# Results of the Hydrobiological Mission 1974 of the Zoological Institute of the University of Vienna

Part VIII: Contributions to the Knowledge of the Freshwater-Gastropods of the Indian Ocean Islands (Seychelles, Comores, Mascarene-Archipelagos)

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(With 100 text-figures and 8 plates, with 58 figures in black and white)

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# Abstract

The study deals with the collection on Freshwater and Brackishwater Gastropods collected on the Seychelles-, Comores- and Mascarene-Archipelagos in the Western Indian Ocean, during the Austrian Hydrobiological Mission, 1974. Some remarks also made on the collection of the Swedish Lund University Mission, 1973, from Madagascar, Nossi-Bé and Rodriguez.

Thirty species of Gastropods are discussed with remarks on the shell, anatomy, ecological and biological features and their geographical range. In the General Part are given the distributions of the recorded species in the different localities of running waters and a survey of the zoogeography of the found water-snails.

#### Zusammenfassung

Die Studie behandelt die Sammlung an Süß- und Brackwasser-Schnecken der Seychellen-, Komoren- und Maskarenen-Inseln im westlichen Indischen Ozean, die von der Österreichischen Hydrobiologischen Expedition 1974 mitgebracht wurde. Von den 30 gefundenen Arten werden Angaben über ihre systematische Stellung, Schale Anatomie und Histologie gegeben. Sie werden von Bemerkungen über ihre Ökologie, Biologie und geographische Verbreitung ergänzt. Im Allgemeinen Teil wird die Verbreitung der Arten in den verschiedenen Lebensräumen der Fließgewässer besprochen sowie ihre zoogeographische Stellung erläutert.

# 1. Introduction

The exploration of the land- and freshwater-gastropods of the Western Indian Ocean Islands, such as Seychelles, Comores and Mascarene, started relatively early after the colonization of the uninhabited islands in the last 17th century. The first descriptions of gastropod shells are based especially on

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collections of different scientific missions, such as by BORY DE SAINT VINCENT 1804) for four principal islands of the Indian Ocean; by the Voyage of "COQUILLE" 1822/25, published by LESSON (1830); a collection from Mauritius and La Réunion, published by FÉRUSSAC; by the Voyage of "ASTROLABE", published by QUOY & GAIMARD (1832); from the Seychelles by DUFO (1840); and by the collections of the Voyage of Captain VESCO, published by MORELET 1851, 1860). SGANZIN (1843) has given a first list of the shells known from Mauritius and La Réunion, including Madagascar. Many shells from the islands were described at first in systematic works, such as Thesaurus Conch., SOWERBY (Neritidae, 1836/49); further in the Syst. Conch. Cabinet, edited by MARTINI & CHEMNITZ with volumes by PFEIFFER, 1853 (Cyclostoma), BROT. 1876 (Melaniacea), BROT, 1874 (Paludomus), MARTENS, 1879 (Neritacea) and CLESSIN & KÜSTER, continued by DUNKER, 1886 (Lymnaeidae). Further, the Conchologica Iconographica edited by REEVE (continued by SOWERBY) with Neritina, 1856; Navicella 1856; Melania, 1860/61; Limnaea, 1872; Physa, 1873/74; Planorbis, 1878.

In the Manual of Conchology by TRYON (continued by PILSBRY) are published the Neritidae, 1888. MARTENS (1869) described some species from the Mascarene Islands from the collection of the Voyage of DECKEN to East-Africa and the nearby islands, and (1880) the collection of MÖBIUS from Mauritius and the Seychelles. MORELET (1882) has given some critical remarks to the publication of MARTENS (1880). DESHAYES (1863) published a catalogue of the molluscs of La Réunion, and CROSSE (1874) a malacological review of the island of Rodriguez (continued by MORELET, 1875, and SMITH, 1876). The widow of the shell-collector LIÉNARD published (1877) a list of the molluscs of the Seychelles and Mascarene-Archipelago, but without any figures and localities. Some shells found at the Seychelles and Mascarene are described by NEVILL (1878/84) in the Hand-List of the Molluscs in the Indian Museum of Calcutta.

The shells of land- and freshwater-molluscs of the Comores islands were described and partly figures by MORELET (1877, 1879 — Mission BEWSHER at Anjouan); (1881a, 1881b, 1882, 1883 — Mission MARIE at Mayotte). CROSSE (1879, 1881) and BOETTGER (1890, 1889, 1892) described shells from the islands of Nossi-Bé and Nossi Comba between the Comores and NW-Madagascar. Based on the collections made by BRAUER, the authors MARTENS & WIEGMANN (1898) published a survey of the land- and freshwater molluscs of the Seychelles.

The collections of "THE PERCY SLADEN-TRUST-EXPEDITION" led by GARDINER in 1905, and between 1908—1909, were the base for the studies of SYKES (1909). A list of gastropods of different East-African islands has been published by KOBELT (1910).

The most important study on the systematic conchology of land- and freshwater-molluscs of the Mascarene islands (including remarks about the malacofauna of the Seychelles) has been given by GERMAIN (1921), illustrated with many figures and photographs, and includes a complete bibliography till 1920. CONNOLLY (1925) published notes on a collection of non-marine molluscs from the Indian Ocean islands. GERMAIN (1934) gives a survey of the composition and origin of the land- and freshwater molluscs of the Seychelles Archipelago, and finally BARNACLE (1967) has published a list of the land- and freshwater shells of the Seychelles, including the islands of Aldebra, Amirantes, Coetivy, Cosmoleda, and Farquhar.

All cited works are almost exclusively lists or descriptions of shells with very few dates, localities or ecological conditions. Many synonyms named in consequence of the great variability-especially of the shells of freshwater molluscs- and anatomical studies of the soft-bodies and the radulae are mostly missing. Only few species from the islands were studied anatomically, such as some Neritidae by BOURNE (1908) and BOUVIER (1886, 1892); Lymnaeidae and Planorbidae by HUBENDICK (1951, 1955); Hydrobiidae and Melaniidae by THIELE (1928). A general survey of the conchology, anatomy, histology, ecology, and distribution of the freshwater-gastropods of Madagascar (with remarks on adjacent islands) has been given by STARMÜHLNER (1969) in a comprehensive monograph.

To complet the collections and studies of the Madegassian freshwatergastropods, the author, assisted by his wife, Edith STARMÜHLNER, and Dr. G. WENINGER, collected in 1974 freshwater-gastropods at the Archipelagos of the Seychelles (Mahé), Comores (Grand Comore, Anjouan) and Mascarene (La Réunion, Mauritius). A small collection of freshwater gastropods from Rodriguez was given to us by P. BRINCK & P. H. ENCKELL (Mission 1973) and is also included in the study. Also we got a sample of *Cleopatra ajanensis* f. *silhouettensis* from Silhouette-island (Seychelles) from Mons. Guy LIONNET (Mahé).

# 2. Material and Methods

At the 83 stations (including the collections of the Lund-University-Mission, 1973, and Silhouette-island) altogether 30 species (including subspecies and formes) were found: 19 species belonging to the Prosobranchia and 11 species to the Euthyneura-Pulmonata-Basonmotophora. The collections were made — if possible — in series, to study the variability of the shells. At every station the density of the species was noted (1 dm<sup>2</sup> for small species,  $1/_{16}$  m<sup>2</sup> for medium-size and larger species and 1 m<sup>2</sup> for rare species). The quantitative counting was made with the aid of wire-frame of 1 dm<sup>2</sup> and  $1/_{16}$  m<sup>2</sup>. At all stations were measured the water-temperature (electrically and with a water-thermometer) and the velocity of the surface current. The nature of the bottom (mud, sand, gravel, boulders, rock), submerged vegetation, and the accompanied fauna were noted (STARMÜHLNER, 1978).

To characterize the chemistry of the water at each place, the pH, the electrolytic conductivity, and the total hardness were measured with chemicals (MERCK). Detailed chemical studies were made by G. WENINGER (1977).

The collected water-snails were preserved in 70% alcohol for anatomical studies, and in BOUIN's liquid for histological sections. Dissections of the specimens were made in a dish with wax under stereoscopic microscope (WILD M5) and the drawings were made with a camera lucida. Study of the prepared radulae was made with a REICHERT-BIONAR. Photographs of the shells in the laboratory were made with a NIKON (portrait lenses) and two electronic flashes. The specimens, discussed in this paper are registered under the number 81.110 in the Collection of Molluscs, 3rd Zool. Dept. of the Natural History Museum, Vienna (Austria).

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4. List of the collected species (including subspecies, resp. forms)

The classification of species follows - with some exceptions - the system of the HANDBUCH DER PALÄOZOOLOGIE, Vol. 6, GASTROPODA : PROSOBRANCHIA, by W. WENZ, 1939, and EUTHYNEURA, by W. WENZ, continued by A. ZILCH. 1959/60.

Phylum: MOLLUSCA Class: GASTROPODA Subclass: PROSOBRANCHIA (= STREPTONEURA) Order: Archaegastropoda Superfamily: Neritacea Family: Neritidae Subfamily: Neritinae Genus: Clithon MONTFORT, 1810 Subgenus: Clithon s. str. 1) Clithon (Cl.) chlorostoma (BRODERIP, 1832) f. comorensis (MORELET, 1877)

- 2) Clithon (Cl.) coronata (LEACH, 1815) (= longispina, Récluz, 1841) including f. despinosa MOUSSON, 1867
- 3) Clithon (Cl.) spiniperda (MORELET, 1860) Genus: Neritina LAMARCK, 1816 Subgenus: Neripteron LESSON, 1830
- 4) Neritina (Neripteron) auriculata LAMARCK, 1816 f. mauriciae LESSON, 1830 Subgenus: Vittina H. B. BAKER, 1923
- 5) Neritina (Vittina) gagates LAMARCK, 1822 Subgenus: Neritina s. str.
- 6) Neritina (Neritina) pulligera (LINNÉ, 1767) knorri Récluz, 1841
- 7) Neritina (Neritina) pulligera (LINNÉ, 1767) stumpfi BOETTGER, 1890 Genus: Septaria FÉRUSSAC, 1807
- 8) Septaria borbonica (BORY DE ST. VINCENT, 1803) Subfamily: Neritiliinae Genus: Neritilia MARTENS, 1879
- 9) Neritilia consimilis MARTENS, 1879 Order: Mesogastropoda Superfamily: Cyclophoracea Family: Viviparidae Subfamily: Bellamyanae Genus: Bellamya JOUSSEAUME, 1886

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10) Bellamya bengalensis (LAMARCK, 1822) f. zonata (HANLEY, 1860) Superfamily: Rissoacea Family: Synceridae (= Assimineidae) Subfamily: Syncerinae (= Assimineinae) Genus: Paludinella PFEIFFER, 1841 11) Paludinella hidalgoi (GASSIES, 1869) granum (MORELET, 1882) Genus: Syncera GRAY, 1821 (= Assiminea FLEMING, 1828) 12) Syncera (= Assiminea) nitida (PEASE, 1864) Subfamily: Omphalotropinae Tribe: Omphalotropeae Genus: Omphalotropis L. PFEIFFER, 1851 Subgenus: Omphalotropis s. str. (= Eutropis KOBELT & MÖLLENDORF, 1898) 13) Omphalotropis (O.) globosa (BENSON, 1852) 14) Omphalotropis (O.) picturata (ADAMS, 1867) 15) Omphalotropis (O.) rangi (FERRUSSAC, 1827 — POTIEZ & MICHAUD, 1838) Superfamily: Cerithiacea Family: Thiaridae (= Melaniidae) Subfamily: Paludominae Tribe: Paludomeae Genus: Cleopatra TROSCHEL, 1856 Subgenus: Zanguebarica P. FISCHER, 1881 16) Cleopatra (Zanguebarica) ajanensis (MORELET, 1860) f. silhouettensis (NEVILL, 1869) Subfamily: Thiarinae Tribe: Thiareae Genus: Thiara BOLTEN (RÖDING), 1798 Subgenus: Plotia (BOLTEN) RÖDING, 1798 17) Thiara (Plotia) scabra (O. F. MÜLLER, 1774) Genus: Melanoides OLIVIER, 1804 Subgenus: Melanoides s. str. 18) Melanoides (M.) tuberculata (O. F. MÜLLER, 1774) Family: Potamidiae Subfamily: Potamidinae Genus: Terebralia SWAINSON, 1840 Subgenus: Terebralia s. str. 19) Terebralia (T.) palustris (LINNÉ, 1767) Subclassis: EUTHYNEURA Order: Basommatophora Superfamily: Ellobiacea (= Actophila) Family: Ellobiidae Subfamily: Melampodinae Genus: Melampus MONTFORT, 1810 Subgenus: Melampus s. str.

20)	Melampus	(Melampus) lividus (DESHAYES, 1830)
	Subgenus:	Micromelampus Möllendorf, 1898

- 21) Melampus (Micromelampus) cf. caffer (KÜSTER, 1844) Superfamily: Lymnaeacea Family: Physidae Genus: Physa DRAPARNAUD, 1801 Subgenus: Physa s. str.
- 22) Physa (Physa) borbonica FÉRUSSAC, 1825
  Family: Lymnaeidae
  Subfamily: Lymnaeinae
  Genus: Lymnaea LAMARCK, 1799
  Subgenus: Radix MONTFORT, 1810
- 23) Lymnaea (Radix) natalensis KRAUSS, 1848 and Lymnaea (Radix) natalensis KRAUSS, 1848 hovarum TRISTRAM, 1863
- 24) Lymnaea (Radix) mauritiana MORELET, 1875
  Family: Planorbidae
  Subfamily: Planorbinae
  Genus: Planorbella HALDEMAN, 1842 (= Helisoma SWAINSON, 1840)
- 25) Planorbella (= Helisoma) duryi (WETHERBY, 1879) Genus: Gyraulus CHARPENTIER, 1837
- 26) Gyraulus mauritianus (MORELET, 1876)
   Genus: Afrogyrus BROWN & MANDAHL-BARTH, 1973
   Subgenus: Afrogyrus s. str.
- 27) Afrogyrus (Afrogyrus) rodriguezensis (CROSSE, 1873) Subgenus: Hovorbis BROWN & MANDAHL-BARTH, 1973
- 28) Afrogyrus (Hovorbis) cf. crassilabrum (MORELET, 1860) Genus: Ceratophallus BROWN & MANDAHL-BARTH, 1973
- 29) Ceratophallus sp. Family: Ferrissidae Genus: Ferrissia WALKER, 1903 Subgenus: Pettancylus IREDALE, 1943
- 30) Ferrissia (Pettancylus) sp.

# 5. List and Description of the stations

The 83 stations, where freshwater- and brackish-water gastropods were collected, during the Austrian Mission (1974), Lund-Mission (1973) and by G. LIONNET (Mahé):

Seychelles-Archipelago:

Mahé:	9 stations
Silhouette :	1 station

Comores-Archipelago:

Grand Comore:	2 stations
Anjouan:	16 stations
Nossi-Bé :	1 station
Madagascar:	1 station

Mascarene-Archipelago:

La Réunion :	24 stations
Mauritius:	25 stations
Rodriguez:	4 stations

# Abbrevations in the list of stations:

Alt: Altitude above sea-level (in m); B: Breadth of the running water (in m); D: Depth of the running water (in m); p: pools between cascade-zones; C: velocity of the surface Current (in m/sec); b: banks; Bo: nature of the Bottom; T: Temperature of the water, during the collection at the station (in ° Celsius); Col: Colour of the water; Ch: Chemistry of the water measured at place; pH: concentration of Hydrogen-ion;  $El_{20}$ : Electrolytic conductivity in  $\mu$  Siemens (at 20° C); T. H: Total Hardness (in German Hardness degree = ° dH).

5.1 Seychelles-Archipelago (Fig. 1)

The Seychelles consist of well over hundred islands. Our mission collected at Mahé (at Praslin and La Digue, no freshwater-gastropods were found). We received one sample from Silhouette island, collected by G. LIONNET. The granitic islands were a part of ancient Gondwanaland, the old Precambric South-Continent (STARMÜHLNER, 1978). The steep slopes of Mahé (highest elevation: 800 m) descend into the sea; joints and dolerite dykes give rise to narrow, deep valleys with V-profiles. The rock faces are smooth and gently rounded. The flat low-lying coastal areas at the mouths of the streams are of calcareous construction from the debris of the adjacent fringing reefs. These areas are inhabited and cultivated, and the streams particularly polluted. The primary tropical rain-forests are reduced to a few patches in the upper slopes of Mahé and Silhouette. Photographs of the stations are to find by Star-MÜHLNER (1978).

5.1.1 Mahé

5.1.1.1. Headwaters to Upper courses (600 m-400 m):

Freshwater-gastropods absent (Ch: pH: 5.3, El<sub>20</sub>: 33, T. H: 0.095° dH).

5.1.1.2. Upper to Middle courses (400 m - 200 m):

No. 1: F/Sey/11/9. 2. 1974: River Seche; slightly polluted by farm-houses and plantations nearby; scrub.

Alt:	310 m	Bo:	granitic	boulders,	gravel;	; b,	p:
B:	$2-5 \mathrm{m}$		muddy v	vater-mosse	<b>3</b> 8		
D:	10-20  cm; p: 1  m	Col:	brownish	, putrid od	lor		
T:	23.5° C (10h)	Ch:	pH: 6.6,	El <sub>20</sub> : 47,	<b>Т. Н:</b> (	0.55°	dH
	Species found: Gyraulus cf. mauritianu	8.					

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Fig. 1. Map of the Western Indian Ocean with Seychelles-, Comores-, Mascarene-Archipelagos and Madagascar

5.1.1.3. Middle to Lower courses (200 m - 10 m):

No. 2: F/Sey/18/15. 2. 1974: River Plaisance; beyond a waterfall of about 20 m height; meadows with small pools, filled with water from floods and rains.

Alt: 120 m

C:

B: 20 cm - 1 m

Bo: granitic boulders, gravel, sand;
p: muddy sand, vegetable debris
Ch: pH: 6.5, El<sub>20</sub>: 35, T. H: 0.15° dH

D: 5-20 cm; p: 20-50 cm

30-75 cm/sec; p: 0

T: 24.7° C (10<sup>30</sup>) - 24.9° (12<sup>h</sup>)

Species found: Lymnaea (Radix) cf. natalensis (only in the pools!).

No. 3: F/Sey/2/5. 2. 1974: River Mamelles; dense secondary forest, very shady.

Alt:	40  m - 20  m	Bo: granitic rock, boulders (10 cm $\emptyset$ ),
<b>B</b> :	2 - 10  m	gravel, sand; algae
D:	5-15  cm; p: 50  cm-1.5  m	Ch: pH: 6.9, El <sub>20</sub> : 54, T. H: 0.65° dH
C:	50  cm - > 1  m/sec; p: 0 - 20  cm/sec	,

T: 24.4° C (10<sup>h</sup>)

Species found: From about 40 m: Neritina pulligera stumpfi and knorri; from about 20 m: Neritina (V.) gagates, Neritilia consimilis.

No. 4: F/Sey/23/18. 2. 1974: River Quenet (or Seychelles College), near the tenniscourt of the College; dense, secondary forest, plantations, villages nearby: polluted.

Alt	: 30 m	Bo: granitic boulders (50 cm $-1$ m $\emptyset$ ),
B:	1 - 3 m	gravel, covered with water-mosses;
D:	1-5  cm; p: 5-30  cm	b, p: muddy sand, vegetable debris
C:	50  cm - > 1  m/sec; p: 0 - 30  cm/sec	Ch: pH: 6.9, El <sub>20</sub> : 46, T. H: 0.33° dH
Т:	25.5° C (16 <sup>h</sup> )	
	Species found: Neritina (V.) gagates,	Neritina (N.) pulligera stumpfi, Gyraulus
cf. r	nauritianus.	

No. 5: F/Sey/12/9. 2. 1974: River Royal, near the Canelle Road; secondary forest, plantations, village nearby: slightly polluted.

Alt:	30 m	Bo: granitic boulders $(20-50 \text{ cm } \emptyset)$ ,
B:	$20 - 50  \mathrm{cm}$	covered with water-mosses; p: sand,
D:	$5 - 20  \mathrm{cm}$	red lateritic mud, vegetable debris
C:	30  cm - > 1  m/sec; b, p: $10 - 30  cm/sec$	Ch: pH: 7.2, El <sub>20</sub> : 116(!), pollution;
T:	26.3° C (16h)	T. H: 1.39° dH
	Species found: Melanoides tuberculata,	Gyraulus cf. mauritianus.

No. 6: F/Sey/25/19. 2. 1974: River Cascade; near the barrage, upstream of the Mangrove-zone in the range of brackish estuary; scrub, plantations nearby.

 Alt: 30 m
 Bo: grantic rock, boulders, gravel, sand

 B: 8-10 m
 Ch: pH: 6.6, El<sub>20</sub>: 33, T. H: 0.18° dH

 D: 20-50 cm; p: 1 m
 Ch: pH: 6.6, El<sub>20</sub>: 33, T. H: 0.18° dH

C: 50 cm - > 1 m/secT:  $26^{\circ} \text{ C} (14^{\text{h}})$ 

Species found: Septaria borbonica.

5.1.1.4. Lower cources to the Mouth-region (10m - 0m):

No. 7: F/Sey/21/17. 2. 1974: River Grande Anse; near the bridge of the western coastal road; scrub.

Alt:	2 m	Bo: granitic rock, boulders $(10 - 30 \operatorname{cm} \emptyset)$ ,
B:	3-6 m	gravel, sand
D:	10 - 50  cm	Ch: pH: 6.8, El <sub>20</sub> : 35, T. H: 0.2° dH
C:	50-75 cm/sec; b: $0-30$ cm/sec	
T:	28° C (16h)	
		Quarter to the baseline Manufalline and the fits

Species found: Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis.

No. 8: F/S ey/8/7. 2. 1974: River Anse de la Mouche; near the Canelles-road, crossing coconut-plantations to the western coastal road, near Anse de la Mouche; the mouth-region damed up by high-tide; flooded brackish-water pools near the borders of the

rivulet; many marine and brackish species occurring, such as Periophthalmus sp., crabs etc.).

Alt	0.5 m	Bo: boulders of dead corals, sa	and
B:	2-3 m (low-tide!)	filamentous blue-green algae	
D:	5-50 cm (low-tide!); p: $1-20$ cm	Ch: El <sub>20</sub> : about 30.000 (brackish)	

D: 5-50 cm (low-tide!); p: 1-20 cm

30 cm/sec (low-tide!) C: T: 32° C-32.5° C (16h)

Species found: Rivulet: Melanoides tuberculata (dense population of pigmy specimens!), Syncera (= Assiminea) nitida, Melampus cf. caffer; Brackish pools nearby: Terebralia palustris.

5.1.2 Silhouette

No. 1: Upper course of the River Maccabee, N of Grande Barbe; leg.: G. LIONNET (Mahé). No ecological data.

Species found: Cleopatra ajanensis f. silhouettensis.

# 5.2 Comores-Archipelago (Fig. 1)

The Comores comprise four main-islands: Grand Comore, Anjouan, Mohéli and Mayotte. They are almost entirely of volcanic origin. Grand Comore, the biggest and youngest island has undissected, active shield volcanoes. It has no river erosion and the waters of the rains seep away in the lava slacks. The rainwater must be collected in large cisterns by the population. The precipitous mountains of Anjouan (highest point: 1595 m) are composed of successions of basalts and ankamarites; the younger lavas partly highly alcalic. In older basaltic sequences are found deep river erosions modified by younger flows and well-preserved cinder cones. The remainder of primeval forests is restricted to the higher, steep parts of the central mountains. The hills and plains are cultivated, mostly with parfume-plantations, such as Ylang.

# 5.2.1 Grand Comore

No. 1: 28. 2. 1974: Walls of the Beach-Hotel Coelacanth, near Moroni; near the coast in the range of scattered rocks in the Upper-Tidal-zone.

Species found: Melampus (M.) lividus.

No. 2: F/Gr. Co/1/28. 2. 1974: Cistern of a village, N of Moroni; filled with collected rain-water; walls covered with filamentous algae.

T: about 28° C Ch: pH: 8.1, El<sub>20</sub>: 118, T. H: 2.85° dH Species found: Afrogyrus (Hovorbis) cf. crassilabrum.

5.2.2 Anjouan

5.2.2.1. Headwaters to Upper courses (900 m-600 m):

T: 20° C (12<sup>30</sup>-13. 3. 1974) Ch: pH: 7.8-8.6, El<sub>20</sub>: 35-94, T. H:  $0.6^{\circ} - 1.9^{\circ} dH$ 

Freshwater gastropods absent!

5.2.2.2. Upper courses (600 m - 400 m):

No. 1: F/An/12 I/11. 3. 1974: River Tatinga, near Dindi; primeval and secondary forest; scrub; on the left side border, influence of a mineral source.

- Alt: 600 m Bo: basaltic boulders, gravel B: 3-8 m filamentous algae; near the mineral D: 5-10 cm; p: 30-50 cmsource: iron-ochre mud 75 cm - > 1 m/sec;Ch: pH: 7.9, El<sub>20</sub>: 120, T. H: 2.6° dH b, p: 10 - 30 cm/sec
- T: 22.9° C (16<sup>h</sup>) 22.2° C (18h)

(Mineral source: Ch: pH: 6, El<sub>20</sub>: 1600, T. H: 55° dH(!), CaO: 221 mg/l, MgO: 102 mg/l, Fe: 13 mg/l, HCO<sub>3</sub>: 1312 ppm, CO<sub>2</sub> (free): 550).

Species found: Lymnaea (Radix) natalensis (also outside of the river in the spraywater near the mineral source!)

No. 2: F/An/12/9. 3. 1974: Headwater and upper course with tributary and reservoir near the village Bazmini on the road Oueni-Col de Patsi; plantations; scrub. Alt  $\cdot$  520 m

LTLU.	020 m
B:	50 cm $->1$ m; reservoir: 5 m $\times$ 5 m
D:	3-10 cm; reservoir: 50 cm

- C: 50 cm >1 m/sec; b: 10 30 cm/secreservoir: 0
- Bo: basaltic boulders, gravel  $(5-20 \text{ cm } \emptyset)$ ; b: muddy stones, sand, vegetable debris

sand:

- Ch: pH: 7, El<sub>20</sub>: 130, T. H: 2.5° dH
- T: 23° C (9<sup>h</sup>); reservoir: 23.5° C (9<sup>h</sup>)

Species found: Lymnea (Radix) natalensis (near the border of the river and on the walls of the water-reservoir).

No. 3: F/An/5/5. 3. 1974: Tributary of the upper course of the River Mutsamudu; secondary forest; scrub.

Alt:	500 m	Bo: basaltic boulders, gravel
<b>B</b> :	1-2 m	$(1-10 \operatorname{cm} \varnothing)$ ; b: muddy stones, algae
D:	$2-5~\mathrm{cm}$	Ch: pH: 8, El <sub>20</sub> : 142, T. H: 3.15° dH
<b>C</b> :	50  cm - > 1  m/sec;	

b, p: 10 - 30 cm/sec T: 22.5° C (10<sup>h</sup>); 23° C (12<sup>h</sup>)

Species found: Septaria borbonica (sporadic), Melanoides tuberculata.

5.2.2.3. Upper to Middle courses (400 m - 150 m):

No. 4: F/An/4/4. 3. 1974: River Mutsamudu, downstream of No. 3; secondary forest; scrub; plantations.

Alt:	250 m	Bo: basaltic boulders, gravel
B:	5-7 m	$(5-20 \text{ cm } \emptyset)$ , sand
D:	10 - 20  cm	
C:	75  cm - > 1  m/sec;	Ch: pH: 8.1, El <sub>20</sub> : 117, T. H: 2.7° dH
	b, p: 10-30 cm/sec	
T:	24.8° C (15 <sup>h</sup> )	

Species found: Lymnaea (Radix) natalensis.

C:

No. 5: F/An/10/8. 3. 1974: River Ouani; narrow gorge near Patsi; plantations; near the banks flooded pools. Alt: 250 m Bo: basaltic boulders (50 cm  $\emptyset$ ), co-B:  $4-8 \text{ m}; \text{ p}: 3-5 \text{ m} \emptyset$ vered with mosses; gravel, muddy D: 5-10 cm; p: 1-2 msand; p: muddy sand, vegetable C: 50 cm ->1 m/sec; b: 0-10 cm/sec debris; T: River: 24.3° C (9<sup>h</sup>-12<sup>h</sup>); Col: brownish p: 26.3° C (12h) Ch: pH: 8.4, El<sub>20</sub>: 180, T. H: 3.5° dH Species found: River: Lymnaea (Radix) natalensis, Ceratophallus sp. Flooded pools: Melanoides tuberculata, Lymnaea (Radix) natalensis, Cerato-

Flooded pools: Melanoides tuberculata, Lymnaea (Radix) natalensis, Cerato phallus sp.

5.2.2.4. Middle to Lower courses (150 m-10 m):

No. 6: F/An/18/20. 3. 1974: River Foumbani; near the village Foumbani (region Sima, NW of the island); scrub; plantations.

Alt	: 150 m	Bo: basaltic rocks with cavities, gravel
<b>B</b> :	1 - 2 m	with algae, sand
$\mathbf{D}$ :	1 - 10  cm	Ch: pH: 6.8, El <sub>20</sub> : 255, T. H: 5.5° dH
C:	30-75  cm/sec	
т:	26° C (11 <sup>h</sup> )	

Species found: Ceratophallus sp.

No. 7: F/An/6/5. 3. 1974: River Mutsamudu; downstream of a waterfall and flowing out from a pool of 20 m  $\emptyset$  and 2-3 m depth in cascades; scrub; plantations.

Alt:	120 m	Bo: basaltic rock, boulders (30 cm-
B:	10-20 m	$1 \text{ m } \emptyset$ ); gravel (5 cm $\emptyset$ ), sand
D:	20-50 cm; p: $1-1.5$ m	Ch: pH: 8.2, El <sub>20</sub> : 135, T.H: 2.9° dH
C:	1  m/sec; b, p: 20-30 cm/sec	

T: 24.9° C (16<sup>h</sup>); 24.5° C (16<sup>30</sup>)

Species found: Clithon spiniperda, Neritina (V.) gagates, Neritina pulligera knorri, Septaria borbonica, Neritilia consimilis.

No. 8: F/An/8/7. 3. 1974: River Hanghoué; scrub; plantations.

Alt	: 90 m	Bo: basaltic boulders (50 cm $-2$ m $\emptyset$ ),
B:	2-8 m	gravel (5 $-10 \text{ cm } \emptyset$ ), sand
D:	5-10  cm; p: 50  cm	Ch: pH: 7.9, El <sub>20</sub> : 130, T.H: 2.6° dH
C:	30  cm - 1  m/sec	
T:	23.6° C (9 <sup>h</sup> ); 25.8° C (12 <sup>h</sup> )	

Species found: Neritina pulligera stumpfi, Septaria borbonica.

No. 9: F/An/15/13. 3. 1974: River Gégé; near the village Gégé on the SE-coast; scrub; coconut-plantations.

Alt	: 20 m	Bo: basaltic boulders $(10-50 \text{ cm } \emptyset)$ ,
B:	4-8 m	gravel (5 cm $\emptyset$ ), sand
D:	$5 - 30  \mathrm{cm}$	Ch: pH: 8, El <sub>20</sub> : 120, T.H: 2.3° dH
C:	75  cm - > 1  m/sec; b, p: 0 - 30  cm/sec	

T: 25.6° C (10<sup>h</sup>); 27.3° C (12<sup>h</sup>)

Species found: Septaria borbonica.

5.2.2.5 Lower courses to the mouth regions (10 m - 0 m):

No. 10: F/An/19/20. 3. 1974: River Bouékouni on the NW-coast; narrow gorge with waterfall and pool of 5 m in diameter and 1-2 m depht; out-flow of the pool reaches the sea in about 50 m.

- Alt: 10 m (out-flow)
- B: 2-5 m
- D: 5-20 cm
- C: 75 cm > 1 m/sec
- T:  $25.5^{\circ}$  C (12<sup>h</sup>)

Species found: Neritina (V.) gagates, Neritina pulligera stumpfi, Septaria borbonica.

gravel

gravel

No. 11: F/An/11/8. 3. 1974: River Oichiconi on the N-coast; about 200 m upstream of the mouth; coconut-plantations.

Alt: 5 m

- B: 3 5 m
- D: 10 30 cm
- C: 30 cm/sec > 1 m/sec
- T: 24.6° C (16<sup>h</sup>); 24.2° (17<sup>30</sup>)

Species found: Septaria borbonica.

No. 12: F/An/20/20. 3. 1974: River Pagé; near the mouth.

- Alt: 3 m
- B: 5-10 m
- D: 10 50 cm
- C: 50 cm 1 m/sec
- T: 25° C (13h)

Species found: Clithon spiniperda, Septaria borbonica.

No. 13: F/An/7/6. 3. 1974: River Pouzine on the N-coast; near the mouth; lower parts under influence of the brackish current during high tide; Ylang-plantation.

Alt	: 2-1 m	Bo: basaltic houlders $(20-50 \text{ cm } \emptyset)$ ,
B:	2-3 m	gravel (5–10 cm $\emptyset$ ), sand
D:	10 - 30  cm	Ch: pH: 7.7; El <sub>20</sub> : 122 (during lowtide!),
C:	30  cm/sec - > 1  m/sec	T.H: 2.5° dH
т٠	25 7° C (15h) · 26° C (17h)	

25.7° C (15<sup>n</sup>); 26° C (17<sup>n</sup>)

Species found: Clithon chlorostoma f. comorensis, Clithon spiniperda, Neritina pulligera stumpfi, Septaria borbonica, Neritilia consimilis.

No. 14: F/An/22/21. 3. 1974: River Jomani on the SO-coast; approx. 100 m upstream of the mouth; scrub; plantations.

- Alt: 2-1 m
- B: 8 m
- D: 20 50 cm
- C: 50-75 cm/sec; b: 20-30 cm/sec
- T: 26.5° C (13<sup>h</sup>)

Species found: Septaria borbonica.

Bo: basaltic rock, boulders (20 cm -1 m

Bo: basaltic boulders  $(10-50 \text{ cm } \emptyset)$ ,

Bo: basaltic boulders  $(10-50 \text{ cm } \emptyset)$ ,

Ch: pH: 7.7, El<sub>20</sub>: 102, T.H: 2.1° dH

Ch: pH: 7.6, El<sub>20</sub>: 43, T.H: 1° dH

Ch: pH: 8.1, El<sub>20</sub>: 186, T.H: 3.9° dH

 $\emptyset$ ), lateritic layers

- Bo: basaltic boulders (40 cm -1 m  $\emptyset$ ), gravel  $(5-10 \text{ cm } \emptyset)$ , sand
- Ch: pH: 7.9,  $El_{20}$ : 108, T.H: 1.8° dH

No. 15: F/An/25/25. 3. 1974: River Pomoni (SE-coast); 100 m upstream of the mouth; scrub; plantations and villages nearby.

Alt: 2-1 mBo: basaltic boulders  $(50 \text{ cm}-1 \text{ m } \emptyset)$ ,B: 10-20 msandD: 5-30 cmCh: No data!C: 50-75 cm/sec; b: 20-30 cm/secT:  $25^{\circ}$  C  $(14^{h})$ 

Species found: Septaria borbonica.

No. 16: F/An/26/25. 3. 1974: River Bandoni on the SE-coast; mouth region with influence of brackishwater during high-tide; scrub; coconut-plantation.

Alt: 1 mBo: basaltic bouldersB: 5 mCh: pH: 7.4, El\_{20}: 85, T.H: 1.7° dHD: 10-20 cm(values taken at low-tide!)C: 50 cm-1 m/sec $75^{\circ} C (17h)$ 

T: 25° C (17<sup>h</sup>)

Species found: Clithon chlorostoma f. comorensis.

No. 17: F/An/3/3. 3. 1974: Source of Papani on the W-coast; S of Domboni; the run-off over a steep slope from a cave, flows in smalls streams 10-30 m to the sea; the pool in the cave is used as bath and lavatory by the population from villages nearby.

Alt	lm	Bo: basaltic boulders $(20-30 \text{ cm } \emptyset)$ ,
B:	1-2 m	gravel (5–10 cm $\emptyset$ ), sand
$\mathbf{D}$ :	2-5  cm; p: 50  cm	Ch: pH: 7.7, El <sub>20</sub> : 216, T.H: 3.7° dH
C:	1-2  m/sec; p: 0-20  cm/sec	
T:	23° C (run-off, 15 <sup>h</sup> )	

Species found: Neritina pulligera stumpfi, Septaria borbonica, Neritilia consimilis.

# 5.3 Island of Nossi-Bé (Fig. 1)

Nossi-Bé is situated on the NW-coast of Madagascar. The freshwatergastropods of the island were studied by STARMÜHLNER (1969). The Swedish Mission (1973) by P. BRINCK and P. H. ENCKEL has given to us one sample:

No. 1: River Djabala/5. 11. 1973: No ecological data!

Species found: Clithon spiniperda.

5.4 Madagascar (Fig. 1)

The freshwater-gastropods of Madagascar were reported in a monograph by Starmühlner (1969). The mission of P. BRINCK & P. H. ENCKEL in 1973 has sent us one sample from the Province Diego-Suarez in N-Madagascar:

No. 1: Loc. 51/3. 11. 1973: River Saharena; 19 km SW of Mahavanona (Prov. Diego-Suarez); Alt: 375 m; no ecological data!

Species found: Lymnaea (Radix) natalensis hovarum.

5.5 Mascarene-Archipelago (Fig. 1)

The Mascarene-islands comprise three main islands: La Réunion, Mauritius and, far to the East, Rodriguez. All islands are of volcanic origin.

5.5.1 La Réunion (Fig. 1)

The island (Highest elevation: Piton des Neiges, 3069 m) consists of two volcanoes. One, the Piton de la Fournaise, is still active. The second, the inactive Piton des Neiges, is apart from a number spectacular gorges with torrents quite well preserved. The central regions have been eroded in three great cirques as an extreme development of amphitheatre-headed valley erosion. Not only the youngest lavas and ashes are preserved, but also the ancient suites of effusive and intrusive rock, ranging from ultrabasic to acid composition are displayed deep within the core of the original volcano. A number of ancient terraces, composed of fluviatile sands and pebble-beds occur in the river gorges draining out from the cirques.

5.5.1.1 Headwaters to Upper courses (2500 m-1500 m): T: 15°-16° C Ch: p: 7.9, El<sub>20</sub>: 52; T.H: 1.15° dH Freshwater gastropods absent!

5.5.1.1 Upper courses (1500 m-700 m):

No. 1: F/Ré/18/13. 4. 1978: Riv. Cilaos, Bras de Benjouin, SW-slope of the Piton des Neiges, Cirque de Cilaos; high-mountain-scrub.

- Alt: 1400 mBo: basaltic boulders  $(1-2 m \emptyset)$ , gravelB: 1-3 mb, p: sand, stones with algaeD: 5-10 cmCh: pH: 8, El<sub>20</sub>: 130, T.H: 3° dHC: 1-1.5 m/sec; b, p: 30 cm/secCh: pH: 8, El<sub>20</sub>: 130, T.H: 3° dH
- T: 15.2° C (17<sup>h</sup>)

Species found: Physa borbonica.

No. 2: F/Re/19/14. 4. 1974: Confluence of the Bras des Etangs with the Ravine Prudent as tributary of the River Cilaos; near the town in the Cirque de Cilaos; approx. 300 m upstream is the inflow of a thermal source, used as thermal-bath; the watertemperature of the thermal-water is 39° C, high deposits of iron-ochre mud; meadow-slope, shrubery borders.

Bo: basaltic boulders  $(20-50 \text{ cm } \emptyset)$ ,

gravel; b, p: mud

Ch: no data!

- Alt: 1200 m
- B: 1 5 m
- D: 5-20 cm, p: 30-50 cm
- C: 75 cm > 1 m/sec,
- b, p: 30-50 cm/sec T: 18.2° C (11<sup>30</sup>)

Species found: Lymnaea (Radix) mauritiana, Physa borbonica.

5.5.1.3 Upper to Middle courses (700 m - 200 m):

No. 3: F/Re/9/8. 4. 1974: River Mathérine; near the road St. Benoit-Takamaka; a tributary of the River Marsouin; torrent with waterfalls in a gorge of a steep slope; misty rain-forest; scrub.

Alt: 700 mBo: basaltic boulders  $(30-50 \text{ cm } \emptyset)$ ,B: 1-2 mgravel  $(5-20 \text{ cm } \emptyset)$ , sandD: 5-20 cmCh: pH: 7.8, El<sub>20</sub>: 62, T.H: 1.25° dH

- C: 1-2 m/sec; b, p: 0.30 cm/sec
- T: 18° C (12<sup>h</sup>, rain)

Species found: Omphalotropis (O.) picturata (near the borders), Physa borbonica.

No. 4: F/R6/3/4. 4. 1974: Tibutary of the upper course of the River Mât; near the road to Hellbourg (Cirque de Salazie); torrent through plantations of water-cress; secondary forest (influence of fertilizers ?).

Alt:	650 m		B	o: basalti	c boulders, ;	gravel;	gelati	nous
B:	50  cm - 1  m			globula	ar algae (cf.	Nostoc	; sp.)	and
D:	5 - 10  cm			filamer	ntous algae;	b: mat	tlike ε	lgae
C:	50  cm - > 1  m/sec			(cf. Sp	<i>irogyra</i> sp.)			
	b, p: $0-30$ cm/sec							
Т:	23.2° C (15 <sup>30</sup> )		Cł	n: pH: 8.	3, El <sub>20</sub> : 250,	T.H: 5.	$25^{\circ} d$	H
	Species found:	Thiara scabra	, Lymnaea	(Radix)	mauritiana,	Physa	borbon	nica.

No. 5: F/Re/1/4. 4. 1974: River Mât; near Salazie; deep, V-like gorge; from the steep slopes, waterfalls of 20-30 m height in the river; shrub and secondary forest.

Alt:	450 m	Bo: basaltic rock, boulders $(20-30 \text{ cm})$
B:	5-10 m	Ø), gravel, sand
D:	30  cm; p: 1-2  m	Ch: pH: 8.3, El <sub>20</sub> : 235, T.H: 4.8° dH
C:	1-2 m/sec; b, p: $0-30$ cm/sec	•
T:	21.5° C (11 <sup>h</sup> ); 23.4° C (13 <sup>h</sup> )	

Species found: Lymnaea (Radix) mauritiana, Physa borbonica (both species also on wet areas of rocks outside of the water!).

No. 6: F/Re(11/9. 4. 1974: River Langevin; between St. Philipp and St. Pierre; near the borders, small pools.

Alt:	400 m	Bo: basaltic rock, boulders $(20-30 \text{ cm})$
B:	6-8 m	$\emptyset$ ), gravel, sand
D:	10 - 20  cm	Ch: pH: 7.7, El <sub>20</sub> : 69, T.H: 1.1° dH
C:	75  cm - 1  m/sec	
T:	17.8° C (15 <sup>h</sup> )	

Species found: Physa borbonica.

5.5.1.4 Middle to Lower courses (200 m-50 m):

No. 7: F/Ré/21/14. 4. 1974: River Cilaos; a tributary of the River St. Etienne, near St. Louis.

Alt: 200 m Bo: basaltic boulders (2	20-30 cm	ø),
B: 20 m gravel (5-10 cm ø	); b: mud	and
D: 5-10 cm paddings of algae		
C: 1 m/sec; p: 0-10 cm/sec Ch: pH: 8, El <sub>20</sub> : 258, T.J	$H: 8.8^{\circ} dH$	
T: 24° C (16 <sup>h</sup> )		

Species found: Lymnaea (Radix) mauritiana, Physa borbonica.

No. 8: F/Re/15/12. 4. 1974: River St. Suzanne, downstream of the waterfall called "Niagara" (height: 40 m) and a basin of 80 m in diameter; borders shrubbery.

	- · - ·	
Alt:	172 m	Bo: basin: basaltic gravel; b: muddy
B:	5-10 m (flow out of the basin!)	sand, stones, on the borders plants
$\mathbf{D}$ :	1 m; b: 10-30 cm	are hanging over in the water, algae;
C:	30-50  cm/sec	river: basaltic boulders, gravel; b:
	basin: $0 - 10 \text{ cm/sec}$	muddy sand
T:	23.5° C (10 <sup>h</sup> )	Ch: pH: 7.4, El <sub>20</sub> : 92, T.H: 1.65° dH

Species found: Basin, banks: Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica; river: Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis, Thiara scabra (only up to 30 cm/sec!).

No. 9: F/Ré/22A/15. 4. 1974: River St. Marie; near Flacourt; bordered by bamboocane, shady.

Alt: 156 m Bo: basaltic boulders (30 cm -1 m  $\emptyset$ ), B: 1-2 mgravel  $(3-10 \text{ cm } \emptyset)$ ; b: muddy sand D: 10 - 30 cm Ch: pH: 7.6, El<sub>20</sub>: 52, T.H: 1° dH C: 75 cm/sec - 1 m/sec; p: 30 cm/sec T: 21.3° (16<sup>h</sup>) Species found: Thiara scabra, Physa borbonica. No. 10: F/Ré/7/6. 4. 1974: Small brook near the road Cap Homard-St. Gilles les Hauts; a tributary of the Ravine St. Gilles; bordered by shrub and meadows. Alt: 150 m Bo: basaltic gravel, sand; b: muddy B: 1 m Ch: pH: 7.4, El<sub>20</sub>: 115, T.H: 2.3° dH D: 20 - 30 cm C: 30 - 50 cm/secT: 19° C (15h) Species found: Lymnaea (Radix) mauritiana, Physa borbonica. No. 11: F/Ré/4/5. 4. 1974: River Mât; near the bridge of the coastal road St. André-Bras Panon-St. Benoit; bordered by scrub and plantations. Alt: 145 m T:  $23.8^{\circ}$  C (10<sup>h</sup>) - 24.5° C (13<sup>h</sup>) B: 10 - 20 mBo: basaltic boulders  $(1-10 \text{ m } \emptyset)$ , D: 10 - 30 cm gravel  $(5-30 \text{ cm } \emptyset)$ , sand C: 1-2 m/sec; b, p: 0-30 cm/sec Ch: pH: 8.1, El<sub>20</sub>: 152, T.H: 3.1° dH Species found: Thiara scabra, Lymnaea (Radix) mauritiana (also be found on wet areas of rocks outside of the water!), Physa borbonica. No. 12: F/Ré/25/17. 4. 1974: Left side tributary of the River Galets (No. 13). Alt: 120 m T: 23.8° C (17h) B: 1 m Bo: basaltic gravel  $(5-20 \text{ cm } \emptyset)$ , sand, D: 1-2 cm; p: 20-50 cmmud C: 50 - 75 cm/sec; p: 0 - 30 cm/sec Ch: see No. 13 Species found: Lymnaea (Radix) mauritiana, Physa borbonica. No. 13: F/Ré/24/17. 4. 1978: River Galets; E of the road-bridge near Le Port; broad trough-like valley; bordered by scrub and meadows. Alt: 118 m T: 24° C (15<sup>30</sup>) B: 8-10 m Bo: basaltic boulders (50 cm -3 m  $\emptyset$ ), D: 20 - 50 cm gravel  $(10-20 \text{ cm } \emptyset)$ ; b, p: muddy C: 75 cm - 1 m/sec; stones with gelatinous brown-green b, p: 10 - 30 cm/sec algae (cf. Nostoc) Ch: pH: 8.6, El<sub>20</sub>: 142, T.H: 2.45° dH Species found: Thiara scabra, Lymnaea (Radix) mauritiana, Physa borbonica. No. 14: F/Ré/12/9. 4. 1974: River Langevin; W of St. Philipp. Alt: 100 m Bo: basaltic boulders (50 cm -1 m  $\emptyset$ ), B: 10 - 15 mgravel  $(10-20 \text{ cm } \emptyset)$  sand; stones D: 5 - 10 cmcovered with gelatinous film of C: 30-50 cm/sec diatoms, globular algae (cf. Nostoc), T:  $20^{\circ} C (17^{h})$ filamentous algae Ch: pH: 7.7, El<sub>20</sub>: 69, T.H: 1.1° dH

Species found: Lymnaea (Radix) mauritiana, Physa borbonica.

No. 15: F/R6/14/11. 4. 1974: River des Pluies; near the village River des Pluies; broad trough-like valley; bordered by shrub and plantations.

Alt:	100 m	Т:	23.5° C (	14 <sup>h</sup> )			
B:	5-8 m	Bo:	: basaltic	boulders	(20 - 50)	$\mathbf{cm}$	ø),
D:	10 - 20  cm		gravel, s	and			
C:	50-75 cm/sec; b: $0-30$ cm/sec	Ch:	: pH: 7.8,	El <sub>20</sub> : 102,	T.H: 2.	1° dH	[]

Species found: Lymnaea (Radix) mauritiana, Physa borbonica.

5.5.1.5 Lower courses to the Mouth-regions (50 m-0 m):

No. 16: F/R6/22/15. 4. 1978: River St. Suzanne; upstream of the coastal road St. Suzanne-St. André; bordered by bamboo-cane, shady.

$\mathbf{Alt}:$	45 m	T: 22.1° C (14 <sup>h</sup> )
B:	5-8 m	Bo: basaltic boulders, gravel and mud
D:	50  cm - 1  m	Ch: pH: 7.4, El <sub>20</sub> : 62, T.H: 1° dH
C:	30-50  cm/sec	

Species found: Septaria borbonica, Neritilia consimilis, Thiara scabra.

No. 17: F/R6/23/16. 4. 1978: River St. Denis; upstream of the capital St. Denis in a broad gorge; bordered by scrub and plantations; upstream villages, pollution influence of sewage is to except.

Alt:	25 m	Bo: basaltic boulders $(20-50 \text{ cm } \emptyset)$ ,
B:	5-8 m	gravel (5-10 cm $\emptyset$ ), covered with
D:	10 - 30  cm	algae; b: floating plants and roots
C:	50  cm - 1  m/sec	from the borders; submerged water-
	b, p: $0-30$ cm/sec	plants, such as Hydrilla sp.; mud
Т:	23.2° C (17 <sup>h</sup> )	Ch: pH: 8.4, El <sub>20</sub> : 105, T.H: 2.5° dH

Species found: Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica, Planorbella (= Helisoma) duryi, Ferrissia (Pettancylus) sp.

No. 18: F/Re/16/12. 4. 1974: Ravine de Charpentier; upstream of St. Marie; bordered by bamboo-cane, shady.

Alt:	20 m	T: $23^{\circ}$ C (14 <sup>h</sup> )
<b>B</b> :	4-6 m	Bo: basaltic gravel $(5-20 \text{ cm } \emptyset)$ , sand
D:	5-30 cm	Ch: pH: 7.2, El <sub>20</sub> : 65, T.H: 1° dH
a		

C: 75 cm - >1 m/sec; b: 10 - 20 cm/sec

Species found: Septaria borbonica, Neritilia consimilis, Lymnaea (Radix) mauritiana, Physa borbonica.

No. 19: F/R6/5/5. 4. 1974: River des Roches; near Beauvallon; 1 km upstream of the mouth-region; bordered by scrub, plantations.

Alt:	10 m	$\mathbf{T}$ :	26.6° (	C (14 <sup>h</sup>	); 5	28.4°	С	(14 <sup>h</sup> ,	cre	эөk
B:	10 - 15  m		near th	he ban	ks					
D:	30  cm - 1.5  m	Bo:	basalti	ie boul	der	s (30	cn	<b>n</b> -1 :	m g	ø),
C:	50  cm - >1  m/sec;		covere	d with	alg	ae				
	b, p: $0-30$ cm/sec	Ch:	pH: 7.	.4, El <sub>20</sub>	;: 77	7, T.E	<b>I</b> : 1	l.5° di	EL ,	

Species found: Clithon coronata, Neritina (N.) gagates, Septaria borbonica, Neritilia consimilis, Thiara scabra.

No. 20: F/Re/10/8. 4. 1974: River Marsouin; near St. Benoit; upstream of the mouth-region; bordered by scrub and plantations.

Alt:	10 m	T: $22.7^{\circ}$ C (15 <sup>h</sup> )
B:	10 - 20  m	Bo: basaltic boulders $(10-50 \text{ cm } \emptyset)$ ,
D:	20 - 50  cm	gravel (5–10 cm $\emptyset$ ), sand
C:	50  cm - > 1  m/sec; b: $0 - 30  cm/sec$	Ch: pH: 8.1, El <sub>20</sub> : 80, T.H: 1.5° dH
	Species found: Clithon coronata, Septar	a borbonica, Lymnaea (Radix) mauritiana.

#### 5.5.1.6 Stagnant waters

No. 21: F/R6/20/14. 4. 1974: Mare de Cilaos; two connected ponds near the town of Cilaos; bordered by scrub and partly polluted by domestic sewage.

Alt: 1220 m	Bo: basaltic boulders, gravel, mud, vege-
Diameter: 20-30 m	table debris
T: 23.7° C (15 <sup>h</sup> )	Ch: pH: 9.2, El <sub>20</sub> : 160, T.H: 3.8° dH
Species found: Physa borbonica.	

No. 22: F/Re/8/7. 4. 1974: Grand Bras de la Ravine Seche; Plaine de la Palmiste; a temporary stream, flowing only after heavy rainfall; outside of the rainy season, ponds and pools in channels and cavities of basaltic rocks; bordered by scrub.

 

 Alt: 950 m
 Bo: basaltic rock, boulders, muddy lavasand, vegetable debris

 Diameters:
 Sand, vegetable debris

 Big pond: ca. 140 m long;
 Ch: pH: 6.9, El<sub>20</sub>: 24, T.H: 0.45° dH

 B: 5-10 m, D: 1-2 m
 T: 23° C (16<sup>h</sup>-big pond)

 Downstream, small ponds and pools of
 50 cm-1 m Ø; rock-pools: 10-50 cm Ø

 and D: 5-10 cm
 Sand D: 5-10 cm

Species found: Physa borbonica.

No. 24: F/R6/6/6. 4. 1974: Source de la Moulin d'Eau; from a sourcepond a small brook flows off to the Etang St. Paul, a big pond with marshes and swamps reaching to the coast in contacts brackish-water; borderd by scrub, plantations, dense growth of *Colocasia antiquorum* on the border of the source-pond.

Alt:	20  m - 10  m			
Dia	Diameter: Source-pond: 20 m			
	D: 20-	-50 cm		
Out	flow of the so	urce-pond:		
B:	50 cm; D: 2	0-30 cm; C: $30-50$ cm/sec		
Т:	source-pond:	21.7° C (10 <sup>h</sup> -shady part)		
		22.5° C (10 <sup>h</sup> -sunny part)		
		23.7° C (12 <sup>h</sup> -sunny part)		
	outflow:	21.2° C (10 <sup>h</sup> -shady)		

Bo: source-pond: basaltic boulders, gravel, sand mud; on the surface *Lemna* sp.; outflow: basaltic gravel, sand, submerged plants, such as *Potamogeton pectinata*, Naja madagascariensis, cf. Fissidens sp., filamentous algae

Ch: pH: 8, El<sub>20</sub>: 1600, T.H: 10.7° dH

Species found: source-pond: Neritina (V.) gagates, Thiara scabra, Melanoides tuberculata; outflow: Syncera (= Assiminea) hidalgoi granum; Etang St. Paul: Thiara scabra.

# 5.5.2 Mauritius (Fig. 1)

Mauritius is like La Réunion a volcanic island, but 5-6 million years older. The central table land, separated from the plains on and near the coast,

is a plateau of about 580 m altitude. It is surrounded by mountains with some prominent peaks to more than 800 m altitude. The denuded stamps of an older series of basalts are covered by a twofold younger series, again basaltic. The island is drained by many rivers receiveing in their courses numerous tributaries from the mountains. The tropical primeval forests, with many endemic species, remain only in the natural forest reserves of the mountains in the SW-Black River Gorge. More than two third of Mauritius is cultivated, mostly with plantations of sugar-cane. The center and the coasts shows a high density of population.

 5.5.2.1 Headwaters (700 m - 600 m):

 T:  $18^{\circ} C - 20^{\circ} C (12^{h})$  

 Freshwater - gastropods absent!

 0.28^{\circ} - 0.3^{\circ} dH

5.5.2.2 Upper courses (600 m-400 m):

No. 1: F/Mau/7. 5. 1974: River des Anguilles; near the tea-estate of Bois-Cheri; bordered by scrub, secondary forest.

Alt	: 580 m	T: $19.4^{\circ}$ C (11 <sup>h</sup> ); $19.5^{\circ}$ C (12 <sup>h</sup> )
B:	4-6 m	Bo: basaltic rock, boulders (30 cm $-1$ m
D:	$5 - 20  \mathrm{cm}$	$\emptyset$ ), filamentous algae; b, p: muddy
C:	75  cm - > 1  m/sec	sand, brightreen cushions of tube-
	b, p: $20 - 30$ cm/sec	like algae
		Ch: pH: 7.6, El <sub>20</sub> : 97, T.H: 1.95° dH

Species found: Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica.

No. 2: F/Mau/25/6. 5. 1974: River Doudy; a tributary of the Grand River NE; bordered by scrub and plantations.

cm Ø),
acea gen.
ular algae
dH
) r >

Species found: Omphalotropis gibbosa (near the banks), Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica.

No. 3: FMau/26/6. 5. 1974: Grand River NE; bordered by scrub and plantations.

Alt:	400 m	T: 20.9° C (13 <sup>h</sup> )
<b>B</b> :	10-20 m	Bo: basalite rock, boulders $(1 \text{ m } \emptyset)$ ,
D:	10  cm; p: 1-2  m	filamentous algae, water-mosses; p:
<b>C</b> :	50 cm/sec;	iron-ochre mud
	b, p: $10-20$ cm/sec	Ch: pH: 7, El <sub>20</sub> : 69, T.H: 1° dH

Species found: Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica, Gyraulus mauritianus.

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5.5.2.3 Upper to Middle courses (400 m-200 m):

No. 4: F/Mau/21/4. 5. 1974: Tributary of the River Moka, a tributary of the Grand River NW; bordered by meadows, sugar-cane plantations, dense growth of *Colocasia antiquorum*; slightly polluted by a laundry-place of a village nearby.

Alt:	380 m	$T: 21.2^{\circ} C (10^{h})$
B:	1 m	Bo: basaltic boulders (50 cm $-1$ m $\emptyset$ ),
D:	10-50 cm	gravel $(1-20 \text{ cm } \emptyset)$ ; b: mud, sub-
C:	50 cm/sec;	merged waterplants and filamentous
	b, p: 10-30 cm/sec	algae
		Ch: pH: 6.6, El <sub>20</sub> : 116, T.H: 1.85° dH

Species found: Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica, Ferrissia (Pettancylus) sp.

No. 5: F/Mau/4/28. 4. 1974: Brook Le Canal; a tributary of the River Baie du Cap, near the road Fantaisie-Chamarel; bordered by scrub.

$\mathbf{Alt}$	: 300 m	T: 21.2° C (10 <sup>h</sup> )
B:	$2-5 \mathrm{m}$	Bo: basaltic boulders (30 cm $-1$ m $\emptyset$ ),
$\mathbf{D}$ :	5-30 cm	gravel (10 cm $\emptyset$ ); b: muddy sand
C:	50 - 75  cm/sec;	Ch: pH: 7.7, El <sub>20</sub> : 130, T.H: 1.85° dH
	b, p: $10 - 30$ cm/sec	

Species found: Clithon corona f. despinosa, Neritina (V.) gagates, Septaria borbonica, Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana.

No. 6: F/Mau/10/30. 4. 1974: River Cascade; downstream of the confluence with the River Terre Rouge, a tributary of the Grand River NW; near the road-bridge between Rose Hill and Reduit; bordered by scrub, dense growth of *Colocasia antiquorum*, plantations, gardens.

Alt:	300 m	Bo: basaltic boulders (50 cm $-1$ m $\emptyset$ ),
в:	4-6 m	gravel, dense growth of submerged
D:	3-5  cm; p: 30-50  cm	waterplants such as Hydrilla sp. and
C:	50 - 75  cm/sec;	others, filamentous algae; b: Salvia
	b, p: $10 - 30$ cm/sec	sp.
Т:	23.8° C (14 <sup>h</sup> )	Ch: $pH: 7.6, El_{20}: 155, T.H: 2.8^{\circ} dH$

Species found: Thiara scabra, Melanoides tuberculatus, Lymnaea (Radix) mauritiana, Physa borbonica, Gyraulus mauritianus.

No. 7: F/Mau/9/30. 4. 1974: River Rempart W; near the road Trois Cavernes-Quatres Bornes; bordered by scrub, sugar-cane plantations, dense growth of *Colocasia antiquorum* near the banks.

Alt:	250 m	T: 22.6° C (10 <sup>h</sup> )
B:	3-6 m	Bo: basaltic rock with cavernes, boulders,
D:	20-50  cm; p: 1-2  m	gravel; dense vegetation of water-
C:	50  cm - 1  m/sec;	mosses, near the borders: Hydrilla sp.
	b, p: $0-30$ cm/sec	Ch: pH: 7.5, El <sub>20</sub> : 200, T.H: 4.25° dH

Species found: Clithon coronata f. despinosa, Neritina (V.) gagates, Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica. No. 8: F/Mau/12/1. 5. 1974: River Patates; NE of Chemin Grenier, S-slope of the Piton Savanne; bordered by secondary forest with dense undergrowth.

Alt:	220 m	$\mathbf{T}$ :	22.6° C (13 <sup>h</sup> )
B:	$2-3 \mathrm{m}$	Bo:	basaltic boulders (20 cm $-1$ m $\emptyset$ ),
D:	20-30 cm; p: $50$ cm $-1$ m		gravel; few algae
~			

C: 75 cm - 1 m/sec; b. p: 10-20 cm/sec Ch: pH: 7.9, El<sub>20</sub>: 93, T.H:  $1.45^{\circ}$  dH

Species found: Neritina (V.) gagates, Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica.

5.5.2.4 Middle to Lower courses (200 m-10 m):

No. 9: F/Mau/19/9. 5. 1974: River Rempart E; near Amaury-bridge; bordered by dense growth of *Colocasia antiquorum* and sugar-cane plantations; slightly polluted by a laundry-place of a village nearby.

Alt	140 m	T: 24° C (12 <sup>h</sup> )
B:	5-7 m	Bo: basaltic boulders, gravel, sand, mud
D:	30-40 cm; p: 50 cm $-1$ m	and vegetable debris
C:	75  cm - > 1  m/sec;	Ch: pH: 7.6, El <sub>20</sub> : 163, T.H: 2.3° dH
	b. p: $10 - 20$ cm/sec	

Species found: Neritina (V.) gagates, Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica.

No. 10: F/Mau/5/28. 4. 1974: Small spring-brook in cascades; near the road Chamarel-Grand Case Noyal; bordered by scrub.

Alt:	130 m	$\mathbf{T}$ :	23.6° C (13h)
B:	30 cm	Bo:	gravel, sand
D:	10 cm	Ch:	no data!

C: 50 cm/sec

Species found: Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica.

No. 11: F/Mau/6/28. 4. 1974: River Citronniers; near Bel Ombre.

Alt:	130 m	$T: 23.5^{\circ} C (17^{h})$
B:	1-3  m	Bo: basaltic rock, boulders, covered with
D:	10 cm; p: 50 cm	algae; brown mud
C:	30-50 cm/sec; b. p: $0-10$ cm/sec	Ch: pH: 7.8, El <sub>20</sub> : 175, T.H: 2.35° dH
	Species formal. Manitime (IV) analysis	Quality Laster Manifeld and Manifeld

Species found: Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis, Thiara scabra, Melanoides tuberculata.

No. 12: F/Mau/11/1. 5. 1974: Confluence of the rivulets Jaquot and Ruisseau Fay d'Herbe; tributaries of the middle course of the River des Gallets; near Chemin Grenier, ravine between sugare-cane plantations; laundry place of a village nearby.

Alt:	130 m	$\mathbf{T}$ :	22.4° C (9 <sup>30</sup> ); 23.4° C (12 <sup>h</sup> )
в:	Rivulets before the confluence: 1 m;	Bo:	basaltic rock, boulders, gravel, some
	Diameter of the confluence-pool: 10 m;		stones covered with algae; p: mud
	Outflow of the confluence-pool: $1-2$ m		and muddy stones
D:	rivulets: $2-5$ cm; p: $10-50$ cm	Ch:	pH: 7.4, El <sub>20</sub> : 134, T.H: 2.35° dH
C:	Fay d'Herbe: waterfall of 10 m		
	height, borders with wet rocks;		
	Jaquot and outflow of the pool:		

Species found: Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica.

75 cm - > 1 m/sec; p: 0 - 30 cm/sec

No. 13: F/Mau/22/5. 5. 1974: River Savannes; downstream of the Rochester Falls in a pool of about 20 m length and 8 m breadth where the rivers flows out; water level of the pool and the outflow depends on the water consumption of a power station upstream of the walls; bordered by scrub and sugar-cane plantations.

Alt: 100 m

B: Rochester Falls: 15 m outflow: 2-3 m

- T:  $21.7^{\circ}$  C ( $10^{h}$ : outflow) Bo: basaltic boulders, gravel (5-20 cm
- D: 5-10 cm (low-water level) 40-60 cm (high-water level)
- Ø), sand, vegetable debris Ch: pH: 7.9, El<sub>20</sub>: 96, T.H: 1.55° dH

Bo: Mud, vegetable debris, some stones

C: outflow: 50 cm/sec (low-water level) 75 cm->1 m/sec (high-water level)

Species found: Clithon coronata, Neritina (V.) gagates, Septaria borbonica, Neritilia, consimilis, Thiara scabra, Melanoides tuberculata.

No. 14: F/Mau/1/27. 4. 1974: Small brook in the Botanical Garden of Pamplemousses; bordered by scrub and meadows.

Alt: 70 m

B: 50 cm

- Ch: pH: 7.6, El<sub>20</sub>: 125, T.H: 1.8° dH
- D: 10 cm
- C: 30 cm/sec; b: 10 cm/sec
- T: 25.7° C (13<sup>h</sup>)

Species found: Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica.

No. 15: F/Mau/3. 5. 1974: River Tombeau; near the road-bridge Terre Rouge — Petite Rosalie; bordered by scrub, meadows, sugar-cane plantations and with dense growth of *Colocasia antiquorum*.

Alt:	60 m	Bo: basaltic boulders (30 cm $-1$ mø),
B:	10 m	gravel $(10-20 \text{ cm } \emptyset)$ , sand; dense
D:	10 - 30  cm	growth of Hydrilla sp., watermosses
C:	50  cm - > 1  m/sec; b: 0 - 30  cm/sec	and filamentous algae
Т:	22.3° C (11 <sup>3</sup> -); 23.8° C (13 <sup>h</sup> )	Ch: pH: 8.2, El <sub>20</sub> : 132, T.H: 2.5° dH

Species found: Clithon coronata f. despinosa, Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica.

No. 17: F/Mau/13/1. 5. 1974: Black River in the Black River Gorge; near the borders are rock-pools, filled with water from floods and rains; bordered by scrub, secondary forest.

Alt:	30 - 40  m	$\mathbf{T}$ :	24.5° C (	16h)	
B:	15 - 20  m	Bo:	basaltic	gravel (5 $-20$ c	m Ø), sand;
D:	10-30  cm; p: 1-2  m		b: mud,	water-mosses,	filamentous
C:	50  cm - > 1  m/sec;		algae		
	b, p: 10-30 cm/sec	Ch:	pH: 8.1,	El <sub>20</sub> : 175, T.H:	$2.65^\circ  \mathrm{dH}$

Species found: (eggs of Neritidae), Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica; rock-pools: Lymnaea (Radix) mauritiana.

No. 18: F/Mau/20/3. 5. 1974: River Remparts E; near Haute Rive; bordered by sugar-cane plantations and dense growth of *Colocasia antiquorum*. Alt: 20 m T: 25.4° C (13<sup>h</sup>) B: 10-15 m Bo: basaltic gravel (5-20 cm  $\emptyset$ ), sand;

D: 20-50 cm C: 20-50 cm/sec; b: 0-20 cm/sec

Ch: pH: 8.1, El<sub>20</sub>: 175, T.H: 2.65° dH

algae

b: mud, water-mosses, filamentous

Species found: Neritina (V.) gagates, Bellamya bengalis f. zonata, Thiara scabra, Melanoides tuberculata.

No. 19: F/Mau/8/29. 4. 1974: River Jacotet; near Beau Champ; about 50 to 100 m upstream of the return current of brackish water during high tide; bordered by scrub. Alt. 15 m T: 23.8° C (16<sup>39</sup>-shedy!)

	10 m	<b>1</b> . <b>2</b> 0.0 0 (10 Shaay.).
B:	1-5 m	Bo: basaltic rock, boulders, gravel (5-
$\mathbf{D}$ :	10 - 50  cm	20 cm $\emptyset$ ); b: iron-ochre mud; Col:
C:	50 - 75  cm/sec;	opalescent
	b: 0-10 cm/sec	Ch: pH: 7.8, El <sub>20</sub> : 150, T.H: 2.5° dH
		~

Species found: Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis, Thiara scabra, Melanoides tuberculata.

5.5.2.5 Lower courses to the Mouth-region (10 m-0 m):

No. 20: F/Mau/28/8. 5. 1974: River du Poste; near the coastal roadbridge; bordered by sugar-cane plantations and scrub.

Alt:	10 m	T: 23.6° C (10 <sup>h</sup> )
B:	510 m	Bo: basaltic boulders (30 cm $-1$ m $\emptyset$ ),
D:	30-50 cm; b: 1 m	gravel
C:	50 cm/sec; b, p: 10 cm/sec	Ch: pH: 7.8, El <sub>20</sub> : 150, T.H: 2.5° dH

Species found: Septaria borbonica, Neritilia consimilis, Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica.

No. 21: F/Mau/29/8. 5. 1974: River Le Chaux; near the town of Mahébourg in the park of the Museum; bordered by scrub, plantations, gardens and large trees (shady); laundry places nearby.

Alt:	10 m	$\mathbf{T}$ :	24.5° C (	13 <sup>h</sup> )			
B:	15 m	Bo:	basaltic	boulders	(30 - 50)	$\mathbf{cm}$	ø),
$\mathbf{D}$ :	10 - 30  cm		gravel (5	5-10 cm	ø), sand;	b: n	nud,
C:	50  cm - > 1  m sec;		vegetable	e debris			
	b: 20-30 cm/sec	Ch:	pH: 7.8,	El <sub>20</sub> : 133	, T.H: 2.3	° dH	[

Species found: Clithon coronata, Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis, Thiara scabra.

No. 22: F/Mau/30/8. 5. 1974: River des Créoles; near the bridge of the coastal-road: Ville Noire to Ferney; bordered by scrub, plantations, villages nearby.

Alt:	10 m	T: 24.5° C (13 <sup>h</sup> )
B:	10 - 20  m	Bo: basaltic boulders $(30-50 \text{ cm } \emptyset)$ ,
D:	$20-50 \mathrm{~cm}$	gravel, sand; b: mud
<b>C</b> :	50  cm - > 1  m/sec;	Ch: pH: 8, El <sub>20</sub> : 130, T.H: 2.4° dH
	b: 20-30 cm/sec	

Species found: Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis, Bellamya bengalensis f. zonata, Thiara scabra.

No. 23: F/Mau/7/29. 4. 1974: River Baie du Cap; near the influence of brackish water during the return current by high-tide; approx. 50 m upstream of No. 24, the mouth-region; bordered by scrub, plantations of sugar-cane.

Alt:	5 m	Bo: basaltic gravel $(10-30 \text{ cm } \emptyset)$ , sand;
B:	6-7 m	dense growth of Salvinia sp., Pota-
D:	10 - 30  cm	mogeton sp., Hydrilla sp., filamentous
C:	30-75 cm/sec; b: 10-30 cm/sec	algao
Т:	22.3° C (9 <sup>h</sup> ); 22.6° C (12 <sup>h</sup> )	Ch: pH: 8.2, El <sub>20</sub> : 165, T.H: 2.65° dH

Species found: Clithon coronata, Neritina (V.) gagates, Neritina (Neripteron) auriculata f. mauriciae, Septaria borbonica, Neritilia consimilis, Thiara scabra, Melanoides tuberculata.

No. 24: F/Mau/3/28. 4. 1974: River Baie du Cap; mouth-region near the coastal road; in the reach of brackish water during hightide (about 50 m downstream of No. 23), many marine animals; bordered by scrub.

 Alt: 1 m
 Bo: basaltic gravel, mud, vegetable

 B: 20-30 m
 debris; dense growth of brackish

 D: 10-50 cm (low-tide!)
 water algae

 C: 10-30 cm/sec (low-tide!)
 Ch: no data!

 T: 26.3° C (10<sup>h</sup>)
 Ch: no data!

Species found: Neritina (V.) gagates (rarely!); Ostreidae gen. sp.

#### 5.5.2.6 Stagnant waters:

No. 25: F/Mau/2/27. 4. 1974: Artifical pond in the Botanical Garden of Pamplemousses; with *Victoria regia*, *Eichhornia crassipes*, *Nymphea* sp., *Hydrilla* sp. and other submerged waterplants and filamentous algae.

Alt: 70 mBo: basaltic stones, mud, vegetableDiameter: 200 to 300 mdebris, borders with cement wallsD: 30 cmCh: pH: 7.6, El<sub>20</sub>: 125, T.H: 1.8° dHT: 26.3° C (13<sup>h</sup>)Time the temperature

Species found: Bellamya bengalensis f. zonata, Thiara scabra, Melanoides tuberculata.

# 5.5.3 Rodriguez (Fig. 1)

An old, small volcanic island E of Mauritius. Collections of freshwater gastropods were made by the Mission (1973) of the University of Lund (P. BRINCK & P. H. ENCKEL).

No. 1: Loc. 106/28. 11. 1973: St. Gabriel, 4 km SE of Port Mathurin. Alt: 400 m

Species found: Omphalotropis rangi, Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Afrogyrus rodriguezensis.

No. 2: Loc. 107/28. 11. 1973: St. Gabriel, 4.5 km SE of Port Mathurin. Alt: 400 m

Species found: Afrogyrus rodriguezensis.

No. 3: Loc. 105/28. 11. 1973: Solitude, 2 km SE of Port Mathurin. Alt: 250 m

Species found: Omphalotropis rangi, Thiara scabra, Melanoides tuberculata, Lymnaea (Radix) mauritiana, Afrogyrus rodriguezensis.

No. 4: Loc. 109/28. 11. 1974: River Manglie; 6 km SW of Port Mathurin. Alt: 250 m

Species found: Thiara scabra, Lymnaea (Radix) mauritiana.

# 6: Systematic-anatomical Part

Abbrevations of the Islands in the list of stations: Sey: Seychelles; M: Mahé; S: Silhouette; Co: Comores; G.Co: Grand Comore; A: Anjouan; N.B: Nossi-Bé; Mad: Madagascar; Mas: Macarene; Ré: La Réunion; Mau: Mauritius; Ro: Rodriguez.

Class: GASTROPPODA Subclass: PROSOBRANCHIA (= STREPTONEURA) Order: Archaegastropoda Superfamily: Neritacea Family: Neritidae

Subfamily: Neritinae

Genus: Clithon MONTFORT, 1810 Subgenus: Clithon s. str.

1) Clithon (Clithon) chlorostcma (BRODERIP, 1832) f. comorensis (MORELET, 1877)

Lit.: 1832 Nerita chlorostoma (BRODERIP, Proc. Zool. Soc., 1832: 201) — 1855/56 Neritina chlorostoma (REEVE, Conch. Icon.: Fig. 94) — 1877 Neritina comorensis (MORELET, J. d. Conch., 25: 345; Pl. 13, Fig. 6) — 1879 Neritina chlorostoma (MARTENS, in M. & CH., Conch. Cab., 2 (10): 168; Pl. 17, Fig. 14, 15, 17) — 1879 Neritina comorensis (MARTENS, ibid.: 271) — 1888 Neritina chlorostoma (TRYON, Man. Conch., 10: 66, including the synonyms: pisiformis Récluz, 1842; siderea GOULD, 1847; parvula (GUILLOU) Récluz; tristis REEVE, 1856; lentiginosa REEVE, 1856; dispar PEASE, 1867; harveyensis MOUSSON; paludosa GARRETT; Pl. 24, Fig. 38, 39; Pl. 25, Fig. 62; Pl. 26, Fig. 83-85) — 1888 Neritina comorensis (TRYON, ibid.: 72; Pl. 26, Fig. 94, 95) — 1929 Neritina comorensis (HAAS, Zool. Jb. (Syst.), 57: 401) — 1976 Clithon cf. chlorostomus (STARMÜHLNER, Ann. Naturhist. Mus. Wien, 80: 507; Pl. 6, Fig. 26, 27).

Localities: Co: A: No. 13 (11 ind.), No. 16 (ca. 120 ind., mostly iuv.).

Shell: The shells of f. comorensis (MORELET, 1877) are nearly identically with the shells of specimens described by STARMÜHLNER, 1976 from Guadalcanal (Solomon-Islands) as cf. chlorostomus. Both populations were found in the lower parts of rivers near the mouth-region and in the zones, influenced by brackish water during high-tide. Mr. Henk H. MIENIS (Curator of the Mollusc-Section of the Zoological Museum of the Hebrew University of Jerusalem, Israel) a well-known specialist of Neritidae, has checked the shells of Guadalcanal and Anjouan. He wrote to the author on 24th March 1977: "I checked again your specimens of Clithon chlorostoma from Guadalcanal and this convinced me that they are indeed chlorostoma. There is a great resemblance between comorensis (MORELET, 1877) and chlorostoma (BRODERIP, 1832) and I'll not be surprised if they turn out to belong to one and same taxon".

Oblong, spire solide, with  $3\frac{1}{2}$  whorls, the adult shells mostly strongly corroded, last whorl bulging, suture with irregular margin and covering a part of the previous whorl; greenish-grey; young specimens show a brown-spotted network; between arrow-head like spots with black borders are very narrow wave lines; compression of the black borders produces three dark bands; growth striae fine, very narrow and wave-like, crossed by fine long striae ( $25 \times$  enlargement!); aperture grey to greyish brown; columellar area plain with shallow transverse and longitudinal furrows; margin with one to three obtuse denticles; colour greyish to blueish (Pl. 1, Fig. 1a, b).

	Shell		Aperture		
Localities	$\mathbf{Height}$	Diameter	Height	Diameter	Col.area
Co: A: No. 13	13.9	10	10	8.2	4
	12.7	9.7	9.7	8.1	3.8
Co: A: No. 16 (iuv.)	8.7	6.7	6.7	3.8	2.5

Sizes (in mm)

The measurements are for the largest shells in the samples.

Operculum: Size (from a specimen with shell-height: 13.9 mm): 6.8 mm  $\times$  4 mm; semilunar, surface granulated with a basal nucleus, growth lines fan-like, in the middle with a narrow arched groove; the superor margin with incision; colour: to the nucleus blackish, to the middle groove yellowwhitish, between the median arch and exterior margin alternatly black-yellowish striped, toward the superior margin gradually darker, outer margin hornybrownish to yellowish; inner surface yellowish to blackish; the outside groove corresponds on the back surface with an arched ridge; the peg yellowish, broad incised, connected with the arched, corded rib (Pl. 3; Fig. 14a, b).

Anatomical remarks: The outside of the mantle dark blue, the margin with yellowish border; Radula: corresponds with the description, given by STARMÜHLNER, 1976 for the specimens from Guadalcanal: central tooth higher than broad, cutting edge in the lower part, first lateral tooth on the outside cutting edge scarcely or not denticulated; the 4th lateral tooth with one denticle on the inner cutting edge and 15-20 smaller denticles along the outer edge; marginal teeths with 7-9 denticles (Fig. 2); Femal reproductive system: spermatheca larger than in the pacific specimens (STARMÜHLNER, 1976) with 10-11 spermatophors: greenish-yellowish, cigar-shaped, one end cork-screwlike and darker coloured, the other end long filiform (lenght: 18 mm!); the vaginal connecting duct is long, slender and the superior part is in narrow loops; it enters in the superior part of the vagina at the base of an ampouleshaped enlargement; the end of the vagina is again narrow and arched; the dark coloured receptaculum seminis with a short duct; ductus enigmaticus and crystal-sae, are typically developed (Fig. 3a, b).

Ecological-biological remarks: Like the specimens of *Clithon* cf. chlorostoma from Guadalcanal (STARMÜHLNER, 1976) these specimens, found at Anjouan, occur only in the lowest parts of the streams, near the mouth-region, in the zones of the return current of brackish water during high tide and with freshwater during low tide. They were associated with *Clithon spiniperda*,



Fig. 2. Clithon chlorostoma f. comorensis: Radula-teeth Fig. 3. Clithon chlorostoma f. comorensis: a) Female reproductive-system; b) Spermatophor

Septaria borbonica and Neritilia consimilis. In these zone also typically brackish water fishes are to observed, such as Kuhlia rupestris and Eleotris fusca. The snails are attached on and between boulders and gravel in a density of about 1 specimen/dm<sup>2</sup> with a current between 30 and 75 cm/sec, the water-temperature was between 25.7° C and 26° C (March,  $15^{h}-17^{h}$ ); chemistry : pH: 7.7, conductivity: 122µ Siemens and total hardness: 2.5° dH. All values in freshwater during low tide. Also MARTENS (1879) states, that Clithon chlorostoma was found in the mouth of a brook on Tahiti, partly in saltwater.

Geographical range: Clithon chlorostoma (including the synonyms: pisiformis, siderea, parvula, tristis, lentiginosa, dispar, harveyensis and paludosa) is recorded by TRYON (1888) in the Pacific from the Marquesas-, Harvey-, Cooks-, Samoan- and Fiji-Islands, MARTENS (1879) cited also Tahiti and Nukahiwa-Islands. STARMÜHLNER (1976) has found the species in Guadalcanal (Solomon-Islands). Clithon chlorostoma f. comorensis from Anjouan is the only record in the Indian Ocean. These records indicate, that these species, such as Neritina pulligera and Neritina (Neripteron) auriculata are distributed in many local forms from the Western Indian Ocean to the Eastern parts of the Pacific.

# 2) Clithon (Clithon) coronata (LEACH, 1815) = (longispina, Récluz, 1841)

Lit.: 1815 Clithon coronata (LEACH, Zool. Misc., II: Pl. 104) - 1841 Neritina longispina (Récluz, Rev. Mag. Zool.: 312) — 1843 Neritina corona (SGANZIN, Mém. Soc. Hist. Nat. Strasbourg, 3: 19) - 1849 Neritina longispina (SOWERBY, Thes. Conch., 2: 552; Pl. CX, Fig. 62) - 1850 Neritina longispina (Récluz, J. de Conch., 1: 147) -1855 Neritina longispina (REEVE, Conch. Ic.: Fig. 21) – 1855 Chliton longispina (H. & A. ADAMS, Gen. rec. Moll.: Pl. XLII, Fig. 30) - 1859 Neritina longispina (CHENU, Man. Conch., 1: 337; Fig. 2474) - 1860 Neritina longispina (MORELET, Sér. Conch., 2: 120) -1863 Neritina longispina (DESHAYES, Cat. Moll. Réunion: 79) - 1867 Neritina mauritiana (MORELET, J. de Conch., 1867: 440) - 1877 Neritina longispina (Llénard, Cat. Moll. Mauritius: 48) - 1879 Neritina (Clithon) longispina (MARTENS, in M. & CH., II (10): 147; Pl. 15, Fig. 16, 17, Fig. 20, 21) - 1879 Neritina despinosa (Mousson, in coll.) - 1880 Neritina (Clithon) longispina (MARTENS, in MÖBIUS, Beitr. Meeresfauna Mauritius: 213) -1892 Neritina (Clithon) longispina (BAKER, Proc. Rochester Ac. Siec., II: 33) - 1908 Paranerita (Neritina) longispina (BOURNE, Proc. zool. Soc. London, 1908: 847; Pl. 55, Fig. 35; Pl. 64, Fig. 64) - 1910 Neritina longispina (KOBELT, Abh. senck. nat. Ges., 32: 93) - 1921 Neritina (Chliton) longispina (GERMAIN, Mém. Soc. zool. France, 1920; vol. suppl.: 389; Fig. 42) - 1956 Clithon longispina (BENTHEM-JUTTING, Treubia, 23 (2): 282; Fig. 12) - 1969 Clithon (Clithon) longispina (STARMÜHLNER, Malacologia, 8 (1/2): 56).

Localities: Mas: Ré: No. 19 (7+48 iuv. ind.), No. 20 (3 ind. f. despinosa); Mau: No. 5 (37 ind., f. despinosa), No. 7 (2 ind., f. despinosa), No. 13 (4 ind.), No. 16 (1 ind., f. despinosa), No. 21 (some ind.), No. 23 (53 ind.).

Sizes (in mm):

		Shell		Aperture		
Localities		Height	Diameter	Height	Diameter	Col.area
Mas: Ré:	No. 19 No. 20	14	13	11.5	9.7	4
	(f. despinosa, iuv.)	5.3	7		no measureme	ents!
Mau:	No. 5 (f. despinosa)	19	18	12.6	12.8	6
	No. 7 (f. despinosa eroded)	21	23	24	24	11.4
	No. 13 (with spines eroded)	14	13.8	11.9	10.2	4.3
	(f. despinosa eroded)	17	16.3	12.9	10.4	4.5
	No. 16 (f. despinosa eroded)	19	14.5	14	11	5
,	No. 21 (with spines	) 17.7	16.5	14	11.5	4.6
	No. 23 (with spines eroded)	13.6	13.8	11.6	10	4.8

The measurements are from the largest shells in the samples.

### Results of the Hydrobiological Mission 1974

Shell: Globular, small spire with 3-4 whorls, the last inflated; above the periphery "shouldered", along this "shoulder" long pointed distantly placed spines of 10-15 mm length; the f. *despinosa* without spines, but the shoulder is well developed; irregularly sculptured by the growth lines, they are sinuous between the suture and the row of spines; the upper whorls often dark olive to brown, either with black spiral bands of various width and number; between these bands occasionally some irregular dark wavy lines or network; aperture oblique, half-moon shaped, columellar area slightly concave, whitish, granular,



Fig. 4. Clithon coronata: Radula-teeth Fig. 5. Clithon coronata: a) Female reproductive-system; b) Spermatophor

porcellanous; columellar edge concave, hardly any or no denticulations (Pl. 1; Fig. 2a, b: f. coronata s. str., Fig. 3a, b, c: f. despinosa).

Operculum: Size (from a specimen with shell-height: 14 mm): 8.5 mm $\times$  4.7 mm; semilunar, exterior surface cloudy-brown to blackish, except the nucleus reddish to yellow-brownish; outer margin reddish-brown to yellowish, transparent, a shallow groove on the surface correspond with a low ridge on the back surface; over the exterior surface are numerous, fine, distantly placed granules; back surface yellowish-whitish, except around the peg is yellowish-orange and connected with the yellowish rib, which is grooved and broadened towards the free tip (Pl. 3, Fig. 15a, b).

Anatomical remarks: Mantle dark blue, except the margin with yellowish border; Radula: central tooth nearly as high as broad, the upper margin as broad as the base; cutting edge slightly curved; inner lateral teeth elongate-rectangular, nearly without denticulation; the 4th lateral tooth with 6-7 broad inner denticles and about 20 very small denticles towards the outside, the marginal teeth with 1+8/10 denticles (Fig. 4). Female reproductive system: large, globular spermatheca with 10-11 spermatophors, one end of the spermatophor very short and S-looped; other end a long, very slender filament in many narrow sloops, which reach to the long, slender and looped vaginal connecting duct, which enters at the superior part of the vagina; the end of the vagina is rolled up in three loops; receptaculum seminis dark coloured and with an short duct; ductus enigmaticus and the crystal sac on the upper part of the ootype are typical (Fig. 5a, b).

Ecological-biologal remarks: These species were found only in the lower courses of the running waters crawling over boulders and gravel in a current between 50 cm-1 m/sec in a density of 1-2 ind./1/16 m<sup>2</sup>; the temperatures at the stations of La Réunion and Mauritius were between 21.7° C and 28.4° C, mostly around 22° and 23° C; the chemical conditions: pH: 7.4-8.2; conductivity: 77-200 µSiemens; total hardness:  $1.5^{\circ}-4.35^{\circ}$  dH. It is to be noted, that the forma *despinosa* (without spines) was only found in the upstream parts of the lower courses, the typical form with spines in the downstream parts near the influence of brackish water during high tide (return current). In the upper parts of the lower courses the f. *despinosa* is associated with *Neritina* (V.) gagates, Septaria borbonica; in the lower courses near the mouth-zone the spiney form also with *Neritina auriculata* f. mauriciae and *Neritilia consimilis*.

Geographical range: Madegassian Subregion (Madagascar, La Réunion, Mauritius, Rodriguez). The occurrence in Java is doubtfull (BENTHEM-JUTTING, 1956).

# 3) Clithon (Clithon) spiniperda (MORELET, 1860)

Lit.: 1860 Neritina spiniperda (MORELET, Sér. Conch., 2: 121; Pl. 6, Fig. 3) – 1879 Neritina spiniperda (MARTENS, in M. & CH., Conch. Cab., 2 (10): 266) – 1881 Neritina spiniperda (CROSSE, J. de Conch., 29: 208) – 1890 Neritina spiniperda (BOETTGER, Nachr.-Bl. dtsch. malak. Ges., 22: 101) – 1892 Neritina (Clithon) rhyssodes (BOETTGER, ibid., 24: 57) – 1929 Neritina (Clypeolum) pulligera knorri (HAAS, Zool. Jb. (Syst.), 57: 428 (pars); Pl. 2, Fig. 25, 26) – 1969 Clithon (Clithon) spiniperda (STARMÜHLNER, Malacologia, 8 (1/2): 28; Figs. 4–57).

Localities: Co: A: No. 7 (6 ind.), No. 12 (8 ind.), No. 13 (30 ind.); N. B.: No. 1 (7 ind.).

Shell: A detailed description is given by STARMÜHLNER (1969) with notes to the descriptions of MORELET (1860) and HAAS (1929): globular, solid, small spire with  $2\frac{1}{2}$  whorls, mostly eroded; last whorl large and slightly "shouldered", rarely with spines; typically with radially, slightly S-shaped grooves, which confine wrinkles of coarse growth striae, which are crossed by very fine spiral rows; olive-green, with light-green bands, but mostly very difficult to see; aperture oblique, broad, semilunar, withe-bluyish; the columellar area more yellowish, concave border with a prominent denticle in the superior third, and 5-6 smaller denticles bleow (Pl. 1, Fig. 4a, b, c).

Sizes	(in	mm)	: 1

	8	Shell		Aperture	
Localities	Height	Diameter	Height	Diameter	Col.area
Co: A: No. 7	17	13	12	10	3.5
No. 12 (iuv.!	) 8.3	8.2	7.8	6	3
No. 13	13.2	11.9	11.3	9.5	3
N.B: No. 1 (iuv.!)	7.2	7.2	7	4.8	2.5

The measurements are from the largest specimens in the samples.

Operculum: Size (from a specimen with shell-height: 17 mm):  $8.9 \text{ mm} \times 5 \text{ mm}$ ; semilunar; a shallow groove over the exterior surface, corresponding with a low ridgeon the backside; exterior minutely puckered with distantly placed granules, yellowish-pink, except the nucleus dark-brown and the outer margin red-brownish bordered; interior surface dark yellowish with a distinct spot near the apophyses and a dark brown margin; the peg is connected with the ridge by a shelly callus (Pl. 3, Fig. 16a, b).

An atomical remarks: A detailled study on the anatomy and histology of *Cl. spiniperda* is given by STARMÜHLNER (1969) from specimens collected on the island of Nossi-Bé. The specimens from Anjouan show, after dissections, no differences: Mantle outside dark blue; Radula: central-tooth nearly squarrish, first lateral-tooth with an lateral, narrow cutting-edge, the fourth lateraltooth with aserrated cutting-edge, only the inner denticle is more prominent; the marginal-teeth also with an serrated cutting-edge (Fig. 6). Femal reproductive organs: The spermatheca globular and filled with some sprematophors; they have a cigar-like shape, one end is short, cork-screw-like, the other end



Fig. 6. Clithon spiniperda: Radula-teeth Fig. 7. Clithon spiniperda: a) Female reproductive-system; b) Spermatophor

long, very slender (total-lenght: 10 mm); receptaculum seminis dark spotted with a short duct; the vaginal connecting duct very slender and looped, which enters in the upper, thickened part of the vagina; a very small ductus enigmaticus is developed (it was overlooked by STARMÜHLNER, 1969) also the crystal sac on the end of the ootype (Fig. 7a, b).

Ecological-biological remarks: As indicated by STARMÜHLNER (1969) Cl. spiniperda occurs only in the lower courses of the running waters near the mouth-zones with a return current of brackish-water during hightide. They are attached to boulders and gravel with a current between 30 cm – 1 m/sec in a density of about 1 ind./dm<sup>2</sup> to 1/16 m<sup>2</sup>; associated with Cl. chlorostoma f. comorensis, Septaria borbonica and Neritilia consimilis.

Temperatures	pH	Chemistry conductivity	total hardness	
24.5° C—26° C	7.7-8.2	102—135 µSiemens	2.1°-2.9° dH	

It is to be noted that specimens, found near the influence of brackish water have developed short eroded spines, specimens in pure freshwater are always spineless.

Geographical range: Comores-Islands, Nossi-Bé and Nossi-Komba. *Clithon spiniperda* is from shell and operculum, related to the Indomalayan species *Clithon bicolor* (STARMÜHLNER, 1969).

Genus: Neritina LAMARCK, 1816

Subgenus: Neripteron LESSON, 1830

### 4) Neritina (Neripteron) auriculata LAMARCK, 1816 f. mauriciae LESSON, 1830

Lit.: 1816 Neritina auriculata (LAMARCK, Anim. s. vert. II (8): 527) - 1827 Neritina auriculata (FERUSSAC, Bull. univ. Sci. nat., 10: 412) - 1828 Neritina cariosa (GRAY (part), in WOOD, Ind. test. suppl.: 25; Pl. 8, Fig. 9 (non Fig. 11) - 1829 Neritina auriculata (RANG, Man. hist. Moll.: 47 (non LAMARCK) - 1830 Neritina (Neripteron) mauriciae (LESSON, Voy. Coqu., Zool., II: 384) - 1849 Neritina auriculata (SowErby, Thes. Conch., 2: Pl. CXIII, Fig. 129, 130) - 1855 Neritina auriculata (REEVE, Conch. Icon.: Fig. 83) -1860 Neritina mauritii (MORELET, Sér, Conch., 2: 119) - 1863 Neritina sandwichensis (DESHAYES, Cat. Moll. Réunion, p.E: 81) - 1868 Neritina deshayesii (PEASE, ibid.: 101) -1875 Neritina alata (ROBILLARD, in MARTENS, in M. & CH., Conch. Cab., 2 (10): 27 and 276; Pl. 6, Fig. 7-9) - 1879 Neritina auriculata (MARTENS, in M. & CH., Conch. Cab., 2 (10): 30; Pl. 6, Fig. 13-15, 24-27) - 1880 Neritina (Neripteron) mauriciae (MARTENS, in Moll., in MÖBIUS, Beitr. z. Meeresf. d. Insel Mauritius: 212) - 1888 Neritina auriculata (TRYON, Man. Conch., 10: 73; Pl. 21, Fig. 58-63) - 1892 Neritina (Alina) mauritii (BAKER, Proc. Rochester Acad. nat. Sc., 2: 33) - 1910 Neritina auriculata (KOBELT, Abh. senck. nat. Ges., 32: 93) - 1921 Neritina (Neripteron) mauritiensis (GERMAIN, Mém. Soc. Zool., 1920: 387; Fig. 40, 41) - 1955 Neritina auriculata (BUTOT, Treubia, 23: 78; Fig. 5d) - 1956 Neritina auriculata (BENTHEM-JUTTING, Treubia, 23 (2): 297; Fig. 222) -1969 Neritina auriculata (STARMÜHLNER, Malacologia, 8 (1/2): 56; Fig. 58-62) - 1970 Neritina auriculata and f. lecontei (STARMÜHLNER, Cah. ORSTOM, sér. Hydrobiol., 4 (3/4): 35; Fig. 12-17) - 1974 Neritina (Neripteron) auriculata (STARMÜHLNER, Bull. Fish. Res. Stn., Sri Lanka, 25 (1/2): 108; Fig. 5-7; Pl. 2, Fig. 2-4) - 1976 Neritina (Neripteron) auriculata (STARMÜHLNRE, Ann. Naturhist. Mus. Wien, 80: 511; Fig. 17-19; Pl. 9; Fig. 64, 65; Pl. 10; Fig. 76-79).

Locality: Mas: Mau: No. 23 (59, mostly iuv.).

Shell: Semi-globular, with flat base;  $1-1\frac{1}{2}$  whorls, apex mostly eroded; growth striae in semi-circles, alternatly stronger and weaker; greenish-brown with dense fine, black coloured wave-lines; sometimes in a network with triangle-shaped spots; aperture large, half-moon shaped, surrounded by a broad peristome which ends in two, widely varying "wings" or "auricles", the depends on the form of the surface, where the snail is resting; the specimens found at the locality Mau: No. 23 (River Baie du Cap) correspond with the figured shell of Fig. 41 of GERMAIN (1921: 388): the upper columellar margin (seen from below) is nearly straight, the "wings" are very little developed, the outer margin is curved, the lower columellar margin drawn forward with a prominent "wing"; columellar edge slightly sinous, with about 1+8+1inconspicous denticulations, whitish (Pl. 1; Fig. 5a, b).

Sizes (in mm):

	Shell		Ap		
Locality	Height	Diameter	Height	Diameter	Col.area
Mau: No. 23	11	13	13	11	6

The measurements are from the largest shell in the sample.

Operculum: Size (from a specimen with shell-height of 11 mm): 7 mm  $\times$  4.3 mm; semilunar, columellar side sinous, nucleus at right hand base; greyishblack with a yellow nucleus and a red-yellowish outside edge; backside whitish to greyish; the peg with a rounded top, the rib sickle-shaped, with a weak denticle on the outside, a furrow on the inner side and an acute free top (Pl. 3; Fig. 17a, b).

Anatomical remarks: A detailled study of the anatomy and histology of *Neritina auriculata auriculata* is given by STARMÜHLNER (1969). Additional details are given from specimens from New Caledonia (f. *lecontei*) by STAR-MÜHLNER (1970) and from different Pacific islands by STARMÜHLNER (1976).

The mantle of the specimens from Mauritius (f. mauriciae) is not coloured and transparent; Radula: central-tooth higher than broad, the first lateral tooth without any denticulation on the cutting-edge, the third lateral tooth with a prominent inner denticle and 15-20 smaller denticle forward to the outer margin, the marginal-teeths with 1+6/7 denticles (Fig. 8). Female reproductive organs: a large, globular spermatheca with 12 to 14 spermatophors; they are thick, U-shaped, rolled uo, with a short, slender, looped end; the vaginal connecting duct slender, and enters, beyond some loops in the middle part of the vagina, in the last third of the vagina, which is ampouleshaped; receptaculum seminis dark spotted, with a short duct; ductus enigmaticus and crystal-sac are typically developed (Fig. 9a, b).

Ecological-biological remarks: As stated by STARMÜHLNER (1969, 1970 and 1976) Neritina auriculata (and her forms) is a typical inhabitant of the lower courses of running waters near the influence of brackish water of the return current during high-tide. It was associated in the locality of Mauritius with Clithon coronata, Neritina gagates, Septaria borbonica and Neritilia con-



Fig. 8. Neritina (Neripteron) auriculata f. mauriciae: Radula-teeth; b) Fig. 9. Neritina (Neripteron) auriculata f. mauriciae: a) Female reproductive-system; b) Spermatophor

similis. These species tolerate slightly brackish water and is always attached below on stones, protected against the current on the surface of the boulders and gravel (30-50/75 cm/sec). The density by station Mau : No. 23 was about 5–10, mostly immature individues/1/16 m<sup>2</sup>.

Temperature	Chemistry (during low-tide!)				
<u></u>	$_{\mathrm{pH}}$	conductivity	total hardness		
$22.3^{\circ} \text{ C} - 22.6^{\circ} \text{ C}$	8.2	165 µSiemens	$2.65^\circ~{ m dH}$		

Geographical range: The species-group (including different forms) is distributed in the Indopacific area (after RIECH, 1937) with the f. *auriculata* s. str.: Madagascar, Ceylon, Malayan Archipelago, Philippines, Moluccas, Aru, New Guinea, Bismarck Archipelago, Solomon-Islands, New Hebrides and New Caledonia. In New Caledonia it occurs also the f. (or subspecies ?) *lecontei* (STARMÜHLNER, 1970). In the eastern parts of the South-Pacific the species is
recorded also from Fiji, Tahiti and other islands to Hawaii (after RIECH, 1937: f. *alata*). In the rivers of Tahiti STARMÜHLNER (1976) states the f. *tahitensis*, resembling the f. *alata*. At Mauritius occurs the widely varying f. *mauriciae*.

#### 5) Neritina (Vittina) gagates LAMARCK, 1822

Lit.: 1822 Neritina gagates (LAMARCK, Hist. nat. an. s. vert., 6 (2): 185) - 1827 Neritina zigzag (FÉRUSSAC, Bull. univ. Sci. nat., 10: 411 (non LAMARCK)) - 1828 Neritina caffra (GRAY, in WOOD, Ind. Test., supp.: Pl. 8, Fig. 10) - 1830 Neritina gagates (LESSON, Voy. Coqu., Zool.: 337) - 1838 Neritina gagates (LAMARCK, Hist. nat. an. s. vert., éd. 2 (8): 570) - 1841 Neritina gagates (DELESSERT, Rec. Coqu. décr. LAMARCK: Pl. 32, Fig. 2) - 1849 Neritina gagates (SOWERBY, Thes. Conch., 2: 537; Pl. 112, Fig. 103, 104) -1849 Neritina caffra (SOWERBY, ibid.; 537; Pl. 112, Fig. 111, 112) - 1850 Neritina caffra (Récluz, J. de Conch., 1: 152) – 1855 Neritina caffra (REEVE, Conch. Icon.: Fig. 37) – 1855 Neritina gagates (REEVE, ibid.: Fig. 47) - 1859 Neritina caffra (CHENU, Man. Conch., 1: 335; Fig. 2448) – 1860 Neritina zigzag (MORELET, Sér. Coch., 2: 120) – 1863 Neritina zigzag (DESHAYES, Cat. Moll. Réunion: 79) – 1863 Neritina strigilata (DESHAYES, ibid.: 79) - 1863 Neritina fulgurata (?) (DESHAYES, in MAILLARD, Notes sur l'ile de Réunion, Moll.: 80; Pl. 10, Fig. 1, 2) - 1863 Neritina modicella (?) (DESHAYES, ibid.: 70; Pl. 10, Fig. 3, 4 and in Cat. Moll. Réunion: 79) - 1869 Neritina gagates (NEVILL, Proc. zool. Soc. London, 1869: 66) - 1874 Neritina caffra (CROSSE, J. de Conch., 22: 241) - 1874 Neritina gagates (CROSSE, ibid.: 241) - 1875 Neritina gagates (MORELET, J. de Conch., 23: 29) -1877 Neritina caffra (LIENARD, Cat. Moll. Maurice: 48) – 1877 Neritina gagates (LIÉNARD, Cat. Moll. Maurice: 48) - 1877 Neritina gagates (LIÉNARD, ibid.: 48 and 82) - 1877 Neritina lineolata (LIÉNARD, ibid.: 48) - 1879 Neritina gagates (MARTENS, in M. & CH., Conch. Cab., 2 (10): 94; Pl. 16, Fig. 11, 12; var. minor: Pl. 10, Fig. 18, 19; v. subplana: Pl. 13, Fig. 8) - 1880 Neritina gagates (MARTENS, Moll., in MÖBIUS: Beitr. Meeresf. Ins. Mauritius: 212) - 1882 Neritina fulgetrum (SMITH, Proc, zool. Soc. London, 1882: 387; Pl. 22, Fig. 23, 24) – 1888 Neritina gagates (including liturata Récluz, caffra GRAY, zigzag Morelet, var. minor and var. subplanispira MARTENS, probably also fulgurata DESHAYES: TRYON, Man. Conch., 10:35; Pl. 10, Fig. 77-79, 97, 98; Pl. 11, Fig. 6) -1890 Neritina (Neritaea) gagates (BOETTGER, Nachr.-Bl. dtsch. malak. Ges., 22: 99) -1908 Paranerita (Neritina) gagates (BOURNE, Proc. zool. Soc. London, 1908: 847; Pl. 54, Fig. 32; Pl. 55, Fig. 36, 37; Pl. 56, Fig. 38-41; Pl. 57, Fig. 42, 43; Pl. 58, Fig. 44, 45; Pl. 59, Fig. 48; Pl. 60, Fig. 50, 52; Pl. 63, Fig. 60) - 1910 Neritina gagates (KOBELT, Abh. senck. nat. Ges., 32: 94-96) - 1909 Neritina zigzag (KOBELT, ibid.: 94) - 1909 Neritina ziczac (KOBELT, ibid.: 95) - 1914 Neritina gagates (ROBSON, J. Linn. Soc., London, 32: 377) - 1921 Neritina (Neritina) gagates (GERMAIN, Mém. Soc. zool. France, 1920, suppl.: 382; Fig. 37-39; modicella: 385; fulgurata: 386) - 1929 Neritina gagates (DAUTZENBERG, Faune Col. Franc., Paris, 3: 526) - 1929 Neritina gagates (HAAS, Zool. Jb. (Syst.); 57: 427) - 1937 Neritina gagates (ANDREWS, J. Morph., 61: 525; Pl. 4, Fig. 24; Pl. 5, Fig. 33) -1969 Neritina (Vittina) gagates (STARMÜHLNER, Malacologia, 8 (1/2): 61; Fig. 63-72).

Localities: Sey: M: No. 3 (some ind.), No. 4 (6 ind.), No. 7 (2 iuv.); Co: A: No. 7 (4 ind.), No. 10 (4 ind.); Mas: Ré: No. 8 (34 ind.), No. 19 (147, mostly iuv.), No. 24 (75, mostly iuv.); Mau: No. 5 (3 ind.), No. 7 (1 ind.), No. 8 (1 ind.), No. 9 (24 ind.), No. 11 (4 ind.), No. 13 (207, mostly iuv.), No. 15 (81 ind.), No. 18 (34 ind.), No. 19 (22 iuv.), No. 21 (215, mostly iuv.), No. 22 (6 ind.), No. 23 (25 and many iuv.), No. 24 (2 ind.).

Shell: Descriptions are given by REEVE (1855); MARTENS (1879); TRYON (1888); GERMAIN (1921) and STARMÜHLNER (1969): solid, globular spire with

 $2\frac{1}{2}$  whorls rapidly increasing, the last whorl about 4/5 of the total height and slightly "shouldered"; apex mostly eroded; polished growth striae fine and delicate, the spiral striae very fine, only to be seen by higher magnification; periost dark brown, but mostly scraped off, by immature specimens close, black zigzag lines on a yellow-brownish ground; aperture yellow-greenish to white-bluish, border of the columellar area yellow to orange, sometimes a yellow-orange spot near the base; about 15 denticles on the border (4+1+1+9), (Pl. 1, Fig. 6a, b; 7a, b and 8a, b).

Sizes (in mm):

		S	hell	Ap	erture	
Localities		$\mathbf{Height}$	Diameter	Height	Diameter	Col.area
Sey: M:	No. 3	24.4	24	19.2	15 <sup>.</sup>	8.7
•		23.5	21.5	18.2	15.3	6.5
	No. 4	23	21.6	18.1	15	7
	No. 7 (iuv.)	12.7	11.3	10.6	7.5	<b>2.5</b>
Co: A:		18.5	17	13.6	11.5	6
	No. 10	21.3	19	12	12.5	7
Mas: Ré:	No. 8	18	17.6	15.7	12.5	6
	No. 19 (iuv.)	12.5	12.2	10.2	7	4
	No. 24	16.3	14.7	13	10	4.5
Mau:	No. 5	21	20.8	17.5	14	5.8
		20.4	18	14.8	11	5.2
	No. 7	27	24.5	21	17	8.5
	No. 8	16.5	15	12.2	10.6	4.5
	No. 9 (eroded)	28	<b>27</b>	<b>22</b>	17	9
		23.2	19.6	16.7	14	7
	No. 11	21	19.8	16.4	12	7
	No. 13	20.7	18	15.5	12	6
	No. 15 (eroded)	<b>22</b>	21	17	13.5	7.5
		23.3	19	16.8	12	6.8
	No. 18	27	<b>24.4</b>	20	16.3	8
	(eroded)	22.2	20	16.4	13	7
Mas: Mau:	No. 19 (iuv.)	5	no measi	ired!		
	No. 21	21	19.5	17	14.4	6.5
		19	19.3	16.2	12.6	5.5
	No. 22	19	17.8	15.5	11.6	5.3
	No. 23	20.3	17	14.5	12.8	6
	No. 24	15.8	13.5	12	10	5.5

The measurements are from the largest specimens from the samples.

Operculum: Size (from a specimen with shell-height of 24.4 mm): 11 mm  $\times$  7 mm; semilunar; external surface polished, very fine fan-like growthstriae with extremly fine granulations; dark brownish, outer edge horny, seddish-brownish; nucleus a little impressed and with a yellow spot; inner surface brownish with a porcellanous covering; peg broad and short, rounded; rib a slightly curved ridge (Pl. 3, Fig. 18a, b).

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An atomical remarks: Detailed studies are given by BOURNE (1908); BAKER (1923); ANDREWS (1937, spermatophors) and STARMÜHLNER (1969). Radula (specimen from Sey: M: No. 3): central-tooth slightly higher than broad; the inner lateral-tooth rectangular with a narrow cutting-edge without denticles; the third lateral-tooth with a serrated edge (1+16/18); marginalteeths with 1+8 denticles (Fig. 10). Femal reproductive system: the specimen from Sey: M: No. 3 with a globular spermatophor-sac or spermatheca, vagina relatively long and broad, receptaculum seminis wit a short duct, the vaginal connecting duct extremly long and placed in many, narrow loops; stretched, leaving the posterior part of the ootype, to the upper part of the vagina, and goes back below the vagina to the lower part of the vagina, where the duct



Fig. 10. Neritina (Vittina) gagates: Radula-teeth Fig. 11. Neritina (Vittina) gagates: a) Female reproductive-system; b) Spermatophor

enters into the vaginal duct; ductus enigmaticus and crystal-sac are typically developed; the spermatophores-mostly 1 to 4 in the sac-have a nematode-like shape, one end is thicker, with a rounded top, the other end long and slender (Fig. 11a, b).

Ecological and biological remarks: Neritina (Vittina) gagates is, like all species of the subgenus Vittina, a characteristic form of the lower courses of running waters, ocurring to the mouth-region, also in zones with brackish water from the return current during high-tide. The species was at the different stations associated with Neritina pulligera stumpfi and knorri, Neritilia consimilis, Septaria borbonica, Clithon spiniperda and Neritina auriculata f. mauriciae. The frequency changed from sporadic to about 30 or more individues/1<sup>1</sup>/16 m<sup>2</sup>, specially if many young specimens are present. The average frequency was about 5–10 ind./<sup>1</sup>/<sub>16</sub> m<sup>2</sup> on stones and gravel in a current between 30 cm/sec—75 cm/sec.

	Temperatures	Chemistry				
		pH	conductivity	total hardness		
Mahé:	24.4° C-28° C	6.8-6.9	$35\!-\!54$ $\mu\mathrm{S}$	$0.2 - 0.65^{\circ} \mathrm{dH}$		
Anjouan :	$24.5^{\circ} \text{ C} - 25.5^{\circ} \text{ C}$	8.1 - 8.2	$135 - 186 \ \mu S$	$2.9 - 3.9^{\circ}  \mathrm{dH}$		
Réunion :	$21.7^{\circ} \mathrm{C}{-}26.6^{\circ} \mathrm{C}$	7.4	$77-92 \mu S$	$1.5 - 1.65^{\circ} dH$		
Mauritius:	$21.2^{\circ} \mathrm{C}{-}26.3^{\circ} \mathrm{C}$	7.6 - 8.2	$93 - 100 \ \mu S$	$1.45 - 4.25^{\circ} \mathrm{dH}$		
Range:	$21.2^{\circ} \mathrm{C} - 28^{\circ} \mathrm{C}$	6.8-8.2	$35 - 186 \ \mu S$	$0.2 - 4.25^{\circ} \mathrm{dH}$		

These data indicate that *Neritina* (*Vittina*) gagates occurs from very soft, slightly acidic water to slightly hard water with alcaline reaction.

Geographical range: Madegassian Subregion: Seychelles, Comores, Nossi-Bé, Nossi-Komba, Madagascar, La Réunion, Mauritius, Rodriguez. CONOLLY (1939) reported the species also from the SE-coast of Africa and STARMÜHLNER (1969) stated that he has found shells, determinated as N. (V.) gagates in the collections of the Naturhistorical Museum of Vienna, Section of Molluscs, collected by the Austrian NOVARA-Mission at the Nicobar-Islands in the Gulf of Bengal. REEVE (1855) has noted as habitat for N. gagates (species 47): Sumatra (on stones) from the collection of CUMING. Probably belong these shells to N. (V.) variegata LESSON, 1831: MARTENS (1879) wrote on page 279 as appendix to N. gagates, that BROT has checked the types of LAMARCK with specimens of MARTENS and found, that under the description of LAMARCK (1822) both species, N. gagates and N. variegata are included! N. (N). variegata ist distributed widely from the Nicobar Islands to East in the Pacific to Tahiti (BENTHEM-JUTTING, 1956; STARMÜHLNER, 1976).

Subgenus: Neritina s. str.

## 6) Neritina (Neritina) pulligera (LINNÉ, 1767) knorri (Récluz, 1841)

Lit.: 1767 Neritina pulligera (LINNÉ, Syst. Nat., 12: 1253) – 1841 Neritina knorri (Récluz, Rev. zool. Cuv., 1841: 274) - 1840 Neritina truncata (SGANZIN, Mém. Mus. Hist. nat. Strasbourg, 3: 20) - 1840 Neritina rara (DUFO, Ann. Sci. nat. (2) 14: 195) -1848 Neritina iris (MOUSSON, Mitth. naturf. Ges. Zürich, 1: 269) - 1849 Neritina bruguieri (Sowerby, Thes. Conch., 2: 512; Pl. 114, Fig. 159) - 1849 Neritina sanguinea (Sowerby, ibid.: 513; Pl. 114, Fig. 162) - 1879 Neritina pulligera (MARTENS, in M. & CH., Conch. Cab., 2 (10): 49; Pl. 9, Fig. 4-5; iris: 52; Pl. 9, Fig. 5-6; knorri: 55; Pl. 8, Fig. 4, 6; bruguieri: 59; Pl. 9, Fig. 11, 13; sanguinea: 61; truncata: 255) - 1881 Neritina knorri (CROSSE, J. do Conch., 29: 207) - 1888 Neritina pulligera (including: rubella MÜLLER, larga HOMBR. & JACQ., conglobata MARTENS, vars. sulcata T. WOODS and canalis MOUSSON (non canalis SOWERBY), further var. knorri Récluz (with the synonyms: beckii SOWERBY and cryptospira MARTENS), var. ovalis SOWERBY) (TRYON, Man. Conch., 10: 56; Pl. 18, Fig. 8-11; Pl. 19, Fig. 16, 18, 22, 24) - 1890 Neritina knorri (BOETTGER, Nachr.-Bl. dtsch. malak. Ges., 22: 98) - Neritella pulligera (BERGH, Morph. Jb., 16: 22; Pl. 3, Fig. 12) - 1910 Neritina pulligera v. knorri (KOBELT, Abh. senck. nat. Ges., 32: 93) -1914 Neritina pulligera v. knorri (ROBSON, J. Linn. Soc., London, 32: 377) – 1919 Neritina pulligera v. knorri (Odhner, Ark. Zool., 12: 43) – 1923 Neritina (N.) pulligera (Baker, Proc. Acad. Nat. Sci. Philadelphia, 75: 149; Pl. 12, Fig. 17) - 1929 Neritina pulligera v.

knorri (DAUTZENBERG, Faune Col. Franc., 3:526) — 1929 Neritina pulligera v. knorri (HAAS, Zool. Jb. (Syst.), 57:427) — 1937 Neritina pulligera (ANDREWS, J. Morph., 61:525; Pl. 5, Fig. 36) — 1937 Neritina pulligera (RIECH, Arch. Naturgesch. (N. F.), 6:73; Fig. 18) — 1956 Neritina pulligera (BENTHEM-JUTTING, Treubia, 23 (2): 307; Fig. 24) — 1956 Neritina pulligera (FRANC, Mém. Mus. Nat. Hist. Nat., sér. A, Zool., 13:25; Pl. 2, Fig. 23) — 1962 Neritina bruguieri (BARNACLE, J. Seych. Soc., 2:57) — 1963 Neritina pulligera (BENTHEM-JUTTING, Nova Guinea, Zool., 20:424) — 1969 Neritina pulligera f. knorri (STARMÜHLNER, Malacologia, 8(1/2):69; Fig. 73-84) — 1970 Neritina pulligera (BRANDT, Arch. Moll., 105(1/4):14; Pl. 1, Fig. 10) — 1976 Neritina pulligera (STARMÜHLNER, Ann. Naturhist. Mus. Wien, 80:531; Fig. 34, 35; Pl. 11, Fig. 104-110; Pl. 12, Fig. 123-128).

Localities: Sey : M : No. 3 (5 ind.); Co : A : No. 7 (16, mostly iuv.).

Shell: Descriptions of the widely varying shell of the *pulligera*-group are given by MARTENS (1879), TRYON (1888), BENTHEM-JUTTING (1956), STAR-MÜHLNER (1969, 1970 and 1976) and BRANDT (1974). The subspecies *knorri* is described by RÉCLUZ (1841), MARTENS (1879), TRYON (1888) and STARMÜHLNER (1969). The shell of subsp. *knorri* is smaller than *pulligera* s. str., the body whorl without the sutural ridge, but extending over the spire, which it completly overs;  $1\frac{1}{2}$  whorls with dense fine and stronger growth striae, more prominent just below the suture; periostracum jet black, if it is scraped off (and by juvenile shells) a pattern of triangular patches is to be seen; aperture bluish with an orange band within the margin; columellar area violaceous, the edge with 15-16 fine denticles, the surface of the area very fine, but with dense granulations and irregular grooves (P. 2; Fig. 9a, b).

	Shell		Aperture			
Localities	Height	Diameter	Height	Diameter	Col.area	
Sey: M: No. 3	23.4	<b>24.6</b>	23.4	27	10.5	
Co: A: No. 7 (iuv.!)	5	6.5	5	4	2	

Sizes (in mm):

The measurements are from the largest specimens in the samples.

Operculum: Size (from a specimen with a shell-height: 23.4 mm):  $10 \text{ mm} \times 7 \text{ mm}$ ; semilunar; nucleus at left hand base; from the nucleus brownblackish, dense, fine and strong radiating growth striae; outside yellowbrownish; outer margin horny, brown-reddish; the peg on the inner surface short, slightly curved and connected with a thin ridge to the sickle-shaped rib, which is longitudinally grooved (Pl. 4; Fig. 19a, b).

Anatomical remarks: Descriptions of the anatomy are to be found in BAKER (1923); ANDREWS (1937); RIECH (1937) and STARMÜHLNER (1969, 1976). Radula: (from a specimen from: Sey: M: No. 3): central-tooth broader than high, first lateral with a broad, rounded projection on the outside of the cutting edge; the third lateral-tooth and the marginal teeth very fine denticulated (Fig. 12). Femal reproductive system: Spermatophor-sac (or Spermatheca) extremely large and globular with about 30-50 nematode-shaped spermatophors, one end broader than the other, which is filiform; receptaculum seminis with short duct, the vaginal connecting duct slender, slightly looped and stretched forward to the middle part of the vagina, wich is ampoule-shaped; from these parts the duct stretches along the vagina and enter into the lower part; ductus enigmaticus and crystal-sac are typically developed (Fig. 13a, b).



Fig. 12. Neritina (N.) pulligera knorri: Radula-teeth Fig. 13. Neritina (N.) pulligera knorri: a) Female reproductive-system; b) Spermatophor

Ecological-biological remarks: The subspecies knorri occurs in the lower courses of the running waters, always in freshwater and upstream of the influence of brackish water from the return current during high-tide. The frequency on stones with a current between 30 cm and 75 cm/sec was sporadic; the species was associated with Neritina pulligera stumpfi, Neritina (V.) gagates and Neritilia consimilis at Mahé, also with Septaria borbonica and Clithon spiniperda at Anjouan.

	Temperatures		Chemistry	
	_	$_{\mathrm{pH}}$	conductivity	total hardness
Mahé:	$24.4^{\circ}$ C	6.9	54 $\mu S$	$0.65^\circ~{ m dH}$
Anjouan:	$24.9^\circ \mathrm{C}$	8.2	$135 \ \mu S$	$2.9$ $^{\circ}$ dH

Geographical range: Neritina (N.) pulligera with its different subspecies, variations or forms is distributed over the coasts of the whole Indopacific area from SE-Africa, E-African Islands including Madagascar to the Andamans and Nicobars, over the Malay-Archipelago to the SE-Asien coast, Philippines and Moluccas, further to Aru, New Guinea, E-Australian coast and South-Pacific islands. The subspecies *knorri* is restricted to the coasts of the Eastern Indian Ocean, such as SE-Africa, Zansibar, Comores, Seychelles, Madagascar and Mascarene-Archipelago.

# 7) Neritina (Neritina) pulligera (LINNÉ, 1767) stumpfi BOETTGER, 1890

Lit.: (Neritina (N.) pulligera s. str. see under 6)).

1890 Neritina stumpfii (BOETTGER, Nachr.-Bl. dtsch. malak. Ges., 22: 99) – 1929 Neritina pulligera stumpfii (HAAS, Zool. Jb., 57: 428; Pl. 2, Fig. 27) – 1969 Neritina (N.) pulligera f. stumpfi (STARMÜHLNER, Malacologia, 8 (1/2): 70; Fig. 75-77).

Localities: Sey: M: No. 3 (11 ind.), No. 4 (18 ind.); Co: A: No. 8 (2 ind.), No. 10 (16 ind.), No. 13 (1 ind.), No. 17 (1 ind.).

Shell: Semiglobular; outside edge of the aperture nearly horizontal; aperture elliptical, without a upwards stretching groove such as in subspecies *knorri*; margin of the aperture reddish (without a bluish border such as in subsp. *knorri*); columellar area reddish to whitish (var. *leucostoma* BOETTGER, 1890); columellar edge with 8-10 very small denticles, only in the middle part; very densely granulated (Pl. 2; Fig. 10a, b).

	S	Shell		Aperture	
Localities	Height	Diameter	Height	Diameter	Col.area
Sey: M: No. 3	17.2	24	17.2	17.2	10
	15.6	22.3	15.6	16.9	9
No. 4	14.8	21	14.8	14	8.5
	14.6	20.2	14.6	15	8
	12.4	17.4	12.4	12.8	7
Co: A: No. 8	14.4	19	14.4	13.1	6.4
	13.2	17.8	13.2	13.7	<b>`6.4</b>
No. 10	11.3	15.4	11.3	10	6.5
No. 13	12	14.2	12	11	5.5
No. 17	12	16	12	12	7

Sizes (in mm):

The measurements are from the largest specimens in the samples.

Operculum: Size (from a specimen with shell-height of 17.2 mm): 12.5 mm $\times$ 7.5 mm; the coloration of the operculum is the most important difference of the subsp. *stumpfi* from all other forms or varieties of the *pulligera*-group: the outer surface is very dark brown, nearly blackish; from the nucleus stretch a yellowish arc-strip, wich is divided Y-like; the other margin horny, reddish-brownish bordered; growth-striae fan-like; inner surface yellowish-

orange; peg short and blunt with a basal ridge to the sickleshaped rib, which has a longitudinal furrow on the outer and inner side (Pl. 4; Fig. 20a, b).

Anatomical remarks: No remarkable differences from the other forms of the *pulligera*-group; Radula: broad central-tooth, the first lateral-tooth with a short stalk and a small cutting edge on the outside; the third lateral tooth and the marginal teeth are serrated with many delicate denticles (Fig. 14). Female reproductive system: large distinct spermatophor-sac (or spermatheca) with about 30-50 very slender sprematophors of 8-10 mm lenght; the vagina is at the opening ampoule-shaped, thickened; the vaginal connection duct enters in the middle part of the vagina after making a loop; ductus enigmaticus and crystal-sac are typical (Fig. 15a, b).



Fig. 14. Neritina (N.) pulligera stumpfi: Radula-teeth Fig. 15. Neritina (N.) pulligera stumpfi: a) Female reproductive-system; b) Spermatophor

Ecological-biological remarks: The subspecies stumpfi occurs like all forms of the *pulligera*-group in the lower courses of the running waters, but always in freshwater, upstream of the influence of brackish water from the return current during high-tide. At Station Sey: M: No. 3, the River Mamelle the subsp. stumpfi was associated with the subsp. knorri, in other stations also with Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis and rarely

	Temperatures	Chemistry				
		pH	conductivity	total hardness		
Seychelles:						
Mahé:	$24.4^\circ{-}25.5^\circ~\mathrm{C}$	6.9	$46-54 \ \mu S$	$0.33^\circ {} 0.65^\circ~\mathrm{dH}$		
Comores:						
Anjouan:	$23.6^\circ - 26^\circ$ C	7.7 - 8.1	$122-216 \ \mu S$	$2.6^\circ~-3.7^\circ~\mathrm{dH}$		
Range:	$23.6^\circ - 26^\circ \mathrm{C}$	6.9 - 8.1	$46 - 216 \ \mu S$	$0.33^{\circ}$ — $3.7^{\circ}$ dH		

also with Clithon spiniperda and Clithon chlorostoma f. comorensis. The frequency was from sporadic to 3-5 ind./1/16 m<sup>2</sup>.

Geographical range: The subspecies *stumpfi* of the *Neritina pulligera*group is restricted in its occurence in the lower courses of the running waters of the Seychelles (Mahé), Comores (Anjouan) and the island of Nossi-Bé, NW of the coast of Madagascar.

Genus: Septaria FÉRUSSAC, 1807

## 8) Septaria borbonica (BORY ST. VINCENT, 1803)

Lit.: 1803 Patella borbonica (BORY ST. VINCENT, Voy. 4 princ. Iles afr., 1: 287; Pl. 37, Fig. 2) - 1805 Crepidula borbonica (ROISSY, Hist. gén. part. Moll., in: BUFFON, édit. SONNINI, 5: 239) - 1807 Septaria borbonica (FÉRUSSAC, Essai d'une Méth. Conch.: 70) – 1816 Navicella elliptica (LAMARCK, Encycl. méth. (Vers.) Expl.: Pl. 456, Fig. 1) - 1822 Navicella elliptica (LAMARCK, Hist. nat. anim. s. vort., 6 (2): 181) -1825 Septaria elliptica (part) (BLAINVILLE, Man. Conch.; 445; Pl. 36, Fig. 1; Pl. 48, Fig. 5) - 1826 Navicella elliptica (QUOY & GAIMARD, Voy. de l'Uranie: Pl. 71, Fig. 3) -1827 Septaria borbonica (FÉRUSSAC, Bull. univ. Sci. nat., 10: 412) - 1832 Navicella elliptica (QUOY & GAIMARD, Voy. de l'Astroblabe, Zool., 2: 206; Pl. 58, Fig. 25-34) -1838 Navicella elliptica (LAMARCK, Hist. nat. anim. s. vert., Ed. 2 (by DESHAYES), 8: 563) - 1840 Septaria or Navicella elliptica (DUFO, Ann. Sci. nat., 2º sér., 14: 194) -1843 Navicella elliptica (SGANZIN, Mém. Soc. hist. nat. Strasbourg, 3: 21) – 1843 Navicella cumingiana (Récluz, Proc. 2001 Soc., London, 1843: 157) - 1849 Navicella porcellana (SOWERBY, Thes. Conch., 2: Pl. 127, Fig. 1, 2) - 1855 Navicella porcellana (REEVE, Conch. Icon.; Fig. 6, 10) - 1860 Navicella porcellana (MORELET, Sér. Conch., 2: 119; 126) - 1863 Navicella porcellana (DESHAYES, Cat. Moll. Réunion, p.E.: 81) - 1874 Navicella porcellana (CROSSE, J. de Conch., 22: 242; var. elliptica: 242) - 1877 Navicella porcellana (LIÉNARD, Cat. Moll. Maurice: 48) - 1878 Navicella porcellana (KOBELT, Jb. dtsch. malak. Ges., 5: 180) - 1881 Navicella borbonica (MARTENS, in M. & CH., Conch. Cab. (2), 10a: 10; 13; Pl. 1, Fig. 4-18) - 1881 Navicella bimaculata (CROSSE, J. de Conch., 29: 207) - 1881 Navicella junghuhni (MARTENS, in M. & CH., Conch. Cab. (2), 10a: 23; Pl. 4, Fig. 13-15) - 1888 Navicella (Cimber) borbonica (TRYON, Man. Conch. (1), 10: 78; Pl. 27, Fig. 2-12) - 1889 Navicella bimaculata (BOETTGER, Nachr.-Bl. dtsch. malak. Ges., 21: 41) - 1890 Navicella borbonica var. depressa (BOETTGER, ibid., 22: 98) -1892 Septaria (Elara) suborbicularis (BAKER, Proc. Rochester Ac. Sci., 2: 33) - 1898 Septaria borbonica (MARTENS, Mitt. zool. Samml. Naturkde. Mus., Berlin. 1 (1): 27) -1908 Septaria borbonica (BOURNE, Proc. 2001. Soc. London, 1908: 810; Pl. 46, Fig. 1-3; Pl. 52, Fig. 23) - 1910 Navicella porcellana (KOBELT, Abh. senck. nat. Ges., 32: 92) -1921 Septaria borbonicensis (GERMAIN, Mém. Soc. zool. France, 1920, suppl.: 398) -1929 Septaria borbonica (ANDREWS, J. Morph., 61: 525; Pl. 4, Fig. 23) - 1956 Septaria borbonica (BENTHEM-JUTTING, Troubia, - (2): 133; Fig. 32) - 1969 Septaria (Septaria) borbonica (STARMÜHLNER, Malacologia, 8 (1/2): 76; Fig. 85-152).

Localities: Sey: M: No. 6 (1 ind.), No. 7 (20 ind.); Co: A: No. 3 (1 iuv.), No. 7 (99 ind.), No. 8 (4 ind.), No. 9 (104 ind.), No. 10 (20 ind.), No. 11 (17 and many iuv.), No. 12 (15 and many iuv.), No. 13 (50 and many iuv.), No. 14 (333 ind.), No. 15 (many ind.), No. 17 (53 ind.); Mas: Ré: No. 8 (6 ind.), No. 16 (2 ind.), No. 18 (40 ind.), No. 19 (157, mostly iuv.), No. 20 (18 ind.); Mau: No. 5 (10 ind.), No. 11 (10 ind.), No. 13 (10 ind.), No. 15 (6 ind.), No. 19 (42 ind.), No. 20 (39 ind.), No. 21 (10 ind.), No. 22 (6 ind.), No. 23 (70 and many iuv.).

#### F. STARMÜHLNER

Shell: Descriptions and figures are given by MARTENS (1881); TRYON (1888); BENTHEM-JUTTING (1956) and STARMÜHLNER (1969): In size, shape, form and coloration widely varying and often confused with *Septaria porcellana* (LINNÉ, 1758). The specimens from our collections are also widely varying, mostly depending on the nature of the bottom, where the nearly sessil specimens were collected. Generally the symmetrical shells are cap-like and without

						Inc	lex
Localities	š	Lenght	Broad	Height	Col.area	Br: L	H: L
Sey: M:	No. 6	20.7	16.3	6.5	3	78.7%	31 %
-	No. 7	<b>22</b>	17	6.8	4	77 %	31 %
Co: A:	No. 7	27.3	20	10	5.5	73 %	36.5%
	No. 8	28.5	20.6	10	5.5	72 %	35 %
		27.6	20	10	4.2	72 %	36 %
	No. 9	35	25.5	14	6.2	73 %	40 %
	No. 10	<b>28</b>	21	10	4.5	75 %	35 %
	No. 11 (eroded)	26.5	20.8	9.2	5	78 %	34.7%
	No. 12 (eroded)	26	21.5	11	5	82 %!	42 %
		25.6	19.2	9.7	4.4	75 %	37 %
	No. 13	<b>30.6</b>	22	12.3	5.5	72 %	40 %
		<b>28.4</b>	21.6	11.3	4.8	76 %	40 %
		26.1	20.3	10.3	5	77 %	39 %
	No. 14	32.6	23.8	13	6	73 %	40 %
	No. 17	<b>24</b>	17.5	9.3	4	73 %	38.7%
Mas: Ré:	No. 8	<b>29.2</b>	22.5	9.6	4.8	77 %	32 %
	No. 16 (eroded)	21	17	7.4	3.8	80 %	35 %
		21	15.9	6	3.48	76 %	29.9%
	No. 18 (eroded)	<b>24</b>	19.4	7.3	4.3	80 %	30 %
		<b>27</b>	19.5	8.3	5	72 %	30 %
	No. 19	22.2	16.6	7	3.5	75 %	31 %
	No. 20	17.5	13.5	5.6	3.8	77 %	32 %
Mau:	No. 5 (eroded)	<b>26</b>	21	10.8	4	80 %	40 %
		27.4	18	9	3.6	65 %	32 %
	No. 11	33.6	<b>24</b>	11.7	5.6	71 %	34 %
		32.2	24.5	12.4	5.2	76 %	38 %
		<b>32</b>	<b>24</b>	12.3	5.5	75 %	38 %
	No. 13	<b>24.4</b>	17	7.8	3.7	69 %	32 %
	No. 15	31	20.6	10.5	4.5	66 %	33.8%
		30.5	22	9.5	4.5	72 %	31 %
		<b>28</b>	19.3	9.5	3.8	69 %	34 %
	No. 19	18	12.7	5.3	<b>2</b>	70.5%	29.4%
	No. 20 (eroded)	20.4	16	7.9	3.5	78 %!	38.7%
		20.7	13.3	6.8	3.1	62.8%	32.8%
	No. 21	<b>22</b>	16	6.3	3.8	72.7%	28.6%
	No. 22	20	14	6	4.2	70 %	30 %
	No. 23	18.2	14	5.6	3	77 %	30 %

Sizes (in mm):

The measurements are from the largest specimens in the samples.

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whorls; the apex reaching the posterior margin of the shell and touching the plane of the aperture; it is always eroded by friction with the substrate (sometimes a little eroded by other causes). The width of the shell is generally greater and the posterior margin a little more pointed than in *S. porcellana*. The ground colour, covered by a dark periostracum, is yellowish-brown to green and ornamented with a network of darker threads, making an elegant pattern of triangular, oval or dot-shaped spots; irregular growth rings; the shells of the specimes of Mahé are extremely thin and fragile, depending on the extremely low content on mineral-salts (Calcium) in the rivers. (Pl. 2, Fig. 11a, b; 12a, b; 13a, b).

The average indices are from:	$\mathbf{Br}:\mathbf{L}$	$\mathbf{H}:\mathbf{L}$
Seychelles (Mahé):	77.85%	31% broad and flat
Comores (Anjouan):	74.69%	38% broad and high
Mascarene (La Réunion):	76.71%	31.5% broad and flat
(Mauritius):	71.6%	33.55% narrow and flat

The average index of all on Indian Ocean Islands collected shells of Septariaborbonica:75.21%33.55% broad and flat

Operculum: It lies in the soft part between foot and pallial organs; without function; size (of a specimen from Seychelles, Mahé, 22 mm lenght; (Sey: M: No. 6): posterior side: 8 mm, anterior side: 5 mm; rib: 0.8 mm; yellow-reddish, exterior somewhat shiney, interior lustreless; the protrused spur of the rib is broader and shorter than in the operculum of *Septaria porcellana* (LINNÉ, 1758) and *p. depressa* (LESSON, 1830) (Pl. 4, Fig. 21; 22a, b). Anatomical remarks: Detailled studies on the anatomy and histology

An atomical remarks: Detailled studies on the anatomy and histology of S. borbonica were made by BOURNE (1908) and STARMÜHLNER (1969). Radula: central-tooth a little higher than broad, cutting edge concave posterior side somewhat broader than anterior side, first lateral tooth with a prominent protrusion on the outer cutting edge, third lateral tooth with many, delicate denticles on the cutting edge, the marginal-teeth with 10-12 denticles (Fig. 16). Femal reproductive organs: the spermatheca (or spermatophor-sac) is only a basal enlargement of the vaginal-duct (in S. porcellana (LINNÉ) it is globular and distinctly set aside from the vaginal duct (STARMÜHLNER, 1976: 540, 541; Fig. 391, 41a). In contrast to S. porcellana f. depressa, speramatophors were never found in the spermatheca of S. borbonica (BOURNE, 1908; ANDREWS, 1937; STARMÜHLNER 1969). Also the dissected females of our samples were without spermatophors. The dark coloured receptaculum seminis is divided in two parts, connected by a short, narrow median duct; the anterior sac passes over the narrow receptaculum duct. The vaginal connecting duct stretches to the median part of the vagina (it is longer and more slender as indicated by specimens from Madgascar by STARMÜHLNER (1969) (113; Fig. 137) than in S. porcellana f. depressa (STARMÜHLNER (1976): 540; Fig. 39a; 541; Fig. 41a). Proximal to entering the vaginal connecting duct, the vagina is ampoule-shaped. The ductus enigmaticus and crystal-sac are typical developed. (Fig. 17).

Ecological-biological remarks: *Septaria borbonica* is a characteristic form of the strong current in the middle and lower courses. The snails are attached to the surface of rocks and boulders in a current-velocity of 50 cm/sec to more than 1 m/sec. The streamlined, cap-like shell, and the broad sucker-like foor are ideal adaptions to the strong current of a torrent or water-



Fig. 16. Septaria borbonica: Radula-teeth Fig. 17. Septaria borbonica: Female reproductive-system

fall. The specimens of the rivers of Mahé posses very thin shells, as a consequence of the very low content of mineral (specially Calcium-) salts in the extremly smooth and slightly acidic waters of these granitic island.

	Temperatures	Chemistry				
	-	$_{\mathrm{pH}}$	conductivity	total hardne	ss	
Seychelles (Mahé):	$26^{\circ} \mathrm{C} - 28^{\circ} \mathrm{C}$	6.6-6.8	$33-35 \ \mu S$	$0.18^\circ - 0.2^\circ$	dH	
Comores (Anjouan):	$23.6^\circ~\mathrm{C}{-}27.3^\circ~\mathrm{C}$	7.7 - 8.2	$43-216 \ \mu S$	$1^{\circ} -3.7^{\circ}$	dH	
Mascarene						
(La Réunion):	$22.1^\circ~\mathrm{C}{-28.4^\circ~\mathrm{C}}$	7.1 - 8.1	$65 - 92 \ \mu S$	$1^{\circ}$ $-1.65^{\circ}$	$^{\rm dH}$	
(Mauritius):	$21.2^\circ \mathrm{C}{-}24.5^\circ \mathrm{C}$	7.6 - 8.2	$130-195 \ \mu S$	$1.85^\circ{-}2.65^\circ$	$^{\rm dH}$	
Range:	$21.2^\circ$ C $-28.4^\circ$ C	6.6 - 8.2	$33 - 216 \ \mu S$	$0.18^\circ\!-\!3.7^\circ$	dH	

In the localities of Anjouan, La Réunion and Mauritius many shells of females were covered with eggs. In some localities of Anjouan many young specimens were also attached to the shells, covering the surface of the shells. The species was associated with Neritina (V.) gagates, Neritina pulligera stumpfi and knorri, Neritina (Neripteron) auriculata f. mauriciae, Clithon spiniperda, Clithon coronata and Neritilia consimilis.

Geographical range: Madagascar, Comores, Seychelles, Mascarene Islands (La Réunion, Mauritius, Rodriguez). Following BENTHEM-JUTTING (1956), the species is also recorded from India, Malay Archipelago, Philippines and various Pacific Islands. It is doubtfull if the records of *Septaria borbonica* from the coasts east of the East African islands, from India, Malay Archipelago are in fact *Septaria porcellana*, including f. *depressa*. All specimens described by STARMÜHLNER (1970) from New Caledonia and (1974) from various Pacific islands between New Guinea and Tahiti belong to *Septaria porcellana* f. *depressa*.

Subfamily: Neritiliinae Genus: Neritilia MARTENS, 1879

### 9) Neritilia consimilis (MARTENS 1879)

Lit.: 1879 Neritina consimilis (MARTENS, in M. & CH., Conch. Cab. (2), 10a: 243; Pl. 23; Fig. 25, 26) — 1880 Neritina (Neritilia) consimilis (MARTENS, Mollusken, in MÖBIUS: Beitr. z. Meeresfauna d. Insel Mauritius: 213–1888 Neritina (Neritilia) consimilis (TRYON, Man. Conch., 10: 54; Pl. 18, Fig. 86) — 1910 Neritina consimilis (KOBELT, Abh. senck. nat. Ges., 32: 94) — 1921 Neritina (Neritilia) consimilis (GERMAIN, Mém. Soc. 2001. France, 1920, suppl.: 394).

Localities: Sey: M: No. 3 (6 ind.); Co: A: No. 7 (5 ind.), No. 13 (15 ind.), No. 17 (1 ind.); Mas: Ré: No. 8 (5 ind.), No. 16 (5 ind.), No. 18 (87 ind.), No. 19 (24 ind.); Mau: No. 11 (1 ind.), No. 13 (5 ind.), No. 19 (250, mostly iuv.), No. 20 (53 ind.), No. 21 (7 ind.), No. 22 (12 ind.), No. 23 (110 & many iuv.),

Shell: MARTENS wrote in the description of the species, that the shells of the types of N. consimilis are very similar to the shells of N. succinea (Récluz. 1841). For this species Récluz, 1841 (Rev. zool., 1841: 343) has stated "doubt-full Madagascar or Guadeloupe?". MARTENS believed that probably N. succinea of Récluz is from Madagascar. The only difference he found is that the operculum of consimilis has "nearly" no peg, such as in succinea. Our study of the operculum (see below) shows, that all investigated specimens from Mahé, Anjouan, Réunion and Mauritius have a distinct peg on the basal interior surface of the operculum, such as is described for N. succinea and also for the pacific species N. rubida (PEASE, 1867).

H. K. MIENIS (Zoolog. Museum, Mollusc Section, The Hebrow University, Jerusalem) who has checked the determination of our specimens, wrote to us 24 March 1977 in a letter: "I checked your material and found pegs on the operculum of all your *Neritilia* material. However, this peg is rather fragile and easily broken when separating it from the animal. It hardly leaves a scar."

Therefore, if it is true, that the real locality of the type-shell of Récluz's N. succinea is Madagascar and not Guadeloupe (French Antilles), the name similis would be a synonym of succinea Récluz, which has priority. Also, GERMAIN (1921) indicated in his monograph on page 394 that N. consimilis is nearly identical with N. succinea from Guadeloupe. His statement (taken from MARTENS, 1879) that the diameter of consimilis (type from River Créole, Mauritius) is a little smaller (3.5 mm) than succinea (4.3 mm) is not true; our full grown specimens (also from River Créole and other localities) all have a diameter between 4.2 mm to 5.5 mm. GERMAIN asked if perhaps N. succinea was transported accidentally from the (french) Guadeloupe to the (partly also french) Mascarene Islands.

But our collections show that the species is not only in the Mascarene rivers, it is also found at the Comores and Seychelles Islands. MIENIS, in a letter to the author, after checking the material of our mission to Madagascar 1958, also found *Neritilia* in the collections, overlooked by us. Another question, also raised by MIENIS in his letter (24 March 1977) after checking our collections, is if *N. consimilis* may be a synonym of *N. rubida* (PEASE, 1867) described from Polynesian islands, also ocurring in Java, Celebes, Thailand, New Guinea (BRANDT, 1974). These species were investigated by STARMÜHLNER (1976) from material collected from Éfaté (New Hebrides) and Tahiti. After comparing the specimens it is seen that the two species are very closely related, but there are some little differences in the shell and anatomy.

The shells of our specimens are obliquely elliptical (and not transversely ovate such as in N. *rubida*), very fine and delicate striulated by growth striae,

		s	hell	Ар	erture	
Localiti	es	Height	Diameter	Height	Diameter	Col.area
Sey: M:	No. 3	5	4	3.6	3	1
	No. 7	5	3.5	3	3	1.2
Co: A:	No. 7	4.6	4	no mea	surements!	
	No. 13	3	2.3	no mea	surements!	
	No. 17	5	4.5	no mea	surements!	
Mas: Re	5: No. 8	4.8	4.3	3	2.6	1.5
	No. 16	5	4.3	3	2.6	1.5
	No. 18	4.5	3.9	3	2.5	1.2
	No. 19	4.5	3	3	2.7	1
Mau:	No. 11	4.8	4	3.2	3.5	1
	No. 13	4.7	4	3	3.3	1
	No. 19	4.2	3	2.3	2.5	0.7
	No. 20	5.3	4.2	3.1	3.3	1.2
	No. 21	4.4	3.5	2.6	2.8	1
	No. 22	5.3	4.5	3.5	4	1.5
	No. 23	4.9	3.9	3	2.8	1

Sizes (in mm):

The measurements are from the largest specimens of the samples.

translucent, yellowish with a reddish, brownish or blackish coating (ironoxyde); the spire slightly elevated, suture simple, last whorl flattened below; aperture obliquely and semi-elliptical (not as extended is in *rubida*); inside withish to yellowish as also the delicate, wrinkled columellar area (if the soft body is shining through the shell, the columellar area is darker); the superior border of the aperture thin and straight, the exterior border arched and at the lower border, which is a little arched, gradually thickened; columellar edge straight, without any denticulation (Pl. 4; Fig. 23a, b).

Operculum: Size (from a specimen with a shell-diameter of 5 mm; Sey: M: 7): 2 mm×1.3 mm; elliptical, inner border straight, outer border coating; as indicated above, a peg-like process was found on all investigated specimens; this process is slightly curved and on the inner flat surface, grooved; MARTENS (1879) noted a difference from N. succinea (and N. rubida), that the operculum of the type-specimen from the River Créole (coll. by Prof. K. MÖBIUS, 19. 10. 1874) is "without an appreciable vestige of peg and rib". MIENIS wrote in his letter of 24 March 1977, like noted above, to us: "However, this peg is rather fragile and easily broken, when separating it from the animal. It even hardly leaves a scar"; It is possible that by the specimen, described by MARTENS, as type, the fragile peg-like process was broken in the preparation (Pl. 4; Fig. 24a, b, c).

Anatomical remarks: Details on the anatomy of Neritilia were given by BAKER (1923, radula); ANDREWS (1937, female reproductive organs) and STARMÜHLNER (1976). The outside surface of the mantle is dark pigmentated; Radula: extremly long; central tooth is lacking; first lateral prolongated, without a cutting edge, but a distinct bicuspid denticulation on the outer end, opposite a small intermediate tooth; the outer lateral possesses on the cuttinge edge 8–12 prominent denticles (STARMÜHLNER, 1976, counted for N. rubida: 12-14 denticles), the marginal-teeth with 5–6 denticles (N. rubida: 4–5 denticles) (Fig. 18). Female reproductive organs: spermatheca (or sperma-



Fig. 18. Neritilia consimilis: Radula-teeth Fig. 19. Neritilia consimilis: Female reproductive-system

tophor-sac) long and U-shaped, but much broader in consimilis, than the slender sac, figured by STARMÜHLNER (1976) for N. rubida (p. 549; Fig. 48). The sac is extended gradually to the vaginal-duct, which enters the albumen gland. The kidney-shaped receptaculum seminis enters with a short, but distinct duct, together with the vaginal duct, in the lumen of the albumen gland. In Neritilia rubida the sac-like receptaculum enters directly into the albumen gland (STARMÜHLNER, 1976). The capsule-gland (= ootype) is-as in Neritilia rubida-enormously developed. On the proximal side the crystal-sac is adjacent. The vagina opens through the central duct of the capsule glande, therefore there is only one female genital-pore in Neritilia (Fig. 19).

Ecological-biological remarks: Like the closely related species N. rubida, N. consimilis occurs exclusively in the lower courses of the running waters, mostly in pure freshwater, but also near the influence of brackish water from the return current during high-tide. The small snails are attached, mostly in groups, in small holes of rocks and boulders, as a rule very near the water surface. Protected by the the holes against the current, they occur in surface currents between 30 cm-50 cm/sec. The frequency fluctuats between 1 and 30 ind./d<sup>2</sup>, mostly around 5-10 ind./dm<sup>2</sup>. They were associated with Neritina pulligera (and his subspecies), Neritina (V.) gagates, Clithon spiniperda, Clithon chlorostoma f. comorensis and Septaria borbonica.

	Temperatures	Chemistry		try		
		pH	conductivity	total hardne	SS	
Seychelles (Mahé):	24.4° C—28° C	6.8-6.9	$33-54 \ \mu S$	$0.2^{\circ} - 0.65^{\circ}$	dH	
Comores (Anjouan):	$23.6^{\circ} C - 26^{\circ} C$	7.7 - 8.2	$122 - 135 \ \mu S$	$2.5^\circ - 3.7^\circ$	dH	
Mascarene						
(Réunion):	22.1° C-26.6° C	7.1 - 7.4	$69-92 \mu S$	1° -1.65°	dH	
(Mauritius):	21.7° C—24.5° C	7.8 - 8.2	96-195 μS	$1.55^{\circ} - 2.65^{\circ}$	dH	
Range:	$21.7^{\circ} C - 28^{\circ} C$	6.8-8.2	$35{-}195~\mu\mathrm{S}$	$0.2^{\circ}$ $-3.7^{\circ}$	dH	

In our collections from the months February to May 1974 were found many juvenile snails.

Geographical range: Neritilia consimilis is known from the E-African Islands, such as Seychelles-, Comores- and Mascarene-Archipelagos. It occurs also in Madagascar (after the revision of the material of the Madagascar-Mission 1958, by H. K. MIENIS). The closely related species Neritilia rubida is reported from Java, Celebes, Thailand, New Guinea and several Pacific islands, such as New Hebrides, Fiji, Samoa and Tahiti. From the Prince-island in the Gulf of Guinea (W-Africa) is described a Neritilia manoeli DOHRN, 1866 (MARTENS, 1879). Order: Mesogastropoda Superfamily: Cyclophoracea Family: Viviparidae Subfamily: Bellamyianae Genus: *Bellamya* 

## 10) Bellamya bengalensis (LAMARCK, 1822) f. zonata (HANLEY, 1860)

Lit.: 1822 Paludina bengalensis (LAMARCK, 1822, Hist. nat. anim. s. vert., 4 (2): 174) - 1838 Paludina bengalensis (LAMARCK, ibid., 8 (2° édit. (DESHAYES): 513) -1841 Paludina bengalensis (DELESSERT, Rec. Coqu.; Pl. 31; Fig. 2) - 1852 Paludina bengalensis (KÜSTER in M. & CH., Coch. Cab.: 17; Pl. 3, Fig. 15, 16) - 1860 Paludina zonata (HANLEY, in REEVE, Conch. Icon.: Fig. 34) - 1869 Paludina bengalensis v. digona (BLANFORD, Proc. zool. Soc. London, 1869: 445) - 1867 Paludina bengalensis (HANLEY & THEOBALD, Conch. Ind.: XVII; 32; Pl. 76, Fig. 8-10; Pl. 76, Fig. 5 = var. gigantea (= P. gigantea v. d. BUSCH, in REEVE, Conch. Icon.: Pl. 1; Fig. 7 = P. bengalensis v. gigantea NEVILL, loc. supra cit., fasc. E, 1877: 28 and Handlist Moll. Ind. Mus. Calcutta, 2, 1844: 21; also P. bengalensis in MORELET, Sér. Conch., 4: 303; P. lineata VALENCIENNES, Rec. obs. zool. anat. comp.: 256 and P. elongata SWAINSON, 1821, Zool. Ill., London, sér. 1: Pl. 98) - 1877 Paludina bengalensis v. doliaris (NEVILL. Cat. Moll. Ind. Mus. Calcutta, fasc. E: 28) - 1877 Paludina zonata (LIÉNARD, Cat. Moll. Maurice: 46) -1877 Paludina zonata (NEVILL, Cat. Moll. Ind. Mus. Calcutta, fasc. E: 31) - 1880 Paludina zonata (MARTENS, Moll., in MÖBIUS: Beitr. Meeresf. d. Ins. Mauritius: 210) - 1884 Paludina zonata (NEVILL, Handlist Moll. Ind. Mus. Calcutta, 2: 23) - 1910 Paludina zonata (KOBELT, Abh. senckenb. nat. Ges., 32: 94) - 1915 Vivipara digona (PRESTON, Fauna Brit. India ..., Moll.: 91) - 1921 Vivipara zonata (GERMAIN, Mém. Soc. zool. France, suppl. 1920: 335).

Localities: Mas: Mau: No. 18 (93 ind.), No. 22 (1 ind.), No. 25 (15 ind.).

Shell: Ovately conical, rather solid, with 5 to  $5\frac{1}{2}$  whorls, below the suture flatly angled, suture depressed; closely spiraled and linearly straited, especially on the underside of the last whorl; young shells wit a row of fine periostracum-hairs below the suture; umbilicus narrow and deep; 3-4 brown spiral-bands on the olive-green ground; aperture pyriformly broad-ovate, dark brown edged; apex mostly eroded, and surface of the whorls sometimes covered with filamentous algae (Pl. 5; Fig. 25).

	Shell		Aperture		
Localities	Height	Diameter	Height	Diameter	
Mas: Mau: No. 18	25.5	18	13	10	
No. 22	29	22.6	25.5	13.5	
No. 25	23	18	12	10	

Sizes (in mm):

The sizes are from the largest shells in the samples.

Operculum: Size (from specimen with shell-height: 23 mm):  $12 \text{ mm} \times 9 \text{ mm}$ ; (shell-height: 29 mm):  $14 \text{ mm} \times 12 \text{ mm}$ ; broad-ovate, horny; with a subcentral nucleus, which is slightly impressed; concentric growth-rings (Pl. 5; Fig. 26).

Anatomical remarks: Detailled anatomical descriptions of different species of *Bellamya* are given by SEWELL (1921); NEUMANN (1928); ROHRBACH (1937) and STARMÜHLNER (1974); Radula: central-tooth with a trapezoid outline, cutting-edge with 5+1+5 denticles; first lateral with 3+1+5; the inner marginal-tooth with 3+1+3 and the outer marginal-tooth with 10-12 equal pointed denticles (Fig. 20). The salivary glands, with two slender ducts, are united in the median line and posses ramified, lateral blind-sacs (Fig. 21).



Fig. 20. Bellamya bengalensis f. zonata: Radula-teeth
Fig. 21. Bellamya bengalensis f. zonata: Salivary-glands
Fig. 22. Bellamya bengalensis f. zonata: Central vervous-system

The central nervous-system is similar to Fig. 21, given by STARMÜHLNER (1974) for *B. dissimilis ceylanica*: Cerebral-ganglia long-oval in outline and united by a short, but broad commissure; from the outside to the inner area run the N. opticus, N. tentacularis and 4 (resp. 5) nerves to the mouth and lips and to the cerebrobuccal-connective; the pleural ganglia are approximate to the cerebral ganglia, being connected to them by very short connectives; the right pleural ganglion gives rise to the thick N. supraintestinalis, the left to the left pallial nerve and the N. subintetinalis; these nerves cross each other, and are separated by the oesophagus; the pedal ganglia are connected with thick connectives with the cerebral- and pleural ganglia (Fig. 22). The sexes

are separate and the females — like all Viviparidae — are viviparous; in the uterus of dissected females from No. 25, about 20-25 embryos were found; the anatomy of the female and male show no differences from the results of other *Bellamya*-species (STARMÜHLNER, 1974: 117; Fig. 22, 23).

Ecological-biological remarks: GERMAIN (1921) stated, that these species was introduced with waterplants from India to Mauritius by the Indian immigrants in the last century. The species is found in stillwaters, such as tanks, ponds, but also creeks of rivers without current, abundant on waterplants, algae and muddy-sandy bottoms. In Mauritius the species was in creeks and borders of running waters only in the slow-flowing lower courses of the plains near the coast. They are associated with *Thiara scabra*, *Melanoides tuberculata*; frequency in the creeks of the River Rempart (Mau: No. 18) was 10-15 ind./1/16 m<sup>2</sup>, in the pond of the Pamplemousses-Garden (Mau: No. 25), 1 ind./m<sup>2</sup>.

Temperatures		Chemistry		
	pH	conductivity	total hardness	
24.5° C—26.3° C	7.6 - 8.15	$125-175 \ \mu S$	$1.8^{\circ}$ — $2.65^{\circ}$ dH	

Like all Viviparidae, *Bellamya bengalensis* f. *zonata* partially filter with the gill microplancton from the respiratory water current.

Geographical range: India; introduced to Mauritius (f. zonata).

Superfamily: Rissoacea Family: Synceridae (= Assimineidae) Subfamily: Syncerinae (= Assimineinae) Genus: Paludinella PFEIFFER, 1841

## 11) Paludinella hidalgoi (GASSIES, 1869) f. granum (MORELET, 1882)

Lit.: 1869 Hydrocena hidalgoi (GASSIES, J. de Conch., 17: 18) – 1882 Assiminea granum (MORELET, J. de Conch., 30: 105; Pl. 4, Fig. 8, 198; Pl. 10, Fig. 15) – 1883 Assiminea granum=hidalgoi (MORELET, J. de Conch., 31: 208) – 1887 Assiminea hidalgoi (BOETTGER, Jahrb. malak. Ges., 14: 180) – 1910 Assiminea granum (KOBELT, Abh. senck. nat. Ges., 32: 94) – 1921 Assemania granum (GERMAIN, Mém. Soc. zool. France; suppl., 1920: 375) – 1927 Paludinella hidalgoi (THIELE, Zool. Jb. (Syst.), 53: 118) – 1956 Syncera hidalgoi (BENTHEM-JUTTING, Treubia, 23 (2): 354; F. 67) – 1961 Assiminea hidalgoi ? (SOLEM, Fieldiana, Zool., 41 (3): 433) – 1962 Assiminea granum (BARNACLE, J. Seych. Soc., 2: 57) – 1970 Paludinella hidalgoi (STARMÜHLNER, Cah. ORSTOM, sér, Hydrobiol., 4 (3/4): 59; Fig. 51–54) – 1974 Assiminea (A.) hidalgoi (BRANDT, Arch. Moll., 105 (I/IV): 148; Pl. 11, Fig. 90) – 1974 Syncera (=Assiminea) cf. hidalgoi (STAR-MÜHLNER, Bull. Fish. Res. Stn., Sri Lanka, 25 (1/2): 129; Fig. 49, 50; Pl. 5, Fig. 48).

Locality: Mas: Ré: No. 24 (390 ind.).

Shell: Conical, yellow-brownish (young specimens with reddish postnuclear whorls), shining and transparent, with a lighter zone below the suture; very fine growth striae crossed by some very delicate, narrow, spiral wavelines (enlargement:  $50 \times !$ ); BENTHEM-JUTTING (1956) and BRANDT (1974) state, that for these species there are 3-5 fine spiral lines on the three postnuclear whorls typically; the specimens from the locality Ré: No. 24 are eroded from the embryonic whorls through 2 to  $2\frac{1}{2}$  postnuclear whorls, therefore from the six whorls only the last 2.5 to 3 whorls can be recognized: BENTHEM-JUTTING (1956) wrote that these raised spiral lines fade away after the fifth whorl; umbilicus narrowly open or closed by the expanded columellar margin; aperture pyriform, angled above and well rounded below; peristome connected by a thin parietal callus; columella thickened, flat and somewhat expanded (Pl. 5; Fig. 27, 28).

Sizes (in mm):

Locality	Shell		Aperture	
	Height	Diameter	Height	Diameter
Mas: Ré: No. 24	2.2	1.5	0.9	0.7
(eroded: 2.5	whorls)			

The measurements are from the largest specimen in the sample.

Operculum: Size (from a specimen with 2.2 mm height): 0.7 mm  $\times$  0.45 mm; thin-corneous, paucispiral with excentrical nucleus (Fig. 23).

Anatomical remarks: For Paludinella it is typical that the head forms a "flaplike fold" which covers the base of the rostrum (ABBOT, 1948: 281; BENTHEM-JUTTING, 1956: 351; Fig. 54; 362; BRANDT, 1974: 152). Our specimens were very contracted by fixation, therefore the fold or cape was not distinctly recognized, but it is a distinct groove on the base of the retracted rostrum (Fig. 25). The body and head with tentacles posses a black pigmentation, only the outer margin of the rostrum is lighter. STARMÜHLNER (1970) noted also a strong pigmentation for the specimens of P. hidalgoi from New Caledonia. The tentacles are very short, but not stubbed, the eyes are placed in the bases (Fig. 24). Radula: Figured by STARMÜHLNER (1970: 60; Fig. 52) for a specimen from New Caledonia. The specimens of Réunion have nearly identically radulae: central-tooth trapezoid with a short handle-like process on the base, laterally with short process, the formula of the denticles on the cutting-edge: 2+1+1 (2); the lateral with 2+1+2 denticles; between the base of the relatively short and broad lateral-tooth and the inner marginaltooth there is a small accessory plate; inner- and outer-marginal-teeth with small "flanges", wing-like lateral processes; the inner marginal: 3+1+1denticles, the outer marginal: 11 denticles (Fig. 23). Male copulatory organ: the penis rises on the neck as a large and simple coiled duct (Fig. 25).

After the radula (central-tooth without any basal cusps) the species *hidalgoi* (including the f. *granum*) is — as indicated by THIELE (1927: 118) —

placed in the genus *Palludinella* and not in *Syncera* (= Assiminea) s. str., as it was done "tentatively" in the studies of BENTHEM-JUTTING (1956) and BRANDT (1974).



Fig. 23. Paludinella hildalgoi f. granum: Operculum Fig. 24. Paludinella hildalgoi f. granum: Radula-teeth Fig. 25. Paludinella hildalgoi f. granum: Head and penis

Ecological-biological remarks: Found near the mouth region of the outflow of a source-pond in a brackish influenced coastal pond and swamp. On stones and among waterplants, such as *Potamogeton*, *Naja* and water-moss (cf. *Fissidens*) in dense populations about 5 ind./cm<sup>2</sup>(!) in a current of 30-50 cm/sec.

Temperatures		Chemistry	
	$_{\mathrm{PH}}$	conductivity	total hardness
$21.2^{\circ}$ C	8	$1600 \ \mu S$	$10.7^\circ~{ m dH}$

The high conductivity and total hardness indicate hard water with brackish influence. Also from other authors, such as BENTHEM-JUTTING (1956), BRANDT (1974) and STARMÜHLNER (1970) the species was recorded from the mouth-regions, especially brackish shores of the Indopacific coasts. Geographical range: Indopacific shores between Mascarene-islands and Pacific islands (New Caledonia). BRANDT (1974) indicated a record from the coasts of Thailand (*Nipa*-palm swamps).

Genus: Syncera GRAY, 1821 (= Assiminea FLEMING, 1828)

## 12) Syncera (= Assiminea) nitida (PEASE, 1864)

Lit.: 1864 Hydrocena nitida (PEASE, Proc. 2001. Soc. London, 1864: 574) – 1869 Hydrocena nitida (PEASE, J. de Conch., 17: 165; Pl. 7, Fig. 11) – 1884 Assiminea nitida (NEVILL, Handlist. Moll. Ind. Mus. Calcutta, 2: 71) – 1887 Assiminea nitida (BOETTGER, Jb. malak. Ges., 14: 192) – 1921 Asseminia nitida (GERMAIN, Mém. Soc. Zool. France; suppl. 1920: 376) – 1949 Syncera nitida (ABBOT, Occ. Pap. B. P. Bishop Mus., 19: 272; Fig. 7a-c) – 1956 Syncera nitida (BENTHEM-JUTTING, Treubia, 23 (2): 355; Fig. 68) – 1974 Assiminea (Assiminea) nitida (BRANDT, Arch. Moll., 105 (1/4): 148; Pl. 11, Fig. 91).

Locality: Sey: M: No. 8 (5 ind.).

Shell: Descriptions are given by PEASE (1864); GERMAIN (1921); BENTHEM-JUTTING (1956) and BRANDT (1974). The shells of our collections are the first record for the Seychelles: broad-conical; elevated spire with 5-6regularly increasing whorls in size, somewhat convex; periphery subangular; shining and somewhat transparent; striated by delicate growth striae, crossed by more delicate, slightly wavy spiral striae (enlargement: more than  $50 \times !$ ); typically a subsutural raised spiral thread along the suture and a similar fine spiral thread along the very narrow or closed umbilicus; yellow-brownish; aperture little oblique, peristome connected by a thin parietal callus; basal and columellar margins thickened and a little expanded (Pl. 5; Fig. 29).

	ŝ	Shell	Ар	erture
Locality	Height	Diameter	Height	Diameter
Sey: M: No. 8	2.3	1.5	1	0.6

Sizes (in mm):

The measurements are from the largest specimen in the sample.

Operculum: Size (from a specimen with shell-height: 2.3 mm):  $0.6 \text{ mm} \times 0.4 \text{ mm}$ ; corneous and paucispiral with an excentrical nucleus (Fig. 26).

Anatomical remarks: Head, tentacles, mantle and upper surface of the intestine-sac dark pigmented; tentacles stubbed; Radula: central-tooth nearly squarrish, the base slightly incised, cutting edge with 2+1+2 denticles and on either side 3 basal cusps; lateral-tooth: 3+1+2 denticles, an accessory plate is developed (in contrast to the details given by BRANDT, 1974: 148), inner marginal with 6, outer marginal with 13 cusps (Fig. 27). Male copulatory organ: the penis lies on the neck as a more slender,S-shaped appendix (Fig. 28).



Fig. 26. Syncera (= Assiminea) nitida: Operculum Fig. 27. Syncera (= Assiminea) nitida: Radula-teeth Fig. 28. Syncera (= Assiminea) nitida: Head and penis

Ecological-biological remarks: The species is described from mangrove and *Nipal*-palm swamps in the coastal area of the Indian Ocean. At Mahé we found the specimens associated with *Melampus* cf. *caffra* juv. in the brackish zone of the mouth of the River Anse de la Mouche on dead corals.

Temperature	Chemistry: conductivity		
32° C	more than 30.000 µSiemens (brackish)		

Frequency was about 5 ind./dm<sup>2</sup> in a current of 10-30 cm/sec.

Geographical range: Coasts of the Indopacific between Seychelles in the East, Mascarene-Islands (f. *nana* NEVILL, 1884) to the Society Islands in the West of the Pacific, northwards to Thailand, Hongkong and Philippines. Subfamily: Omphalotropinae

Family: Omphalotropeae

Genus: Omphalotropis PFEIFFER, 1851

Subgenus: Omphalotropis s. str. (= Eurytropis KOBELT & MÖLLENDORF, 1898)

# 13) Omphalotropis (Omphalotropis) globosa (BENSON, 1852)

Lit.: 1852 Cyclostoma globosum (BENSON, in PFEIFFER, Proc. zool. Soc. London, 1852: 151) - 1852 Omphalotropis globosa (PFEIFFER, Proc. zool. Soc. London, 1852: 151) — 1852 Omphalotropis globosa (PFEIFFER, Conspectus: 49) — 1852 Realia globosa (GRAY, Cat. phaneropneumona or terr. operc. Moll. Coll. Brit. Mus.: 222) - 1852 Cyclostoma globosum (PFEIFFER, Monogr. pneumonopomorum vivent, 1: 311) - 1853 Cyclostoma globosum (PFEIFFER, in M. & CH., Conch. Cab.: 296; Pl. 39, Fig. 14-16) - 1858 Hydrocena globosa (PFEIFFER, Monogr. Pneumopomorum vivent, 2: 164) - 1869 Omphalotropis globosa (PEASE, J. de Conch., 17: 141) - 1877 Omphalotropis globosa (LIENARD, Cat. Moll. Ile Maurice: 60) - 1878 Omphalotropis globosa (NEVILL, Handlist Moll. Ind. Mus. Calcutta, 1: 319) - 1880 Omphalotropis globosa (MARTENS, Moll., in MÖBIUS: Beitr. z. Meeresfauna d. Ins. Mauritius: 188) - 1898 Omphalotropis globosa (MARTENS, Mitt. zool. Samml. Mus. Naturkde. Berlin, 1 (1): 5) - 1898 Omphalotropis (Eurytropis) globosa (KOBELT & MÖLLENDORF, Nachrichtsbl. deutsch. malakozool. Ges., 1898: 149) - 1910 Omphalotropis globosa (KOBELT, Abh. senck. nat. Ges., 32: 94) - 1921 Omphalotropis (Eurytropis) globosa (GERMAIN, Mém. Soc. zool. France; suppl. 1920: 285) - 1927 Omphalotropis-Arten (THIELE, Zool. Jb. (Syst.), 53: 121) - 1956 Omphalotropis-Arten (BENTHEM-JUTTING, Treubia, 23 (2): 363; Fig. 56).

Locality: Mas: Mau: No. 2 (1 specimen).

Shell: Globose-conical; six whorls, separated by a distinct suture; last whorl broad globose, umbilicus open and with a weak spiral ridge; brownreddish with whitish, cloud-like spots in vertical bands; aperture suboblique oval, white-yellowish (Pl. 5, Fig. 30).

Sizes (in mm):

	S	shell	Aperture	
Locality	$\mathbf{Height}$	Diameter	Height	Diameter
Mas: Mau: No. 2	5.5	3.5	2.5	2

Only one specimen was found.

Operculum: Size: 2.5 mm $\times$ 2 mm, thin-horny; paucispiral, nucleus excentrical, delicate, wave-like growth striae.

Anatomical remarks: Proboscis of the species of the genus Omphalotropis overlyed by a fold or "cape", like figured by ABBOT (1948) and cited by BENTHEM-JUTTING (1956). Radula: descriptions of radulae from species of Omphalotropis has given THIELE (1927). The radula of the O. globosa, recolted at Mauritius, very similar: central-tooth two times higher than broad with 4+1+4 denticles on the cutting edge, lateral with the formula 2+1+2 (3), inner marginal with 8, outer marginal broad, fan-like with about 35 bicuspid denticles (Fig. 30); Central nervous-system: thick oval cerebral-ganglia connected by a short commissure, dorsally rises the N. opticus, N. tentacularis and forward the cerebro-buccal-connective and two labial nerves; left pleuralganglion with a distinct connective to the supraintestinalganglion; the right pleural-ganglion connected with the subintestinal-ganglion and a longer con-

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nective to the supraintestinal-ganglion; short but distinct connectives from the pleural- and cerebral-ganglia to the pedal-ganglia; statocysts with one statolith (Fig. 31). Male copulatory organ: penis arises on the neck with a broad, flattend base and with a long-furrow on the outside; the proximal end is short and finger-shaped (Fig. 29).

Ecological-biological remarks: The species of *Omphalotropis* are normally living outside of water. The occurrence in waterbiotopes is only



Fig. 29. Omphalotropis globosa: Head and penis
Fig. 30. Omphalotropis globosa: Radula-teeth
Fig. 31. Omphalotropis globosa: Central nervous-system

accidental, if specimens are living on plants etc. near the borders of running waters.

Geographical range: Genus with Indopacific range. O. globosa is recorded from Mauritius and Seychelles (Mahé).

### 14) Omphalotropis (Omphalotropis) picturata (ADAMS, 1867)

Lit.: 1867 Omphalotropis picturata (ADAMS, Proc. zool. Soc. London, 1867: 306; Pl. 19, Fig. 13) — 1870 Omphalotropus picturata (NEVILL, J. asiat. Soc. Bengal. 39 (2): 416) — 1877 Omphalotropis picturata ? (LIÉNARD, Cat. Moll. Maurice: 60) — 1878 Omphalotropis picturata (NEVILL, Handlist Moll. Ind. Mus. Calcutta, 1: 320) — 1880 Omphalotropis picturata (MARTENS, Moll., in MÖBIUS, Beitr. Meeresf. d. Ins. Mauritius: 188) —

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1898 Omphalotropis (Eurytropis) picturata (KOBELT & MÖLLENDORF, Nachrichtsbl. deutsch. malakozool. Ges., 32: 94, 95) — 1921 Omphalotropis (Eurytropis) picturata (GERMAIN, Mém. Soc. zool. France; suppl. 1920: 284).

Locality: Mas: Ré: No. 3 (3 ind.).

Shell: According to GERMAIN (1921) very closely related to O. variegata (MORELET, 1866), and perhaps only a variety of these species. But O. picturata has only six whorls (variegata: seven whorls) and the size is smaller than in variegata; there are no spiral ridges, but very fine, dense growth-striae; reddish with broad irregularly broad zigzag-lines, withish spots without distinct borders; umbilicus open and surrounded by a white, not very prominent spiral ridge; aperture suboblique, oval (Pl. 5; Fig. 31).

Sizes (in mm):

Locality	SI	nell	Aperture	
	$\mathbf{H}_{\mathbf{e}ight}$	Diameter	$\mathbf{H}\mathbf{eight}$	Diameter
Mas: Ré: No. 3	4.2	3	2	1.5

The measurement is from the largest specimen in the sample.

Operculum: Typical for the subgenus.

Anatomical remarks: Radula: central-tooth with six cusps; lateral with the formula 1+1+3; inner marginal with 6 and the broad outer marginal wit 20-23 denticles (Fig. 32). Female reproductive system: slender, coiled oviduct enters in a broad sac-like uteral part, with the opening on the mantle edge; in the first third of the uteral-sac enters the duct of the receptaculum seminis, lying between the oviduct and the lower part of the rectum, which is full with densely packed, ovoid faeces (Fig. 33); Male reproductive organs: long, finger-shaped penis (Fig. 34). On the inner side of the mantle are five small folds as remainder of a gill (Fig. 33).

Ecological-biological remarks: As indicated by O. globosa the species of this genus are predominantly terrestrical and arborial, but specimens, living near the borders of running waters are also to be found sometimes under water in the regions near the border. The three found specimens of O. picturata were crawling on stones along the border of a typical mountain torrent. The occurrence of some gill-folds shows also, the species must be able to respire under water. The specimens were found sporadically by a surface-current of 10-30 cm/sec.

Temperature		Chemistry	
-	$\mathbf{pH}$	conductivity	total hardness
18° C	7.85	62 µS	1.25° dH

Geographical range: Mascarene Archipelago (La Réunion, Mauritius).

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Fig. 32: Omphalotropis picturata: Radula-teeth Fig. 33. Omphalotropis picturata: Mantle cavity opened, to show the lower parts of the female genital-system and the rectum Fig. 34. Omphalotropis picturata: Head and penis

# 15) Omphalotropis (Omphalotropis) rangi (FÉRUSSAC, 1827) POTIEZ & MICHAUD, 1838)

Lit.: 1827 Cyclostoma rangii (FÉRUSSAC, Bull. univ. Sc. nat., 10: 409) — 1838 Cyclostoma rangii (POTIEZ & MICHAUD, Gal. Moll. DOUAI, 1: 240; Pl. 24, Fig. 18, 19) — 1868 Omphalotropis borbonica (ADAMS, Proc. zool. Soc. London, 1868: 292; Pl. 28, Fig. 14) — 1870 Omphalotropis borbonica (NEVILL, J. asiat. Soc. Bengal, 29 (2): 415) — 1878 Omphalotropis rangii (NEVILL, Handlist Moll. Ind. Mus. Calcutta, 1: 320) — 1880 Omphalotropis rangii (MARTENS, Moll., in MÖBIUS: Beitr. Meeresf. d. Ins. Mauritius: 189) — 1898 Omphalotropis (Eurytropis) borbonica (KOBELT & MÖLLENDORF, Nachrichtsbl. deutsch. malakozool. Ges., 1898: 151) — 1910 Omphalotropis borbonicus (KOBELT, Abh. senck. nat. Ges., 32: 95) — 1909 Omphalotropis rangii (KOBELT, ibid.: 95) — 1921 Omphalotropis (Eurytropis) rangi (GERMAIN, Mém. Soc. zool. France; suppl. 1920: 288; Pl. 6, Fig. 24; Pl. 6, Fig. 16).

Localities: Mas: Ro: No. 1 (1 ind.), No. 3 (1 ind.).

Shell: Oval-globular; spire conical with six whorls, the first five whorls slightly convex, the last whorl big, globular and with two spiral ridges below the suture and submedian; umbilicus, deep, funnel-shaped, surrounded by a withish spiral ridge; the first whorls with delicate, dense longitudinal striae, the last whorl with rows of dotted lines and distinct growth-striae; the first whorls red-brownish, last whorl below the suture yellowish, downwards to the submedian spiral-ridge light-brownish with yellowish, cloud-like or zigzag-like spots, below the spiral ridge dark brownish; aperture oval, border of the columella slightly reflected (Pl. 5, Fig. 32).

	Shell		Aperture	
Localities	Height	Diameter	Height	Diameter
Mas: Ro: No. 1	5.6	3.4	2.7	1.6
No. 3	5.8	3.5	2.8	1.7

Sizes (in mm):

The measurements are from the two found specimens.

Operculum: Typical for the subgenus. Anatomical remarks: No dissections were made.

Ecological-biological remarks: The specimens were found at the small island of Rodriguez by the Mission (1975) of the University of Lund (coll.: P. BRINCK & P. H. ENCKEL) in small streams in 250 m to 400 m altitude, SE of Port Mathurin. They were associated with *Thiara scabra*, *Melanoides tuberculata*, *Lymnaea* (*Radix*) mauritiana and *Ajrogyrus rodriguezensis*, but always sporadically. As in all species of the genus they are living mostly in humid terrestrial habitats, but according to RANG, in FÉRRUSAC (1827: 409): "surtout prés des rivières".

Geographical range: Mascarene-Archipelago (La Réunion, Mauritius and — as the first record — Rodriguez).

Superfamily: Cerithiacea Family: Thiaridae (= Melaniidae) Subfamily: Paludominae Tribe: Paludomeae Genus: Cleopatra TROSCHEL, 1856 Subgenus: Zanguebarica FISCHER, 1881

16) Cleopatra (Zanguebarica) ajanensis (MORELET, 1860) f. silhouettensis (NEVILL, 1869)

Lit.: 1860 Paludomus ajanensis (MORELET, Sér. Conch., 2: 110; Pl. 6, Fig. 10) – 1869 Paludomus ajanensis var. silhouettensis (NEVILL, Proc. zool. Soc. London, 1869: 66) – 1870 Philopotamis ajanensis (BROT, Car. rec. species fam. Melaniidae: Amer. J. Conch., 6, app: 271) – 1880 Paludomus baccula (BROT, in M. & CH., Conch. Cab, (I), 25: 47 (= baccula REEVE, 1852 = ajanensis MORELET, 1860); Pl. 8, Fig. 4, 4a, 5, 6) – Philopotamis ajanensis and Philopotamis sp. (of NEVILL from Silhouette-island) (MARTENS, Moll. in MÖBIUS: Beitr. z. Meeresfauna d. Ins. Mauritius: 34) – 1921 Paludomus ajanensis v. silhouettensis (GERMAIN, Mém. Soc. zool. France; suppl. 1920: 435) – 1962 Cleopatra ajanensis (BARNACLE, J. Seych. Soc., 2: 57).

Locality: Sey: S: No. 1 (2 empty shells).

Shell: Ovoid-conical; our two shells from the collection G. LIONNET (Mahé) are with eroded apex and only three convex whorls with a distinct suture; dense spiral-striae, crossed by the growth striae and nodules on the crossing points; umbilicus closed; dark brownish, partly with a black coating and remainder of algal growth on the surface; aperture ovoid, on the top

pointed, below rounded, and slightly extended, distinct parietal callus (Pl. 6; Fig. 33a, b).

Sizes (in mm):

		Shell		Aperture	
Locality .	$\mathbf{Height}$	Diameter	Height	Diameter	
Sey: S: No. 1 (eroded	1) 9.5	6	5.3	4	
(eroded	l) 9	5.7	5	3.6	

The measurements are from the two empty shells of the collection.

Operculum: According to BROT (1880): corneous, solid dark-reddish, outer border rounded; nucleus lateral (our specimens without operculum).

Anatomical remarks: Only empty shells; anatomical details from the species of *Cleoptra* from Madagascar are given by STARMÜHLNER (1969: 184).

Ecological-biological remarks: According to the collector Mr. G. LIONNET (Mahé), found in a torrent of the island of Silhouette, the River Maccabe, N of Grande Barbe.

Geographical range: Cleopatra ajanensis was first described from brackish waters of Raz Hofoun, near Cape Guardafui (NE-Somalia). The f. silhouettensis is known from Silhouette-island of the Seychelles Archipelago. Records from CUMING from Mahé are doubtfull. Paludomus baccula was described by REEVE, but the locality, River Ganges in India, is according to BROT (1880) very doubtfull. But the described shell and the figure of REEVE from baccula is identic with P. ajanensis. The Paludomus baccula from River Ganges, figured by HANLEY & THEOBALD (1876) is quite another species than P. baccula of REEVE: the shell is much larger and also different in shape. Following the opinion of BARNACLE (1962) and our determination, the var. silhouettensis is a form of the East-African Cleopatra ajanensis. The genus Cleopatra is recorded in different species from Africa and Madagascar. The related genus Paludomus occurs in Ceylon, South-India and SE-Asia in three subgenera and several species.

Subfamily: Thiarinae Tribe: Thiareae Genus: *Thiara* BOLTEN (RÖDING), 1798 Subgenus: *Plotia* (BOLTEN) RÖDING, 1798

# 17) Thiara (Plotia) scabra (Müller, 1774)

Lit.: 1774 Buccinum scabrum (MÜLLER, Hist. Verm., 2: 136) – 1779 Buccinum scabrum (SCHRÖTER, Gesch. d. Flußconch.: 299; Pl. 6, Fig. 13) – 1786 Helix scabra (CHEMNITZ, Conch. Cab., 9: 188; Pl. 136, Fig. 1259) – 1789 Helix aspera (GMELIN, Syst. Nat., éd. 13: 3656) – 1792 Bulimus scaber (BRUGIÉRE, Enc. Méth., vers, I: 350) – 1807 Melania scabra (FÉRUSSAC, Essai méth. Conch.: 73 (non REEVE) – 1822 Melania spinulosa (LAMARCK, Hist. nat. anim. s. vert., 6 (2): 166) – 1829 Melania mauriciae

(Lesson, Voy. Coqu., Zool. 2: 358) - 1829 Melania doreyiana (Lesson, ibid.: 358) -1829 Melania spinescens (LESSON, ibid.: 363) - 1838 Melania spinulosa (LAMARCK, Hist. nat. anim. s. vert., éd. 2 (DESHAYES), 8: 433) - 1838 Melania scabra (LAMARCK, ibid.: 443) - 1841 Melania spinulosa (DELESSERT, Rec. Coqu., décr. LAMARCK: Pl. 30; Fig. 15) - 1842 Melanium granum (BUSCH, in PHILIPPI, Abb. & Beschr., 1, Melania, 4: Pl. 1; Fig. 7) - 1844 Melania pugilis (HINDS, Ann. Mag. Nat. Hist., 14: 10 and Sulphur, 1844: 58) - 1847 Melania scabrella (PHILIPPI, Abb. & Beschr., 1, Melania, 4; Pl. 4; Fig. 13) - 1849 Melania spinulosa (MOUSSON, Land- & Süßw. Moll. Java: 76; Pl. 11, Fig. 11, 12) - 1850 Melania acanthica (LEA, Proc. zool. Soc. London, 1850: 194) Melania cochlea (LEA, ibid.: 196) - 1850 Melania denticulata (LEA, ibid.: 194) - 1850 Melania pagoda (LEA, ibid.: 197) – 1855 Plotia spinulosa (ADAMS, Gen. rec. Moll.) – 1858 Melania datura (DOHRN, Proc. zool. Soc. London, 1858: 135) - 1859 Melania elegans (REEVE, Conch. Icon.: Pl. 26; Fig. 178) - 1860 Melania pagoda (REEVE, ibid.: Pl. 26; Fig. 182) -1860 Melania scabra (REEVE, ibid.: Pl. 26; Fig. 183) - 1860 Melania granum (REEVE, ibid.: Pl. 33, Fig. 219) - 1860 Melania rugosa (BROT, Rev. & Mag. Zool., 1860: 257) -1860 Melania myurus (BROT, ibid.: 257; Pl. 27; Fig. 14, 15) - 1868 Melania spinulosa (BROT, Matér. Mel., 2: 38; Pl. 2, Fig. 6; Pl. 3, Fig. 8) - 1872 Melania spinulosa (BROT, ibid., 3: 19; Pl. 1, Fig. 15) - 1874 Melania scabra (BROT, in M. & CH., Conch. Cab., 1 (24): 266; Pl. 27, Fig. 14, 15) - 1874 Melania granum (BROT, ibid.: 270; Pl. 27, Fig. 12) -1874 Melania myurus (BROT, ibid.: 271; Pl. 28, Fig. 1) - 1874 Melania acanthica (BROT, ibid.: 278; Pl. 28, Fig. 10) - 1874 Melania spinulosa (CROSSE, J. de Conch., 22: 240) -1875 Melania scabra (MORELET, ibid., 23: 29) - 1876 Melania scabra (HANLEY & THEO-BALD, Conch. Ind.: XVI and 31; Pl. 73, Fig. 1-4) – 1877 Melania spinulosa (LIÉNARD, Cat. Moll. Ile Maurice: 44) - 1880 Melania snellemanni (SCHEPMAN, Midd. Sumatra Exp.: 15; Pl. 1, Fig. 5; Pl. 3, Fig. 9) - 1880 Melania scabra (MARTENS, Moll., in MÖBIUS: Beitr. Meeresfauna d. Ins. Mauritius: 211) - 1881 Melania bockii (BROT, J. de Conch., 29: 157; Pl. 6, Fig. 3) - 1884 Melania savinieri (MORELET, J. do Conch., 32: 330; Pl. 7, Fig. 2) – 1884 Melania (Plotia) scabra (NEVILL, Handlist Moll. Ind. Mus. Calcutta, 2: 281) - 1890 Melania subcancellata (BOETTGER, Ber. senck. nat. Ges., 1890: 151; Pl. 6, Fig. 4) – 1897 Melania pinguicola (MARTENS, in WEBER, Erg. zool. Reise Niederl. Ostind., 4: 74; Pl. 4, Fig. 17-20) - 1897 Melania scabra with the var. spinulosa, nodosocostata, angulifera and mutica (MARTENS, ibid.: 62; Pl. 4, Fig. 6-12; Pl. 9, Fig. 8, 9) -1897 Melania granum (MARTENS, ibid.: 65) - 1897 Melania savinieri (MARTENS, ibid.: 315) - 1898 Melania scabra (MARTENS, Besch. Weichthiere Deutsch-O.Afr.: 196) -1904 Melania varia (BULLEN, Proc. mal. Soc. London, 6: 110) - 1910 Melania mauriciae (KOBELT, Abh. senck. nat. Ges., 32: 94) - 1910 Melania scabra (KOBELT, ibid.: 94, 96) -1914 Melania intrepida (FULTON, Proc. mai. Soc. London, 11: 163) - 1915 Thiara (Plotia) scabra (PRESTON, Moll. Fauna Brit. Ind.: 35) - 1921 Melania (Plotia) scabra (GERMAIN, Mém. Soc. Zool. France; suppl. 1920: 366) - 1928 Melania sykesi (DEGNER, Treubia, 10: 377) – 1931 Melania (Plotia) scabra (THIELE, Handb. syst. Weichtierkde.: 200) – 1934 Melania zollingeri (RENSCH, Trop. Binnengew., 5: 233 – non zollingeri BROT, 1868) – 1934 Melania scabra (RENSCH, ibid.: 234) – 1937 Thiara (Plotia) scabra (RIECH, Arch. Naturgesch. (N. F.), 6: 42; Fig. 1-5; 49) - 1938 Thiara (Plotia) scabra (WENZ, Handb. Paläozool., Gastr., 1: 713; Fig. 2058) - 1948 Thiara (Plotiopsis) scabra (ABBOTT, Bull. Mus. comp. Zoöl., Havard, 100 (3): 191; Pl. 3, Fig. 12) - 1956 Thiara scabra (BENTHEM-JUTTING, Treubia, 23 (2): 393; Fig. 72, 88) - 1963 Thiara scabra (BENTHEM-JUTTING, Nova Guinea, Zool., 20: 466) – 1963 Thiara scabra acanthica (BENTHEM-JUTTING, ibid.; 467) – 1974 Thiara (Plotia) scabra (STARMÜHLNER, Bull. Fish. Res. Stn.-Sri Lanka, 25 (1/2): 156; Fig. 147-149; Pl. 15, Fig. 146) - 1976 Thiara scabra (STAR-MÜHLNER, Ann. Naturhist. Mus. Wien, 80: 565; Fig. 70, 71; Pl. 15, Fig. 170-172).

Localities: Mas: Ré: No. 4 (42 ind.), No. 8 (257 & many iuv.), No. 9 (1 ind.), No. 11 (1 iuv.), No. 13 (5 ind.), No. 16 (94 ind.), No. 17 (89 ind.),

No. 19 (9 ind.), No. 21 (145 ind.), No. 23 (4 ind.); Mau: No. 1 (3 ind.), No. 3 (4 ind.), No. 5 (72 ind.), No. 6 (72, mostly iuv.), No. 7 (20, mostly iuv.), No. 8 (2 ind.), No. 9 (90 ind.), No. 10 (50 ind.), No. 11 (137 ind.), No. 12 (30 ind.), No. 13 (103 ind.), No. 14 (226 ind.), No. 15 (47 ind.), No. 16 (223 ind.), No. 17 (9 ind.), No. 18 (4 ind.), No. 19 (24 ind.), No. 20 (77 ind.), No. 21 (210 ind.), No. 22 (10 ind.), No. 23 (11 ind.), No. 25 (16 ind.); Ro: No. 1 (15 ind.), No. 3 (9 ind.), No. 4 (9 ind.).

Shell: The extremely variability of the shell of these species is expressed in the large number of synonyms in the literature. Elevated conical, with a high spire and a large, last whorl; surface of the whorls roughly striated in spiral direction, below the periphery, especially in the region of the umbilicus, the spiral striae form stronger ridges; the spiral striation is crossed by ribs in vertical direction; ab about the third of the distance between the suture and the periphery, the axial ribs form - more or less - prominent spines, pointing obliquely outward; these spines are of various strengths in different shells. varying between blunt knobs and sharp prickly needles, especially on young, immature shells; fresh shells are somewhat transparent and shining, the surface is eroded or coated by encrustations; 8-12 whorls, descending step-like, with distinct suture; periphery rounded below the spines; umbilicus closed; apex often eroded; yellowish-brownish to olive-brownish, with irregular reddishbrownish spots and flames, 2-3 spiral bands, but often absent; aperture almost oval, pointed above, rounded below; peristome not continous, but connected by a white callus; basal margin somewhat channeled (Pl. 6; Fig. 34a, b, 35a, b, 36).

	S	hell	Ap	erture	
Localities	$\mathbf{Height}$	Diameter	Height	Diameter	Spines-Length
Mas: Ré: No. 4	17.6	7.9	7.5	4.5	knobs
No. 8	21.4	11	12	7	1.5
No. 9	13.3	6.6	5.5	3	0.5
No. 13 (iuv.)	9	4.5	4.3	4.3	0.5
No. 16 (eroded)	24.3	11.8	12.4	6.5	1 - 2
No. 17 (eroded)	19.5	9	9.3	5.4	1
No. 19 (eroded)	22.6	12.7	13	6.8	knobs
	20.6	10.9	10.6	6.7	knobs
	20.6	9.8	9.7	5.2	knobs
No. 23	16.2	7.8	7.7	4.5	knobs
No. 24 (eroded)	22.5	10.5	10.5	7	<b>2</b>
	21.2	10	10	6.5	2
	21	10.5	10.9	6.9	2
Mau: No. 1 (eroded)	16	8	7.2	4.4	knobs
No. 3 (eroded)	16.6	8.4	8	5	0.5 - 1
No. 5	19	9.5	9.3	6	knobs
No. 6	12.2	6.6	6.5	4	knobs
No. 7 (eroded)	10	5.8	5.2	3	knobs

Sizes (in mm):

F.	Sta	RMÜ	HLN	ER
г.	STA	RWO	HTV	ER

		Shell		Aperture		
Localities		Height	Diameter	Height	Diameter	Spines-Length
	No. 8 (eroded)	10.5	6	5.2	3.7	knobs
	No. 9 (eroded)	11	6.5	5.3	3.5	knobs-1
	No. 10 (eroded)	10.6	6.2	5.5	3	knobs
	No. 11	23.8	11.4	11	8	1
	No. 12	<b>20</b>	10.5	10	5.6	knobs
	No. 13 (eroded)	19.6	9.4	9	5.4	knobs
	No. 14 (eroded)	12.3	7.3	7.4	4.4	knobs
•	No. 15 (eroded)	15	8	7.7	4.5	knobs
	No. 16 (eroded)	14.2	7.7	6.8	4	knobs
	No. 17 (eroded)	9.4	5.5	5.1	2.8	0.3 - 0.4
	No. 18 (eroded)	10	5.8	5	2.9	1
	No. 19	17.5	8.2	7.5	5	1 - 1.5
	No. 20 (eroded)	15.2	8	7.3	3.8	1
	No. 21	21.8	10	9.7	7.6	2 - 3
	No. 22 (eroded)	21.3	10.2	10	6.6	<b>2</b>
	No. 23 (eroded)	22.2	10.5	10	6.8	2
	No. 25	11.3	6.5	6.4	3.6	` knobs
Ro:	No. 1	9.3	5.1	4.3	2.5	knobs
	No. 3	10	5.8	5	3	knobs-1
	No. 4	19.7	9.5	8.6	5.2	knobs
		18.3	9.7	9	5.8	knobs

The measurements are from the largest specimens in the samples.

Operculum: Descriptions and figures are given by STARMÜHLNER (1974; p: 158; Fig. 147) and STARMÜHLNER (1976; p: 567; Fig. 70): horny, oval, blackish-brownish, excentric nucleus.

Anatomical remarks: No differences to the detailed descriptions to be found in RIECH (1937; p. 41-45; Fig. 1-5) and STARMÜHLNER (1974; 1976).

Ecological-biological remarks: Very frequent on the borders of running waters in low current and on sandy-muddy bottom with high content of organic matter; also in stillwaters with rich vegetation; sometimes they occur to the mouth-regions of streams with influence of brackish water (see STARMÜHLNER, 1976: 568). RIECH (1937) and STARMÜHLNER (1977) indicate that the spines are always distinctly developed in population of stillwaterbiotopes, but also in localities with influence of brackish water. In populations from running waters with stronger current, the spines are well developed only in juvenile specimens; on the shells of older individues they are mostly knoblike and eroded till the base.

	Temperatures		Chemistry			
	_	$_{\rm pH}$	conductivity	total hardness		
La Réunion	21.3° C-26.6° C	7.4-8.6	$52 - 250 (1600 \ \mu S)$	$1^{\circ}-5.2^{\circ}$ (10.7° dH)		
Mauritius	19.4° C-25.7° C	7 - 8.2	69—200 µS	1°-4.25° dH		
Range	$19.4^{\circ} C - 26.6^{\circ} C$	7 -8.6	52-250 (1600) μS	1°-5.2° (10.7)° dH		

These data correspond with the statements, given by STARMÜHLNER (1974) for the occurrence of *Thiara scabra* in the streams of Ceylon and by STAR-MÜHLNER (1976) for rivers on Pacific islands. It is remarkable that the species was found in Réunion also in slightly brackish water (cond.: 1600  $\mu$ S, total hardness: 10.7° dH). The species was found mostly in a surface-current of 10-30 cm/sec, but also in stillwater without current. The frequency in the running waters of Réunion near the banks was between 5 and 30, sometimes to 50 (mostly iuvenile) individues/1/16 m<sup>2</sup>. In the pond of N. 24, rich on submerged vegetation and organic debris, the density reaches on the muddy bottom 40-60 individues/1/16 m<sup>2</sup>!

In the slow-running streams of Mauritius, in the middle and lower courses of the coastal plains, surrounded by plantations (fertilizer), and — in consequence — is found a rich growth on submerged waterplants, algae and organic material in the creeks. The density of the snails in these rivers was very high with 30-60, sometimes to more than 100 individues/1/16 m<sup>2</sup> in a surface-current between 0-20 cm/sec. In rivers the species occurs up to a maximum surface-current of 30-50 cm/sec, but in such regions the density goes down to 1 ind./1/16 m<sup>2</sup>.

Thiara scabra was associated with Melanoides tuberculata, Lymnaea (Radix) mauritiana, Physa borbonica, in one locality also with the introduced Planorbella (= Helisoma) duryi and a Ferrissia (Pettancylus) sp. In some localities of Mauritius also with Gyraulus mauritianus and Bellamya bengalensis f. zonata.

Geographical range: On the coasts of the Indopacific from the E-coast of Africa, Madagascar, Mascarenes, Ceylon over SE-Asia, Malay Archipelago, Philippines, Palau, Moluccas and New Guinea to the Bismarck-Archipelago. Solomon-, New Hebrides- and Fiji-Islands, New Caledonia, E-Australia and Samoa.

Genus: *Melanoides* OLIVIER, 1804 Subgenus: *Melanoides* s. str.

18) Melanoides (Melanoides) tuberculata (O. F. MÜLLER, 1774)

Lit.: 1774 Nerita tuberculata (MÜLLER, Hist. Verm., 2: 191) – 1779 Strombus costatus (SCHROETER, Flußconch., 373; Pl. 8, Fig. 14) – 1804 Melanoides fasciolata (OLIVIER, Voy. Emp. Ottom., 6: Pl. 31, Fig. 7) – 1822 Melania truncatula (LAMARCK, Hist. anim. s. vert., 6 (2): 167) – 1827 Paludina (Melania) virgulata (FÉRUSSAC, Bull. univ. Sc. nat., 10: 411) – 1831 Melania terebra (LESSON, Voy. Coqu., 2: 345) – 1834 Melania virgula (QUOY & GAIMARD, Voy. Astrolabe, Zool., 3: 141; Pl. 56, Fig. 1–4) – 1836 Melania pyramis (BENSON, J. asiat. Soc. Bengal, 5: 345) – 1837 Melania adspersa (TROSCHEL, Arch. Naturgesch., 1837: 175) – 1838 Melania punctata (POTIEZ & MICHAUD, Gal. Moll. Mus. DOUET, 1: 262; Pl. 27, Fig. 15, 16) – 1843 Melania truncatula (SGANZIN, Mém. Soc. hist. nat. Strasbourg, 3: 19) – 1847 Melania suturalis (PHILIPPI, ibid.: 173; Pl. 4, Fig. 6) – 1847 Melania rivularis (PHILIPPI, ibid.: 174; Pl. 4, Fig. 17) – 1848 Melania unifasciata (MOUSSON, Mitth. naturf. Ges. Zürich, 1: 269) – 1849 Melania coarctata (MOUSSON, Land- u. Süßw. Moll. Java: 67) – 1849 Melania unifasciata (MOUSSON, ibid.:

70; Pl. 11, Fig. 8) - 1849 Melania inhonesta (Mousson, ibid.: 71) - 1849 Melania cylindracea (MOUSSON, ibid.: 72; Pl. 11, Fig. 6, 7) - 1849. Melania tuberculata (incl. f. virgulata and f. plicifera) (MOUSSON, ibid.: 73; Pl. 11, Fig. 9) - 1850 Melania juncea (LEA, Proc. zool. Soc. London, 1850: 189) - 1850 Melania turriculus (LEA, ibid.: 190) -1850 Melania tigrina (HUTTON, J. asiat. Soc. Bengla, 19: 658) - 1852 Melania fasciolata (RAYMOND, J. de Conch., 3: 325) - 1853 Melania fasciolata (RAYMOND, ibid., 4: 33) -1855 Melania judaica (Mousson, Malak. Bl., 2: 53; Pl. 2, Fig. 1-3) - 1858 Melania layardi (DOHRN, Proc. zool. Soc. London, 1858: 135) - 1859 Melania coarctata (REEVE, Conch. Icon., 12: Pl. 5; Fig. 22; further: Melania exusta: Pl. 12; Fig. 74; Melania tuberculata: Pl. 13; Fig. 87 and Pl. 16; Fig. 110; Melania punctulata: Pl. 15; Fig. 100; Melania crepidinata: Pl. 17; Fig. 120; Melania ornata: Pl. 21; Fig. 146; Melania inhonesta: Pl. 33; Fig. 226; Melania commersoni: Pl. 35; Fig. 237) - 1860 Melania tuberculata (MORELET, Ser. Conch., 2: 111) - 1860 Melania obscura (BROT, Rev. Mag. Zool., 1860: Pl. 17; Fig. 9) - 1860 Melania beryllina (BROT, ibid.: 8; Pl. 17, Fig. 8) - 1861 Melania rothiana (MOUSSON, Coqu. terr. fluv. ROTH, Paléstine: 61) - 1863 Melania tuberculata (DESHAYES, Cat. Moll. Réunion p.E.: 81) - 1864 Melania matheroni (GASSIES, Faune Conch. Nouv. Calédonie, 1: 96; Pl. 4, Fig. 5; further: Melania lancea: 97; Melania mageni: 95; Pl. 6, Fig. 10; Melania canalis: 98; Pl. 6, Fig. 2; Melania montrouzieri: Pl. 5; Fig. 10) - 1864 Melania psorica (MORELET, J. de Conch., 12: 287) – 1865 Melania rubropunctata (TRIST-RAM, Proc. zool. Soc. London, 33: 541) - 1870 Melania javanica (BROT, Amer. J. Conch., 6: No. 200) - 1871 Melania mariei (GASSIES, Faune Conch. Nouv. Calédonie, 2: 159; Pl. 6, Fig. 15) – 1874 Melania tuberculata (JICKELI, Fauna Land- u. Süßw. Moll. NO-Afrika: 251; Pl. 3, Fig. 7 and Pl. 7, Fig. 36) - 1874 Melania tuberculata (BROT, in M. & Сн., Conch. Cab., 1 (24): 247; Pl. 26, Fig. 11; further: Melania ornata: 173; Pl. 21, Fig. 23; Melania distinguenda: 190; Pl. 21, Fig. 8; Melania inhonesta: 206; Pl. 23, Fig. 8; Melania matheroni: 211; Pl. 23, Fig. 8; Melania denisoniensis: 234; Pl. 25, Fig. 6, 6A; Melania crepidinata: 238; Pl. 25, Fig. 13; Melania commersoni: Pl. 244; Pl. 26, Fig. 1, 1a, 6; Melania javanica: 246; Pl. 26, Fig. 7; Melania cylindracea: 252; Pl. 27, Fig. 7; Melania malayana: 253; Pl. 26, Fig. 5; Melania pareyssi: 254; Pl. 27, Fig. 5; Melania unifasciata: 262; Pl. 27, Fig. 7; Melania psorica: 316; Pl. 33, Fig. 4, 4a) - 1876 Melania rodericensis (SMITH, Ann. Mag. Nat. Hist., 17: 404) - 1877 Melania tuberculata (LIENARD, Cat. Moll. Ile Maurice: 44; 82) - 1877 Melania virgulata (LIÉNARD, ibid.: 44) - 1877 Melania singularis (TAPPARONE-CANEFRI, Ann. Mus. Civ. Stor. Nat. Genova, 9: 30; Pl. 1, Fig. 18) -1880 Melania tuberculata (MARTENS, in MÖBIUS: Beitr. Meeresf. d. Ins. Mauritius: 211) -1880 Melania wilkinsoni and M. scalariformis (TENNISON WOODS, Proc. Linn. Soc. N. S. Wales, 4: 25; Pl. 4, Fig. 4) - 1883 Melania pellicens (TAPPARONE-CANEFRI, Ann. Mus. Civ. Stor. Nat. Genova, 19: 30; Pl. 1, Fig. 18; further: Melania dominula: 31; Pl. 1, Fig. 16; Melania petiti: 37 – non Philippi; Melania nicobarica: 38) – 1884 Melania (Striatella) tuberculata (NEVILL, Handlist Moll. Ind. Mus. Calcutta, 2: 239) - 1898 Melania tuberculata (MARTENS, Beschr. Weicht. D. O. Afrika, 193) - 1908 Melania tuberculata (DAUTZENBERG, J. de Conch. 56: 23; Pl. 2, Fig. 4, 5) - 1910 Melania tuberculata (KOBELT, Abh. senck. nat. Ges., 32: 39; 94-96; Pl. 10, Fig. 5, 6) - 1912 Melania tuberculata (CONNOLLY, Ann. S. Afr. Mus., 11 (3): 264) - 1914 Melania (Striatella) tuberculata (DAUTZENBERG & GERMAIN, Rev. zool. afr., 4 (1): 62; Pl. 3, Fig. 3-8; var. anomala: Pl. 4, Fig. 7-10) - 1915 Tiara (Striatella) tuberculata (PRESTON, Fauna Br. India, Moll.: 15) - 1919 Melania woodwardi (MARTIN, Samml. Geol. Reichsmus. Leiden: 96) — 1921 Melania (Melanoides) tuberculata (GERMAIN, Mém. Soc. Zool. France, suppl. 1920: 368) - 1934 Melania tuberculata truncatula (RENSCH, Zool. Jb. (Syst.), 65: 400; Fig. 2a-e) - 1934 Melania tuberculata truncatula (RENSCH, Trop. Binnengew., 5: 228) -1937 Melania tuberculata truncatula (RIECH, Arch. Naturgesch. (N. F.), 6: 55) - 1938 Melanoides (Melanoides) tuberculata (WENZ, Handb. Paläozool., Gastr., 1: 715; Fig. 2065) – 1948 Thiara (Melanoides) tuberculata (ABBOTT, Bull. Mus. comp. Zoöl., Havard, 100 (3): 289; Pl. 3, Fig. 13) - 1950 Melanoides ningpoensis (SUVATTI, Fauna Thailand:

61) — 1956 Melanoides tuberculata (BENTHEM-JUTTING, Treubia. 23 (2): 412; Fig. 69, 73, 91) — 1956 Melania tuberculata tuberculata (FRANC, Mém. Mus. Nat. Hist. Nat. Paris, Sér. A, Zool., 13: 56; Pl. 6, Fig. 7) — 1957 Melanoides tuberculata (STARMÜHLNER & EDLAUER, S. B. Öst. Akad. Wiss. (Math.-Nat. Kl.), 166: 452; Pl. 2, Fig. K; Pl. 3, Fig. 13) — 1962 Thiara tuberculata (BARNACLE, J. Seych. Soc., 2: 56) — 1963 Melanoides tuberculatus (BENTHEM-JUTTING, Nova Guinea, Zool. 20: 473) — 1969 Melanoides (Melanoides) tuberculatus (STARMÜHLNER, Malacologia, 8 (1/2): 224; Fig. 269—320) — 1970 Melanoides tuberculatus (STARMÜHLNER, Cah. ORSTOM, sér. Hydrobiol., 4 (3/4): 89; Fig. 129—132) — 1974 Melanoides tuberculata (BRANDT, Arch. Moll., 105 (1/4): 164; Pl. 12, Fig. 9—12) — 1974 Melanoides (Melanoides) tuberculata (STARMÜHLNER, Bull. Fish. Res. Stn. Sri Lanka, 25 (1/2): 159; Pl. 15, Fig. 150—153) — 1976 Melanoides (Melanoides) tuberculatus (STARMÜHLNER, Ann. Naturhist. Mus. Wien, 80: 591; Pl. 17, Fig. 206).

Localities: Sey: M: No. 5 (25 ind.), No. 8 (153 ind.); Co: A: No. 3 (1 ind.), No. 5 (8 ind.); Mas: Ré: No. 8 (1 ind.), No. 17 (3 ind.), No. 24 (3 ind.); Mau: No. 1 (7 ind.), No. 2 (3 ind.), No. 3 (31 ind.), No. 4 (97 ind.), No. 5 (19 ind.), No. 6 (27 ind.), No. 7 (17 ind.), No. 8 (35 ind.), No. 9 (2 ind.), No. 10 (1 ind.), No. 11 (12 ind.), No. 12 (47 ind.), No. 13 (9 ind.), No. 14 (35 ind.), No. 15 (29 ind.), No. 16 (9 ind.), No. 17 (105 ind.), No. 18 (28 ind.), No. 19 (9 ind.), No. 20 (5 ind.), No. 23 (3 ind.), No. 25 (40 ind.); Ro: No. 1 (24 ind.), No. 3 (9 ind.).

Shell: Descriptions of the extremely variable shell of these species are given by BROT (1874); GERMAIN (1921); RENSCH (1934); BENTHEM-JUTTING (1956); FRANC (1956); STARMÜHLNER (1957, 1970, 1974, 1976); BRANDT (1974) and many other authors: turreted with high spire and moderately large last whorl; 10—15 whorls, but the first often eroded; sometimes below the suture somewhat "shouldered"; whirls with spiral striae, well raised in the upper whorls, but mostly flattened on the later ones, crossed by vertical striae which can even be developed as coarse, sometimes undulating ribs; straw-yellow to olive with darker red-brown dots and flames, either irregularly distributed or arranged in vertical rows; umbilicus closed, sometimes bordered with a spiral band; aperture vertical-oval, pointed above, rounded below; peristome connected by a thin callus against the penultimate whorl (Pl. 6; Fig. 37, 38).

		Shell		Aperture	
Localities		$\mathbf{Height}$	Diameter	Height	Diameter
Sey: M:	No. 5 (eroded)	15.5	6.2	5.5	3.6
	No. 8 (pigmy-	8.3	4	2.5	1.5
	population in	7.8	2.4	2	<b>. 1</b>
	brackish water)				
Co: A:	No. 3 (eroded)	9.7	4.2	3.8	2.2
	No. 5	12.5	4.7	4	2.5
Mas: Ré:	No. 8 (iuv.)	<b>9</b> )	4.2	3.8	1.8
	No. 17 (iuv.)	6.5	2.8	1.3	0.9
	No. 24 (eroded)	17.4	7	6.8	4

Sizes (in mm):

		s	hell	Aperture	
Localit	ies	Height	Diameter	Height	Diameter
Mau:	No. 1 (eroded)	23.8	10.3	10.3	5.8
	No. 2	19.6	7.8	7.5	4.1
	No. 3 (eroded)	20.8	8	7.5	4.7
		22	7.8	7.5	4.4
		20.8	8.1	7.8	4.8
	No. 4 (eroded)	23	8.5	7.4	4.7
	No. 5 (eroded)	18.7	8	7.8	4.2
		18.4	7.4	7.1	4
	No. 6 (eroded)	12.7	7.2	6.8	4
		17.3	6.5	6.1	3.7
		16.2	5.2	4.5	3
-	No. 7 (eroded)	25.8	8.4	7.8	4.7
	No. 8 (eroded)	22	8.6	8	5
	No. 9	18.3	6.2	5.9	3.5
	No. 10 (iuv.)	10.5	4	3.2	2.2
	No. 11 (eroded)	19.3	7.3	7	4.5
		18.4	6.4	5.5	3.4
	No. 12	27.7	9	9	5
	No. 13 (eroded)	18.5	6.2	6	3.6
	No. 14 (eroded)	11.4	6.5	6	5
		14.7	6.1	5.4	3.8
		14.8	6.4	5.5	3.5
	No. 15 (eroded)	18.3	6.2	5.9	3.5
	No. 16 (eroded)	18.5	6.2	6	3.6
	No. 17 (eroded)	14.5	6.2	5.5	3.5
	No. 18 (eroded)	21.3	8.2	8	4.2
	No. 19 (eroded)	19.1	5.8	5.6	3.3
		13.7	6.3	6	3.8
	No. 20	22.8	8.2	8	4.5
	No. 23 (eroded)	22	8.4	7.8	5.9
	No. 25 (eroded)	17	7.3	7	4
Ro:	No. 1	10.2	3.7	3.1	1.9
	No. 3 (eroded)	12.5	4.8	4.4	2.2
		12.5	4.6	4.2	2

The measurements are from the largest specimens in the samples.

Operculum: Typically for the genus: horny, blackish-brown, nucleus excentric.

Anatomical remarks: Details of the anatomy of these, as all Thiaridae, viviparous and mostly parthenogenetic species, are given by RAMAMOORTHI (1949); STARMÜHLNER & EDLAUER (1957) and STARMÜHLNER (1969, 1970 and 1976). It is to note, that the specimens of the pigmy population from station Sey: M: No. 8 in brackish water with a maximal shell height of only 7-8.3 mm were full grown and mature with embryos in the brood-pouch!

Ecological-biological remarks: The ubiquitous species occur in nearly all freshwater biotopes from upper courses to the mouths in the border-
region of running waters and in stillwaters if the temperature is higher than  $18^{\circ}$  C and the current (in running waters) not more than 30-50 cm/sec. They prefer soft bottom, such as sand and mud with high content of organic matter. The snails feed on the growth, such as diatoms and other algae on bottom, but also on rotted vegetable and animal material.

The frequency on Mahé was extremely high only in the brackish water zone of the mouth-region: with a temperature up to  $32^{\circ}$  C the relatively density of a population of pigmy specimens was more than 1600 ind./1/16 m<sup>2</sup> sandymuddy bottom, associated with *Paludinella hidalgoi* f. granum and *Melampus* cf. caffra. In the running waters of the island interior the species occurs only at one station with a pH: 7.2, conductivity: 116  $\mu$ S and total hardness: 1.39° dH (temperature: 26.3° C). These station has had the highest value for conductivity and total hardness of all investigated stations in running waters of Mahé. After our observations these is depending on polluted water, coming from a village and plantations nearby. In all other rivers with much lower values *Melanoides tuberculata* does not occur!

On the islands of Anjouan (Comores) and La Réunion (Mascarene) with steep slopes and typically rocky torrents, with strong currents and waterfalls, *Melanoides tuberculata* occurs only rarely on the borders or in pools and creeks between cascade zones, localities with low current, and soft bottom.

	Temperatures	· · · · · · · · · · · · · · · · · · ·	Chemistry	y
	_	pH	conductivity	total hardness
Anjouan	22.5° C-26.3° C	8 -8.4	$142 - 180 \ \mu S$	$3.1^{\circ} - 3.5^{\circ} dH$
La Réunion	$23.2^{\circ} \mathrm{C} - 27.5^{\circ} \mathrm{C}$	7.4 - 8.6	$92-240 \ \mu S$	$1.65^{\circ}-5^{\circ} \mathrm{dH}$
Range	22.5° C—27.5° C	7.4-8.6	$92-240 \ \mu S$	$1.65^{\circ}-5^{\circ}$ dH

The highest frequency and density for this species occur in the middle to lower courses of Mauritius. In these localities the medium current lies between 10 and 30 cm/sec, rarely up to 50 cm/sec; they have a rich vegetation of algae and submerged water plants; the bottom (sand, mud) is covered with thick organic layers. This high primary production is caused by the influence of fertilizers from surrounding sugar-cane and other plantations. In the region of the borders with a current between 0-20 cm/sec the density was between 30 to 90, sometimes up to 120 ind./1/16 m<sup>2</sup>. The density goes down when the current is stronger than 30 cm/sec to only 1-2 ind./1/16 m<sup>2</sup> with a current of 50 cm/sec.

Temperatures		· · · · · · · · · · · · · · · · · · ·	Chemistry	· · · · · · · · · · · · · · · · · · ·
		pH	conductivity	total hardness
Mauritius	19.4° C—26.3° C	6.6-8.2	$66 - 200 \ \mu S$	1°-4.25° dH

In the upper courses with relatively low temperature  $(19.4^{\circ} \text{ C}-19.9^{\circ} \text{ C})$  low chemical values (pH: 6.6-7.6; conductivity: 66-97  $\mu$ S; total hardness: 1° dH), stronger currents, rocky bottom and low primary production, the frequency and density are only 1-2 ind./1/16 m<sup>2</sup>. In the headwaters with slightly acidic waters and a total hardness below 0.5° dH, this species and all other gastropods are absent!

Melanoides tuberculata was associated at Mahé with Gyraulus cf. mauritianus, at Anjouan with Lymnaea (Radix) natalensis and Ceratophallus sp. At Réunion and Mauritius the species was found together with Thiara scabra, Lymnaea (Radix) mauritiana, and Physa borbonica (at one locality also with the introduced Planorbella (= Helisoma) duryi).

Geographical range: From S-Europe, Lower Asia, and N-Africa to Middle, SE-, and S-Africa; Madagascar and E-African Islands; SE and S-Asia, the Malay Archipelago, Philippines, Moluccas, New Guinea, Bismarck-Archipelago, Solomons, New Hebrides, New Caledonia, E-Australia, Fiji, Samoa, Tahiti and W-Carolines. On some islands it was probably brought in passively by man through paddy-culture and water plants.

Family: Potamididae Subfamily: Potamidinae Genus: Terebralia Swainson, 1840 Subgenus: Terebralia s. str.

# 19) Terebralia (Terebralia) palustris (LINNÉ, 1767)

Lit.: 1767 Strombus palustris (LINNÉ, Syst. Nat., ed. 12: 1213) - 1874 Pyrazus palustris (TAPPARONE-CANEFRI, Mem. Reale Acc. Sci. Torino (2) 28: 41) - 1897 Potamides palustris (MARTENS, in WEBER, Erg. Reise O-Indien, 4: 176; Pl. 9, Fig. 24, 25) - 1899 Potamides palustris (MARTENS, in WEBER, Erg. Reise O-Indien, 4: 176; Pl. 9, Fig. 24, 25) - 1899 Potamides palustris (MARTIN, Samml. Geol. Reichsmus. Leiden (N. S.), 1: 210; Pl. 32, Fig. 478) - 1902 Potamides palustris (MARTENS, RUMPHIUS, Gedenkb.: 120) - 1914 Potamides palustris (KONINGSBERGER, Java zool. biol. Part 10: 446) - 1914 Potamides palustris (LESCHKE, Mitt. naturh. Mus. Hamburg, 31: 259) - 1919 Potamides palustris (MARTIN, Samml. Geol. Reichsmus. Leiden, 93: 130; 132) - 1925 Potamides palustris (OOSTINGH, Meded. Lanb. Hoogesch., 29 (1): 46) - 1929 Potamides palustris (BENTHEM-JUTTING, Treubia, 11: 86) - 1931 Potamides palustris (OOSTINGH, Arch. Moll., 63: 194) - 1956 Terebralia palustris (BENTHEM-JUTTING, Treubia, 23 (2): 444; Fig. 111) - 1974 Terebralia palustris (BRANDT, Arch. Moll., 105 (1/4): 194; Pl. 14, Fig. 57, 58).

Locality: Sey: M: No. 8 (93 ind.).

Shell: Descriptions by BENTHEM-JUTTING (1956), and BRANDT (1974): high-turreted, thick; brownish-black, with indistinct lighter spiral bands or vertical flames; sculpture with strong, obtuse and irregularly placed axial ribs, which are crossed by four, 2-4 mm broad spiral sulci; they divide the axial ribs into several spiral rows of distinct tubercles, cery closely on the base of the last whorl; old periods of arrested growth are marked by a thick varix; 13-20 whorls with flat sides, apex often eroded, umbilicus closed; aperture oval, brownish and glossy within, with short siphonal canal at the base, columella with two spiral folds (Pl. 7, Fig. 39). Sizes (in mm):

	S	shell	Aperture		
Locality	Height	Diameter	Height	Diameter	
Sey: M: No. 8	117	34	34	34	
			(+sipho: 10)		

The measurements are from one of the larger specimens in the samples.

Operculum: Size (from a specimen with a shell-height of 117 mm): 50 to 60 mm in diameter); corneous, horny-brownish; nucleus central, multispiral, outside borders thin and translucent (Pl. 7, Fig. 40a, b, c).



Fig. 35. Terebralia palustris: Head and mantle-border

Anatomical remarks: The mantle edge fringed by 15-16 fingershaped processes; the head is prolonged to a short snout, tentacles long extended; the eyes lie on the base (Fig. 35). In the mantle cavity from left to right: the osphradium is a long ridge along the gill, which consists of many triangular blades; a thick layer indicate the hypobranchial gland which is bordered on the right side by the wide rectum, filled with many cigar-shaped faeces; on the transition from the right mantle-roof to the mantle-floor the female open genital-groove is extended, bordered by two folds (Fig. 36). This groove corresponds with the open "pallial-oviduct", described for Cerithium by JOHANSSON (1953), for Potadoma by BINDER (1959) and Melanatria by STARMÜHLNER (1969). Radula: central-tooth with the formula: 3/4+1+3, the median tooth very broad and trapezoid; the lateral with 1+1+2 denticles, the median cusp prominent; inner marginal with 1+1+2 and outer marginal with 3+1 cusps, both with "flanges" on the outsides (Fig. 37). Central nervous system: cerebral-ganglia ovoid in shape and connected by a short and thick commissure: from the dorsal side arise the N. opticus and N. tentacularis and



Fig. 36. Terebralia palustris: Mantle cavity opened to show (from right to left): Osphradium, gill, rectum filled with faeces and female genital-groove



Fig. 37. Terebralia palustris: Radula-teeth Fig. 38. Terebralia palustris: a) Central nervous-system, b) Pedalganglia

near the anterior side four labial nerves and the cerebrobuccal-connective; the pleural-ganglia are connected to the outside of the cerebral-ganglia and arise the pallial nerves and the pleuro-supra, especially the pleuro-subintestinal-connectives which cross each another. A N. zygomaticus is developed and arises from the left pallial-ganglion; the pedal-ganglia, connected with short connectives to the cerebral- and pleural-ganglia are globiform and give rise to three prominent pedal-nerves (Fig. 38a, b). The central nervous-system of *Terebralia* is very similar to the conditions found in *Melanatria* (STARMÜHLNER, 1969).

Ecological-biological remarks: Terebralia palustris was found in brackish pools (temperature: more than  $30^{\circ}$  C; conductivity: more than  $16.000 \mu$ Siemens) near the mouth of the River Anse de la Mouche, some hundred meters inside the W-coast of Mahé. The snails were crawling on the sandy-muddy bottom and feeding on the thick layer of diatoms and bluealgae, covering the ground.

Geographical range: Brackish coastal area of the Indopacific: E-Africa to N-Australia, Philippines and Thailand.

Subclass: EUTHYNEURA Order: Basommatophora Superfamily: Ellobiacea (= Actophila) Family: Ellobiidae Subfamily: Melampodinae Genus: Melampus MONFORT, 1810 Subgenus: Melampus s. str.

# 20) Melampus (Melampus) lividus (DESHAYES, 1830)

Lit.: 1830 Auricula livida (DESHAYES, Enc. méth., Vers, 2: 91) - 1837 Melampus lividus (BECK, Ind. Moll.: 106) - 1838 Auricula livida (LAMARCK, Hist. nat. anim. s. vert., 2º éd., 8: 338) - 1844 Auricula livida (KÜSTER, in M. & CH., Conch. Cab. (2): 44; Pl. 6, Fig. 21-25) - 1848 Auricula livida (KRAUSS, Südafr. Moll.: 81) - 1854 Melampus lividus (ADAMS, Proc. zool. Soc. London, 1854: 10) - 1856 Melampus lividus (PFEIFFER, Mon. Auric. viv.: 40) - 1857 Melampus lividus (PFEIFFER, Cat. Auric. Brit. Mus.: 29) -1860 Melampus lividus (Morelet, Sér. Conch., 2: 94) - 1863 Melampus lividus (Des-HAYES, Cat. Moll. Réunion, p.E.: 83) - 1877 Melampus lividus (LIÉNARD, Cat. Moll. Ile Maurice: 58) - 1878 Auricula livida (Sowerby, in REEVE, Conch. Icon.; Pl. 7; Fig. 58) - 1878 Melampus lividus (NEVILL, Handl. Moll. Ind. Mus. Calcutta: 217) -1880 Melampus lividus (MARTENS, Moll., in MÖBIUS: Beitr. Meeresfauna Ins. Mauritius: 208) - 1882 Melampus lividus (Morelet, J. de Conch., 30: 101) - 1898 Melampus lividus (MARTENS, Besch. Weichth. Deutsch O-Afr.: 264) - 1910 Melampus lividus (KOBELT, Abh. senck. nat. Ges., 32: 94-96) - 1912 Melampus lividus (CONNOLLY, Ann. S-Afr. Mus. 11 (3): 227) - 1921 Melampus lividus (GERMAIN, Mém. Soc. zool. France;/suppl. 1920: 240) - 1962 Melampus lividus (BARNACLE, J. Seych. Soc., 2: 56).

Locality: Co: G.Co: No. 1 (1 ind.).

Shell: Spire with eight whorls; the first whirls "Chinese hat-shaped"; dark yellowish, near the suture brownish, on the base of the spire with a typically red-brownish spot, like indicated for these species by KUSTER (1844:

45); on the right side of the aperture with seven to eight transversal folds, three parietal teeth and one fold on the spire.

Sizes (in mm):

	S	hell	Aperture	
Locality	Height	Diameter	Height	Diameter
Co: Gr.Co: No. 1	14.1	8.6	11	1.7

The measurements are from the single, not full grown specimen.

Anatomical remarks: The single specimen collected was not dissected.

Ecological-biological remarks: Like all species of *Melampus* a typical form of the brackish coastal area. Our specimen was found on the coastal wall of the "Hotel Coelacanth" in Moroni (Grand Comore).

Geographical range: Coasts of SE-Africa, Comores, Seychelles, Mascarene, Madagascar and recorded also from the Nicobars.

Subgenus: Micromelampus Möllendorf, 1898

## 21) Melampus (Micromelampus) cf. caffer (KÜSTER, 1844) iuv.

Lit.: 1844 Auricula caffra (KÜSTER, in M. & CH., Conch. Cab. (2): 36; Pl. 5, Fig. 7) – 1844 Auricula caffra (KRAUSS, S-Afr. Moll.: 82) – 1854 Melampus ater (ADAMS, Proc. zool. Soc. London, 1854: 10) – 1856 Melampus caffer (PFEIFFER, Mon. Auric. viv.: 40) – 1857 Melampus caffer (PFEIFFER, Cat. Auric. Brit. Mus. :29) – 1858 Melampus ater (ADAMS, Gen. rec. Moll., 2: 243) – 1860 Melampus caffer (MORELET, Sér. Conch., 2: 94) – 1869 Melampus caffer (NEVIL, Proc. zool. Soc. London, 1869: 66) – 1871 Melampus caffer (MARTENS & LANGKAVEL, Südseeconch.: 56; Pl. 3, Fig. 11) – 1877 Melampus caffer (LIÉNARD, Cat. Moll. Ile Maurice: 81) – 1878 Auricula caffra (SOWERBY, in REEVE. Conch, Icon.: Pl. 7; Fig. 53) – 1878 Melampus caffer (NEVILL, Handl. Moll. Ind. Mus, Calcutta, 2: 216) – 1880 Melampus caffer (MARTENS, Moll., in MÖBIUS: Beitr. Meeresfauna Ins. Mauritius: 208) – 1883 Melampus caffer (TAPPARONE-CANEFRI, Ann. Mus. Civ. Storia Nat. Genova, 19: 229) – 1884 Melampus caffer (GARRETT, J. Ac. nat. Sc. Philadelphia, 9: 89) – 1890 Melampus caffer (MÖLLENDORF, Ber. senck. naturf. Ges., 1890: 254) – 1912 Melampus caffer (CONNOLLY, Ann. S.-Afr. Mus., 11 (3): 226) – 1921 Melampus caffer (GERMAIN, Mém. Soc. zool. France; suppl. 1920: 247).

Locality: Sey: M: No. 8 (10 ind.).

Shell: Only immature, not full grown shells were found: the spire mamillary, embryonic whorls smooth; below the suture, spiral lines, crossed by the growth lines, making square-like folds (older shells only with delicate growthlines); six to seven whorls of chestnut-brownish colour; very young shells, below the suture, with one yellow spiral band, the middle part with two spiral bands without distinct borders; in the lower third a fourth spiral band; with older, but still not full grown shells, the spiral bands are very difficult to distinguish; aperture narrow, parietal-area on the upperside bordered by one parietal-fold, below three smaller folds and one blunt tooth; outside area of the inner aperture with three upper and two under withish folds, connected by a small callus. Sizes (in mm):

		Shell	Aperture	
Locality	Height	Diameter	Height	Diameter
Sey: M: No. 8	4.5	3	3.3	0.6

The measurements are from the largest of the immature shells.

Anatomical remarks: No dissection was made.

Ecological-biological remarks: *Melampus* cf. *caffra* iuv. was collected, together with *Paludinella hidalgoi* f. *granum* on dead corals in the mouth region of the River Anse de la Mouche. This locality is covered with brackish water during high tide and with freshwater during low tide; temperature: 32° C; surfacecurrent: 30-50 cm/sec.

Geographical range: Indopacific coasts: SE-Africa, Madagascar, Comores, Seychelles, Mascarene, Ceylon, Andaman and Nicobar-Islands, New Guinea, New Caledonia, Loyalty-Islands, Tahiti.

Superfamily: Lymnaeacea Family: Physidae Genus: Physa DRAPARNAUD Subgenus: Physa s. str.

## 22) Physa borbonica FÉRUSSAC, 1827

Lit.: 1827 Physa borbonica (FERUSSAC, Bull. univ. Sc. nat., 10: 408-1838) Physa nana (POTIEZ & MICHAUD, Gal. Moll. DOUAI, 1: 225; Pl. 22, Fig. 15, 16) – 1843 Physa borbonica (SGANZIN, Mém. Hist. nat. Strasbourg, 3: 18) – 1860 Physa borbonica (MORELET, Sér. Conch., 2: 97; Pl. 6, Fig. 5) – 1869 Physa seychellana (MARTENS, Moll., in DECKEN: Reisen in O-Afr., 3: 60; Pl. 6, Fig. 5) – 1878 Physa borbonica (NEVILL, Handl. Moll. Ind. Mus. Calcutta: 230) – 1880 Physa borbonica (MARTENS, Moll., in MÖBIUS: Beitr. Meeresfauna Ins. Mauritius: 209; var. nana: 209; Pl. 19, Fig. 11, 12) – 1886 Physa seychellana (CLESSIN, in M. & CH., Conch. Cab. (2): 343; Pl. 48, Fig. 8) – 1910 Physa borbonica (KOBELT, Abh. senck. nat. Ges., 32: 94, 95) – 1921 Bullinus (Isidora) borbonicensis (GERMAIN, Mém. Soc. zool. France; suppl. 1920: 233; var. nana: 234).

Localities: Mas: Ré: No. 1 (81 ind.), No. 2 (70 ind.), No. 3 (90 iuv.), No. 4 (8 ind.), No. 5 (16 ind.), No. 6 (22 ind.), No. 7 (7 ind.), No. 8 (2 ind.), No. 9 (23 ind.), No. 10 (24 ind.), No. 11 (1 ind.), No. 12 (26 ind.), No. 13 (11 ind.), No. 14 (24 ind.), No. 15 (13 ind.), No. 17 (20 ind.), No. 18 (1 iuv.), No. 21 (3 ind.), No. 22 (14 ind.); Mau: No. 1 (6 ind.), No. 2 (5 ind.), No. 3 (2 ind.), No. 4 (many ind.), No. 5 (many ind.), No. 6 (80 ind.), No. 7 (17 ind.), No. 8 (many ind.), No. 9 (many ind.), No. 10 (many ind.), No. 11 (many ind.), No. 12 (2 ind.), No. 14 (1 ind.), No. 15 (2 ind.), No. 16 (10 ind.), No. 17 (12 ind.), No. 20 (1 ind.).

Shell: As lefthanded shell described as *Physa* it was placed by GERMAIN (1921) without study on the anatomy to the lefthanded African genus Bul(l) inus (*Isidora*) from the family of Planorbidae. But our study of the anatomy shows that these species really is a representative of the lymnaeid genus *Physa*, as it was described (after the shell) by FÉRUSSAC (1827). The variation of the shell

in size and shape is — like in many freshwater-gastropods — very marked. A small form of the species is f. nana POTIEZ & MICHAUD, 1838.

The shell is normally thin, fragile and transparent; spire elevated with about 4-5 whorls, the first sometimes eroded, the body-whorl big and bulging; white to brownish-yellowish, shining, sometimes with a milky, whitish band on the suture; very fine, dense growth-striae, crossed by also very delicate spiral grooves (enlargement:  $50 \times !$ ). Aperture oval, peristome turned over an enclose a fine slit of the umbilicus, on the inner side of the margin with a white, callus-lip (Pl. 7, Fig. 41).

Sizes (in mm):

			Shell	Ар	erture
Localities		Height	Diameter	Height	Diameter
Mas: Ré:	No. 1	11.4	6.3	7.5	3.6
	No. 2 (f. nana)	7.5	5	5.8	3
	No. 3 (f. nana)	7	4	4.5	2.2
	No. 4 (f. nana)	6.8	3.7	4	1.8
	No. 5 (f. nana)	6.8	3.7	4	1.8
	No. 6 (f. nana)	7.7	4.1	4.9	2.3
	No. 7 (f. nana)	7.9	4.7	5.2	3.1
	No. 8 (f. nana)	5.6	3	3.2	1.6
	No. 9 (f. nana)	6.5	3.9	4	2.4
	No. 10 (f. nana)	6.4	3.7	4.1	2.2
	No. 11	9	5	6	2.5
	No. 12 (f. nana)	5.5	2.8	3	1.6
	No. 13 (f. nana)	7.7	4.3	5.2	2.6
	No. 14 (f. nana)	7.2	3.8	4.6	2.2
	No. 15 (f. nana)	7.6	4	4.3	2.4
	No. 17 (f. nana)	7.4	4	4.9	2.5
	No. 18 (iuv.)	3	no measureme	nts!	
	No. 21	10.2	6	7.2	· 4
	No. 22 (f. nana)	7.5	4.3	5	2.9
Mas: Mau:	No. 1 (f. nana)	5.3	3.1	3.6	1.7
	No. 2 (f. nana)	5.2	3	3.5	1.8
	No. 3 (f. nana)	5	3	3.4	1.5
	No. 6 (f. nana)	7.8	4.5	5.2	2.7
	No. 7 (f. nana)	5.4	3.4	4.1	<b>2</b>
	No. 12 (f. nana)	6.5	4	4.4	<b>2</b>
	No. 14 (f. nana)	4.5	2.8	3.4	1.6
	No. 15	10.8	6.3	8.2	4.1
	No. 16 (f. nana)	5.2	3	3.5	1.8
	No. 17	9.3	5.3	6.8	3
	No. 20 (f. nana)	5	2.9	3.3	1.5

The measurements are from the largest specimens of the samples.

Anatomical remarks: The study of the soft-bodies from the specimens of our samples shows, that all specimens from La Réunion and Mauritius with a left-handed "*Physa*-like" shell are really typically for the genus *Physa* and not for the African genus *Bulinus*. These genus has also a left-handed turreted shell, but is anatomically a genus of the family Planorbidae.

The mantle on the outside has an irregularly pattern of white-yellowish spots on a dark blue ground-pigmentation; the mantle edge is lighter and posseses-typically for the genus Physa- four finger-shaped processes on the right and three similar processes on the left corner (Fig. 39). In life these "mantle-tentacles" lie over the outside of the shell. In the left corner of the



Fig. 39. Physa borbonica: Soft-body with pigmentation Fig. 40. Physa borbonica: Pneumostom and finger-shaped processes Fig. 41. Physa borbonica: Jaw

Fig. 42. Physa borbonica: Radula-teeth

Fig. 43. Physa borbonica: Receptaculum seminis and vagina

Fig. 44. Physa borbonica: Prostata-gland

Fig. 45. *Physa borbonica*: a) Lower part of vas deferens, coiled penis and praeputium with praeputial-gland; b) coiled penis

mantle, beside the three processes open the anus and, as thickened fold, the pneumostom (Fig. 40). The jaw is very small, acute triangular, with 5-6 longitudinal ribs (Fig. 41). Radula: broad and typical for the genus *Physa*: central-tooth three times more broad than high, and with eight acute cusps, on the outside with circle-shaped "flanges"; the laterals with six to seven prominent denticles and also with circle-shaped to oval "flanges"; the marginals sickle-shaped with a short handle-shaped "flange" and seven to eight well developed cusps (Fig. 42). The salivary glands are connected as a half-circle below the rise of the oesophagus from the pharyngeal bulb. The central nervous

system consists of long-ovoid cerebral-ganglia united by a distinct, small commissure; the pleural-, parietal-ganglia and the abdominal (or visceral-) ganglion are connected, in the form of a half-circle; nearby are the cerebral-ganglia and the pleural-ganglia with short connectives to the globoid pedal-ganglias.

Genital-organs: on the femal part open the ovoid receptaculum with a distinct slender duct in the pigmented, lower part of the vagina (Fig. 43); the male duct posseses the vas deferens, a prostata gland, consisting of densely packed, short and thick tubule, which are branched on the blind end (Fig. 44); the penis lies rolled up in some loops before the transition in the thick praeputium, which has — typical for the genus Physa — a globiform praeputial-gland on the left side (Fig. 45a, b).

Ecological-biological remarks: Both in rivers of La Réunion and Mauritius, the small f. *nana* of *Physa borbonica* dominated in the samples. The species occurs from the upper (from 1200 m in Réunion) to the lower courses of the running waters on the borders or in pools and creeks between cascadezones, if the current dees not exceed more than 30 cm—50 cm/sec. The density in the rivers was:

	0-30  cm/sec	30-50 cm/sec
La Réunion	: $30-60$ ind./1/16 m <sup>2</sup>	15-30 ind./1/16 m <sup>2</sup>
	(sometimes: 90—	to
	120 ind./1/16 m <sup>2</sup> )	sporadic
Mauritius:	60—120 ind./1/16 m <sup>2</sup>	15—30 ind./1/16 m <sup>2</sup>
	(sometimes: up to	to
	180 ind./1/16 m <sup>2</sup> !)	$\operatorname{sporadic}$

They prefer, like the associated species Lymnaea (Radix) mauritiana, Gyraulus mauritianus, Planorbella (Helisoma) duryi, Melanoides tuberculata and Thiara scabra, sandy-muddy bottom, dense vegetation of algae and submerged water-plants and rotted organic material.

Temperatures		Chemistry	γ
	pH	conductivity	total hardness
15.2° C—24° C	6.95 - 8.8	$24-258~\mu\mathrm{S}$	0.45°-5.75° dH
19.4° C-24.5° C	6.6 - 8.2	$66 - 220 \mu S$	1° -4.25° dH
15.2° C-24.5° C	6.6 - 8.8	$24-258$ $\mu S$	$0.45^\circ$ – $5.75^\circ$ dH
	Temperatures : 15.2° C-24° C 19.4° C-24.5° C 15.2° C-24.5° C	Temperatures         pH           15.2° C-24° C         6.95-8.8           19.4° C-24.5° C         6.6 -8.2           15.2° C-24.5° C         6.6 -8.8	$\begin{array}{c} {\rm Temperatures} & {\rm Chemistry} \\ {\rm pH} & {\rm conductivity} \\ {\rm s} 15.2^{\circ}{\rm C}{\rm -24^{\circ}}{\rm C} & 6.95{\rm -8.8} & 24{\rm -258}\mu{\rm S} \\ {\rm 19.4^{\circ}}{\rm C}{\rm -24.5^{\circ}}{\rm C} & 6.6 & {\rm -8.2} & 66{\rm -220}\mu{\rm S} \\ {\rm 15.2^{\circ}}{\rm C}{\rm -24.5^{\circ}}{\rm C} & 6.6 & {\rm -8.8} & 24{\rm -258}\mu{\rm S} \end{array}$

These found values shows that *Physa borbonica* occurs in a very widespread range of ecological conditions. On the average the density of *Physa borbonica* (only in the upper courses of Mauritius in a temperature below  $20^{\circ}$  C with

5 to 10 ind./1/16 m<sup>2</sup>) in the running waters of Mauritius (specially in the middle courses and the transitions to the lower courses with an immense production on algae and submerged water-plants in the slow-flowing parts) are higher than in the faster flowing streams of the steep sloped island La Réunion. In the lower parts of the lower courses and in the mouth-region, — typical habitat of the different species of Neritidae, — *Physa borbonica* is, like *Lymnaea* (*Radix*) mauritiana, gradually disappearing. In one locality — Mas: Ré: No. 5 — *Physa borbonica* (and *Lymnaea* (*Radix*) mauritiana) were found on irrigated rocks in a hygropetric habitat. At many localities the species was observed in copulation and on stones and submerged water-plants spawns were deposited (April-May, 1974).

Geographical range: Mascarene Archipelago: La Réunion, Mauritius. Reported also from the Seychelles by MARTENS (1869), but not found by our mission on the islands of these Archipelago.

Family: Lymnaeidae Subfamily: Lymnaeinae Genus: Lymnaea LAMARCK, 1799 Subgenus: Radix MONTFORT, 1810

# 23) Lymnaea (Radix) natalensis KRAUSS, 1848

Lit.: 1848 Limnaeus natalensis (KRAUSS, Südafr. Moll.: 85) – 1866 Limnaeus natalensis var. exsertus (MARTENS, Malak. Bl., 1866: 191; Pl. 3, Fig. 8, 9) – 1868 Limnaea orophila (MORELET, VOY. WELWITSCH, Angola Benguela: 87; Limnaea sordulenta: 87) – 1872 Limnaea natalensis (REEVE, Conch. Icon.: Pl. 7; Fig. 46) – 1883 Limnaea (Stagnaliana) caillaudi (BOURGIGNAT, Ann. Sci. nat. zool. Paris, 15: 89; L. (Raffrayana) raffrayi: 93) – 1883 Limnaea africana (BOURGIGNAT, Hist. Malac. Abysinie: 95) – 1886 Limnaeus natalensis var. exsertus (MARTENS, in M. & CH., Conch. Cab., 1 (17): 400) – 1888 Limnaea jouberti (BOURGIGNAT, Ann. Sci. nat. zool., 10: 7) – 1892 Limnaea nyansae (MARTENS, Sitz. Ber. Ges. naturf. Fr. Berlin, 1892: 16) – 1894 Limnaea elmeteitensis (SMITH, Proc. zool. Soc. London, 1: 167) – 1897 Limnaea (Radix) undussumae (MARTENS, Besch, Weichth. Deutsch-O.-Afr., 4: 135) – 1919 Lymnaea natalensis (GERMAIN, Bull. Mus. Hist. nat. Paris, 25: 179) – 1936 Lymnaea natalensis (HAAS, Abh. senck. naturf. Ges., 431: 1) – 1951 Lymnaea natalensis (HUBENDICK, Kungl. Svenska Vet. Ak. Handl., 3 (1): 158; Fig. 71, 78, 80, 86, 87, 170, 345, 346, 248).

Localities: Sey: M: No. 2 (many ind. of cf. *natalensis*, KRAUSS, 1848); Co: A: No. 1 (6 ind.), No. 2 (110 ind.), No. 4 (1 ind.), No. 5 (72 iuv.).

Shell: Considering the great intraspecific variation in form, size and shape of the shells (as in all species of Lymnaea, especially in subgenus Radix) GERMAIN (1919) and HUBENDICK (1951) have reduced the great number of forms and species of Lymnaea, described from Africa South of Sahara to only one species. Accordingly, after HUBENDICK's studies on a large number of specimens, concerning Lymnaea natalensis KRAUSS, 1848, he write on page 158: "... the systematical independence of which is problematical."

The specimens found at Mahé (Seychelles) have a fragile oblong shell with only three whorls, rapidly increasing; the body whorl big and slightly convex; yellowish, translucent; fine and dense growth lines; aperture ovoid,

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top acute, base rounded; a columellar fold is present, as is a narrow umbilical chink (Pl. 7; Fig. 43). These specimens are determined as cf. *natalensis* and were probably introduced; *Lymnaea* was never before reported from the Seychelles. The slender-oblong shells of the specimens found in different localities of running waters on Anjouan (Comores) have an acute spire of four to four and half whorls; yellowish, translucent and with dense, very delicate growth-striae, sometimes crossed by fine spiral-grooves; bulging body-whorl (Pl. 7; Fig. 42a, b).

C			
Sizes	ın	$\mathrm{mm}$	):

Localities		S	Shell		Aperture		Ratio-Index	
		Height	Diameter	Height	Diameter	D:H	$\operatorname{Sp}: \mathbf{H}$	
Sey: M	: No. 2	11	6.4	9.2	5.2	58%	17%	
		10.8	6.3	8.9	4.6	58%	17.6%	
Co: A:	No. 1	9	5	6.7	3.3	55.5%	26%	
	No. 2	10	5	7	4	50%	30%	
	No. 4	10.4	5.5	7.4	4	52.8%	29%	
	No. 5 (eroded)	13.7	7.9	9.7	6	57.6%	29%	

The measurements are from the largest specimens in the samples.

Anatomical remarks: Outside the mantle is dark blue with whiteyellowish, circle-shaped spots; mantle-border yellow-greyish to dark blaue with small irregularly black dots (Fig. 46); Central nervous-system: cerebral-



Fig. 46. Lymnaea (Radix) cf. natalensis (from Mahé, Seychelles): Soft body with pigmentation

Fig. 47. Lymnaea (Radix) cf. natalensis (from Mahé, Seychelles): Intestine

Fig. 48. Lymnaea (Radix) cf. natalensis (from Mahé, Seychelles): Jaw

Fig. 49. Lymnaea (Radix) cf. natalensis (from Mahé, Seychelles): Radula-teeth

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ganglia oblong connected by a moderately, slender commissure; from the dorsal side arise the N. tentacularis and N. opticus; on the frontal side the cerebrobuccal-connective and the two labial nerves; the pleural-, parietalganglia and the abdominal-ganglion as half-circle below the cerebral-commissure; pallial- and cerebral-ganglia connected with short connectives to the large pedal-ganglia; on their surface the statocysts with many statoliths (Fig. 50). Intestine: salivary glands half-circle-shaped connected to moderately long oesophagus; stomach divided into a anterior part, muscle-part and a sacshaped posterior part with the openings of the digestive gland-ducts and a short coecum (Fig. 47); jaw: semilunar-shaped, inner edge slightly concave with one or two median cusps (Fig. 48, 54); radula: about 24-30 teeth in each half row; central tooth slightly asymmetrical, one cusp, sometimes bicuspid; the laterals with three prominent cusps, the marginals with four to five acute denticles (Fig. 49, 55). Genital organs: praeputium and penis sheath nearly of the same length; praeputium with two muscular-pillars; velum and sarcobelum are normally developed, the penis reaches in the distal third of the penis sheath



Fig. 50. Lymnaea (Radix) cf. natalensis (from Mahé, Seychelles): Central nervous-system
Fig. 51. Lymnaea (Radix) cf. natalensis (from Mahé, Seychelles): a) Prostata-gland;
b) Cross-section through the prostata-gland

Fig. 52. Lymnaea (Radix) cf. natalensis (from Mahé, Seychelles): a) Vas deferens, penis and praeputium; b) Longitudinal-section of the praeputium end the end of the penis
Fig. 53. Lymnaea (Radix) cf. natalensis (from Mahé, Seychelles): Receptaculum seminis and lower part of the vagina

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(Fig. 52a, b; 57a, b), but never in the lumen of the praeputium, as Lymnaea (Radix) natalensis hovarum! As indicated by HUBENDICK (1951) the prostata has one fild directed inwards, but it does not occupy the whole lumen (Fig. 51a, b; 56); the globiform receptaculum seminis is connected with the end of the vagina by a long and slender duct (Fig. 53).

Ecological-biological remarks: On Mahé (Seychelles) Lymnaea (Radix) cf. natalensis was found rarely on the borders of pools, filled with flood waters, the temperature was about  $25^{\circ}$  C; pH: 6.5, conductivity:  $35 \mu$ Siemens



Fig. 54. Lymnaea (Radix) natalensis: Jaw
Fig. 55. Lymnaea (Radix) natalensis: Radula-teeth
Fig. 56. Lymnaea (Radix) natalensis: Cross-section through the prostata-gland
Fig. 57. Lymnaea (Radix) natalensis: a) Lower part of the vas deferens, penis and praeputium; b) Longitudinal-section of the praeputium and penis

and total hardness:  $0.15^{\circ}$  dH. At Anjouan Lymnaea (Radix) natalensis was in greater density only in stillwater habitats, such as water-tanks filled with water from a brook (60 to 100 individues/1/16 m<sup>2</sup>), in pools, filled with flood water near the borders of rivers and in sprayed water of a mineral-source flowing in a mountain-river. In these localities were found also spawn and young specimens in March, 1974. In running waters Lymnaea (Radix) natalensis was always sporadic to observe, living near the borders in a surface-current of only 10— 20 cm/sec (the majority of the running waters of Anjouan are torrents with strong currents).

	Temperatures		Chenistry		
		$\mathbf{p}\mathbf{H}$	conductivity	total hardness	
Anjouan	22.2° C-26.3° C	7.9-8.4	117—180 μS	3.5° dH	
(sprayed w of a miner	al-source: 22.2° C	6	1600 μS(!)	53° dH(!)	

In some localities of Anjouan Lymnaea (Radix) natalensis was associated with Ceratophallus sp. and Melanoides tuberculata.

Geographical range: Africa, S of the Sahara; in number of oases of the Sahara and in the Nile drainage area as far as Northern Egypt, Yemen and Oman; probably the Cape Verde islands and Tenerife. Our collections from the Seychelles and the Comores are the first records for these islands; it is presumed that on these islands the species was introduced passively by man or waterbirds.

23a) Lymnaea (Radix) natalensis KRAUSS, 1848 ssp. hovarum TRISTRAM, 1863

Lit.: 1863 Lymnaea hovarum (TRISTRAM, Proc. zool. Soc. London, 1863: 61) – 1882 Lymnaea electa (SMITH, ibid., 1882: 385; Pl. 22, Fig. 12, 13) – 1882 Lymnaea hovarum (SMITH, ibid.: 385) – 1894 Lymnaea suarezensis (DAUTZENBERG, J. de Conch., 42: 110; Pl. 4, Fig. 3) – 1910 Lymnaea electa (KOBELT, Abh. senck. nat. Ges., 32: 90) – 1914 Lymnaea hovarum (ROBSON, J. Linn. Soc., London, 32: 380) – 1920 Lymnaea hovarum (GERMAIN, Bull. Mus. Hist. nat., 26: 160) – 1929 Lymnaea (Radix) natalensis (HAAS, Zool. Jb. (Syst.), 57: 412; Pl. 2, Fig. 11–13) – 1951 Lymnaea natalensis (HUBENDICK, Kungl. Svenska Vet. Ak. Handl., 3: 82; 158; Fig. 186, 193, 276, 298/46, 347n) – 1953 Lymnaea natalensis (GRJÉBINE & MENACHÉ, Mém. Inst. Sci. Madagascar (A), 8: 87) – 1956 Lymnaea hovarum (BANSON, OMS Conf. Afr. Bilh., Brazzaville (34): 25) – 1958 Lymnaea hovarum (BRYGOO, Arch. Inst. Pasteur, Madagascar, 26: 75) – 1969 Radix (Radix) hovarum (STARMÜHLNER, Malacologia, 8 (1/2): 244; Fig. 321–352).

Locality: Mad: No. 1 (some individues).

Shell: Descriptions are given by TRISTRAM (1863); SMITH (1882); DAUTZENBERG (1894); HUBENDICK (1951) and STARMÜHLNER (1969). It varies in size and shape, like all shells of the genus Lymnaea (Radix). There are all transitions between the forms of Madagascar to the forms of Africa belonging to the natalensis-group (Pl. 7; Fig. 44).

Sizes (in mm):

	S	Shell		Aperture		Ratio-Index	
Locality	Height	Diameter	Height	Diameter	D:H	Sp:H	
Mad: No. 1	13.1	8.2	9.5	6.5	62.5%	27.5%	

The measurements are from the largest specimen in the sample.

Anatomical remarks: A detailed study of anatomy and histology of Lymnaea (Radix) natalensis hovarum was given by STARMÜHLNER (1969) who

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studied many specimens from different localities of Madagascar. The specimens of the collection of BRINCK & ENCKELL (Swedish Mission 1973) from the Saharena-River, Prov. Diego Suarez, N-Madagascar, show no differences: the mantle surface is yellowish spotted on a dark blue ground, the mantle border possesses dark, irregular spots on a light ground of marble pattern; jaw: halfmoon-shaped (Fig. 58); radula: central-tooth slightly asymmetrical, one prominent central cusp and each side a very small lateral cusp; laterals tri-



Fig. 58. Lymnaea (Radix) natalensis hovarum: Jaw Fig. 59. Lymnaea (Radix) natalensis hovarum: Radula-teeth

Fig. 60. Lymnaea (Radix) natalensis hovarum: a) Prostata-gland; b) Cross-section through the prostata-gland

Fig. 61. Lymnaea (Radix) natalensis hovarum: Lower part of the vas deferens, penis and praeputium

Fig. 62. Lymnaea (Radix) natalensis hovarum: Receptaculum seminis and lower part of the vagina

cuspid, from teeth 9-10 wit four cusps and the marginals with four to five denticles of different size (Fig. 59); genital organ-system: receptaculum seminis globiform and with a long slender duct (Fig. 62); prostate gland unifolded (Fig. 60a, b); the most important difference to *natalensis* s. str., as indicated before by RANSON (1956) and STARMÜHLNER (1969) is the long penis, which projects always with its free top in the upper third of the praeputium (Fig. 61).

Ecological-biological remarks: According to STARMÜHLNER (1969) found in Madagascar in all limnetic habitats, such as border of lakes, ponds,

irrigation-channels, rice-fields and sandy-muddy banks and borders of running waters, as in Mad: No. 1 (River Saharena).

Geographical range: The subspecies *hovarum* of the African Lymnaea (Radix) natalensis-group is known from the whole island of Madagascar, but mainly recorded from the central highland.

# 24) Lymnaea (Radix) mauritiana MORELET, 1875

Lit.: 1875 Limnaea mauritiana (MORELET, J. de Conch., 23: 33) — 1877 Limnaea rufescens (LIÉNARD, Cat. Moll. Maurice: 58) — 1880 Limnaea mauritiana (MARTENS, Moll. in MÖBIUS: Beitr. Meeresfauna Ins. Mauritius: 33; Pl. 19, Fig. 9, 10) — 1910 Limnaea mauritiana (KOBELT, Abh. senck. nat. Ges., 32: 94) — 1921 Limnaea (Radix) mauritianensis (GERMAIN, Mém. Soc. zool. France; suppl. 1920: 227; Fig. 21) — 1951 Lymnaea mauritiana (HUBENDICK, Kungl. svensk. Ak. Vet. Handl., 3: 106; Fig. 278, 290; 167; Fig. 358).

Localities: Mas: Ré: No. 2 (19 ind.), No. 4 (46 ind.), No. 5 (50 ind.), No. 7 (61 ind.), No. 8 (33 ind.), No. 10 (30 ind.), No. 11 (55 ind.), No. 12 (14 ind.), No. 13 (62 ind.), No. 14 (51 ind.), No. 17 (58 ind.), No. 18 (2 iuv.), No. 20 (1 ind.), No. 23 (45 ind.); Mau: No. 1 (4 ind.), No. 2 (13 ind.), No. 3 (17 ind.), No. 4 (67 ind.), No. 5 (19 ind.), No. 6 (119 ind.), No. 7 (62 ind.), No. 8 (20 ind.), No. 9 (4 ind.), No. 10 (5 ind.), No. 11 (some ind.), No. 12 (13 ind.), No. 14 (9 ind.), No. 15 (42 ind.), No. 16 (some ind.), No. 17 (27 ind.), No. 20 (some ind.); Ro: No. 1 (20 ind.), No. 3 (2 ind.), No. 4 (4 ind.).

Shell: Descriptions are given by MORELET (1875); GERMAIN (1921) and HUBENDICK (1951): the shells vary a great deal: the ratio-index between height and maximal diameter and between the height of the spire and height of the shell differs, as well as different details in the shell form; generally the shell is long-ovate with a prominent, somewhat obtuse spire, consisting of three to four whorls separated by a shallow suture; the pointed apex is mostly reddish, the other parts horny-yellowish, slightly transparent; very fine, delicate growth-striae, which are only on the body-whorl, a little more prominent; on the upper whorls the growth striae are crossed by fine spiral-grooves; a columellar fold is usually developed, no umbilical chink occurs (Pl. 7, Fig. 45, 46, 47, 48, 49, 50, 51, 51).

	S	Shell		Aperture		Ratio-Index	
Localities	Height	Diameter	Height	Diameter	D:H	$\mathbf{Sp}:\mathbf{H}$	
Mas: Ré: No. 2	11.6	6.7	8.4	5	58%	28%	
No. 4	9	4.4	6	3.3	49%	34%	
	8.5	5	6.4	4.3	59%	25%	
No. 5 (river)	8	4	5	2.6	50%	37.5%	
(hygropetric)	10.2	5.7	7	3.9	56%	32%	
(hygropetric)	10.1	5.7	6.3	3.4	57%	38%	
(hygropetric)	10	5.2	6.2	3.2	52%	38%	

Sizes (in mm):

		S	hell	Ap	erture	Ratio	o-Index
Localiti	es	$\mathbf{Height}$	Diameter	Height	Diameter	$\mathbf{D}:\mathbf{H}$	$\operatorname{Sp}:\mathbf{H}$
	No. 7	12.5	6.6	9.3	4.5	53%	26%
	No. 8	11	6	8	4.5	54%	27%
	No. 10 (eroded)	9	5.4	6	3.5	60%	34%
	No. 11 (river)	8.5	4.8	6	3.5	56%	30%
	(hygropetric)	12	6.4	9.4	5.2	53%	22%
	(hygropetric)	11	6	8	4.8	54%	28%
	No. 12	10.6	5	7	3.4	47%	34%
	No. 13	11.8	6.4	8.9	4.3	54%	25%
		11	6	7.5	4	54%	32%
	No. 14	12.7	7.6	10	5.6	60%	22%
	No. 15	11.7	7	9	5.7	60%	23%
		11.4	6.2	8.6	4.5	54%	25%
	No. 17	13.1	7.4	10	5.8	56%	24%
	No. 18 (iuv.)	7	3.8	4.2	2.5	54%	40%(!)
	No. 20 (iuv.)	5.6	no mea	surements	:!		
	No. 23	19 .	11.5	15	7.5	60%	22%
		15	9	12.5	6	60%	17%
		12.3	6.8	9	4	55%	27%
Mau:	No. 1 (eroded)	10.6	5.6	7.3	4.3	53%	31%
	No. 2 (eroded)	8	4	<b>5</b>	2	50%	37.5%
	(eroded)	7.3	4.7	5.3	3.5	64%	27.4%
	No. 3	9	4.3	5.6	2.8	47%	38%(!)
	No. 4 (eroded)	11	5.4	7.8	4.3	49%	30%
	No. 5 (eroded)	8.6	4.8	5.7	3.3	55%	34%
	No. 6 (eroded)	10.5	6	7.8	3.9	57%	26%
		11	5.7	7.4	4	52%	33%
		10.5	5.5	7.7	3.6	52%	27%
	No. 7 (eroded)	8.4	4.8	5.8	3.7	57%	31%
	No. 8 (eroded)	10.6	5.5	7.2	4.2	51%	32%
	No. 9 (eroded)	9.1	5	6	3	55%	34%
	No. 10 (eroded)	7	4.3	4.5	2.5	61%	36%
	No. 12	10	5.3	7.9	4	53%	21%
	No. 13	8	4.7	5.5	2.7	58%	32%
	No. 15 (eroded)	14.3	7.5	10	5	52%	30%
		9.6	4.7	6.5	4	50%	33%
	No. 17	9.2	5	6.8	4	54%	27%
Ro:	No. 1	12.5	7	9.4	4	56%	25%
	No. 3 (eroded)	9.5	5	6.2	3.5	52%	35%
	No. 4	18.8	8.5	14.4	6	45%	23.5%

The ratio-index of Lymnaea (Radix) mauritiana from our samples changes by:

Diameter: Height = 45% to 64%; average: about 53.3%

Spire : Height = 17% to 40%; average: about 30%

The measurements are from the largest specimens in the samples.

Anatomical remarks: Some details are given by HUBENDICK (1951: 106; Fig. 278, 290 and 167). Outer mantle surface dark blue with rounded,

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yellowish spots, mantle border blackish (Fig. 63); jaw: halfmoon-shaped, inner edge concave (Fig. 64); radula: central-tooth asymmetrical with a prominent central cusp and a small denticle on the left side; laterals tricuspid, sometimes the first with incisived cusps, from 8/9th tooth, two central and two lateral cusps, from the 13th tooth to the marginals (about 25 teeth each half-row) with three central and two to three small lateral cusps (Fig. 65); genital organ-system: receptaculum seminis with a long and slender duct, dark blue



Fig. 63. Lymnaea (Radix) mauritiana: Soft body and pigmentation Fig. 64. Lymnaea (Radix) mauritiana: Jaw

Fig. 65. Lymnaea (Radix) mauritiana: Radula-teeth

Fig. 66. Lymnaea (Radix) mauritiana: Receptaculum seminis and lower part of the vagina Fig. 67. Lymnaea (Radix) mauritiana: Cross-section through the prostata-gland

Fig. 68. Lymnaea (Radix) mauritiana: a) Lower part of the vas deferens, penis and praeputium; b) Longitudinal-section of the upper part of the praeputium and penis; c) penis

pigmented like the lower part of the vagina (Fig. 66); the prostate with one large fold (Fig. 67); the penis is coiled within the penis sheat and does not enter in the proximal chamber of the thick and pigmented praeputium, with two muscle pillars (Fig. 68a, b, c).

Ecological-biological remarks: Lymnaea (Radix) mauritiana is, with Physa borbonica, Thiara scabra and Melanoides tuberculata, one of the most frequent freshwater-gastropods in the still- and running waters of the

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Mascarene-Archipelago. In brooks, rivers and streams they occur from 1200 m (Réunion), 750 m (Mauritius) in the border-regions or pools and creeks between cascade-zones, where the current lies between 0 and 30 cm/sec. Sometimes the snails are found in a surface-current of 50 cm to maximal 75 cm/sec, but in such localities they are attached below the stones or on the sides, protected against the stronger current and always in a much lower density, than in habitats with slow current and sandy-muddy botten and rich vegetation:

	0-30 cm/sec	30-50 cm/sec	50-75 cm/sec
La Réunion :	20-60 ind./1/16 m <sup>2</sup> (sometimes up to 120 ind./1/16 m <sup>2</sup>	5-20 ind./1/16 m <sup>2</sup>	sporadic
Mauritis:	30-60 ind./1/16 m <sup>2</sup> (sometimes up to 120-180 ind./1/16 m <sup>2</sup> )	5—20 ind./1/16 m <sup>2</sup>	sporadic

The highest density was counted in the middle courses and transitions to the lower courses, if the rivers cross the cultivated areas with plantations and villages nearby. In such parts, influenced by fertilizers and organic sewage, a high production of algae and submerged water-plants is the base for an enormous development of water snails.

	Temperatures		Chemistry	у
	-	$_{ m pH}$	conductivity	total hardness
La Réunion :	18.2° C-24° C	7.4-8.8	$102 - 258 \ \mu S$	1.1°-8.8° dH
Mauritius:	19.4° C—25.7° C	6.6 - 8.2	$66 - 220 \mu S$	$1^{\circ}$ $-4.25^{\circ}$ dH
Range:	$18.2^{\circ} C - 25.7^{\circ} C$	6.6 - 8.8	$66-258~\mu\mathrm{S}$	$1^{\circ} - 8.8^{\circ} dH$

In the upper courses of the running waters of Mauritius with a very low content of mineral-salts and very soft, slightly acidic water the frequency of *Lymnaea* (*Radix*) mauritiana is very low and in the headwaters with a pH of 6, a conductivity below 50  $\mu$ Siemens and a total hardness of only 0.3° dH the species does not occur, as in all other freshwater-gastropods!

In some localities many young specimens, spawn and specimens in copulation were found in April (La Réunion) and May (Mauritius). The species was also found on wet rock localities with a very thin water-film or sprayed water.

Geographical range: Mascarene Archipelago: La Réunion, Mauritius, Rodriguez.

Family: Planorbidae Subfamily: Planorbinae Genus: *Planorbella* HALDEMAN, 1842

## 25) Planorbella (= Helisoma) duryi (WETHERBY, 1879)

Lit.: 1879, Planorbis (Helisoma) duryi (WETHERBY, J. Cincinnati Soc. Nat. Hist., 2: 93-100; fig. 4) - 1979 Helisoma duryi (FRANDSEN & MADSEN, Acta Tropica, 36: 67-84).

Locality: Mas: Ré: No. 17 (71 ind.).

Shell: The found shells are dicoidal with a slight tendency to be pseudodextral, moderatelly large, the base much less concave or almost flat; periphery rounded, narrowly and irregularly striated by growth striae; last whorl occasionally of irregular shape, with inflations and constrictions; the specimens from La Réunion with five whorls, rapidly increasing in diameter, the last whorl large and dilated towards the aperture; brown yellowish, corroded shells whitish; aperture broad sickle-shaped; peristome rounded and without an angle, sharp and not continous (Pl. 8, Fig. 53a, b). These shells we have determinated for *Indoplanorbis exustus* (DESHAYES, 1834), but the Danish Bilharziasis Laboratory (F. FRANDSEN), which has studied material from Réunion also by dissections found out, that the shells are belonging to *Planorbella* (= *Helisoma*) duryi. The shells of these two species are nearly identically and the determination is only possible after the genital organs.

Sizes (in mm):

	Shell		Aperture	
Locality	Height	Diameter	Height	Diameter
Mas: Ré: No. 17	7	14.7	5	8.5

The measurements are from the largest specimens in the sample.

Anatomical records: The soft bodies of the specimens from La Réunion were decomposed; a dissection was not possible, only jaw and radula could be prepared: jaw: middle portion wide and low, striated on its outer face



Fig. 69. Planorbella (= Helisoma) duryi: Jaw

and slightly bent downwards at the end (Fig. 69); radula: about 23-25 teeth on each of half row; central tooth with broad base, concave incised, cutting edge small, bicuspid; first laterals tricuspid, the marginals wit four to six central denticles and 1-2/3 cusps on the outer side (Fig. 70).





Fig. 70. Planorbella (= Helisoma) duryi: Radula-teeth

Ecological-biological remarks: *Planorbella duryi* was never before recorded in waters of La Réunion; it must be introduced after a letterinformation of F. FRANDSEN passively (waterplants). Our specimens were found in the lower course of the River St. Denis, near the capital of the island. The surroundings are scrub and plantations but also some suburb-villages; therefore influence of organic sewage is presumed. This deposit of organic mud on the borders and a very rich development of algae and water-plants form the base for a rich development of freshwater-gastropods.

Planorbella duryi was found in a density of 50 to 60 individues/ $1/16 \text{ m}^2$ in the zones of the banks and pools (0-30 cm/sec) and with about 5 to 30 individues/ $1/16 \text{ m}^2$  in parts with a surface-current of 30-50 cm/sec. Adult specimens were often in copula, and spawn was found on stones and water plants. The species was associated with *Thiara scabra*, *Melanoides tuberculata*, *Lymnaea* (*Radix*) mauritiana, *Physa borbonica* and *Ferrissia* (*Pettancylus*) sp.

Temperature		Chemistry	
	$\mathbf{pH}$	conductivity	total hardness
23.2° C	8.4	105 μS	2.5° dH

Geographical range: The "locus typicus" of *Planorbella duryi* are the Everglades in Florida, USA. After information of the Danish Bilharziasis Laboratory these species is introduced (accidentally or by men, waterplants waterbirds) in many subtropical and tropical countries and islands (Mauritius, COURTOIS, 1973 in FRANDSEN & MADSEN, 1979: 70).

Genus: Gyraulus CHARPENTIER, 1837

## 26) Gyraulus mauritianus (MORELET, 1876)

Lit.: 1876 Planorbis mauritianus (MORELET, J. de Conch., 24: 91; Pl. 3, Fig. 7) – 1880 Planorbis mauritianus (MARTENS, Moll., in MÖBIUS: Beitr. Meeresfauna Ins. Mauritius: 210) – 1882 Planorbis mauritianus (MORELET, J. de Conch., 30: 104) – 1910 Planorbis mauritianus (KOBELT, Abh. senck. nat. Ges., 32: 94) – 1921 Planorbis (Gyraulus) mauritianensis (GERMAIN, Mém. Soc. 2001. France; suppl. 1920: 231). Localities: Sey: M: No. 1 (62 ind.), No. 4 (1 ind.), No. 5 (1 ind.); Mas: Mau: No. 3 (1 ind.), No. 6 (35 ind.), No. 16 (3 ind.).

Shell: Descriptions are given by MORELET (1876); GERMAIN (1921). After checking our specimens, D. S. BROWN (Dept. of Zoology, Exper. Taxonomy, British Museum), specialist for African Planorbidae, wrote to us (letter from 22. 1. 1976): "It was quite a surprise to find that MORELET'S *Planorbis* mauritianus is a true Gyraulus ...". Also GERMAIN (1921) has found, that the shells of mauritianus are closely related to the variable oriental species Gyraulus saigonensis (CROSSE & FISCHER, 1863) a synonym of Gyraulus convexiusculus (HUTTON, 1849 = G. compressus, HUTTON, 1834).

The specimens of Mahé are nearly identically with the shells (and anatomy) of the specimens from the localities of Mauritius: compressed, subconvex on the upper side and concave below (if the aperture is left!); spire with three to four whorls, separated by deep sutures; the last whorl large, convex on the periphery; fragile, translucent, yellowish, sometimes with a red-brownish coating; fine, delicate growth-striae, crossed by very fine spiral-striae (enlargement:  $50 \times !$ ); aperture slightly oblique, oval-rounded (Pl. 8; Fig. 54a, b; 55a, b).

Sizes (in mm):

Localities		Maximal Diameter	Minimal Diameter	Height
Sey: M:	No. 1	3.6	no measurements!	1
-	No. 4	2.6	no measurements!	
	No. 5	2.7	no measurements!	
Mas: Mau	: No. 3	3.4	2.9	0.95
	No. 6	3.5	2.9	1
	No. 16	3	2.5	0.8

The measurements are from the largest specimens in the samples.

An atomical remarks: Mantle surface with two dark blue longitudinal stripes, which have lateral branches; in the upper whorls the digestive gland and intestine shine through the translucent, unpigmented skin (Fig. 71a, b; 78); the pseudobranch on the left side is a small lobe with a free, rounded margin; on the inner surface the anal-aperture on the right side of the channelshaped mantle lobe (Fig. 72; 79); the long-stretched kidney with its excretory duct shows external folds (Fig. 73); jaw: composed of large plates, concave curved on the cutting edge (Fig. 74); radula: about fifteen teeth in each half row: central tooth bicuspid; first laterals (no. 1-10) tricuspid with prominent denticles, sometimes the third denticle divided in two small cusps; the marginals with 1/2+1+2 cusps (Fig. 75; 80); genital organ-system: receptaculum seminis globular and with a short duct to the lower part of the vagina (Fig. 76; 81); prostate is composed of seven unbranched diverticula, arising from a common duct which is branched from the vas deferens (Fig. 82); the vas deferens enters a penis sheat from the same distances as the praeputium, and



Fig. 71. Gyraulus cf. mauritianus (from Mahé, Seychelles): a) soft body; b) soft body Fig. 72. Gyraulus cf. mauritianus (from Mahé, Seychelles): Pseudobranch, rectum and pneumostom

Fig. 73. Gyraulus cf. mauritianus (from Mahé, Seychelles): Pericard and kidney Fig. 74. Gyraulus cf. mauritianus (from Mahé, Seychelles): Jaw

Fig. 75. Gyraulus cf. mauritianus (from Mahé, Seychelles): Radula-teeth

Fig. 76. *Gyraulus* cf. *mauritianus* (from Mahé, Seychelles): Receptaculum seminis and lower part of the vagina

Fig. 77. Gyraulus cf. mauritianus (from Mahé, Seychelles): a) Lower part of the vas deferens, penis with stilet and praeputium (partly in longitudinal-section); b) Lower part of the vas deferens, penis with stilet and praeputium

is only slightly smaller than the praeputium with two muscle pillars; the penis has a prominent stilet with a rounded base, the male aperture lies immediately proximal to the stilet (Fig. 77a, b; 83a, b).

Ecological-biological remarks: Gyraulus cf. mauritianus was found in the rivers of Mahé (Seychelles) only in parts which are slightly polluted by organic sewage near villages and plantations. On the borders with a current of 0-30 cm/sec they were found on muddy stones — in one station together with Melanoides tuberculata — from sporadic to a density of 15 individues/ 1/16 m<sup>2</sup>.

In similar habitats occurs the species in the slow-flowing streams of Mauritius, especially if the influence of organic sewage is evident. The density was mostly sporadic, high in only one locality with about 50 to 60 individues/ $1/16 \text{ m}^2$ . They are mostly associated with *Thiara scabra*, *Melanoides tuberculata*, *Lymnaea* (*Radix*) mauritiana and *Physa borbonica*.

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2 N	Temperatures		Chemistry			
	î.	$_{\rm pH}$	conductivity	total hardness		
Mahé (Seychelles)	$23.5^{\circ} \text{ C} - 26.3^{\circ} \text{ C}$	6.6 - 7.2	46-116 µS	0.33°-1.39° dH		
Mauritius	$20.9^{\circ} \mathrm{C}{-}23.8^{\circ} \mathrm{C}$	7 - 8.2	$69 - 155 \ \mu S$	$1^{\circ}$ $-2.8^{\circ} \mathrm{dH}$		
Range:	$20.9^\circ$ C $-26.3^\circ$ C	6.6 - 8.2	$46-155 \ \mu S$	$0.33^\circ - 2.8^\circ \mathrm{dH}$		

Geographical range: Endemic for Mauritius; probably passively introduced in Mahé (Seychelles) by water plants, where our collections are the first record. *Gyraulus mauritianus* is near related to the widely distributed oriental-oceanic species *Gyraulus convexiusculus* with many forms.

Genus: Afrogyrus BROWN & MANDAHL-BARTH, 1973

Subgenus: Afrogyrus s. str.



Fig. 78. Gyraulus mauritianus: Soft body with pigmentation Fig. 79, Gyraulus mauritianus: Pseudobranch, rectum and pneumostom Fig. 80. Gyraulus mauritianus: Radula-teeth

Fig. 81. Gyraulus mauritianus: Receptaculum seminis and lower part of the vagina Fig. 82. Gyraulus mauritianus: Prostata-gland

Fig. 83. Gyraulus mauritianus: a) Lower part of the vas deferens, penis with stilet and praeputium; b) stilet

27) Afrogyrus (Afrogyrus) rodriguezensis (CROSSE, 1873)

Lit.: 1874 Planorbis rodriguezensis (CROSSE, J. de Conch., 21: 144) — 1874 Planorbis rodriguezensis (CROSSE, ibid., 22: 232; Pl. 8, Fig. 8) — 1880 Planorbis rodriguezensis (MARTENS, Moll., in MÖBIUS: Beitr. Meeresf. Ins. Mauritius: 210) — 1886 Planorbis rodriguezensis (CLESSIN, in M. & CH., Conch. Cab., 2 (17): 216) — 1910 Planorbis rodriguezensis (KOBELT, Abh. senck. nat. Ges., 32: 96) — 1921 Planorbis (Gyraulus) rodriguezensis (GERMAIN, Mém. Soc. zool. France; suppl. 1920: 232). Localities: Mas: Ro: No. 1 (26 ind.), No. 2 (5 ind.), No. 3 (3 ind.). Shell: D. S. BROWN (Dept. of Zoology, Exper. Taxonomy; British Museum) an expert on African Planorbidae, wrote to us (22nd November 1976) checking the specimens of the samples, collected by P. BRINCK & P. H. ENCKELL (Swedish-Mission 1973) at Rodriguez: "It was quite a great surprise to find ... whereas CROSSE's *Planorbis rodriguezensis* is an true *Afrogyrus*. "The new genus *Afrogyrus* with two subgenera *Afrogyrus* s. str. and *Hovorbis* were created by BROWN & MANDAHL-BARTH, 1973 (Proc. malac. Soc. London, 40: 290; Fig. 3i, j, k) from the development of the penial stylet.

Descriptions of the shell are given before by CROSSE (1873, 1874) and by GERMAIN (1921). The specimens of the Swedish-Mission — collections have a lentil-shaped, depressed shell with a large sinked upper surface but nearly plane below (aperture seen from left side!); three-three and half whorls rapidly increasing, separated by distinct sutures; body-whorl big and rounded, ascending to the aperture (seen from the left side) which is oblique and transverse-oval; delicate dense, sometimes slightly ribbed growth-lines; translucent, yellowish, aperture withish, borders united by a fine callus (Pl. 8; Fig. 56).

Sizes (in mm):

Localities	Maximal Diameter	Minimal Diameter	Height
Mas: Ro: No. 1	4.2	3.6	1.4
No. 2	3.6	3	1.2
No. 3	3.2	2.6	0.9

The measurements are from the largest specimens in the samples.

Anatomical remarks: Head, tentacles and mantle outside-surface dark blue pigmented, except the mantle-border and the translucent parts of the kidney (Fig. 84); pseudobranch a small lobe with a free, rounded margin, on the inner surface the anal aperture, on the right side, the channel-shaped mantle fold at the pneumostome (Fig. 85); salivary glands: sausage-shaped and connected behind in a half-circle; jaw: composed by many cuticular-plates, the free cutting-edge slightly concave and serrated (Fig. 86); radula: about 17-18 teeth on each half-row: central tooth distinct bicuspid; laterals from 2 to 9/10 also bicuspid, the inner cusp much larger than the outer denticle; marginals with three to four denticles in the formula 1+1+1/2 (Fig. 87); genital organ-system : receptaculum seminis globular and with a short, relatively thick duct to the lower part of the vagina (Fig. 88); the prostate-gland on the male tract with ten unbranched diverticula; penis-sheat and penis of about the same lenght, the distal part of the sheat somewhat enlarged, the penis posseses on its top a very small, simple stylet, the opening is lateral just behind the base of the stylet (Fig. 89a, b).

Ecological-biological remarks: The specimens from the collections of the Swedish Mission 1973 were associated with *Thiara scabra*, *Melanoides* 

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Fig. 84. Afrogyrus (Afrogyrus) rodriguezensis: Soft-body with pigmentation Fig. 85. Afrogyrus (Afrogyrus) rodriguezensis: Pseudobranch, rectum, and pneumostom Fig. 86. Afrogyrus (Afrogyrus) rodriguezensis: Jaw

Fig. 87. Afrogyrus (Afrogyrus) rodriguezensis: Radula-teeth

Fig. 88A. Afrogyrus (Afrogyrus) rodriguezensis: Receptaculum seminis and lower part of the vagina

Fig. 88B. Afrogyrus (Afrogyrus) rodriguezensis: Prostata-gland

Fig. 89. Afrogyrus (Afrogyrus) rodriguezensis: a) Lower part of the vas deferens, penis and praeputium (partly in longitudinal-section); b) Distal part of the penis with penisopening and short stilet

tuberculata, Lymnaea (Radix) mauritiana, and in two stations also with Omphalotropis rangi. The altitude of the stations was 250 m and 400 m. No other datas were given on the labels.

Geographical range: The species is endemic for the small island of Rodriguez in the East of Mauritius. The range of the genus *Afrogyrus*, subgenus *Afrogyrus* s. str. includes, following BROWN & MANDAHL-BARTH, 1973: "most of Africa as these snails are doubtless often overlooked."

Subgenus: Hovorbis BROWN & MANDAHL-BARTH, 1973.

## 28) Afrogyrus (Hovorbis) cf. crassilabrum (MORELET, 1860)

Lit.: 1860 Planorbis crassilabrum (MORELET, Sér. Conch., 2: 96; Pl. 6, Fig. 8) – 1860 Planorbis trivialis (MORELET, ibid.: 97; Pl. 6, Fig. 7) – 1863 Planorbis (Nautilina) caldwelli (TRISTRAM, Proc. 2001. Soc. London, 1863: 51) – 1878 Planorbis crassilabrum

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(KOBELT, Jb. dtsch. malak. Ges., 5: 180; Planorbis trivialis: 180) - 1879 Planorbis trivialis (MORELET, J. de Conch., 27: 312; Planorbis crassilabrum: 312) - 1881 Planorbis crassilabrum (CROSSE, ibid., 29: 202) - 1882 Planorbis trivialis (MORELET, ibid., 30: 197)-1883 Planorbis hildebrandti (MARTENS, Jb. dtsch. malak. Ges., 10:83) - 1886 Planorbis crassilabrum (CLESSIN, in M. & CH., Conch. Cab. 17: 150; Pl. 22, Fig. 6; Planorbis trivialis: 196; Pl. 29, Fig. 7) – 1891 Planorbis sp. (VOELTZKOW, Zool. Anz., 14: 217) – 1894 Planorbis alluaudi (DAUTZENBERG, J. de Conch., 42: 101; Pl. 4, Fig. 2; Planorbis simpliculus: 101; Pl. 4, Fig. 1) - 1905 Planorbis madagascariensis (pars) (ANCEY, ibid., 53: 320) — 1909 Planorbis trivialis (GERMAIN, Arch. Zool. Exp. Gén. (5), 1: 121) — 1910 Planorbis (Tropidiscus) trivialis (KOBELT, Abh. senck. nat. Ges., 32: 90; Planorbis (Tr.) crassilabrum: 90) - 1910 ?Planorbis dixoni (NEWTON, Ann. Mag. nat. Hist. (8), 5:8; Pl. 1, Fig. 6, 7) - 1916 Planorbis (Tropidiscus) trivialis (GERMAIN, Ann. Pal., 10: 39; Pl. 5, Fig. 9) - 1918 Planorbis (Planorbis?) hildebrandti (GERMAIN, Bull. Mus. Hist. nat., 24: 46; Planorbis (Tropidiscus) trivialis: 48; Planorbis (Tr.) simpliculus: 49; Planorbis (TR.) alluaudi: 50; Planorbis (Gyraulus ?) crassilabrum: 50) - 1929 Planorbis (Planorbis) trivialis (HAAS, Zool. Jb. (Syst.), 57: 419) - 1935 Planorbis (Gyraulus) crassilabrum (GERMAIN, Ann. Sci. Nat. (10), 18: 442; Planorbis (Planorbis) trivialis: 442) - 1953 Planorbis trivialis (GRJÉBINE & MENACHÉ, Mem. Inst. Sci. Madagascar (A), 8: 87; Planorbis crassilabrum: 87) - 1956 Anisus crassilabrum (RANSON, OMS Conf. Afr. Bilh. Brazzaville (34): 6; Fig. 4) - 1958 Anisus crassilabrum (BRYGOO, Arch. Inst. Pasteur, Madagascar, 26: 66) — 1969 Anisus (Anisus) crassilabrum (STARMÜHLNER, Malacologia, 8 (1/2): 307; Fig. 420-451) - 1973 Afrogyrus (Hovorbis) trivialis (BROWN & MANDAHL-BARTH, Proc. malac. Soc. London, 40: 292; Fig. 3k, 4c, d).

Locality: Co: G.Co: No. 1 (46 ind.).

Shell: After examining the shell (and the anatomy) of the specimens from Grand Comore, Dr. D. S. BROWN (Dept. of Zoology, Exper. Taxonomy, British Museum) wrote (22 November 1976) to us: "the snails from Grand Comore are interesting because the bluntly angular shell seems different from the carinate shells from Madagascar which I regard as *trivialis*." After checking the material of *Afrogyrus* from the collection of the Austrian Mission 1958 to Madagascar (STARMÜHLNER, 1969) D. S. BROWN wrote, that he also found, as stated by STARMÜHLNER (1969), all transitions in the shells from non-carinate to carinate in the madegassian specimens of *Afrogyrus*. The species name for these varying Madegassian species-group, occuring also on the Comoro-Islands, therefore shall be given as *Afrogyrus* (*Hovorbis*) crassilabrum (this species name is given by MORELET, 1860 one page (96) before trivialis (97) and has priority).

The new genus Afrogyrus and the subgenus Hovorbis were created by BROWN & MANDAHL-BARTH, 1973. As cited above, Afrogyrus is distinguished from all other Planorbidae (with the exception of Armiger) by the possession of a very small, simple stylet. Subgenus Hovorbis with one species Afrogyrus (Hovorbis) crassilabrum MORELET, 1860 (by BROWN & MANDAHL-BARTH: trivialis MORELET, 1860) has a comparatively large shell, completing five whorls with four to nine diameter; the depressed last whorl is bluntly (f. crassilabrum s. str.) with transitions to angulated with a fringe of periostracum (f. trivialis); fine, delicate growth-striae, fragile, translucent, yellowish; aperture oblique (Pl. 8, Fig. 57). Sizes (in mm):

	$\operatorname{Sh}$	Aperture		
Locality	Maximal Diameter	Minimal Diameter	Height	Diameter
Co: Gr.Co: No. 1	4.5	3.8	1	1.2

The measurements are from the largest specimen in the sample.

An atomical remarks: According to BROWN & MANDAHL-BARTH, 1973 the most important characteristic of the subgenus *Hovorbis* is the short basal projection of the penial stylet; also found on the specimens of Grand Comore (Fig. 90a, b); on the female duct of Madegassian specimens BROWN & MANDAHL-BARTH have never observed "neither a receptaculum seminis (= spermatheca) nor a duct though a vaginal swelling is present". STARMÜHLNER (1969) has described and figured from a Madegassian specimen a receptaculum with a very short duct. BROWN & MANDAHL-BARTH, 1973 have checked some specimens from the Madegassian material of the Austrian Mission 1965 and have found only a vaginal swelling. Examining the specimens from Grand Comore



Fig. 90. Afrogyrus (Hovorbis) crassilabrum: a) Lower part of the vas deferens, penis and praeputium; b) Distal part of the penis with penis-opening and stilet

Fig. 91. Afrogyrus (Hovorbis) crassilabrum: a) Receptaculum seminis and vaginal-swelling; b) Receptaculum seminis on the lower part of the vagina

Fig. 92. *Ceratophallus* sp., Lower part of the vas deferens, penis without distinct sclerotisation and with terminal opening in the proximal part of the praeputium

Fig. 93. Ceratophallus sp.: Receptaculum seminis and lower part of the vagina Fig. 94. Ceratophallus sp.: Radula-teeth we found sometimes a vaginal swelling, but in some specimens also a separate oval receptaculum but without a distinct duct, close to the vagina. It seems there are transitions between a simple vaginal swelling and a separate sacshaped appendage. This would explain that sometimes only a vaginal swelling was found, but other specimens had a separate receptaculum, but close to the vaginal duct (Fig. 91a, b).

The mantle surface were slightly dark blue pigmented; the pseudobranch is simple with a free border, on the right with the pneumostome-fold; radula: 17-18 teeth half-row: central-tooth symmetrical, bicuspid; laterals tricuspid (formula: 1+1+1) to the 9/10th tooth; the marginals with four cusps of different sizes.

Ecological-biological remarks: Collected in a cistern of a village near Moroni filled with rain-water; the cemented walls were covered with filamentous green-algae; chemistry: pH: 8.1 - conductivity: 118 µSiemens - total hardness:  $2.58^{\circ}$  dH.

Geographical range: Madagascar, Nossi-Bé; Grand Comore (probably passively introduced ?).

Genus: Ceratophallus BROWN & MANDAHL-BARTH, 1973.

29) Ceratophallus sp.

Lit.: 1973 Ceratophallus: new genus (BROWN & MANDAHL-BARTH, Proc. malac. Soc. London, 40: 287; as type-species: Planorbis natalensis KRAUSS, 1848; Pl. 5, Fig. 9).

Localities: Co: A: No. 5 (12 ind.), No. 6 (18 ind.).

Shell: The new genus *Ceratophallus* was created by BROWN & MANDAHL-BARTH, 1973 (type-species: *Planorbis natalensis* KRAUSS, 1848: Pl. 5, Fig. 9) and is distinguished from all other Planorbidae by an anatomical characteristic, by the long progessively sclerotized distal part of the penis, through which the vas deferens passes to the near terminal male aperture. The flat discoidal shell of the specimens found in Anjouan have a flattened underside and an almost horizontal last whorl; very fine, delicate growth-striae; three to four whorls, translucent, yellowish; aperture oblique, basal margine slightly projected (Pl. 8, Fig. 58a, b).

Sizes	(in	mm)	):
	•		

Localities	Maximal Diameter	Minimal Diameter	Height
Co: A: No. 5 (iuv.)	2.4	2.1	0.6
No. 6	4.3	2.7	0.8

The measurements are from the largest specimens in the samples.

Anatomical records: BROWN wrote in a letter (22nd November 1976): ... "the snails from Anjouan I think are a small form of *Ceratophallus* (lacking obvious sclerotisation on the penis, but having a clearly terminal opening)."

Our dissections confirm this statement (Fig. 92). On the female duct an ovoid receptaculum seminis with a short duct to the lower part of the vagina is developed (Fig. 93). The outside of the mantle is translucent and only slightly pigmented; head and tentacles are dark blue; on the small rounded pseudobranch lies the anal-aperture on the inner surface and at the right the pneumostome-lobe; the radula with about 17 teeth each half-row: central-tooth bicuspid; the laterals tricuspid and the marginals with the formula: 1+1+2/3 (Fig. 94).

Ecological-biological remarks: The snails were found in localities with nearly no current, in creeks near the borders of rivers and in flooded pools adjacent to the rivers, rich with filamentous algae. They were associated with Lymnaea (Radix) natalensis and Melanoides tuberculata.

Temperatures		Chemistry	
1	$_{ m pH}$	conductivity	total hardness
24° C-26.3° C	6.8-8.4	$180-225 \ \mu S$	$3.5^\circ$ — $5.5^\circ$ dH

Geographical range: According to BROWN & MANDAHL-BARTH (1973) the geographical range of *Ceratophallus* includes Eastern Africa from Eritrea to Cape Province. The type species *Ceratophallus natalensis* has according to the authors an extensive range, found in a variety of habitats including temporary pools. In Eritrea the species is so variable that BROWN (1965) suggested the existence of a species-group and he thinks that a further analysis of variation over a greater geographical area is desirable. It is probably that the specimens from Anjouan also belong to the *natalensis*-group.

Family: Ferrissidae Genus: Ferrissia WALKER, 1903 Subgenus: Pettancylus IREDALE, 1943.

30) Ferrissia (Pettancylus) sp.

Lit.: 1964 Studies on Ancylidae. The Subgroups (HUBENDICK, Medd. Göteborgs Mus. Zool. Avd., 137, Ser. B, 9 (6): 72pp.) – 1969 Ferrissia (Ferrissia) modesta (STAR-MÜHLNER, Malacologia, 8 (1/2): 362; Fig. 506-560).

Localities: Mas: Ré: No. 17 (35 ind.); Mau: No. 4 (5 ind.).

Shell: B. HUBENDICK (Naturhistoriska Museet Göteborg) who has studied intensively the Ancylidae of the world (but he has not critically worked out the African Ancylidae) has checked our material and wrote to us (28 Octobre 1976): "... the one from Mauritius is free from distinct characteristics ... I really cannot say anything about that one. The one from La Réunion is a little more distinctive. It is comparatively elongate and tall. It has a radial sculpture-apart from the apical micro-sculpture-which is somewhat reminiscent of the one in *Gundlachia radiata* GUILDING from West Indies. The Réunion-species is of course a clear *Ferrissia*, however. To me it does not seem to fot with the description of STARMÜHLNER (1969) on *Ferrissia modesta* CROSSE, occurring in Madagascar. I have not critically worked out the African Ancylidae and therefore I cannot give any clear-cut answer."

The shells of station Ré: No. 17 are elongated oval; front side broad rounded, back side more narrow; apex on the left side and with very fine radial sculpture; irregularly stairlike growth-striae; translucent, fragile, greywhitish (Fig. 95). The small shells of Mau: No. 4 are yellowish, covered with a reddish-brown coat; leftside apex dense and delicate radially striated (Fig. 96).

Sizes (in mm):

Localities	Maximal Diameter	Minimal Diameter	Height
Mas: Ré: No. 17	3	1.9	1.1
Mau: No. 4	2	1	0.7

The measurements are from the largest specimens in the samples.

Anatomical remarks: Dissected were some specimens from the station Ré: No. 17: Mantle translucent, the inner organs shine through; one irregularly dark blue spot lies in the anterior part between the two anterior adductormuscles. A similar spot was described and figured by HUBENDICK (1967: 21; Fig. 75, 76) for Ferrissia (Pettancylus) neozelandica and also by STARMÜHLNER (1976: 627; Fig. 158) for a Ferrissia (Pettancylus) sp. from Tahiti. Intestine: the salivary glands are connected, the slender oesophagus is proximally extended to the anterior part of the stomach, then following is muscle-stomach and the posterior part of the stomach with an appendix and the apertures of the digestiv gland-ducts; the intestine, embedded in the large digestive gland, forms a long stretched loop and with the rectal part of the left side of the body opens on the outside of the pseudobranch lobe; the kidney, connected by a short reno-pericardial-duct with the pericard, runs at first behind and goes forward following a narrow loop, forms an S-shaped loop, runs with the renalduct again behind and opens below the pseudobranch lobe (Fig. 97, 98). The jaw: typically reversed, U-shaped and composed of small cuticular plates (Fig. 99); radula: 14 teeth in each half-row; central-tooth bicuspid, lateralteeth tricuspid, and the marginals with three prominent cusps in the front and three to four morde delicate, but acute cusps on the outer side (Fig. 100): this type of radula corresponds with the description and figure of Ferrissia modesta from Madagascar, given by STARMÜHLNER (1969: 366; Fig. 513). The genitalsystem were not dissected.

Ecological-biological remarks: The snails of the station Ré: No. 17 were found in a lower course on stones with a surface-current of 50 cm - 1 m/secin a high density of about 200 to 250 individues/1/16 m<sup>2</sup>, associated with *Thiara* scabra, Lymnaea (Radix) mauritiana, Physa borbonica and Planorbella (= Helisoma) duryi. The specimens of Mauritius were found sporadically — on stones in a surface — current of 50 cm/sec, associated with *Melanoides tuberculata*, *Lymnaea* (*Radix*) mauritiana and *Physa borbonica* — in the transition zone between upper and middle courses of rivers.

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Temperatures		Chemistry	
_	$_{\mathrm{pH}}$	conductivity	total hardness
Mas: Ré: No. 17: 23.2° C	8.4	$105 \ \mu S$	$2.5^\circ \mathrm{dH}$
Mau: No. 4: 21.2° C	6.65	116 $\mu S$	$1.85^{\circ} \mathrm{dH}$

Geographical range: In consequence of the impossibility of an exact determination of the specimens of *Ferrissia* (*Pettancylus*) found at La Réunion and Mauritius, no statement of the biogeographic relation can be given at moment. It is possible that *Ferrissia* was introduced passively, like other freshwater snails of the Mascarene-Islands.



Fig. 95. Ferrissia (Pettancylus) sp.: Shell from station Mas: Ré: No. 17
Fig. 96. Ferrissia (Pettancylus) sp.: Shell from station Mas: Mau: No. 4
Fig. 97. Ferrissia (Pettancylus) sp.: Translucent soft-body, seen from the upper-side
Fig. 98. Ferrissia (Pettancylus) sp.: Soft-body seen from the left side: pseudobranch, rectum and renal-duct opening

Fig. 99. Ferrissia (Pettancylus) sp.: Mouth with jaw, seen from the under-side Fig. 100. Ferrissia (Pettancylus) sp.: Radula-teeth 7. General Part

7.1 Longitudinal Distribution of the Collected Species of Freshwater-Gastropods in the Running Waters of the Islands

# 7.1.1 SEYCHELLES

A) Mahé

a) Headwaters to Upper courses (600 m-400 m): Temp.: 21.6° C - Ch.: pH: 5.3; T.H.: 0.095° dH; El<sub>20</sub>: 33  $\mu$ S. Found species: Freshwater Gastropods absent!

b) Upper to Middle courses (400 m-200 m): Temp.: 23.5° C - Ch.: pH: 6.6; T.H.: 0.55° dH; El<sub>20</sub>: 47 μS.

b<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Gyraulus cf. mauritianus.

c) Middle to Lower courses (200 m-10 m):

Temp.: 24.4° C-26° C - Ch.: pH: 6.5-6.9; T.H.:  $0.15^{\circ}-0.65^{\circ}$  dH; El<sub>20</sub>: 33-54  $\mu$ S. c<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Lymnaea (Radix) cf. natalensis, Gyraulus cf. mauritianus (in polluted area with pH: 7.2; T. H.:  $1.39^{\circ}$  dH;  $El_{20}$ : 116  $\mu$ S: Melanoides tuberculata).

c<sup>2</sup>) Medium to strong current (30 cm/sec-1 m/sec):

Found species: From about 40 m altitude: Neritina pulligera stumpfi and knorri, Septaria borbonica; from about 20 m altitude: Neritina (V.) gagates, Neritilia consimilis.

d) Lower courses (10 m - 1 m):

 ${\tt Temp.: 28^{\circ} \, C-Ch.: pH: 6.8; T.H.: 0.2^{\circ} \, dH; El_{20}: 35 \ \mu S.}$ 

d<sup>1</sup>) Medium to strong current (30 cm - 1 m/sec):

Found species: Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis.

e) Mouth-region (1 m-0 m):

Temp.: up to 32° C - Ch.:  $El_{20}$ : 20.000  $\mu$ S (brackish).

e<sup>1</sup>) Brackish pools (no current):

Found species: Terebralia palustris.

e<sup>2</sup>) Low to Medium current (10 cm-30 cm/sec):

Found species: Melanoides tuberculata (pigmy-population!), Syncera (= Assiminea) nitida, Melampus cf. caffer.

These lists establish the following results for the longitudinal distribution of freshwater gastropods in running waters of Mahé: In the headwaters and upper courses of the granitic, primary forests with acidic waters and extremly low content of mineral salts, no freshwater gastropods occur. In the transition to the middle courses, region of secondary forests and plantations the small *Gyraulus* cf. *mauritianus* was occasionally found near the banks and creeks if vegetable mud and debris are deposited. *Lymnaea* (*Radix*) cf. *natalensis* was only found at one station in flooded pools of a rivulet. This species was probably introduced and was never before recorded from the Seychelles. In the transition from the middle to the lower courses the occurence of species of the family Neritidae is typical as in all Indopacific islands. From about 40 to 50 m altitude Neritina pulligera stumpfi and knorri were recorded, both subspecies are restricted to the East-African islands. In a medium to strong current a population of Septaria borbonica was discovered with extremly thin shells. From about 20 m altitude we also found Neritina (V.) gagates and the small Neritilia consimilis in clusters. Melanoides tuberculata occurred exclusively in a polluted part of a rivulet with higher total hardness and conductivity. A pigmy population of high density was found in the brackish moth-zone. In this region near the coast the minute Syncera (= Assiminea) nitida and the pulmonate Melampus cf. caffer juv. are characteristic for brackish habitats. In flooded brackish pools with water-temperatures more than  $30^{\circ}$  C Terebralia palustris is found crawling on muddy bottom.

B) Silhouette

a) Upper courses:

Found species: Cleopatra ajanensis f. silhouettensis (collected by G. LIONNET, Mahé). No other data.

7.1.2 COMORES

A) Grand Comore

a) Stillwater-Cistern:

Temp.: Between 26° C and 28° C – Ch.: pH: 8.1; T.H.: 2.58° dH;  $El_{20}$ : 118  $\mu$ S. Found species: *Afrogyrus (Hovorbis)* cf. *crassilabrum*.

B) Anjouan

a) Headwaters to Upper courses (900 m-600 m):

Temp.: 20° C - Ch.: pH: 7.8; T.H.: 0.6° dH; El<sub>20</sub>: 35 µS.

Found species: Freshwater Gastropods absent!

b) Upper courses (600 m - 400 m):

Temp.: 22.2° C-23° C - Ch.: pH: 7 -8;T.H.:  $2.5^{\circ}$ -3.15° dH; El<sub>20</sub>: 120-142  $\mu$ S. b<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Melanoides tuberculata, Lymnaea (Radix) natalensis.

b<sup>2</sup>) Medium to strong current (30 cm-1 m/sec):

Found species: Septaria borbonica.

c) Upper to Middle courses (400 m-150 m):

Temp.: 24.3° C-26.3° C - Ch.: pH: 8.1-8.4; T.H.:  $2.7^{\circ}$ -3.5° dH; El<sub>20</sub>: 117-180  $\mu$ S. c<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Melanoides tuberculata, Lymnaea (Radix) natalensis, Ceratophallus sp.

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d) Middle to Lower courses (150 m-10 m):

Tomp:  $23.6^{\circ}-27.3^{\circ}$  C - Ch.: pH: 6.8-8.2; T.H.:  $2.3^{\circ}-5.5^{\circ}$  dH; El<sub>20</sub>:  $120-255 \ \mu$ S.

d<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Ceratophallus sp.

 $d^2$ ) Medium to strong current (30 cm-1 m/sec):

Found species: Neritina pulligera stumpfi and knorri, Neritina (V.) gagates, Clithon spiniperda, Septaria borbonica.

e) Lower courses to the Mouth-regions (10 m-0 m):

 $Temp.: 23.6^{\circ}-26.5^{\circ} \ C \ - \ Ch.: \ 7.4-8.1; \ T.H.: \ 1^{\circ}-3.9^{\circ} \ dH; \ El_{20}: \ 43-216 \ \mu S.$ 

 $e^{1}$ ) Medium to strong current (30 cm - 1 m/sec):

Found species: Clithon spiniperda, Clithon chlorostoma f. comorensis, Neritina pulligera stumpfi, Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis.

At the Comores-Archipelago there are no running waters on young volcanic island of Grand Comore. In the cisterns filled with collected rainwater the only recorded species was *Ajrogyrus* cf. *crassilabrum*, probaly introduced from Madagascar. On the older volcanic island of Anjouan with torrents on steep slopes no freshwater-gastropods occur in the headwaters with very low hardness and conductivity. In the upper courses, near the borders and banks with low surface-current and in pools (and thanks for drinking waters nearby the rivulets) only *Melanoides tuberculata* and *Lymnaea* (*Radix*) nata*lensis* were recorded. On the transition to the middle courses and downstream to the lower courses a small *Ceratophallus* sp. is also represented.

From the transition of the middle to the lower courses, downstream to the mouth, the family Neritidae dominates with some species in the medium to strong current of cascades, such as Neritina pulligera knorri and stumpfi; in lower parts succeeded by Neritina (V.) gagates; and on the transition to the lower courses downstream to the influence of brackish-water from recurrent flow of high-tides Clithon spiniperda and Clithon chlorostoma f. comorensis are typically found. In parts with strong currents, such as cascades and waterfalls, Septaria borbonica is attached to the surface of rocks and boulders. Near the water surface was recorded the small Neritilia consimilis in clusters.

# 7.1.3 MASCARENE

A) La Réunion

a) Headwaters (2500 m-1500 m):

 $Temp.: 15^{\circ}-16^{\circ} C - Ch.: pH: 7; T.H.: 1.15^{\circ} dH; El_{20}: 52 \ \mu S.$ 

Found species: Freshwater Gastropods absent.

b) Upper courses (1500 m-700 m):

Tomp.:  $15.2^{\circ}-18.2^{\circ}$  C - Ch.: pH: 8; T. H.:  $3^{\circ}$  dH; El<sub>20</sub>: 130  $\mu$ S.

b<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Lymnaea (Radix) mauritiana, Physa borbonica.
c) Upper to Middle courses (700 m-200 m):

Temp.:  $17.8^{\circ}-23.4^{\circ}$  C - Ch.: pH: 7.7-8.3; T.H.:  $1.1^{\circ}-5.25^{\circ}$  dH; El<sub>20</sub>:  $62-250 \mu$ S. c<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Thiara scabra, Omphalotropis picturata (sporadic in water, mostly outside at wet border), Lymnaea (Radix) mauritiana, Physa borbonica.

d) Middle to Lower courses (200 m-50 m): Temp.: 19°-24° C - Ch.: pH: 7.4-8.6; T.H.: 8.8° dH; El<sub>20</sub>: 52-258  $\mu$ S.

d<sup>1</sup>) Banks and pools (0-30 cm/sec): Found species: Melanoides tuberculata, Thiara scabra, Lymnaea (Radix) mauritiana, Physa borbonica.

d<sup>2</sup>) Medium to strong current (30 cm/sec-1 m/sec): Found species: Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis (lower courses only!)

e)Lower courses to the Mouth-regions (50 m-0 m):

 $\text{Temp.: } 22.1^{\circ}-26.6^{\circ}\text{ C} - \text{Ch.: pH: } 7.2-8.4; \text{T.H.: } 1^{\circ}-2.5^{\circ}\text{ dH; } \text{El}_{20}\text{: } 62-105 \ \mu\text{S}.$ 

e<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Melanoides tuberculata, Thiara scabra, Lymnaea (Radix) mauritiana, Physa borbonica, Planorbella (= Helisoma) duryi.

e<sup>2</sup>) Medium to strong current (30 cm/sec-1 m/sec): Found species: Neritina (V.) gagates, Clithon coronata, Septaria borbonica, Neritilia consimilis, Ferrissia (Pettancylus) sp.

f) Affluent to brackish ponds and swamps of the coast (10 m-0 m):

Temp.: 21.2° C - Ch.: pH: 8; T.H.: 10.7° dH; El<sub>20</sub>: >1600 μS.

f<sup>1</sup>) Medium current (30 cm-50 cm/sec): Found species: Syncera (= Assiminea) hidalgoi f. granum.

In the headwaters of the volcanic mountains (2500 m-1500 m altitude) with low content of mineral salts, freshwater gastropods are absent. From about 1500 m altitude in the banks, creeks and pools between cascades, rich in algae, two pulmonates, Lymnaea (Radix) mauritiana and Physa borbonica occur. They are found in localities with little or no current downstream to lower courses on the coast. From an altitude from about 700 m they are associated with Thiara scabra, and from about 200 m also with Melanoides tuberculata. In one eutrophic rivulet with rich submerged vegetation Planorbella (= Helisoma) duryi an introduced species, was recorded. In a mountaintorrent Omphalotropis picturata, a terrestrial prosobranch, mostly found in wet localities, was found near the banks, partly in water.

The cascade-zones of the middle and lower courses are colonized by different species of Neritidae, such as Neritina (V.) gagates and Septaria borbonica. In the lower parts they are associated with the longspined Clithon coronata and the small Neritilia consimilis, the last always in clusters just below the water surface. On the same eutrophic rivulet, where Planorbella

duryi was found occurs, probly also introduced, on floating waterplants and stones in the medium current the freshwater limpet *Ferrissia* (*Pettancylus*) sp.

In brackish zones near the mouth region the minute Syncera (= Assiminea) hidalgoi f. granum was attached in high density on stones and waterplants.

B) Mauritius

a) Headwaters (700 m - 600 m):

 $\begin{array}{l} \text{Temp.: } 20^\circ-21^\circ\ \text{C}\ -\ \text{Ch.: pH: } 6.1-6.5;\ \text{T.H.: } 0.28^\circ\ \text{dH};\ \text{El}_{20}\text{: } 43-54\ \mu\text{S}.\\ \text{Found species: Freshwater Gastropods absent.} \end{array}$ 

b) Upper courses (600 m-400 m):

Temp.:  $19.4^{\circ}-20.9^{\circ}$  C - Ch.: pH: 6.6-7.6; T.H.:  $1^{\circ}-1.95^{\circ}$  dH; El<sub>20</sub>: 66-97  $\mu$ S. b<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Melanoides tuberculata, Thiara scabra, Omphalotropis gibbosa (sporadic in water, mostly outside at wet border), Lymnaea (Radix) mauritiana, Physa borbonica, Gyraulus mauritianus.

c) Upper to Middle courses (400 m-200 m):

Temp.:  $21.2^{\circ}-23.8^{\circ}$  C - Ch.: pH: 6.6-7-9; T.H.:  $1.85^{\circ}-4.25^{\circ}$  dH; El<sub>20</sub>:  $93-200 \mu$ S. c<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Melanoides tuberculata, Thiara scabra, Lymnaea (Radix) mauritiana, Physa borbonica, Gyraulus mauritianus.

c<sup>2</sup>) Medium to strong current (30 cm-75 cm/sec):

Found species: Neritina (V.) gagates, Clithon coronata f. despinosa (both species occurring from about 300 m altitude), Septaria borbonica, Ferrissia (Pettancylus) sp.

d) Middle to Lower courses (200 m-10 m):

Temp.:  $21.7^{\circ}$  C-25.4° C - Ch.: pH: 7.6-8.2; T.H.:  $1.55^{\circ}$ -2.65° dH; El<sub>20</sub>: 96-195  $\mu$ S. d<sup>1</sup>) Banks and pools (0-30 cm/sec):

Found species: Melanoides tuberculata, Thiara scabra, Bellamya bengalensis f. zonata, Lymnaea (Radix) mauritiana, Physa borbonica.

d<sup>2</sup>) Medium to strong current (30 cm-75 cm/sec):

Found species: Clithon coronata (spined form from about 100 m altitude), Neritina (V.) gagates, Septaria borbonica, Neritilia consimilis.

e) Lower courses to the Mouth-regions (10 m-0 m): Temp.: 22.3°-26.3° C - Ch.: pH: 7.8-8.2; T.H.: 2.3°-2.65° dH; El<sub>20</sub>: 130-165 μS.

 $e^1$ ) Banks and pools (0-30 cm/sec):

Found species: Melanoides tuberculata, Thiara scabra, Bellamya bengalensis f. zonata, Lymnaea (Radix) mauritiana, Physa borbonica (the last two species do not occur in the mouth-regions with brackish-water influence!).

e<sup>2</sup>): Medium to strong current (30 cm-75 cm/l m/sec): Found species: Clithon coronata (spiny form), Neritina (V.) gagates, Neritina (Neripteron) auriculata f. mauriciae, Septaria borbonica, Neritilia consimilis. The headwater-streams of Mauritius are - as in the other high elevated Indian Ocean islands, such as Seychelles, Comores and La Réunion - very soft, slightly acidic and with a very low content on mineral salts. These characteristics cause the absence of freshwater gastropods.

On the banks in creeks and pools between cascades with very little or no current, and a high production of algae and submerged water-plants, the dominant gastropods from the upper courses downstream to the lower courses are the prosobranchs *Melanoides tuberculata* and *Thiara scabra*, further the pulmonate *Lymnaea* (*Radix*) mauritiana and *Physa borbonica*. These species occur mostly in high densities, sometimes associated with *Gyraulus mauritianus* in the upper and *Bellamya bengalensis* f. *zonata* in the middle and lower courses. All these species are to be found also in stagnant waters, such as pools, thanks, etc. At one station the land-prosobranch *Omphalotropis gibbosa* was occasionally near the border.

In the cascade-zones of the middle courses different species of Neritidae appear: *Clithon coronata* is represented from an altitude of about 300 m in the spineless form of *despinosa*. In the lower courses downstream to the mouth the typically longspined form is characteristic. *Neritina* (*Vittina*) gagates occurs from the middle courses at about 300 m altitude downstreams to the brackish regions of the mouth, where salt waters enters during hightide. *Neritina* (*Neripteron*) auriculata f. mauriciae, attached on the underside of stones is to be found exclusively in the lower parts of the lower courses near the influence of brackish water from high tides.

Septaria borbonica, with a streamlined shell, is always attached to the surface of rocks and stones, overflowed by the strong current (cascades, waterfalls). These Neritidae occur from an altitude from about 300 m downstream to the lower courses as long as there is no brackish water present. *Ferrissia* (*Pettancylus*) sp., a very small pulmonate species with a caplike shell was recorded sporadically in cascade-zones between upper and middle courses. The snails were mostly attached to floating water-plants.

Neritilia consimilis, a small species of Neritidae, was recognized from the lower parts of the middle courses at 100 m altitude downstream to the mouthregion, but also outside of the influence of brackish water. The specimens are attached in clusters on stones, just below the water surface.

## C) Rodriguez

From the small isolated island of Rodriguez, E of Mauritius, only a small collection of freshwater gastropods was recorded by the Lund-University-Mission of 1973.

In the small creeks only species, typically of stagnant waters or very slow current, were found: *Melanoides tuberculata* and *Thiara scabra*, besides the pulmonate Lymnaea (Radix) mauritiana and Afrogyrus (Afrogyrus) rodriguezensis, an endemic species of an African genus of small Planorbidae.

At two localities *Omphalotropis rangi*, a terrestrial prosobranch, known from wet localities, such as borders of creeks etc., was recorded.

# 7.2 Zoogeographical Range of the recorded Freshwater-Gastropods of Indian Ocean Islands (Seychelles, Comores, Mascarene)

Abbrevations: Af: Africa; Co: Comores; Ma: Madagascar; Sey: Seychelles; Ré: Réunion; Mau: Mauritius; Ro: Rodriguez; I., B: India, incl. Burma; Cey: Ceylon (Sri Lanka); Mal: Malay Archipelago; Ph: Philippines; N.G.: New Guinea; P.I.: Pacific Islands. Nossi-Bé: island of Nossi-Bé, NW of Madagascar; And: Andaman-Islands; Nic: Nicobar-Islands; N-Aus: N-Australia; Gr.Co: Grand Comore; Anj: Anjouan; int: introduced

				2	Pala	eotr	opis					Aust Austr	ralis Ocea
	Ethiopis	•	N	Iadeg	assis				Ori	ientalis	5	s. str.	nis
Species	AÎ	Co	Ma	Sey	Ré	Mau	Ro	I.,B	Cey	Mal	Ph	N.G.	P.I.
Clithon chlorostoma (f. comorensis)	_	+		_	_	_	-	_	-	_	_	-	+
Clithon coronata (incl. f. despinosa)	-	-	+	—	+	+	+	-	_	(?)		-	-
Clithon spiniperda	-	+	+ (Nossi Bé)	 i-	-	—	_	-	_	-	-	_	_
Neritina (N.) auri- culata		_	+	_	+ f. :	+ mauri	(+) iciae	+	+	+	+	+	+
Neritina (V.) gagates	+ ?	+	+	+	+	+	+	+ ? (And Nic.)	 )		-	-	_
Neritina (N.) pulligera								+	,	+	+	+	+
knorri	+	+	+	+	+	+	(+)	(And	ł.	[with	differe	nt form	s]
stumpfi	_	+	+	+	—	_	_	Nic.)	)				
Septaria borbonica	_	+	+	+	+	+	+	+?		(+)?	(+)?	(+)?	(+)?
Neritilia consimilis	_	+	+	+	+	+	+	_	_	[Ne	erililia	rubida]	
Bellamya bengalensis		—		—	_	+		+	_		_		_
f. zonata						int.							
Paludinella hidalgoi f. granum		-	-	(+)	+	+	+	(+)	(+)	+	÷	+	+
Syncera (= Assiminea) nitida	—	_	-	+	+	+	÷	(+)	(+)	+	+	+	+
Omphalotropis globosa	_	—		+	(+)	+	(+)		_	·	_		
Omphalotropis picturata	ı —	_		_	+	+	(+)	_	_	_	· _	_	_
Omphalotropis rangi		_	—	—	+	+	+	-					
Cleopatra (Z.) ajanensis	. +	_	_	+	—	_	_	—			_		_
• · · · ·			[f. silh	ouette	nsis]								
Thiara scabra	+	_	+	—	+	+	+ (	(+) And.	+	+	+	+	+
Melanoides tuberculata	+	+	+	+	+	+	+	+	, +	+	+	+	+

			Pε	alaeo	otroj	pis						Aust	ralis
Species	Ethiopis Af	s Co	Ma	Made Sey	gassi Ré	s Mau	Ro	Or I.,B	ienta Cey	lis Mal	Ph	Austr. s. str. N.G.	Ocea nis P.I.
Terebralia palustris	+	(+)	(+)	+	(+)	(+)	(+)	+	+	+	+	(+) (N-Aus.	_
Melampus lividus	+	+	+	+	+	+	+	+ (Nic.)	(+)	_			_
Melampus cf. caffer	+	+	÷	+	+	+	+	+ (And Nic.)	+	(+)	(+)	+	+
Physa borbonica Lymnaea (Radix)		-		?	+	+	?	_ '	_		_		-
natalensis s. str.	+	+	+ hovarur	+ n)		—			—		-		_
Lymnaea (Radix) mauritiana Planorhella (Helicom		- (/		—	+	+	+	_					—
durni	u) A spec	eies. o	riginat	ing f	rom ]	Florid	a .in	trodu	ced i	n many	v tron	ical cour	tries
Gyraulus mauritianus	_	_		-	_	+		_	_		,	_	
Afrogyrus (A.) rodri- guezensis					_	-	+.	-	_		—		
Afrogyrus (Hovorbis)	- "	+	、 <del>+</del>		—	—	_	-	_	—			_
Ceratophallus sp.	+ ((	r.co. + (Ani.)	.)		_		—						-
Ferrissia (Pett- ancylus) sp.	diff. species	 	F. (P.) modesta	) — x	+	+				differe	ent sp	ecies	

7.2.1 Species with a Palaeotropis-Australis Range (including Oceanis-Region) = Indopacific Range:

Melanoides tuberculata, Thiara scabra, Terebralia palustris, Melàmpus lividus, Melampus cf. caffer, Neritina (Neripteron) auriculata-group, Neritina (N.) pulligera-group, Clithon chlorostoma-group, Paludinella hidalgoi f. granum, Syncera (= Assiminea) nitida.

7.2.2 Species with an Ethiopis-Madegassis-(Orientalis?) Range: Neritina (Vittina) gagates.

7.2.3 Species with an Ethiopis-Madegassis Range:

Lymnaea (Radix) natalensis-group (including hovarum from Madagascar), Ceratophallus sp., Cleopatra ajanensis (including f. silhouettensis).

7.2.4 Species with a Madegassis-Orientalis Range:

Septaria borbonica (the distribution eastwards the Australis Region is doubtfull and perhaps a confusion with Septaria porcellana (including porcellana depressa); 7.2.5 Species with a Madegassis Range:

a) Endemic for Madagascar [passively introduced to Grand Comore-island(?)]:

Afrogyrus (Hovorbis) crassilabrum

b) Endemic for Comores-islands and Nossi-Bé: Clithon spiniperda.

c) Endemic for the Mascarene-Archipelago: Omphalotropis picturata, Omphalotropis rangi, Omphalotropis globosa (also recorded from the Seychelles!), Physa borbonica, Lymnaea (Radix) mauritiana, Gyraulus mauritianus (probably also introduced to the Seychelles!).

d) Endemic for Rodriguez: Agrogyrus (Afrogyrus) rodriguezensis

7.3 Comparison of the geographical range of the recorded species of fresh- and brackish-water gastropods from running waters of Indian Ocean islands (Seychelles, Comores, Mascarene):

7.3.1 Seychelles: From 12 recorded species in	n running	waters	are	with
Palaeotropis-Australis (incl. Oceanis) Range:	: 54%			
(Ethiopis ?)-Madegassis-(Orientalis) Range:	7.5%			
Ethiopis-Madegassis Range:	15.5%			
Madegassis-Orientalis Range:	7.5%			
Madegassis Range:	15.5%			

This list indicates that the majority of gastropods in the running waters of the Seychelles have a wide geographic range in the Indopacific. No endemic species occur in the Seychelles Archipelago, with exception of a forma of the Eastafrican *Cleopatra ajanensis* (anatomy unknown, onyl shells recorded). This species is the only old faunistic element in the freshwater gastropod fauna of these islands. The genus *Cleopatra* is typical of the Ethiopian Region, including the Madegassian Subregion (with endemic species). The near related genus *Paludomus* occurs with many endemic species (and an endemic subgenus: *Tanalia*) in Ceylon and other parts of the Oriental Region (STARMÜHLNER 1969; 1974).

An other Ethiopic element is Lymnaea (Radix) cf. natalensis, but probably passively introduced by man to Mahé. Only from the Madegassian Subregion are recorded two species of Omphalotropis, a genus of landprosobranchs and found only occasionely in water on the borders of running waters. The genus with many species is distributed on different Indian Ocean islands.

Gyraulus cf. mauritianus, recorded on Mahé, was probably passively introduced by Indian immigrants from Mauritius. Neritina pulligera, widely distributed on the coasts of the Indopacific with many local forms occurs on Mahé with the subspecies knorri (range: SE-Africa, Comores, Madagascar, Mascarene-Archipelago) and the subspecies stumpfi (range: Comores, island of Nossi-Bé).

## 7.3.2 Comores

## 7.3.2.1 Grand Comore

The geologically youngest island of the Comores-Archipelago, Grand Comore, is lacking any running and natural stagnant waters. Rainwater is collected by the inhabitants in cisterns. In such localities was recorded A*frogyrus (Hovorbis)* cf. *crassilabrum.*, a highly variable species, known from Madagascar. The snail was probably introduced passively by man to Grand Comore.

## 7.3.2.2 Anjouan

11 recorded species of gastropods in the running waters are distributed:

Palaeotropis-Australis (incl. Oceanis) Range:	36%
(Ethiopis ?)-Madegassis-(Orientalis ?) Range:	9%
Ethiopis-Madegassis Range:	18%
Madegassis-Orientalis Range:	18%
Madegassis Range:	18%

The only endemic species for the Comores-Archipelago (including the island of Nossi-Bé) is *Clithon spiniperda*. A related species, *Clithon bicolor*, is known from the Malay Archipelago (STARMÜHLNER, 1969). Neritilia consimilis was recorded from all islands of the Madegassian Subregion and is very near related to the Pacific species Neritilia rubida (see STARMÜHLNER, 1976). *Clithon chlorostoma*, recorded from different Pacific islands (STARMÜHLNER, 1976) is after our apinion identical with *Clithon comorensis*, described from Anjouan. The specimens recorded at Anjouan are in our opinion only a local form of the Pacific *Clithon chlorostoma*.

More than one-third of the recorded species have a wide range on the Indopacific coasts, but are represented in local forms such as the Neritina pulligera-group with the subspecies knorri and stumpfi in the Madegassian Subregion. Immigrated (or passively introduced by man or water-birds) from the Ethiopian Region are the pulmonate snails Lymnaea (Radix) natalensis and a Ceratophallus sp. (some species are known from Africa). Septaria borbonica was recorded on all islands of the Madegassian Subregion. The species is probably distributed eastwards to islands of the Oriental Region (BENTHEM-JUTTING, 1956). The record in the Australian Region (Pacific Islands, RIECH, 1937) is probably confused with Septaria porcellana and S. p. depressa. Neritina (Vittina) gagates is recorded from all islands of the Madegassian Subregion, but the records on the coast of SE-Africa and in the east of the Indian Ocean, from the Andaman- and Nicobar-Islands are doubtfull.

### 7.3.3 Mascarene

### 7.3.3.1 La Réunion

17 recorded species of freshwater- and brackish-water gastropods (one species, *Ferrissia* (*Pettancylus*) sp. not included!) in running waters are distributed:

Palaeotropis-Australis (incl. Oceanis)	Range: 48%
Tropical ubiquistic Range:	5.5%
Madegassis-Orientalis Range:	11.5%
Madegassis Range:	35%

Nearly half of the recorded gastropods in running waters are widely distributed on the coasts of the Indopacific. In contrast to the Seychelles and Comores, no species from the Ethiopian region was found. Only *Neritina* (*Vittina*) gagates, a characteristic species of the Madegassian Subregion, probably extended its range westward to the coast of SE-Africa.

A third of the collected species are recorded only from the Madegassian Subregion, such as *Clithon coronata*, *Neritilia consimilis* and two species of *Omphalotropis*, collected on banks of rivulets. All four species have related species in the Oriental Region, resp. on Pacific islands.

Lymnaea (Radix) mauritiana and Physa borbonica are endemic to the Mascarene-Archipelago. Septaria borbonica probably occurs eastward to the Malay Archipelago (BENTHEM-JUTTING, 1956). Planorbella (= Helisoma) duryi is passively introduced by man like in many subtropical and tropical countries of the world.

## 7.3.3.2 Mauritius

19 recorded species of fresh- and brackish-water gastropods (one species, *Ferrissia* (*Pettancylus*) sp. not included!) in running waters are distributed:

Palaeotropis-Australis (incl. Oceanis) Range:	42%
(Ethiopis ?)-Madegassis-(Orientalis ?) Range:	5%
Madegassis-Orientalis Range:	11%
Madegassis Range:	42%

From 42% of widely distributed gastropods half (as on other Indian Ocean islands) are recorded in brackish localities of the mouth-regions of running waters. Neritina (Neripteron) auriculata is a extremly variable species in shape and form of the shell. From Mauritius was described a forma mauriciae (GERMAIN, 1921). Bellamya bengalensis f. zonata-mostly in stagnant waters with muddy bottom was also found sometimes on the banks of slow-flowing rivers. The species was introduced from India, probably also from Indian immigrants. All other recorded species are distributed only in the Madegassian Subregion or have the center of the range on the islands of the Subregion. Two species are endemic for the Mascarene-Archipelago: Lymnaea (Radix) mauritiana and Physa borbonica; one species is endemic only for Mauritius: Gyraulus mauritianus (probably introduced on Mahé, Seychelles).

## 7.3.3.3 Rodriguez

12 recorded species of freshwater- and brackish-water gastropods in running waters are distributed:

Palaeotropis-Australis (incl. Oceanis) Range:	46%
(Ethiopis?)-Madegassis-(Orientalis?) Range:	8%
Madegassis-Orientalis Range:	8%
Madegassis Range:	38%

On the small islands of Rodriguez, the farest island of the Mascarene-Archipelago, in the Eastern Madegassian Subregion, are nearly half of the recorded (and reported) species from running waters widely distributed on the coasts of the Indopacific. The majority of these species occur in brackish habitats of the mouth-zones.

Two species, *Melanoides tuberculata* and *Thiara scabra* are the most common freshwater snails on Indopacific islands and probably introduced by man passively with rice- and waterplants in many habitats.

More than the half of the collected running water-gastropods have their occurrence in the Madegassian Subregion, such as *Clithon coronata*, *Neritilia consimilis*, *Septaria borbonica* and *Neritina* (*Vittina*) gagates, but all with near-related species of the same genus in the Oriental, resp. Australian and Oceanic Regions. Lymnaea (Radix) mauritiana and Omphalotropis rangi are endemic for the Mascarene-Archipelago, and one species, *Afrogyrus* (*Afrogyrus*) rodriguezensis, is endemic to the small island. *Afrogyrus* (*Afrogyrus*), created by BROWN & MANDAHL-BARTH (1973) is distributed with different species in the Ethiopian Region.

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#### Abbrevations of the text-figures

- A: Abd.g.: Abdominal ganglion A.g.: Albumen gland ant. Ad.: anterior Adductor-muscle
- B: b.c.: basal cusps (on central-tooth of the radula)
- C: C.B.c.: Cerebro-Buccal-connective Ce.t.: Central-tooth (or Rachis-tooth) Coe.: Coecum Cr.: Crystal-sac
- D: D.e.: Ductus enigmaticus Di.gl.: Digestive gland
  - d.sp.: darkblue spot
- F: f.: foot
  - F.l.: First lateral-tooth
  - f.p.: fingerlike process (on the mantle edge)
  - fl. f.: flaplike fold
  - Fo. l.: Fourth lateral-tooth
- G: g.: gill

ge.gr.: genital groove Go.: Gonade

- I: I.m.: Inner marginal-tooth Int.: Intestine
- J: J.: Jaw
- K: Kid.: Kidney
- L: l. Bu.g.: left Buccal-ganglion l.C.g.: left Cerebral-ganglion l.Par. g.: left Parietal-ganglion l.Pe.g.: left Pedal-ganglion l.Pl.g.: left Pleural-ganglion

- M: m.lac.: mantle-edge lacune M.t.: Marginal-tooth m.st.: muscle stomach N: N.l.: Nervus labialis (1-3)N.o.: Nervus opticus N.t.: Nervus tentacularis O: Oes.: Oesophagus O.m.: Outer marginal-tooth Oot.: Ootype (with capsule gland) Os.: Osphradium Ov.: Oviduct P: Pe.: Penis Per.: Pericard Pn.: Pneumostom po. p. st.: posterior part of stomach post.Ad.: posterior Adductor Prae.: Praeputium Prae.gl.: Praeputial gland Pro.: Prostate Ps.: Pseudobranch R: r.Bu.g.: right Buccal-ganglion r.C.g.: right Cerebral-ganglion Re.: Rectum Ret.: Retractor-muscle Rh.: Rhachis-tooth (or Central-tooth) r.Par. g.: right Parietal-ganglion r.Pl. g.: right Pleural-ganglion R.s.: Receptaculum seminis
  - re.du.: renal duct
- S: Sal.gl.: Salivary gland Sb.g.: Subintestinal-ganglion Sp.g.: Supraintestinal-ganglion Sp. s.: Spermatophor-sac (or Spermatheca) Stat.: Statocyst Sti.: Stilet
- U: Ut.p.: Uteral part (of oviduct)
- V: Vag.: Vagina V.c.d.: Vaginal connecting duct

### Explanation of the plates

### Plate 1

Fig. 1. Clithon (Cl.) chlorostoma f. comorensis; Co: A: No. 13; a: aperture; b: dorsal side; Height: 13.9 mm

Fig. 2. *Clithon (Cl.) coronata*; spined form; Mas: Mau: No. 21; a: aperture; b: dorsal side; Height: 17.7 mm

Fig. 3. *Clithon (Cl.) coronata f. despinosa*; Mas: Mau: No. 5; a: aperture; b: young specimen from dorsal side with rests of spines; c: f. *despinosa* from dorsal side; Height: 19 mm (adult)

Fig. 4. *Clithon (Cl.) spiniperda*; Co: A: No. 13; a: aperture; b: young specimen from dorsal side with rests of spines; c: adult specimen from dorsal side without spines; Height: 13.2 mm (adult)

Fig. 5. Neritina (Neripteron) auriculata f. mauriciae; Mas: Mau: No. 23; a: aperture; b: dorsal side; Height: 11 mm

Fig. 6. Neritina (Vittina) gagates; Sey: M: No. 3; a: aperture; b: dorsal side; Height: 24.4 mm

Fig. 7. Neritina (Vittina) gagates; Mas: Mau: No. 8; a: aperture; b: dorsal side; Height: 16.5 mm

Fig. 8. Neritina (Vittina) gagates; Mas: Ré: No. 19; a: aperture; b, c: dorsal sides of immature specimens, to show the zig-zag lines on the shells; Height: 12.5 mm

### Plate 2

Fig. 9. Neritina (Neritina) pulligera knorri; Sey: M: No. 3; a: aperture; b: dorsal side; Height: 23.4 mm

Fig. 10. Neritina (Neritina) pulligera stumpfi; Sey: M: No. 3; a: aperture; b: dorsal side; Height: 17.2 mm

Fig. 11. Septaria borbonica; Sey: M: No. 7; a: aperture; b: dorsal side; Lenght: 22 mm

Fig. 12. Septaria borbonica; Co: A: No. 15; a: aperture; b: dorsal side; Lenght: 30 mm

Fig. 13. Septaria borbonica; Mas: Mau: No. 15; a: aperture; b: dorsal side; Lenght: 31 mm

#### Plate 3

Fig. 14. Clithon (Cl.) chlorostoma f. comorensis; Co: A: No. 13; Operculum: a: ventral side; b: dorsal side; Size:  $6.8 \times 4$  mm

Fig. 15. Clithon (Cl.) coronata; Mas: Ré: No. 19; Operculum: a: ventral side; b: dorsal side; Size:  $8.5 \times 4.7$  mm

Fig. 16. Clithon (Cl.) spiniperda; Co: A: No. 13; Operculum: a: ventral side; b: dorsal side; Size:  $8.9 \times 5$  mm

Fig. 17. Neritina (Neripteron) auriculata f. mauriciae; Mas: Mau: No. 23; Operculum: a: ventral side; b: dorsal side; Size:  $7 \times 4.3$  mm

Fig. 18. Neritina (Vittina) gagates; Sey: M: No. 3; Operculum: a: ventral side; b: dorsal side; Size:  $11 \times 7 \text{ mm}$ 

### Plate 4

Fig. 19. Neritina (Neritina) pulligera knorri; Sey: M: No. 3; Operculum: a: ventral side; b: dorsal side; Size:  $10 \times 7$  mm

Fig. 20. Neritina (Neritina) pulligera stumpfi; Sey: M: No. 3; Operculum: a: ventral side; b: dorsal side; Size:  $12.5 \times 7.5$  mm

Fig. 21. Septaria borbonica; Sey: M: No. 7; Operculum: ventral side; Size:  $8 \times 5$  mm Fig. 22. Septaria borbonica; Co: A: No. 15; Operculum: a: ventral side; b: dorsal

side; Size: 7.8×4.9 mm

Fig. 23. Neritilia consimilis; Sey: M: No. 7; a: aperture; b: dorsal side; Size:  $7.8 \times 4.9 \text{ mm}$ 

Fig. 24. Neritilia consimilis; Sey: M: No. 7; Operculum: a) ventral side; b, c: dorsal side; Size:  $2 \times 1.3$  mm

#### Plate 5

Fig. 25. Bellamya bengalensis f. zonata; Mas: Mau: No. 25; Aperture; Height: 23 mm
Fig. 26. Bellamya bengalensis f. zonata; Mas: Mau: No. 25; Operculum; Size: 12×
9 mm

Fig. 27. Paludinella hidalgoi f. granum; Mas: Ré: No. 24; Aperture; Height: 2.2 mm Fig. 28. Paludinella hidalgoi f. granum; Mas: Ré: No. 24; Dorsal side (apex eroded);

## Height: 2.2 mm

Fig. 29. Syncera (= Assiminea) nitida; Sey: M: No. 8; Aperture; Height: 2.3 mm

F. STARMÜHLNER: Results of the Hydrobiological Mission 1974 of the Zoological Institute of the University of Vienna



Plate 1

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b а а b Fig. 53 Fig. 54 b a b а Fig. 56 Fig. 55 b а b a Fig. 58 Fig. 57

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Fig. 30. Omphalotropis (O.) globosa; Mas: Mau: No. 2; Aperture; Height: 5.5 mm Fig. 31. Omphalotropis (O.) picturata; Mas: Ré: No. 3; Aperture; Height: 4.2 mm Fig. 32. Omphalotropis (O.) rangi; Mas: Ro: No. 1; Aperture; Height: 5.6 mm

#### Plate 6

Fig. 33. Cleopatra (Zanguebarica) ajanensis f. silhouettensis; Sey: S: No. 1; a, b: Aperture (apex eroded); Height: 9.5 mm

Fig. 34. Thiara (Plotia) scabra; Mas: Ré: No. 4; a, b: Aperture; Height: 17.6 mm, 15 mm

Fig. 35. Thiara (Plotia) scabra); Mas: Mau: No. 21; a, b: Aperture; Height: 21.8 mm, 19 mm

Fig. 36. Thiara (Plotia) scabra; Mas: Ré: No. 24; Aperture; (f. pagoda); Height: 22.5 mm

Fig. 37. Melanoides (M.) tuberculata; Sey: M: No. 8; Aperture; specimen of a pigmy population; Height: 8.3 mm

Fig. 38. Melanoides (M.) tuberculata; Mas: Mau: No. 4; Aperture; (apex eroded); Height: 23 mm

### Plate 7

Fig. 39. Terebralia palustris; Sey: M: No. 8; Aperture; Height: 117 mm

Fig. 40. Terebralia palustris; Sey: M: No. 8; Operculum; Diameter: 50-60 mm

Fig. 41. Physa borbonica; Mas: Ré: No. 1; Aperture; Height: 11.4 mm

Fig. 42. Lymnaea (Radix) natalensis; Co: A: No. 5; Aperture; Height: a) 13.7 mm; b) 11 mm

Fig. 43. Lymnaea (Radix) cf. natalensis; Sey: M: No. 2; Aperture; Height: 11 mm
Fig. 44. Lymnaea (Radix) natalensis hovarum; Mad: No. 1; Aperture; Height:
13.1 mm

Fig. 45: Lymnaea (Radix) mauritiana; Mas: Ré: No. 5; Aperture; Height: 10 mm Fig. 46. Lymnaea (Radix) mauritiana; Mas: Ré: No. 5; Aperture; Height: 8 mm Fig. 47. Lymnaea (Radix) mauritiana; Mas: Ré: No. 23; Aperture; Height: 19 mm Fig. 48. Lymnaea (Radix) mauritiana; Mas: Ré: No. 23; Aperture; Height: 15 mm Fig. 49. Lymnaea (Radix) mauritiana; Mas: Mau: No. 6; Aperture; Height: 11 mm Fig. 50: Lymnaea (Radix) mauritiana; Mas: Mau: No. 6; Aperture; Height: 10.5 mm Fig. 51. Lymnaea (Radix) mauritiana; Mas: Ro: No. 4; Aperture; abnorme form;

Height: 18.8 mm

Fig. 52. Lymnaea (Radix) mauritiana; Mas: Ro: No. 4; Aperture; normale form; Height: 15 mm

#### Plate 8

Fig. 53. Planorbella (= Helisoma) duryi; Mas: Ré: No. 17; two shells; Diameter: 14.7 mm

Fig. 54. Gyraulus cf. mauritianus; Sey: M: No. 1; two shells; Diameter: 3.6 mm

Fig. 55. Gyraulus mauritianus; Mas: Mau: No. 6; two shells; Diameter: 3.5 mm Fig. 56. Afrogyrus (Afrogyrus) rodriguezensis; Mas: Ro: No. 1; two shells; Diameter:

4.2 mm

Fig. 57. Afrogyrus (Hovorbis) cf. crassilabrum; Co: Gr. Co:No. 2; two shells; Diameter: 4.5 mm

Fig. 58. Ceratophallus sp.; Co: A: No. 5; two shells; Diameter: 4 mm