an opinion accepted by Lucena (1956: 82) after examining specimens sent by Jaeckel.

Another consulted malacologist was Dartevelle, who admitted the possibility of confusion by Jaeckel between the planorbid of Santos and the samples in the Museum of Berlin, where no longer existed the type and paratypes of *A. camerunensis*, lost during the bombardment of that city.

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Received 25 May 2006
Accepted 26 June 2006

Soon after, Dartevelle asked Lucena to contribute to a jubilean publication homaging H Schouteden, honorary director of the Museum, adding : "I ask you to add that it was due to the information transmitted by Dr Jaeckel and myself that you perceived that this shell introduced, without doubt, by the slaves was not really Bequaert's *B. pfeifferi* but Boettger's *A. camerunensis*, of which I myself informed you to have found a form at the Lower Congo".

The identification of the planorbid as *A. camerunensis* was denied by Boettger, who assured that it was *Planorbis lugubris*, proposed by Wagner (in Spix & Wagner 1827) for a planorbid collected by Spix in the Brazilian state of Bahia. But Boettger himself then agreed, according to Lucena (1956), that it was really his *A. camerunensis*.

Ruiz and Carvalho (1953) identified two species in Santos: *A. immunis* (Lutz) and *A. nigricans* (Spix), the former much more frequent and the only one infected with *Schistosoma mansoni* (Note: *immunis* and *nigricans* are really one and the same species, *B. tenagophila*).

Examining ten samples of the local planorbid (Paraense & Deslandes 1956) we verified that it was indistinguishable in shell and anatomy (Figs 1, 2, 3) and genetically (crossing tests) from *A. nigricans* (now *B. tenagophila*). As to "*Bulinus tropicus*", it was really *Physa acuta,* a senior synonym of *Physa cubensis*, as shown recently by Paraense and Pointier (2003).

An exemplary case is that of a planorbid sent in 1956 by Professor Fraga de Azevedo, director of the Instituto de Medicina Tropical of Lisbon, and identified as *Biomphalaria pfeifferi* (Krauss), descendant of specimens collected in Sul do Save, province of Mozambique, Portuguese West Africa. The characters of the shell (Fig. 4) and reproductive system (Fig. 5) agreed entirely with those of *B. straminea* (then called *Taphius centimetralis*) and those African specimens crossed freely with our *centimetralis* from Pernambuco.

We communicated that result to Prof. Azevedo, who asked for an article for the Annals of his Institute (Paraense & Deslandes 1957a), in which, of course, we considered as synonyms the two nominal species and tried to understand the extent of its distribution. Some years later I came to know, by a member of that Institute, that on the occasion of a visit to Pernambuco Prof. Azevedo had brought to Lisbon those planorbids, which contaminated an aquarium of his Institute. In a paper on the synonymy of *B. straminea* (Paraense 1963) I wrote about this subject:

"This mistake, regrettable as it was, pointed to the reliability of the anatomic in association with the genetic approach in the systematics of planorbids. In fact, in this case the Brazilian species was recognized, in spite of the mistakes about its name and origin".

In 1956 our colleague Emmanuel Dias, who was trying to control planorbids in Egypt, sent to Dr Frederico Simões Barbosa a batch of *Biomphalaria boissyi* (=*B. alexandrina*) collected in Cairo, a part of which was intended for me. Barbosa et al. (1956) suceeded in crossing a specimen of *boissyi* with another of albino *B. glabrata* (then *A. glabratus*) of Recife, concluding that "the snails from Egypt and Brazil have a common gene pool". Afterwards Barbosa and Carneiro (1957) signalized only two morphological differences between *glabrata* and *boissyi*: the absence in *boissyi* of a spermiduct between the collecting canal of the ovotestis and the seminal vesicle (Fig. 6) and of a longitudinal ridge on the renal tube, characteristic of *glabrata*.

From the batch sent by E Dias I received seven specimens, unfortunately preserved in alcohol (Paraense & Deslandes 1957b). On dissection they showed a renal region and a reproductive system identical to those of "*Taphius nigricans*" (now *B. tenagophila*), except for the absence (Figs 7, 8) of the duct between the ovotestis and the seminal vesicle (Barbosa & Carneiro's paper was not yet published). The absence of such duct is also noted in Plate I of Malek's (1954) paper on *B. boissyi* (Fig. 9).

Fig. 1: specimens of *Australorbis nigricans* (= *Biomphalaria tenagophila*) from Santos, SP, showing tendency to concavaty of right surface (biconcave forms). 1: usual form, right side strongly depressed; 2: infrequent flattened variant; 3: frequent biconcave form; 4: typical biconcave form; 5, 6: intermediate form; 7: infrequent variants tending to planoconcavity. (a: right side; b: front; c: left side). - All figs × 2.

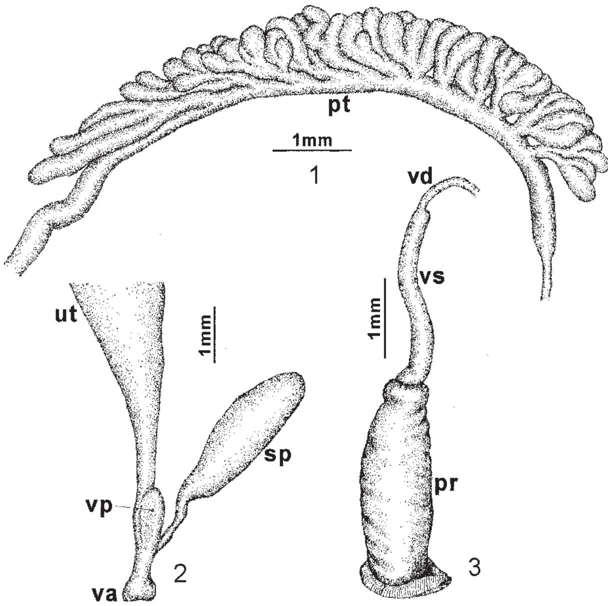

Fig. 2: prostate and copulatory organs of *Australorbis nigricans* (= *Biomphalaria tenagophila*) from Santos, SP. 1: prostate from free surface; 2: female copulatory system; 3: male copulatory system.

In December 1981 planorbid snails with typical *B. glabrata* shell, collected at Gaza, west of Cairo, were sent to a research institute in Cairo-Embaba. Commenting on the subject, Pflüger (1982) alerted to the possibility of colonies of that snail kept in African laboratories establishing in the field and of adaptation of local *S. mansoni* strains to the invader, considered by him endowed with broader ecological tolerance than the local *B. alexandrina*. Five years later Malek and Yousif (unpublished) collected at Kafr Abu Gomaa village, near Cairo, specimens that they identified as *B. glabrata*. That finding was mentioned by Yousif et al. (1996), who also found that snail in irrigation and drainage systems at three other localities near Cairo and demonstrated its susceptibility (52%) to the local strain of *S. mansoni*. According to Yousif et al. (1998) it hybridized with *B. alexandrina*, the hybrid invaded the irrigation and drainage systems in the Nile delta and the valley north of El-Menya, and both were found infected with *S. mansoni*.

Kristensen et al. (1999) utilized random amplified polymorphic DNA (RAPD) to differentiate species and populations of *Biomphalaria* from Egypt and other countries, concluding that "in the Nile Delta *B. glabrata* as well as *B. alexandrina* is living in the field, and it appears that

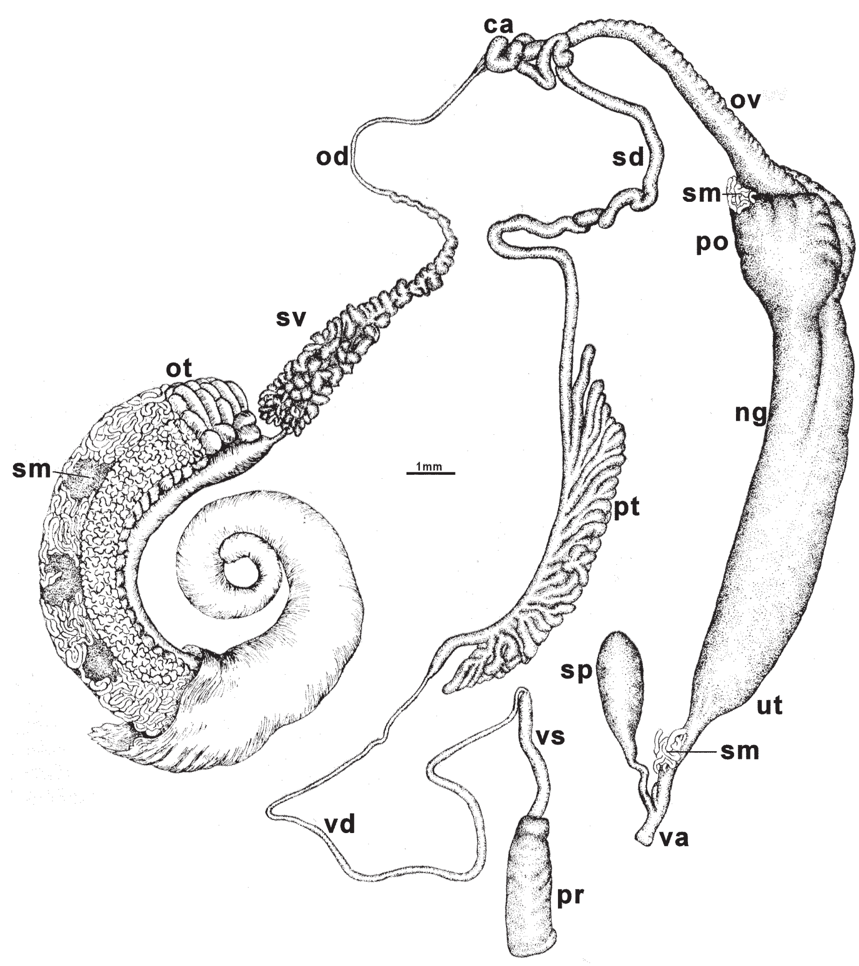

Fig. 3: reprodutive system of infected *Australorbis nigricans* (= *Biomphalaria tenagophila*) from Santos, SP. Sporocysts of *Schistosoma mansoni* (sm) in digestive gland covering ovotestis, and on pouch of oviduct and vagina.

hybridization may be occurring between the two".

Recently Pointier et al. (2005) recorded the occurrence of *B. tenagophila* at Kinshasa, Democratic Republic of Congo, based on observations on the morphology of the shell and reproductive system, and molecular characterization (Figs 10, 11).

Contrasting with the above-mentioned findings, all specimens of *Biomphalaria* collected in 2002-2003 by Lofty et al. (2005) from 37 of 76 localities between the Nile Delta and Lake Nasser were *B. alexandrina*, according to the results of species-specific polymerase chain reaction assays that sampled both nuclear and mitochondrial genomes, and according to DNA sequence data. These results surprised the authors, because some specimens

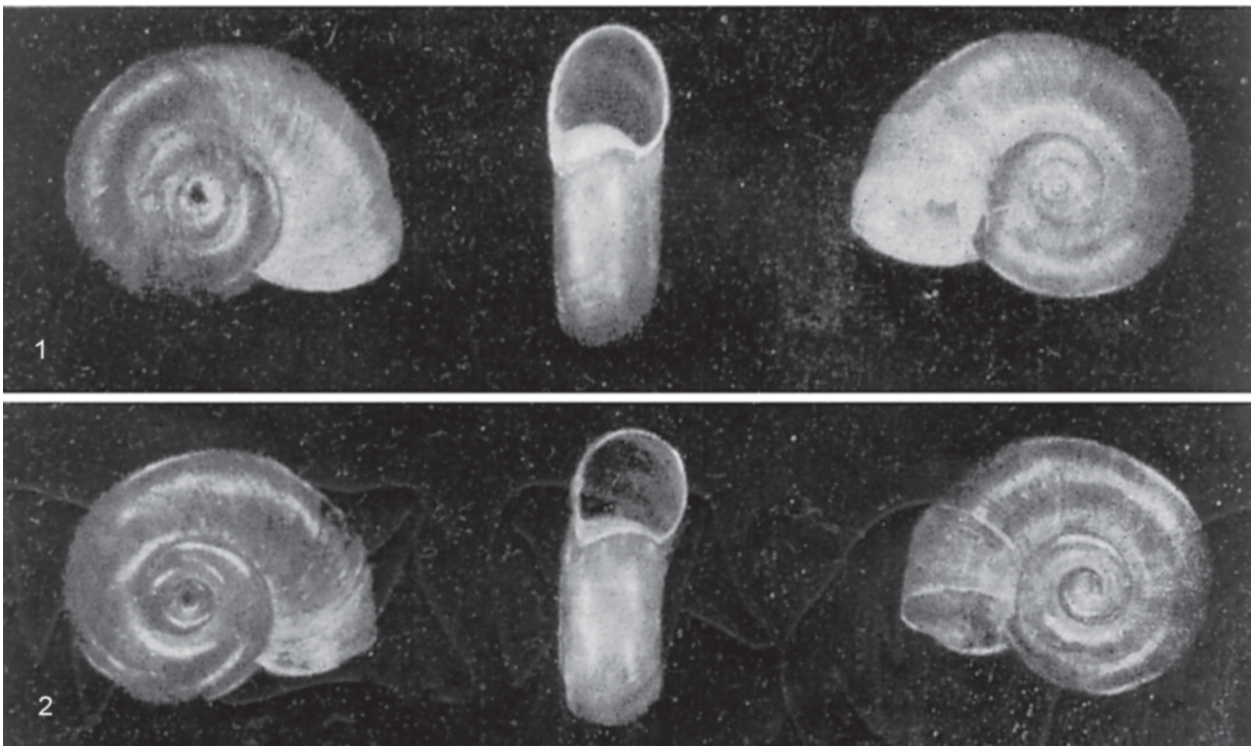

Fig. 4: shell of two "African" specimens received from Prof. Fraga de Azevedo. × 3.

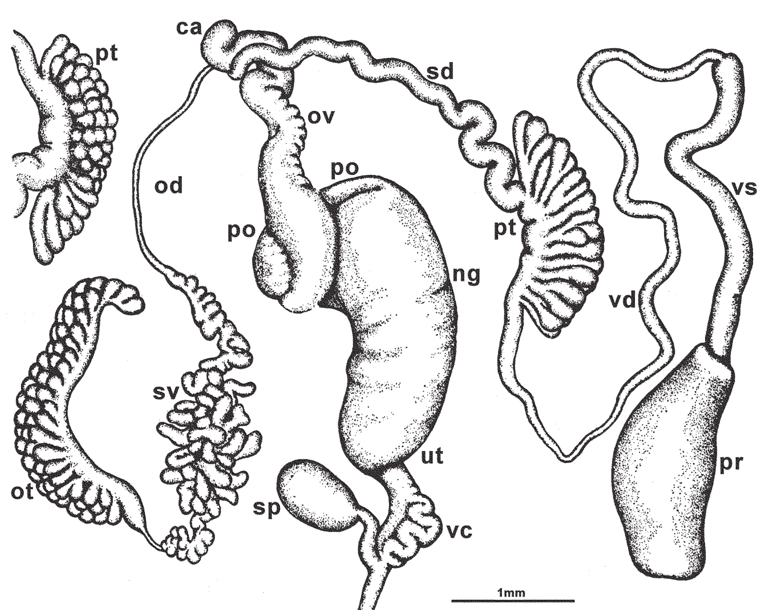

Fig. 5: reprodutive system of "African" specimen.

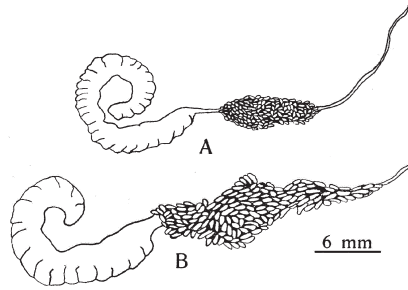

Fig. 6: tha seminal vesicles region in F2 hybrids. A: type *glabratus*, B: type *boissyi*. From Barbos & Carneiro 1957.

were, in size and shell, very similar to *B. glabrata*.

Only exceptionally have the mechanisms involved in the above-mentioned intercontinental displacement been considered. As far as I am acquainted, the only example is that of introduction of *B. straminea* with freshwater plants and fishes in some streams in Hong-Kong (Meier-Brook 1974), with subsequent extension to the mainland (Liu et al. 1982).

As seen above, so far the investigations led to different results. It is desirable that the subject be dealt with integrally, including shell and internal anatomy, crossing experiments and molecular characterization.

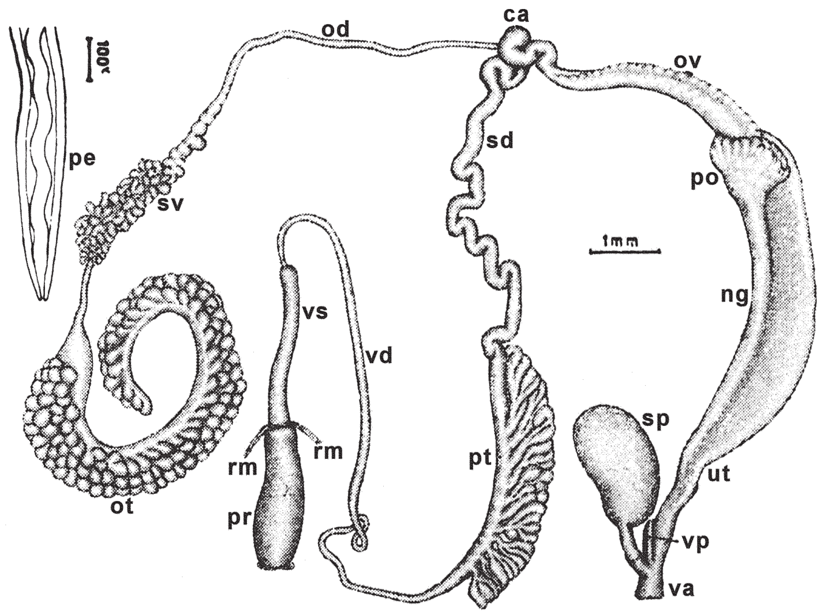

Fig. 7: reproductive system of *Taphius nigricans* (= *Biomphalaria tenegophila).*

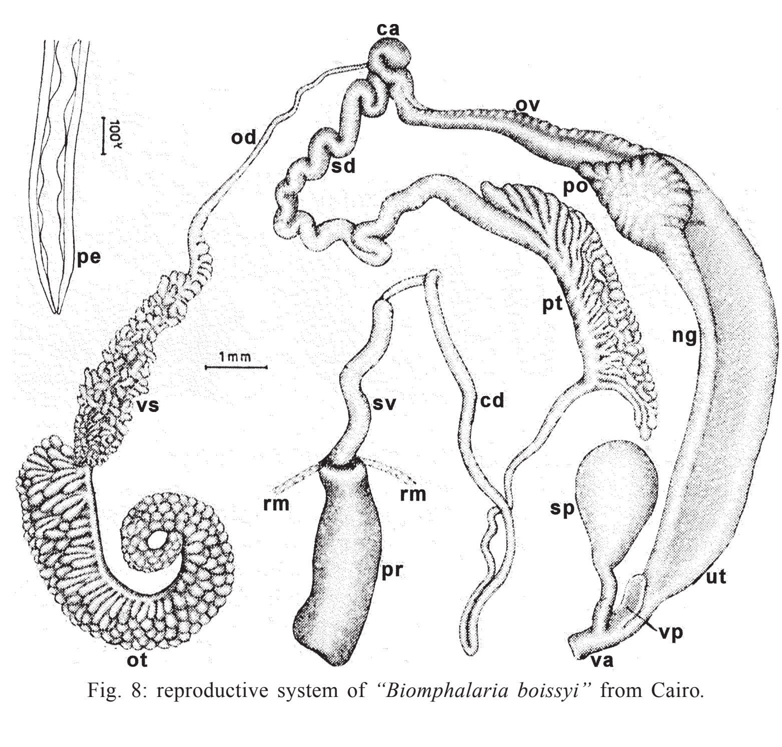

Fig. 8: reproductive system of *"Biomphalaria boissyi"* from Cairo.

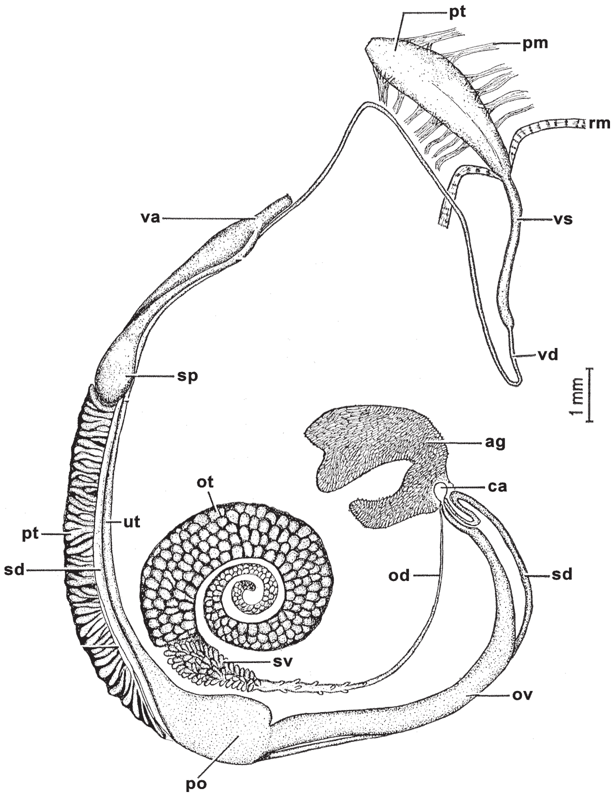

Fig. 9: reproductive system of *Biomphalaria boissyi* (after Malek 1954).

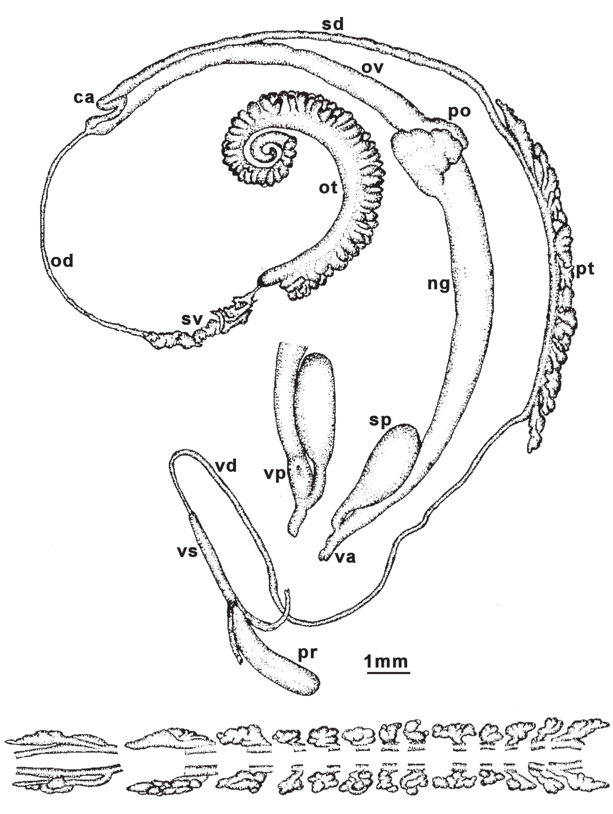

Fig. 10: anatomy of the reproductive system of *Biomphalaria* collected by Tchuem Tchuenté (1994) in Mangungu River, Kinshsa, DRC (after Pointier et al. 2005).

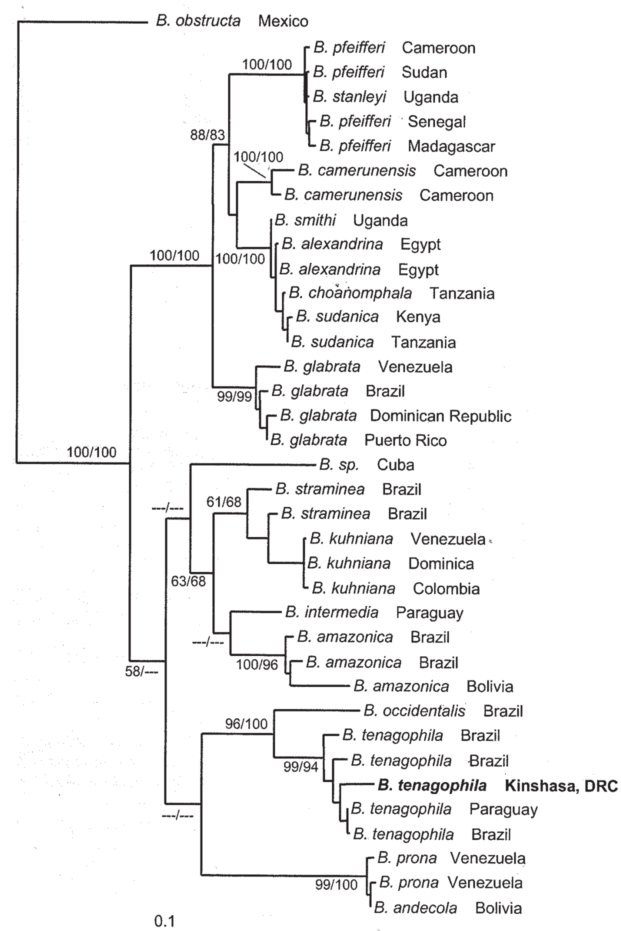

Fig. 11: maximum likelihood tree generated from ITS1, ITS2 and 16S sequence data (Pointier et al. 2005). Bootstrap support values are displayed for major branch nodes (MP/ML); dashes indicate < 50% support.

LEGEND OF FIGURES

ag – albumen gland
ca – carrefour
cc – collecting canal
fd – foremost diverticulum
hd – hindmost diverticulum
ng – nidamental gland
od – ovispermiduct
ot – ovotestis
ov – oviduct
pe – penis
pm – protractor muscle
po – pouch of oviduct
pr – prepuce
pt – prostate
rm – retractor muscle
sd – spermiduct
sm – sporocysts of Schistosoma mansoni
sp – spermatheca
sv – seminal vesicles
ut – uterus
va – vagina
vc – vaginal corrugation
vd – vas deferens
vp – vaginal pouch
vs – vergic sac

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