DANISH BILHARZIASIS LABORATORY

in collaboration with the Eastern Mediterranean Regional Office of the WORLD HEALTH ORGANIZATION

A FIELD GUIDE

to

FRESHWATER SNAILS

IN COUNTRIES OF

THE WHO EASTERN MEDITERRANEAN REGION

1983

A FIELD GUIDE TO FRESHWATER SNAILS IN COUNTRIES OF THE WHO EASTERN MEDITERRANEAN REGION

DANISH BILHARZIASIS LABORATORY
WHO COLLABORATING CENTRE FOR APPLIED MALACOLOGY

COPENHAGEN

1983

PREFACE

This Field Guide to the freshwater snails found in countries of the WHO Eastern Mediterranean Region (EMRO) includes all species of medical or veterinary importance, with emphasis on the three genera: Lymnaea, Biomphalaria and Bulinus.

The guide covers three zoogeographical regions, namely, the Palaearctic, Oriental and Ethiopian regions.

The freshwater snails from the Middle East are little known and collection of more snail material, followed by a taxonomical revision for some of the genera, is desirable. The main difficulties are found within the prosobranchs, which are without medical importance. Taxonomic problems are also recognized within the genus Lymnaea some species of which may act as intermediate host of the liverfluke, Fasciola.

All genera of freshwater snails and all species of medical or veterinary importance are represented in this guide by drawings. However,as the size of the species may be very variable, it is unfortunately not possible to draw all of them to the same scale. The actual size of the mature snail species is giving in mm.

Acquaintance with certain technical terms and the ability to carry out a very simple dissection are essential in order to achieve a reliable identification within some of the genera. Thus the first part of this guide is a very short introduction to malacology; it provides the necessary explanation of the anatomy of pulmonates and how to carry out a dissection and other malacological procedures.

Snails which cannot be identified by the use of this guide, or for which confirmation of the identification is desired, can be sent to the address given below.

This guide to the freshwater snails found in countries of the WHO Eastern Mediterranean Region has been prepared at the request of the WHO Regional Office for the Eastern Mediterranean Region. The expenses incurred have, in part, been covered by a WHO/EMRO grant.

The author wishes to thank all who have in one way or another contributed to the guide, with special thanks to Dr. Fergus McCullough, WHO/Geneva, for his commitment and positive criticism during its preparation.

Flemming Frandsen

Danish Bilharziasis Laboratory

(WHO Collaborating Centre for
Applied Malacology)
Jaegersborg Alle 1 d
DK 2920 Charlottenlund

DENMARK

C O N T E N T S

COUNTRIES OF THE WHO EASTERN MEDITERRANEAN REGION

COUNTRY	SURFACE AREA IN SQ. KM.	POPULATION IN MILLIONS (1982)
Afghanistan	647,497	15.5
Bahrain	622	0.4
Cyprus	9,251	0.6
Democratic Yemen	332,968	2.0
Djibouti	22,000	0.3
Egypt	1001,449	44.7
Iran	1648,000	39.9
Iraq	434,924	12.7
Israel	20,770	4.1
Jordan	97,740	2.5
Kuwait	17,818	1.5
Lebanon	10,400	2.9
Libya	1759,540	3.0
Oman	212,457	1.0
Pakistan	803,943	87.1
Qatar	11,000	0.2
Saudi Arabia	2149,690	8.9
Somalia	637,657	4.0
Sudan	2505,813	18.9
Syria	185,180	9.4
Tunisia	163,610	6.5
United Arab Emirates	83,600	1.0
Yemen Arab republic	195,000	8.0

INTRODUCTION TO MALACOLOGY

Freshwater snails consist of two well defined parts, the shell and the soft parts. Under normal conditions much of the latter, i.e. the head and foot, is outside the shell. The rest of the animal's soft parts, i.e. the upper part containing digestive gland, stomach, intestine, parts of the reproductive system, etc., is always protected by the shell. Under certain conditions, for example during aestivation, attack by predators, periods of rest and shell production, the head-foot region is withdrawn into the shell.

This introduction provides a short account of the morphology of the shell and the anatomy of the soft parts. It includes only the most important features which may be relevant to the identification of freshwater snails as indicated in the keys of this guide. For more elaborate studies it will be necessary to refer to various handbooks.

The drawings of morphological and anatomical details are done mainly from freshwater snails of medical or veterinary importance, which in the area covered by the guide include the following genera: *Lymnaea* (the intermediate host for *Fasciola*, liver fluke), *Biomphalaria* and *Bulinus* (both intermediate hosts for the blood flukes belonging to the genus *Schistosoma*).

A list of selected references for further reading is given on p. 44.

GASTROPOD SHELL

More than 200,000 fossil snail species and about 80.000 recent species have been described according to shell morphology. Therefore it has been necessary to develop a very specific and distinct terminology for the description of the shell.

THE FUNDAMENTAL FEATURES OF THE SHELL (Fig. I)

A shell is a conical tube, spirally coiled around a central axis or columella. The separate coils of the spiral are called whorls. The whorls are usually in close contact, each whorl being partially covered by its successor. The line occurring where two whorls meet are called the sutures.

The last whorl is called the body whorl and is found around the opening or aperture, through which the body of the snail can be protruded or retracted. All whorls above the body whorl form the spire, the tip of which is called the apex.

An umbilicus or hole, adjacent to the aperture in the axis of the shell, may be present if the whorls are not contiguous with the columella. If the columella is solid, the snail is called imperforate, otherwise perforate or umbilicate.

WHORLS

The whorls may be flat, convex or angular. If an angle is present between the suture and periphery it is called a shoulder angle. If the angle is very protruded and sharp, it is called a keel and the whorls are carinated.

SEPTA / INTERNAL LAMELLAE

Sets of internal lamellae, also called septa, are found in shell of various genera of pulmonates. It is possible to see the septa in transparent light. They may be more or less visible. The number of septa vary between 1 and 9.

SCULPTURE

The sculpture of the shell consists of the pronounced macrosculpture including growth lines, striae and ribs, the more irregular sculpture which may be transverse or spiral and the more delicate microsculpture, consisting of transverse lines, dots or ribs, visible only with the aid of a lens or microscope. Various types of macrosculpture as well as microsculpture are illustrated in Figure I. The most pronounced sculptures are found on prosobranch shells. Microsculpture is a very important character in identifying *Bulinus* species.

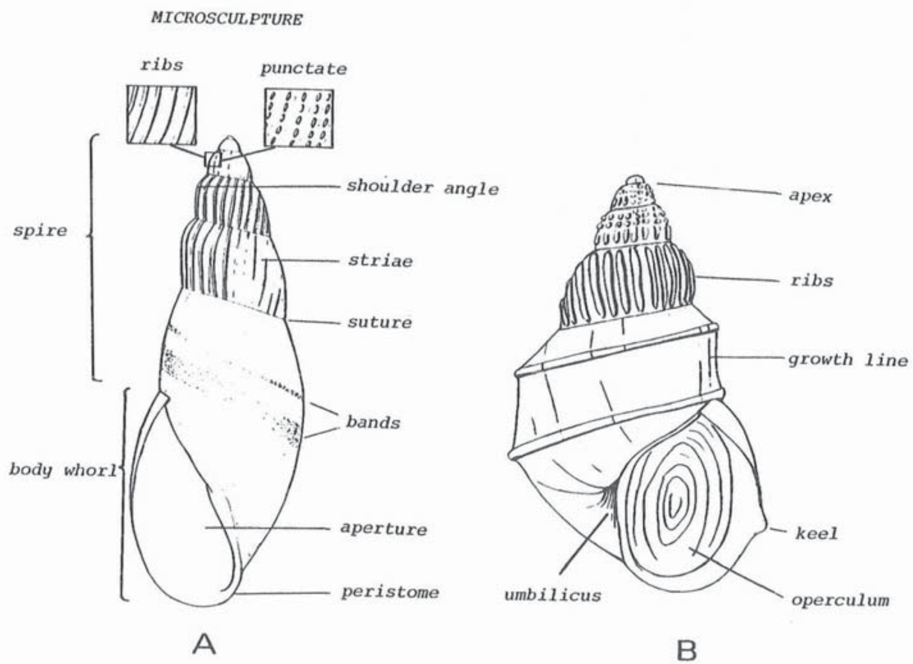


FIGURE I. MORPHOLOGICAL FEATURES OF THE SHELL

A: A sinistral shell. B: A dextral shell.

DIRECTION OF COILING

A shell may be either dextral (opening to the right) or sinistral (opening to the left), when held with the aperture facing the observer and apex upward. Snails with a dextral shell normally have genital openings, anus and pneumostome placed on the right side of the body and snails with a sinistral shell, on the left side.

COUNTING OF WHORLS

The number of whorls varies considerably according to species and size and it is often difficult to predict the maximum size or number of whorls for a fully grown shell as freshwater snails increase in size throughout their lifespan.

Figure IIA illustrates the counting of whorls, the arrow indicating the direction of counting and the broken line the limit of each whorl. Whorls may be slowly increasing (Figure IIB) or rapidly increasing (Figure IIC). In shells of the same diameter the number of whorls is greater for the one with slowly increasing whorls than the one with rapidly increasing whorls.

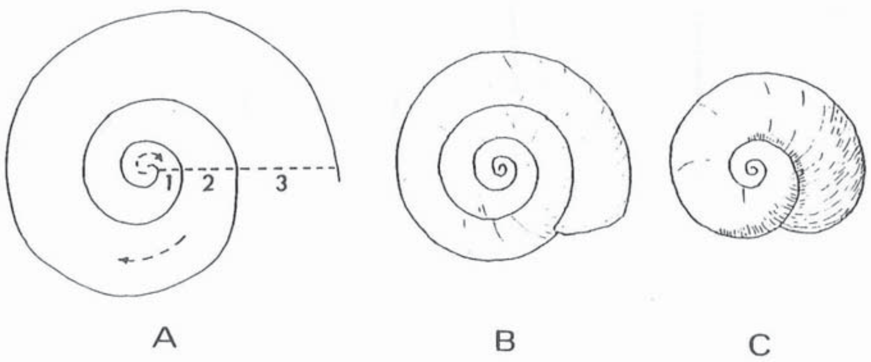


FIGURE II. A: *Counting of whorls.* B: *Slowly increasing whorls.* C: *Rapidly increasing whorls.*

MEASURING OF THE SHELL

The dimensions of the shell are also important characters. The height of the shell is the distance between the apex and the basal margin of the aperture, measured parallel to the columella (Figure III). The width is the distance between the outer lip and the opposite wall, measured at right angle to the columella. Methods for measuring the dimensions of the shell and aperture are illustrated in Figure III.

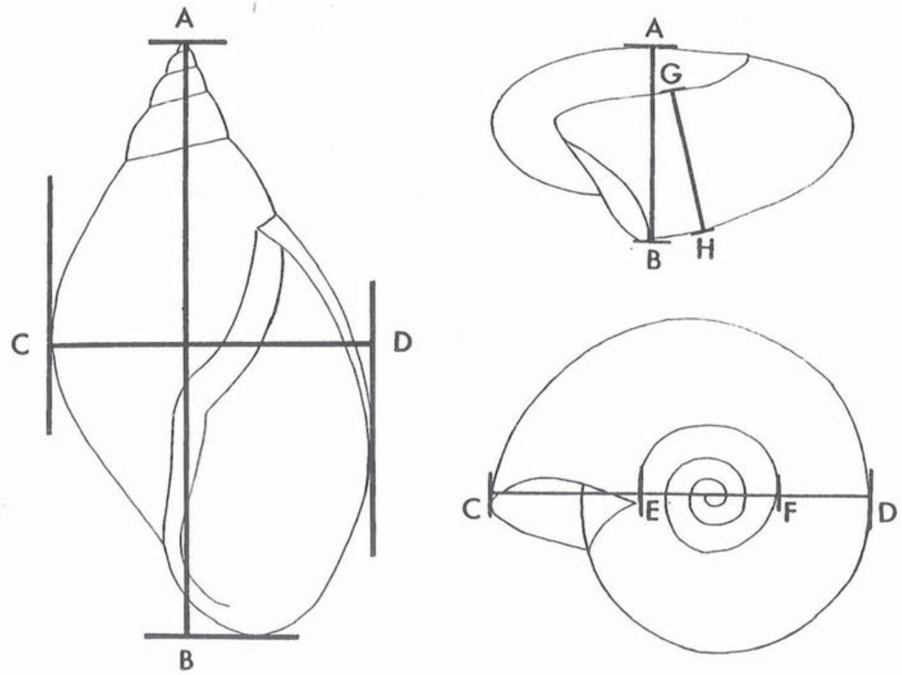


FIGURE III. MEASURING OF THE SHELL

A – B: *Height of the shell.* C – D: *Diameter of the shell.*
E – F: *Diameter of umbilicus of a planorbid shell.*
G – H: *Height of the last whorl.*

APERTURE

The aperture is the opening leading to the cavity of the shell and is enclosed by the peristome consisting of four parts: the outer lip, the basal margin, the columellar margin and parietal wall. The basal margin in many prosobranches is notched and drawn out into a spout. In some snails there is an uneven transition between the columella and the basal margin, a so-called truncate columella. A similar structure is very often found in the genus Bulinus and is called a false truncation since it is caused by a fold on the columella.

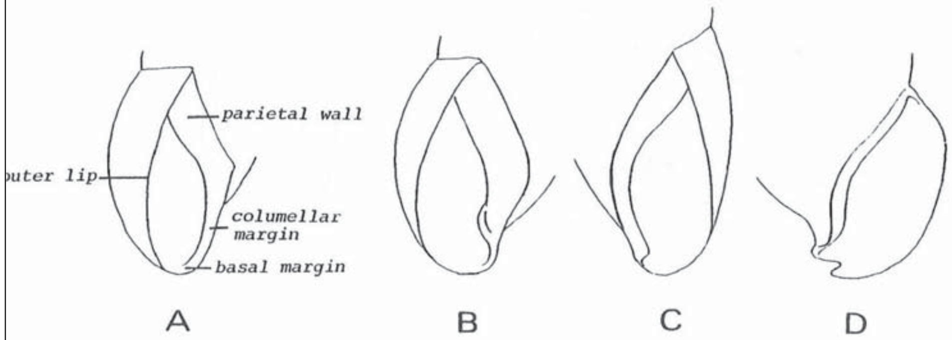


FIGURE IV. VARIOUS DESIGNS OF THE APERTURE

A: *The four parts of the peristome.* B: *False truncation, fold on columella.* C: *Real truncation.* D: *A notch.*

OPERCULUM

When prosobranchs retract their head and foot into the shell, the aperture is closed by a lid, or operculum. Pulmonates close their aperture during hibernation or aestivation with layers of coagulated mucus.

The operculum is formed at the upper part of the foot. It may be formed of horny material, conchiolin, which makes it bendable, or it may be strengthened by calcareous layers which is rigid.

The growth of the operculum follows the growth of the shell in either a concentric or spiral direction. An operculum with spiral growth may consist of a few, rapidly increasing whorls (paucispiral) or slowly increasing whorls (multispiral). Certain opercula have a spiral older part and a younger outer part which is concentric. Opercula of the family Neritidae possess a rib and peg, apophyses, on the inner surface.

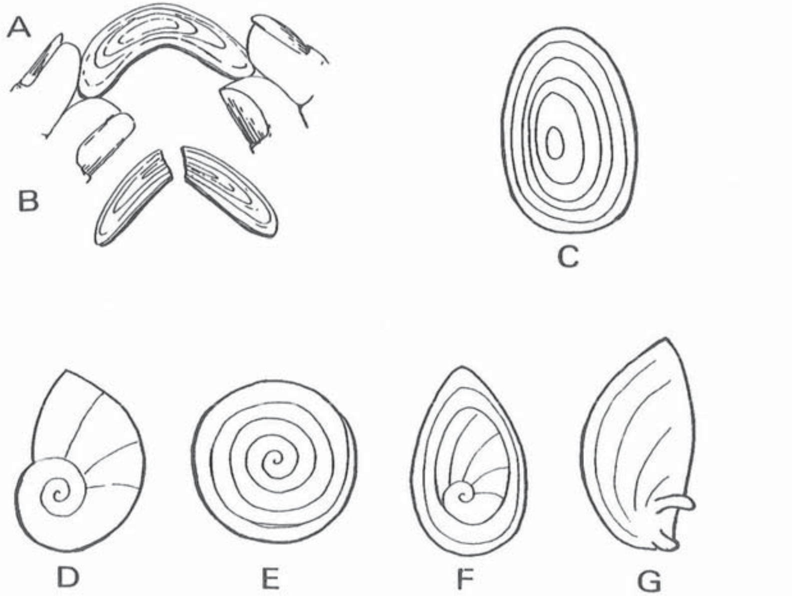


FIGURE V. OPERCULUM

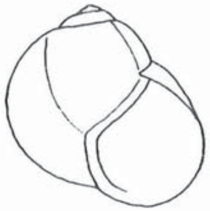
A: *Corneous operculum.* B: *Calcareous operculum.* C: *Concentric operculum.* D: *Paucispiral operculum* E: *Multispiral operculum.* F: *Concentric operculum with a spiral inner part.* G: *Operculum with apophyses.*

THE FORM OF THE SHELL

The globose shell may be considered as a fundamental form from which other forms can be derived. The height and width of the shell as well as of the aperture are almost the same. The most important types and their characteristics are illustrated in Figure VI.

GLOBOSE SHELL

The height and width of the shell are about the same.

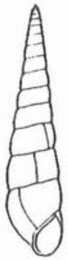


CONICAL SHELL

The height of the shell is larger than the width. The spire is cone-shaped.

TURRETED SHELL

The height is many times greater than the width.



HEMISPERICAL SHELL

The spire is very short, often partly hidden.

DISCOID OR DISC-SHAPED SHELL

The shell is coiled in one plane.

LENTIFORM OR LENS-SHAPED SHELL

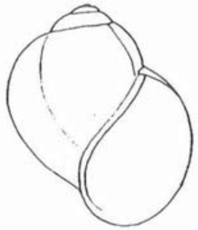
The shell is coiled with an angular or carinate periphery.

FIGURE VI. THE FORM OF THE SHELL

Again from the globose shell another evolutionary series can be seen in the ovate shell, where the whorls are distinctly higher than wide. Types derived from this form are illustrated in Figure VII.

OVATE SHELL

The width and height of the whorls are about the same.



ACUMINATE SHELL

The height twice the width.

TURRICULATE SHELL

The height is many times the width.

Some special types of shells which are not typically coilded are the shield and cap shaped forms.

CAP-SHAPED SHELL

SHIELD-SHAPED SHELL

FIGURE VII. THE FORM OF THE SHELL

COLOUR OF THE SHELL

The shells of freshwater snails are often black or reddish-brown, mostly due to a secondary coating. The usual colour is yellow or brown, sometimes with bands in red or other darker colours.

THE GASTROPOD ANATOMY

The soft part of the snail is attached permanently to the columella of the shell by a great retractor muscle. A number of internal organs can be located in the visceral mass, in the body whorl, and are surrounded by a large fold of skin called the mantle. Organs such as the lung, kidney and heart are situated along the inner wall of the mantle. The mantle border provides for the growth of the shell. Parts of the digestive and reproductive systems are found in the head-foot region.

The muscular foot is furnished with a flat, creeping sole. The front part contains the head with a pair of tentacles, eyes and mouth. The male genital opening is found near the base of the tentacles, while the female opening is found on the same side, close to the mantle border.

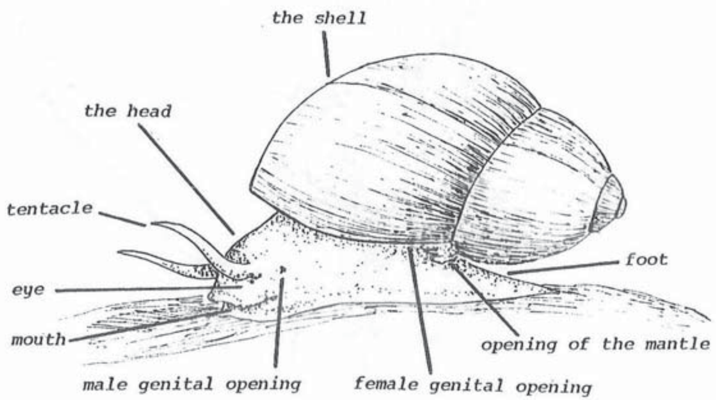


FIGURE VIII. EXTERNAL FEATURES OF SNAILS

MANTLE CAVITY

Some anatomical structures in the mantle cavity are of importance in the identification of certain freshwater snails. To examine the mantle organs it is necessary to cut open the mantle in order to view them from the underside. The technique is illustrated in Figure XVI.

The mantle cavity has contact with the outside world through the pneumostome. For some members of the Planorbidae family a large folded lobe, serving as a gill and called a pseudobranch, may be situated close to the pneumostome.

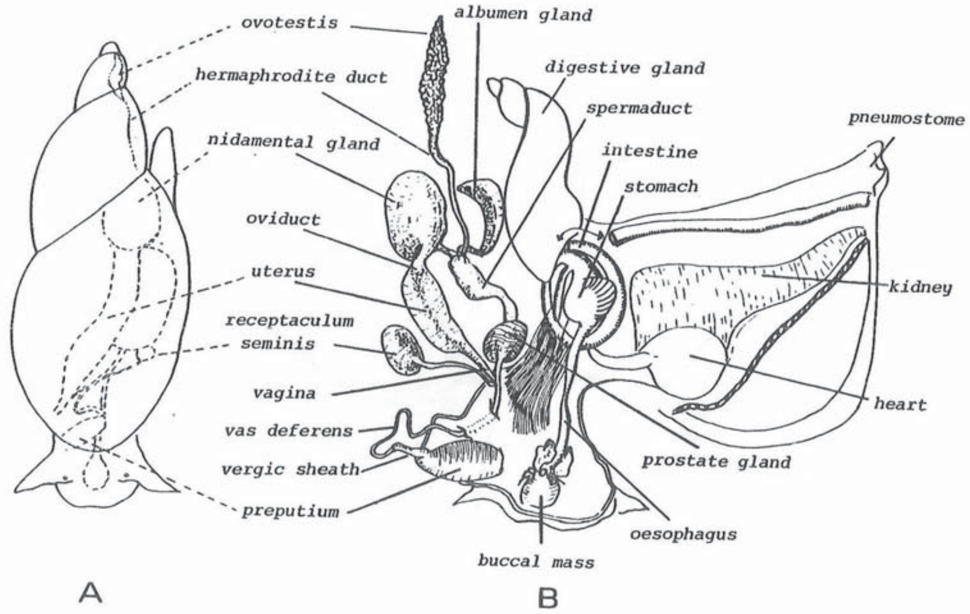


FIGURE IX. DIGESTIVE AND REPRODUCTIVE SYSTEMS OF *LYMNAEA*.

A: *The organs in situ*. B: *The dissected snail with the organ systems displayed.*

DIGESTIVE SYSTEM

The digestive system consists of the buccal mass, a long oesophagus, crop, gizzard and stomach, a long intestine and a large digestive gland.

Inside the pear-shaped buccal mass are the horny jaw and the radula, The latter is used to rasp food and consists basically of a plate-like structure with minute teeth arranged in transverse rows on the upper surface. The rasped food is passed down the oesophagus to the stomach. The intestine loops backwards and forwards and lies embedded in the digestive gland. The intestine leads to the rectum, situated to the left side of the mantle border in Bulinus species and to the right side in Lymnaea species.

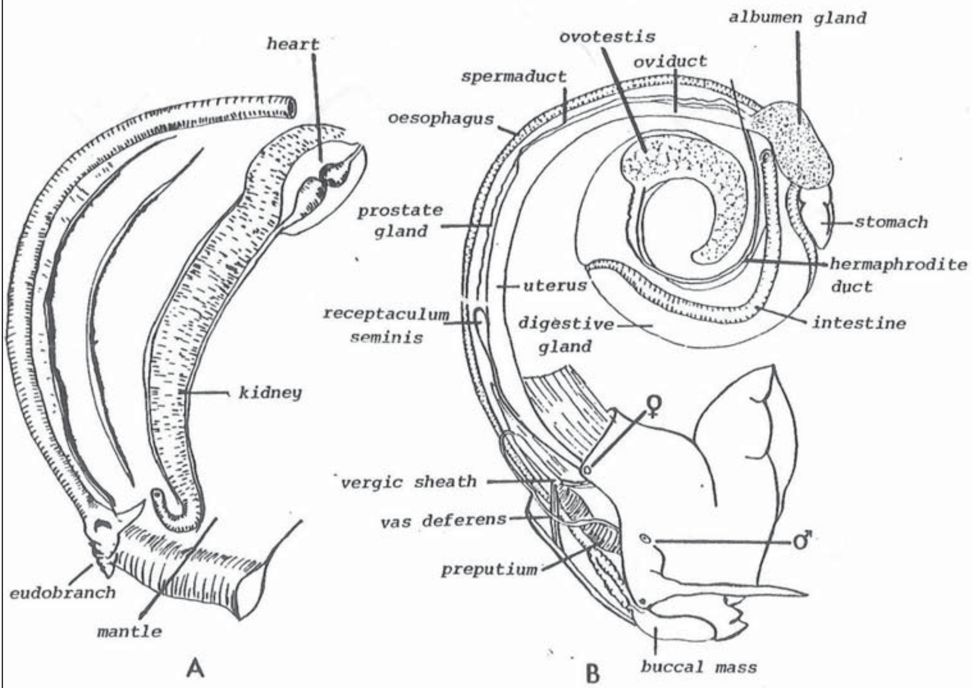


FIGURE X. DIGESTIVE AND REPRODUCTIVE SYSTEMS OF *BIOMPHALARIA*.

A: The organs associated with the mantle. *B: The organs in situ.*

RADULA

The radula teeth are of great systematic value and several types are found in snails. Three types, two of which are found in prosobranchs, are common in freshwater snails. The rhipidoglossate radula (Figure XIIA) contains transverse rows consisting of a central tooth, on either side of which 4-7 differently formed lateral teeth and a great number of marginal teeth are found. The rhipidoglossate radula is known from a few primitive freshwater-brackish water species. The other radula type, typical of prosobranchs, is called taenioglossate (Figure XIIB) and is by far the most common. It consists of one central tooth, one lateral and two marginal teeth. In some groups of prosobranchs the central tooth is provided with additional cusps on the basal plate.

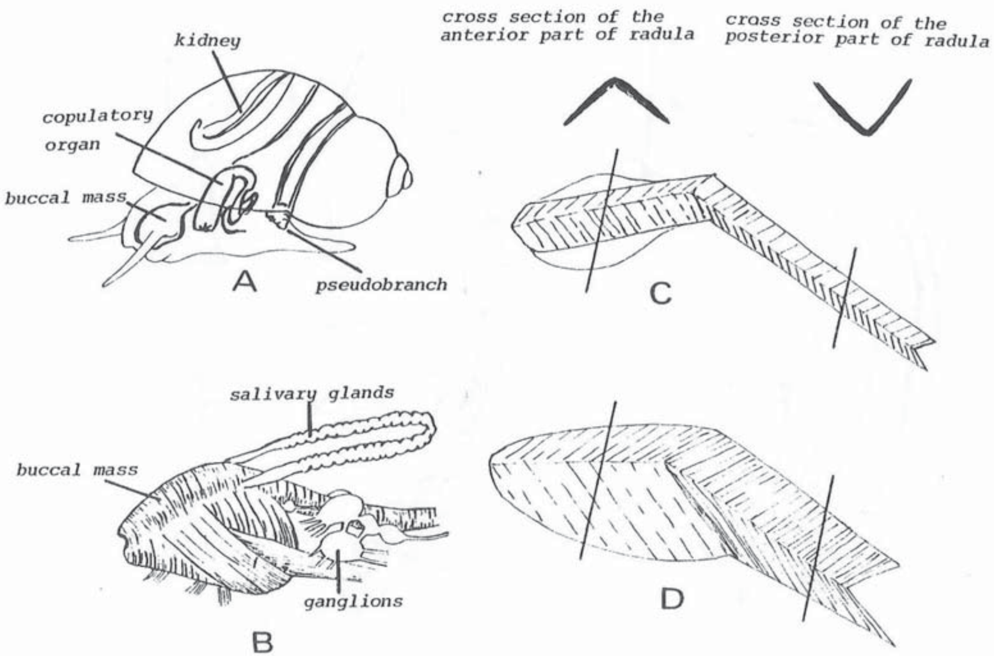


FIGURE XI. THE BUCCAL MASS AND RADULA.

A: Buccalmass in situ. B: The buccal mass. C: Radula from a prosobranch snail. D: Radula from a pulmonate snail.

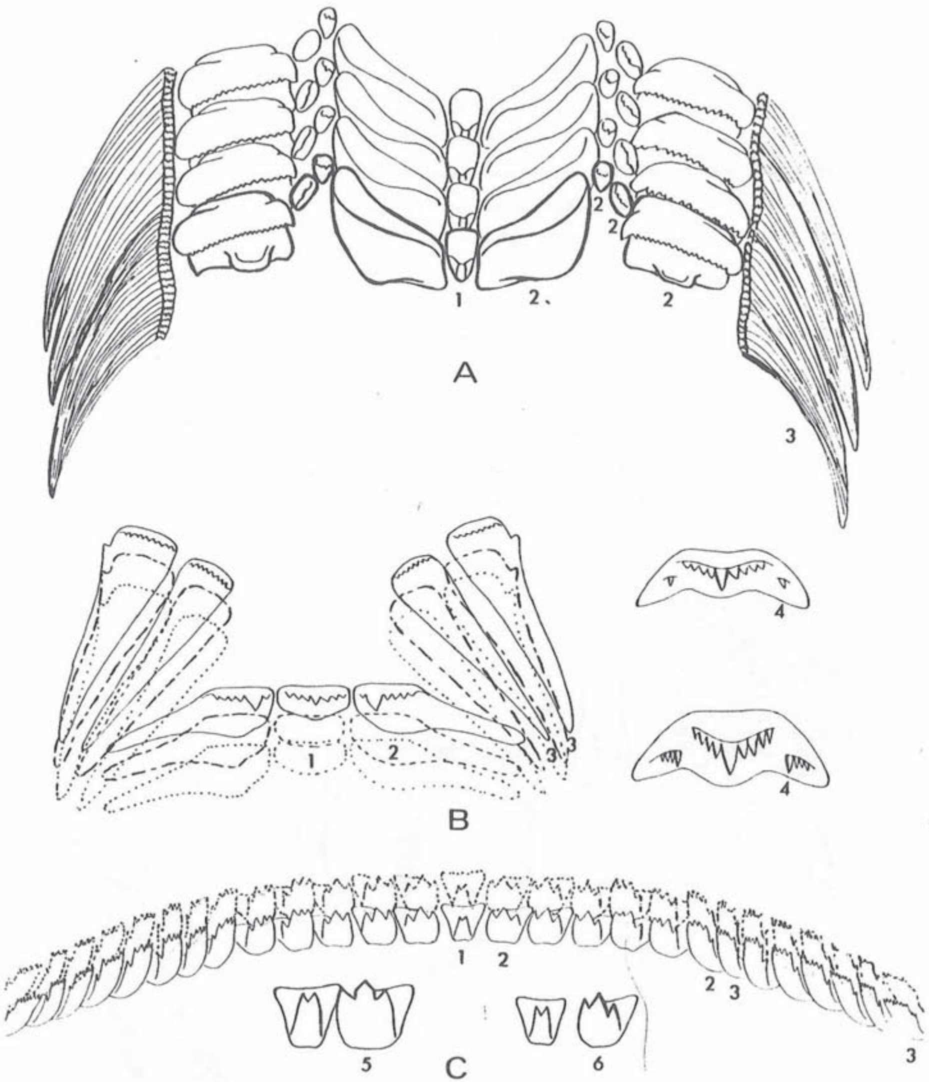


FIGURE XII. TYPES OF RADULA

A: Rhipidoglossate radula. B: Taenioglossate radula and two central teeth with basal denticles. C: Pulmonate radula with two examples of the shape of the mesocone in the first lateral tooth. 5: arrowhead shaped and 6: triangular shaped.

1: Central tooth. 2: Lateral teeth. 3: Marginal teeth 4: Basal denticle. 5: Arrowhead shaped mesocone. 6: Triangular shaped mesocone.

The pulmonates have only one type of radula which consists of a great number of very small, rather uniform teeth. These can be divided into one central tooth, several lateral teeth and numerous marginal teeth. The shape of the central cusps (mesocone) of the first lateral tooth is of great importance in snail identification. The mesocone may be either arrowhead-shaped (Figure XIIC.1) or triangular (Figure XIIC.2). The preparation of the radula is discussed in the section covering techniques (pages 19-22).

REPRODUCTIVE SYSTEM OF PULMONATE SNAILS

The reproductive system (Figures XIII and XIV) is important in snail classification. The genital organs consists of the ovotestis, which produces egg cells and semen, and the hermaphrodite duct, which leads from the ovotestis and divides into the male and female ducts.

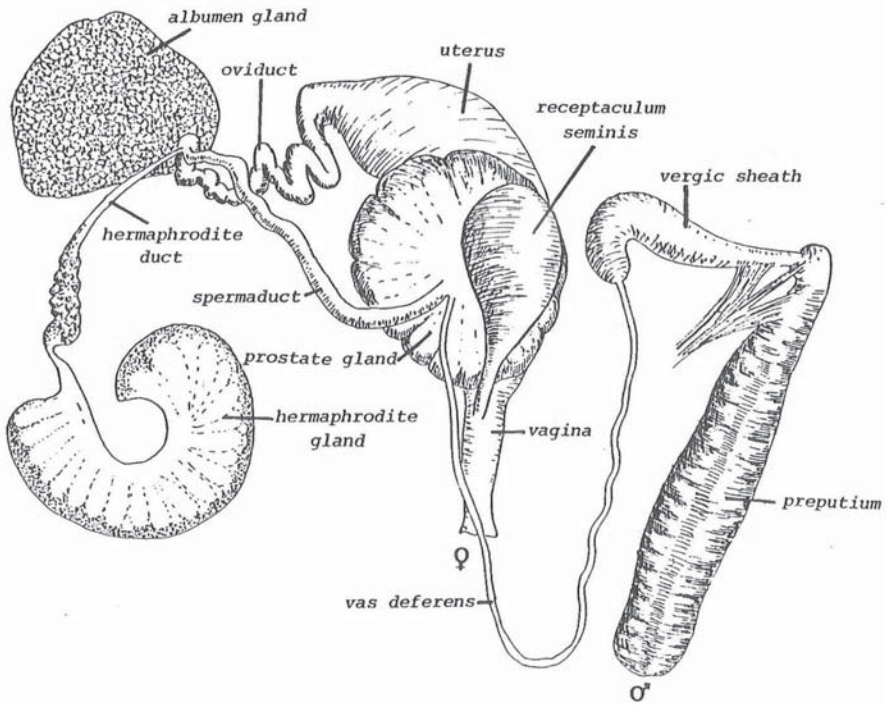


FIGURE XIII. REPRODUCTIVE SYSTEM OF *BULINUS*

The female duct is differentiated into an oviduct, a uterus and a vagina before opening through the genital pore beneath the mantle border. Various glands, such as the albumen and nidamental, are attached to the oviduct.

The male duct, or spermaduct, is a long, curved tube which is provided with a well developed prostate gland. The vas deferens follows along the uterus and the vagina before disappearing into the body wall to the top of the copulatory organ. In freshwater pulmonates the copulatory organ consists of two parts, the upper a vergic or penial sheath surrounding the penis itself, the lower a wider muscular preputium which is an invagination from the surface of the body.

The copulatory organ (Figure XV) owing to its considerable variability, is significant in identifying genera within the family Planorbidae.

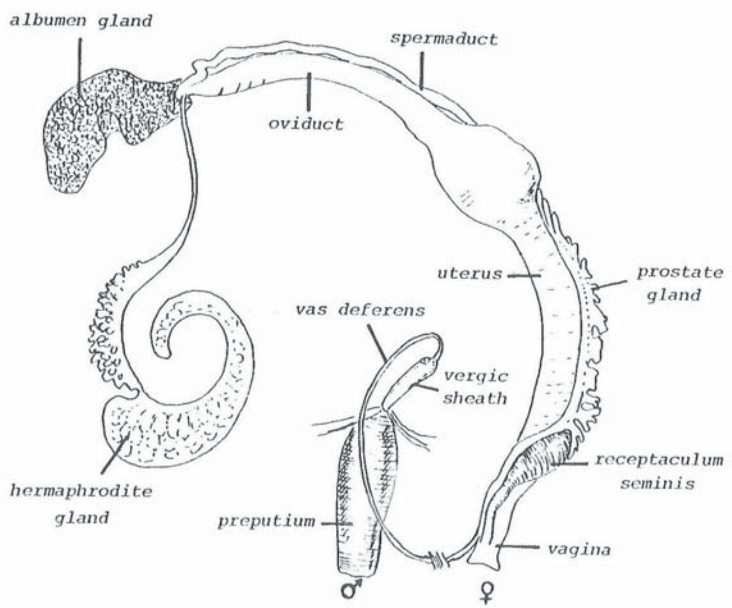


FIGURE XIV. REPRODUCTIVE SYSTEM OF *BIOMPHALARIA*

REPRODUCTION

All species of pulmonates are oviparous. i.e. egg laying. Both oviparous and viviparous (producing fully developed juveniles) species are found among the prosobranchs.

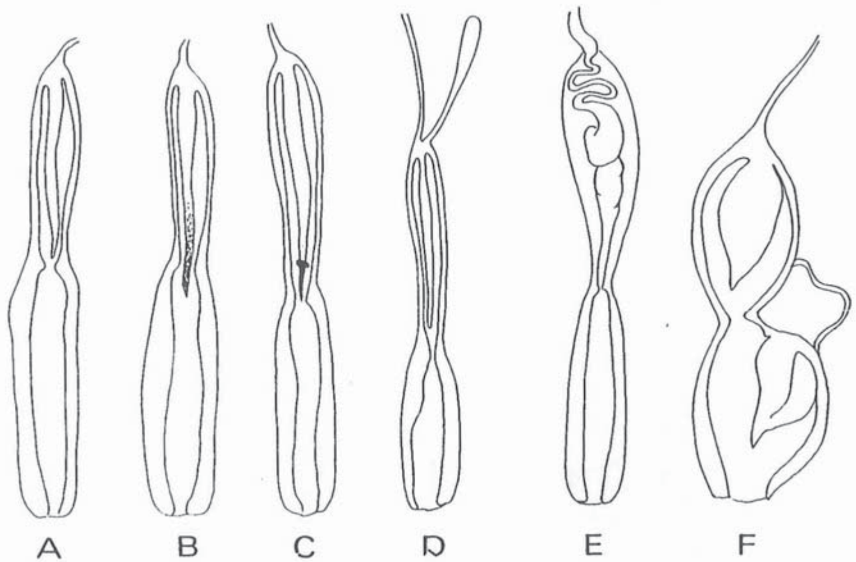


FIGURE XV. COPULATORY ORGANS FROM SPECIES OF PLANORBIDAE.

A: *Biomphalaria*. B: *Ceratophallus, the penis is scleroid.* C: *Gyraulus, the penis with a stiletto.* D: *Segmentorbis, an appendage on top of the vergic sheath.* E: *Bulinus, the copulatory organ completely invaginated.* F:*Helisoma, a gland on the upper part of the preputium's wall.*

TAXONOMY

All species of plants and animals are named according to a system of binomial nomenclature, elaborated by the Swedish biologist Carl von Linné in 1758. Thus in snail nomenclature the first name indicates the genus and the second the species. Species names are followed by the author's name and the year of the first published description. Where the author's name appears in brackets, a later revision has occurred.

HOW TO DISSECT A SNAIL

The following notes for dissecting a freshwater snail are primarily based on an examination of pulmonates for the most important taxonomical characters. The removal of the buccal mass can also be used in studies of prosobranchs.

1) REMOVAL OF THE SOFT PARTS

The snail must be kept in alcohol (70%) or in formalin (4%) for at least 24 hours or killed in boiling water prior to the removal of the soft parts. It is possible to extract the body with fine forceps or with the aid of a pin bent in the shape of a small hook or by a bent pair of forceps.

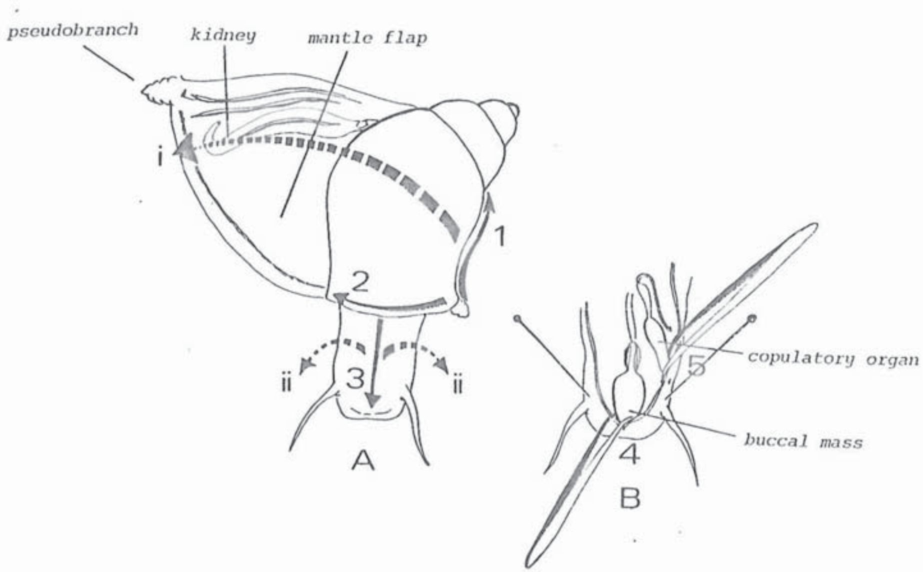


FIGURE XVI. HOW TO DISSECT A SNAIL

A: Opening of the mantle and the head. B: Removal of buccal mass and copulatory organ.

2) ORIENTATION OF THE SNAIL

The snail is orientated with the head region pointing towards the observer and the tip of the visceral parts in the opposite direction. For sinistrally coiled snails the genital openings (and thereby the copulatory organ) and the pneumostome are therefore found in the right side and vice-versa for dextrally coiled snails.

3) OPENING OF THE MANTLE (see Figure XVI A)

The mantle cavity is opened and the mantle removed as follows: using a pair of scissors cut the tissue along the columella (cut 1) and release the anterior part by cutting along the mantle border (cut 2). The mantle can be reflected to the left for sinistral snails (movement i) and the organs thus observed.

4) OPENING OF THE HEAD REGION (see Figure XVI B)

The head region is opened by an incision extending from the mantle border to between the tentacles (cut 3). Utmost care must be taken because the skin is very thin. The sides can be displaced (movement ii) and fixed into position by pins. The buccal mass and the copulatory organ may be removed by a pair of forceps (cut 4 and 5, respectively).

HOW TO STAIN A RADULA

There are many methods of staining the radula once the buccal mass has been removed, but the following two have been used over a long period of time at the Danish Bilharziasis Laboratory.

MALLORY STAINING

1. The hydrolization of the buccal mass for isolation of the radula is effected in 7.5% sodium hydroxide (NaOH) for two hours at 80°C or 24 hours at 22°C. The radula must then be cleaned of its surrounding tissues before the next step is undertaken.

2. Neutralize the radula in 15% acetic acid for 2-3 minutes.
3. Stain the radula in diluted Mallory 2 for about 3 minutes.
4. Wash the radula in 2% oxalic acid for 2 minutes.
5. Dehydrate in 96% alcohol for 3 minutes.
6. Wash the radula in xylene.
7. Transfer the radula to a slide with Eukitt or Euparal. Straighten it out under a dissecting microscope and cover with a slip. It is essential to straighten the radula very carefully and to place the teeth upwards, since the shape of the teeth otherwise cannot be seen with accuracy. The shape of the two types of radula is illustrated in Figure XII.

CHRYSOIDIN STAINING

1. The buccal mass is removed anu hydrolized as in the first method.
2. Stain the radula in a solution of acetic acid and aniline blue for 5 minutes.
3. Stain the radula further in a solution of Chrysoidin for 5 minutes.
4. Dehydrate in absolute alcohol for a few seconds.
5. Transfer the radula to a slide with Eukitt or Euparal, then carefully straighten it out and cover it with a slip.

Please note that all time intervals are approximate and depend mainly upon the size of the radula.

HOW TO PREPARE THE SOLUTION FOR STAINING THE RADULA

Stock solution of Malleroy 2:

Aniline blue	0.5 gr
Orange G	2.0 gr
Oxalic acid	2.0 gr
Distilled water	100 ml

Prior to staining, the solution is diluted as follows: 1 part Malleroy 2 and 9 parts distilled water.

The stock solution may be stored in a refrigerator for up to one year, the diluted solution for a shorter period.

Aniline blue and 15% acetic acid:

A very small amount of aniline blue is added to a 15% solution of acetic acid.

Chrysoidin stain:

Saturated aqueous solution.

HOW TO CLEAN THE SHELL AND THE OPERCULUM

The shell, as well as the operculum, may be cleaned in a saturated aqueous solution of oxalic acid. The length of time required for this operation depends upon the thickness of the coating.

EQUIPMENT FOR DISSECTION OF SNAILS

In addition to a dissecting binocular microscope and a compound microscope, the following tools are necessary to undertake a proper anatomical study of the snail.

2 pairs of fine forceps (watchmakers)
1 fine pointed small forceps
1 fine pointed small scissor
1 scalpel
1 caliper
small pins
a container with bottom covered by plasticine
small petri dishes

KEYS TO IDENTIFICATION OF FRESHWATER SNAILS

HOW TO USE THE IDENTIFICATION KEYS

In each paragraph two questions, A and B, are posed. Often, a series of differing criteria are put forward in A as well as in B, e.g. the criterion in A may be "without operculum" and in B "with operculum". The correct answer leads either to another paragraph or assigns the snail to a family, genus or species.

IDENTIFICATION KEY FOR FRESHWATER SNAILS

The freshwater snails are divided into two subclasses, which are identified as follows:

A Presence of an operculum. Each row of teeth in the radula consists of a small number of differently formed teeth (taenioglossate, or more rarely rhipidoglossate).

PROSOBRANCHIA PAGE..24

B Absence of an operculum. Each row in the radula consists of a very large number of uniform teeth.

PULMONATA PAGE......29

PROSOBRANCHIA

1 A Shell hemispherical, consisting of few whorls, spire small. Operculum with apophyses..........................NERITIDAE (PAGE 25)

B Shell depressed or high, with distinct spire. Operculum without apophyses......continue with couplet 2

2 A Operculum corneous, spiral or concentric with a spiral nucleus.................. 3

B Operculum calcareous, concentric........ 9

3 A Full grown shell more than 10 mm high... 6

B Full grown shell less than 10 mm high... 4

4 A Shell wider than high. Aperture circular Operculum multispiral.............. VALVATIDAE (PAGE 26)

B Shell higher than wide. Aperture ovate. Operculum paucispiral.................. 5

5 A Lateral teeth without accessory plates. Found only in Egypt.............. HYDROBIIDAE (PAGE 26)

B Lateral teeth with accessory plates. The snails are found in Somalia.......ASSIMINEIDAE (PAGE 27)

6 A Shell dextral.......................... 7

B Shell sinistral...................... PILIDAE (PAGE 26)

7 A Shell conical, no sculpture. Operculum concentric....................... VIVIPARIDAE (PAGE 25)

B Shell high, often sculptured. Operculum spiral or concentric with spiral nucleus. 8

8 A Basal margin of aperture entire. Operculum concentric with a spiral nucleus or paucispiral........................ THIARIDAE (PAGE 27)

B Basal margin with a notch. Operculum multispiral........................POTAMIDIDAE (PAGE 28)

9 A Full-grown shell less than 15 mm high.............................BITHYNIIDAE (PAGE 27)

B Full-grown shell more than 15 mm high................................PILIDAE (PAGE 26)

Family Neritidae

Two genera with at least three species in the EMRO Region. No species of medical importance.

Genus *Theodoxus* Montfort, 1810 (Fig. 1, p. 39)

Theodoxus nilotica (Reeve, 1856)
Known from Egypt

Theodoxus jordani (Sowerby, 1832)
Known from Israel, Jordan, Lebanon, Oman and Syria

Genus *Neritina* Lamarck, 1816 (Fig. 2, p. 39)

Neritina natalensis Reeve, 1855
Known from Somalia

Family VIVIPARIDAE

One genus with two species in the EMRO Region, neither of medical or veterinary importance.

Genus *Bellamya* Jousseaume, 1886 (Fig. 3, p. 39)

Bellamya unicolor (Olivier, 18o4)
Known from Egypt and Sudan.

Bellamya bengalensis (Lamarck, 1822)
Known from Iran, Iraq, Pakistan and Syria

Family PILIDAE

Two genera are present in the African part of the EMRO Region. One genus is present in the Arabian Peninsula. No species of medical importance.

Genus *Lanistes* Montfort, 1810 (Fig. 4, p. 39)
Two species present in the EMRO Region.

Lanistes carinatus (Olivier, 1804)
Known from Egypt, Somalia and Sudan.

Lanistes ovum Peters, 1845
Known from Sudan and Somalia

Genus *Pila* Röding, 1798 (Fig. 5, p. 39)
The following three species are found in the EMRO Region

Pila speciosa (Philippi, 1849)
Known from Somalia

Pila ovata (Olivier, 1804)
Known from Egypt, Jordan and Syria

Pila wernei (Philippi, 1851)
Known from Sudan and Somalia

Family VALVATIDAE

One genus with three species are present in the EMRO Region. All are without medical and veterinary importance.

Genus *Valvata* Müller, 1774 (Fig. 6, p. 39)

Valvata nilotica Jickeli, 1874
Known from Egypt

Valvata saulcyi Bourguignat, 1853
Known from Israel, Jordan, Lebanon, Sinai and Syria

Valvata piscinalis Müller, 1774
Known from Iran

Family HYDROBIIDAE

Four genera with at least 5 species are found in the EMRO Region. All species are without medical or veterinary importance.

Genus *Hydrobia* Hartmann, 1821 (Fig. 7, p. 39)

Following two species are found in the Region.

Hydrobia ventrosa (Montagu, 1803)
Known from Egypt

Hydrobia musaensis (Frauenfeld, 1855)
Known from Egypt

Genus *Pseudamnicola* Paulici, 1878 (Fig. 8, p. 39)

Pseudamnicola solitaria Tchernov, 1971
Known from Israel

Genus *Gangetia* Annandale and Prashad, 1921 (Fig. 9, p. 39)

Gangetia enzielliana Ancey, 1890
Known from Iran

Genus *Pyrgula* Cristofori and Jan, 1894 (Fig. 10, p. 39)

Pyrgula barroisi Dautzenberg, 1894
Known from Israel, Iraq, Jordan and Syria

Family BITHYNIIDAE

Three genera with five species are found in the EMRO Region. All species are without medical or veterinary importance

Genus *Gabbiella* Mandahl-Barth, 1968 (Fig. 11, p. 39)

Gabbiella senaariensis (Küster, 1852)
Known from Egypt and Sudan

Gabbiella parvipila (Verdcourt, 1958)
Known from Somalia

Genus *Jubaia* Mandahl-Barth, 1968 (Fig. 12, p. 39)

Jubaia excentrica Mandahl-Barth, 1968
Known from Somalia

Genus *Bithynia* Leach, 1818 (Fig. 13, p. 39)

Bithynia tentaculata (Linnaeus, 1758)
Known from Afghanistan and Iran

Bithynia badiella (Küster, 1852)
Known from Iran, Iraq, Israel, Jordan, Lebanon and Syria

Family ASSIMINEIDAE

One genus with one species in the Region, and this species is without medical importance.

Genus *Eussoia* Preston, 1912 (Fig. 14, p. 39)

Eussoia aethiopica (Thiele, 1927)
Known from Sudan

Family THIARIDAE

Four genera each with one species are found in the EMRO Region and none is of medical or veterinary importance.

Genus *Cleopatra* Troschel, 1856 (Fig. 15, p. 40)

Cleopatra bulimoides (Olivier, 1804)
Known from Egypt, Somalia, Sudan and Syria

Cleopatra hemmingi Verdcourt, 1956
Known only from Somalia.

Genus *Melanoides* Olivier, 1804 (Fig. 16, p. 40)

Melanoides tuberculata Müller, 1774
Known from all countries in the EMRO Region.

Genus *Thiara* Röding, 1798 (Fig. 17, p. 40)

Thiara scabra (Müller, 1774)
Known from Democratic Yemen, Iraq, Jordan, Oman and Syria

Thiara amarula (Linnaeus, 1758)
Known from Somalia.

Genus *Melanopsis* Ferrussac, 1807 (Fig. 18, p. 40)

Melanopsis praemorsa (Linnaeus, 1758)

Known from most of the countries in the Asian part of EMRO Region. Probably several species occur. Further taxonomical research is desirable.

Family POTAMIDIDAE

One genus with one species of medical importance in the EMRO Region.

Genus *Pirenella* Gray, 1847 (Fig. 19, p. 40)

Pirenella conica (Blainville 1829)

20 x 7 mm. The shell is slender, strongly sculptured with nodules. The shell is often brightly coloured with brown and blue spiral bands. Operculum corneous and multispiral Found in brackish water along the Mediterranean Coast, Egyptian lagoons and in Birket Qarun.
Pirenella conica is the first intermediate host for the trematode *Heterophyes heterophyes*. The second intermediate hosts are various species of fish. In certain areas of Egypt this parasite is common and causes serious infection with diarrhaea which may be accompanied by blood.
H. heterophyes is located in the upper part of the intestine.

PULMONATA

1 A Shell spirally coiled.................... 2

B Shell cap-shaped.................. ANCYLIDAE (PAGE 38)

2 A Shell globose or higher................. 3

B Shell discoid...................... PLANORBIDAE Planorbinae (PAGE 32))

3 A Shell dextral , triangular tentacles..LYMNAEIDAE (PAGE 29)

B Shell sinistral......................... 4

4 A Shell glossy. The blood is colourless. A pseudobranch absent. Radula teeth in V-shaped transverse rows.............. PHYSIDAE (PAGE 29)

B Shell usually dull. The blood is red. A pseudobranch present. Radula teeth in slightly curved transverse rows...... PLANORBIDAE Bulininae (PAGE 35)

Family PHYSIDAE

One genus with one species occurs in the EMRO Region and it is without medical or veterinary importance.

Genus *Physa* Draparnaud, 1801

Physa acuta Drapernaud, 1805 (Fig. 20, p. 40)

15 x 9 mm. This species resembles some species of *Bulinus*, Distinguishing characters are: the shell differs in its more sharply pointed apex, smoother surface without ribs, lack of blood haemoglobin and pseudobranch and finally difference in the radula
Common in streams and ponds.
The species is known from all countries in the region.

Family LYMNAEIDAE

One genus with several species is found in the EMRO Region. Some members of the genus act as intermediate of the common liverflukes Fasciola hepatica and F. gigantica. One of the species also acts as intermediate host for a bloodfluke found in sheep and goats.

Genus *Lymnaea* Lamarck, 1799

KEY TO THE SPECIES

1 A Spire as high as or slightly smaller than aperture.................................. 2

B Spire much shorter than aperture........... 3

2 A The whorls convex separated by a deep suture. Columella straight. The vergic sheath is short in comparison with praeputium.................................. *L. truncatula*

B Whorls of spire more or less flat. Columella twisted. The vergic sheath is longer than praeputium.................................. *L. palustris*

3 A Shell with distinct spiral lines........... *L. columella*

B Shell without spiral lines................. 4

4 A Columella straight. Spire relatively high. The whorls does not bulge at all.......... *L. pereger*

B Columella twisted. Spire is short. The body-whorl has either moderate or pronounced bulging.................................. *L. auricularia group*

Lymnaea truncatula (Müller, 1774) (Fig. 21, p. 40)

10 x 5 mm. The small size and convex whorls of the spire are distinctive.
Small streams, seepages and temporary pools.
Known from Afghanistan, Egypt, Iraq, Iran, Israel, Jordan, Oman, Pakistan and Syria.
L. truncatula is intermediate host for *Fasciola hepatica*, which is a very common found liver fluke in ruminants. This leverfluke is of great economic importance.

Lymnaea palustris (Müller, 1774) (Fig. 22, p. 40)
16 x 8 mm. Usually larger and with less convex whorls than *L. truncatula*. The columella is also more twisted. The growth lines are very pronounced. The vergic sheath is as long as the praeputium.
Found in temporary as well as permanent waterbodies.
Known from Iran, Israel , Jordan, Oman, Saudi Arabia and Syria.

Lymnaea columella Say, 1817 (Fig. 23, p. 41)

17 x 9 mm. The shell is narrower than *L. natalensis*/ *L. arabica* and is easily distinguished from these by the close-set spiral lines, which result in a reticulated pattern.
Originally an American species but now introduced into many tropical and subtropical countries. Known from Egypt.
A possible intermediate host for *Fasciola hepatica*.

Lymnaea pereger (Müller, 1774) (Fig. 24, p. 41)

14 x 8 mm. This is a very variable species. The spire is relatively high. Since the whorls does not bulge, the aperture is smaller than in the *auricularia group*. This species is known from Iran.

Lymnaea auricularia group

The classification of *Lymnaea* species is very difficult. An important character in the differentiation of this group from the preceding, is the shape and size of the spermathecal duct. In *L. pereger* the duct is short and thick and in the *auricularia group* the spermathecal duct is long and slender.

The group includes the following species:

Lymnaea auricularia (Linnaeus, 1758) (Fig. 25, p. 41)

17 x 14 mm. The whorls increase rapidly, the aperture is very large and the spire is short and sharply pointed. In the typical shell the columellar fold is very pronounced. Found in streams, pools and other types of waterbodies. Known from Israel, Oman, Saudi Arabia and Yemen.

Lymnaea natalensis Krauss, 1848/ *L. arabica* Smith, 1894 (Fig. 26, p. 41)

23 x 15 mm, but very variable in size. The shell's appearance may follow the description for the preceeding species, but it is possible to differentiate this species on the slender shell and a relatively higher spire. The body whorl does not bulge as in *L. auricularia*. *L. natalensis* is the predominant species of *Lymnaea* on the African continent. *L. arabica*, which has been described from the Arabian Peninsula, is very closely related to *L. natalensis*. They are perhaps the same species, but since extensive studies are needed before a final conclusion can be made, the names are used as follows: *L. natalensis* for the type found in Africa and *L. arabica* for the species found in the Middle East. The species are mostly found in permanent waterbodies. *L. natalensis* is intermediate host for *Fasciola gigantica*, which is a very common found liverfluke in ruminants all over Africa. *F. gigantica* is of great economic importance.

Lymnaea gedrosiana Annandale and Prashad, 1919 (Fig. 27, p. 41)

11 x 6 mm. The general appearance of the shell accords well with the preceeding species, but the spire is higher and more slender. There seems to be no difference in the anatomy between the two species. The columellar fold is only slightly developed.
Normally found in waterbodies with dense submerged vegetation.
Known from Iran, Iraq, Pakistan and Saudi Arabia.
L. gedrosiana is the intermediate snail host for a bloodfluke *Orientobilharzia turkestanicum* which is found in sheep and goats.

Family PLANORBIDAE

This family, from the viewpoint of public health, is the most important of all the families of freshwater snails found in the EMRO Region. The family is divided into the following two subfamilies:

Planorbinae: consists of species with a discoid or lentiform shell pseudo dextral. The animal is always sinistral, its anus, pneumostome and genital openings, being found on the left side. Nine genera occur in the EMRO Region.

Bulininae: sinistral, globose or higher shells. Two genera are found in the region. One of the genus has a discoid shell, but the anatomy is in accordance with the diagnosis for the subfamily.

Subfamily Planorbinae

KEY TO THE GENERA

1 A Larger species, shell more than 2 mm high.............................. 2

B Smaller species, shell less than 2 mm high......................... 4

2 A Shell 2-3 mm high and usually with a distinct angle below the periphery..................... Planorbis (PAGE 33)

B Shell more than 3 mm high, a peripheral angle is not present....... 3

3 A Shell less than 6 mm high. A penial gland is not present...... Biomphalaria (PAGE 33)

B Shell up to 14 mm high. A penial gland is present................. 8

4 A Shell discoid, flat on both sides. 5

B Shell lentiform, with convex upper side and flat under side.......... 7

5 A Shell small and very flat, consisting of 4-5 slowly increasing whorls. Verge with a small cap-like stylet. Afrogyrus (PAGE 34)

B Shell relatively higher and in most cases with fewer and more rapidly increasing whorls................. 6

6 A Slowly increasing whorls, without transverse sculpture. Verge with a slerotized tip, but without a stylet.................. Ceratophallus (PAGE 34)

B Rapidly increasing whorls, costulate or without sculpture. Verge with a long well developed stylet.... Gyraulus (PAGE 35)

7 A Shell usually without internal septa....................... Lentorbis (PAGE 35)

B Shell with 3-9 sets of internal septa.................... Segmentorbis (PAGE 35)

8 A Copulatory organ consists of a simple praeputium and vergic sheath (Bulinus-type)........................ Indoplanorbis (PAGE 35)

B Copulatory organ with a large accessory gland............................ Helisoma (PAGE 34)

Genus *Planorbis* Geoffroy, 1767 (Fig. 28, p. 41)

Planorbis planorbis (Linnaeus, 1758)
Known from Egypt, Iran, Iraq, Lebanon, Libya and Saudi Arabia.

Planorbis intermixtus Mousson, 1874
Known from Iraq

Genus *Biomphalaria* Preston, 1910

KEY TO THE SPECIES

1 A Full-grown shell consists of 4.5-5 rapidly increasing whorls. Diameter of umbilicus smaller than height of last whorl.......... *B. pfeifferi*

B Full-grown shell consists of 5.5-6.5 more slowly increasing whorls. Diameter of umbilicus as large as or larger than height of shell............................ 2

2 A The whorls are rounded on the upper side apart from the last third of the ultimate whorl, which is flattened. Umbilicus usually not much larger than height of last whorl................................. *B. alexandrina*

B The whorls are flat on the upper side. Umbilicus 1.5 times as large as height of last whorl.............................. *B. sudanica*

Biomphalaria pfeifferi (Krauss, 1848) (Fig. 29, p. 41)

5.5 x 16 mm, but often smaller. Usually the penis sheath is shorter than the preputium and the mesosones on the first lateral teeth are triangular.
This species has been named *B. arabica* (Melvill and Ponsonby, 1896), but since the anatomical, morphological and biochemical data are in good accordance with *B. pfeifferi*, this species name is preferred. The only reason for using *B. arabica* should be to stress the geographical distribution.
Mainly found in man-made waterbodies.
Known from Democratic Yemen, Egypt, Libya, Oman, Saudi Arabia, Sudan and Yemen.
B. pfeifferi is the most important intermediate snail host for *Schistosoma mansoni*, which causes intestinal schistosomiasis in human beings.
B. pfeifferi may also act as intermediate host for various species of stomach flukes belonging to the family Paramphistomatidae.

Biomphalaria alexandrina (Ehrenberg, 1831) (Fig. 30, p. 41)

4.8 x 14.2 mm, but very variable in size. Some populations show affinities to *B. pfeifferi* and others to *B. sudanica*.
The penis sheath is long and the mesocone on the first lateral tooth is arrowhead-shaped.
Found in irrigation canals.
Egypt (from Aswan to the Mediterranean Coast) and Sudan (between Khartoum and Kosti).
This species is intermediate host of *S. mansoni*.

Biomphalaria sudanica (Martens, 1870) (Fig. 31, p. 42)

4.2 x 15.1 mm and sometimes larger. The flat shell with the very large umbilicus is distinctive. Penis sheath nearly as long as the preputium, mesocones of lateral teeth triangular.
Found in swamps and seems to be very closely associated with rich aquatic vegetation.
Known from the southern part of Sudan.
Intermediate host of *S. mansoni*, but compatibility with this parasite is often low.

Genus *Helisoma* Swainson, 1840 (Fig. 32, p. 42)

Helisoma duryi (Wetherby, 1879)

9.5 x 20 mm or larger. With the high shell and flat whorls in the umbilicus, it is easily distinguishable from *Biomphalaria* species. The copulatory organ is more complicated than for *Biomphalaria* e.g. there is a penial gland and a duct between the accessory preputial organ and the penis sheath.
This snail is originally an American species which has been introduced into greenhouses and botanical gardens in many parts of the world. *Helisoma duryi* has been recorded from several countries in Africa. It has also been suggested as a potential biological control agent of *Biomphalaria* and *Bulinus* in certain kinds of habitat.
Known from Saudi Arabia and Egypt.

Genus *Afrogyrus* Brown and Mandahl-Barth, 1973 (Fig. 33, p. 42)

Afrogyrus oasiensis (Demian, 1962)
Known from Egypt

Afrogyrus coretus (Blainville, 1826)
Known from Libya, Sudan and probably Somalia

Genus *Ceratophallus* Brown and Mandahl-Barth, 1973 (Fig. 34, p. 42)

Ceratophallus natalensis (Krauss, 1848)
Known from Sudan.
Acts as intermediate host of several species of stomach flukes found in cattle and sheep.

Genus *Gyraulus* Charpentier, 1837 (Fig. 35, p. 42)

Gyraulus costulatus (Krauss, 1848)
Known from Sudan

Gyraulus ehrenbergi (Beck, 1837)
Known from Egypt

Gyraulus euphraticus (Mousson, 1874)
Known from Iraq

Gyraulus convexiusculus (Hutton, 1849)
Known from Bahrain, Democratic Yemen, Iraq, Oman, Saudi Arabia and Yemen

Genus *Lentorbis* Mandahl-Barth, 1954 (Fig. 36, p. 42)

Lentorbis junodi (Connolly, 1922)
Known from Sudan

Genus *Segmentorbis* Mandahl-Barth, 1954 (Fig. 37, p. 42)

Segmentorbis angustus (Jickeli, 1874)
Known from Sudan and Yemen

Segmentorbis eussoensis (Preston, 1912)
Known from Egypt and Sudan

Segmentorbis kanisaensis (Preston, 1914)
Known from Sudan

Genus *Indoplanorbis* Annandale and Prashad, 1920 (Fig. 38, p. 42)

This genus belongs to the subfamily Bulininae. The anatomy of *Indoplanorbis* is quite different from the species belonging to the subfamily Planorbinae. See also p. 38.

Subfamily Bulininae

This subfamily is composed of two genera, Indoplanorbis and Bulinus. However in this publication, the former is listed in the key for the subfamily Planorbinae due to its discoidal shell.

Genus *Bulinus* Müller, 1781

KEY TO THE SPECIES

1 A Shell umbilicate, columellar margin broadly reflected.................................. 2

B Shell not umbilicate, columellar margin less broad................................. 3

2 A Shell less than 7 mm high, found in the Middle East......................... *B. wrighti*

B Shell more than 8 mm in height, found in the African part of the EMRO Region......... *B. umbilicatus*

3 A Shell globose or ovate with a spire shorter than aperture..............................4

B Shell turriculate with a spire higher than aperture.................................. 6

4 A Columella not truncate. Microsculpture on spire consists of transverse ribs. No ridge on the kidney............................. *B. truncatus*

B Columella truncate but in some cases it is obsolete. Microsculpture on spire consists of a corrugation or is absent. A ridge on the ventral side of the kidney............. 5

5 A Columella with a distinct truncation. The whorls have a characteristic shoulder. Microsculpture consists of a corrugation... *B. abyssinicus*

B Truncation almost obsolete. Microsculpture almost absent............................. *B. ugandae*

6 A Shell with a shoulder and transverse ribs commonly present. Found on the African continent................................ *B. forskalii*

B Shell without typical shoulder and transverse ribs. Known from the Middle East........... *B. beccari*

Bulinus wrighti Mandahl-Barth, 1965 (Fig. 39, p. 43)

7 x 6 mm. The shell is small and globose with a wide umbilicus. The columella is straight. Very often the shell is covered with a very strongly marked reticulate sculpture.
Found in temporary pools filled up with rainwater.
Known from Democratic Yemen, Oman, Saudi Arabia and Yemen.
B. wrighti can act as intermediate snail host for urinary bilharzia caused by *Schistosoma haematobium* but the actual role of this species in transmission is still unknown.

Bulinus umbilicatus Mandahl-Barth, 1973 (Fig. 40, p. 43)

15 x 11 mm. The whorls are strongly convex. Umbilicus widely open despite the broadly reflected columellar margin.
Mostly known from temporary pools.
Known from Sudan.
Its role in transmitting strains of *S. haematobium* is not fully elucidated. Laboratory experiments indicate that it is nonsusceptible to the *africanus*-borne strain. Further research is needed.

Bulinus abyssinicus (Martens, 1866) (Fig. 41, p. 43)

14.2 x 9.0 mm. The shell is usually pure white and with a characteristic shoulder angle. The corrugate micro-sculpture is pronounced.
Found in marshes, irrigation canals and drains.
Known from Somalia.
B. abyssinicus is the intermediate host of *S. haematobium* in Somalia.

Bulinus ugandae Mandahl- Barth, 1954 (Fig. 42, p. 43)

15 x 11 mm. The columellar truncation is very feeble, and very often it may be difficult to distinguish it from *B. truncatus*, but the sbulpture is almost absent and the ridge on the kidney is always present.
Found in muddy substrate in temporary as well as permanent waterbodies.
Occurs in Sudan.
This snail does not act as an intermediate host of *S. haematobium* but is a possible transmitter of *S. bovis*.

Bulinus truncatus (Audouin, 1827) (Fig. 43, p. 43)

14.6 x 10 mm, but sometimes up to 20 mm high. The shell is very variable. The arrowhead-shaped mesocones on the first lateral tooth are distinctive. No truncation on the columella and no ridge on the kidney. The sculpture, transverse ribs, are often very pronounced especially in young specimens.
Found in irrigation canals, man-made lakes, permanent and seasonal pools,etc.
Known from Democratic Yemen, Egypt, Iran, Iraq, Israel, Jordan, Lebanon, Libya, Sudan, Syria, Saudi Arabia and Tunisia.
B. truncatus is the most important intermediate host of *S. haematobium* in the area north of the Sahara. This snail is also an important transmitter of cattle parasites such as *S. bovis* and the stomach fluke *Paramphistomum microbothrium*.

Bulinus forskalii (Ehrenberg, 1831) (Fig. 44, p. 43)

10.2 x 3.8 mm, but sometimes larger, 17.0 x 5.4 mm.
A shoulder angle is usually present at whorls 3 - 5.
Transverse ribs are commonly present. The mesocones on the first lateral tooth are triangular.
B. forskalii is found in a great variety of natural and man-made waterbodies. It is most common in small, temporary pools.
Known from Egypt, Sudan and Somalia.
B. forskalii has been suspected of being an intermediate host of *S. haematobium*, but this has not been confirmed.
This snail is an intermediate host of *S. intercalatum* and some strains of *S. bovis*.
B. forskalii transmits several species of stomach flukes (Paramphistomatidae).

Bulinus beccarii (Paladilhe, 1872) (Fig. 45, p. 43)

7 x 3.4 mm. The shell is far more slender than *B. truncatus* and *B. wrighti*. There are no marked transverse ribs and only a very weak shoulder on the earlier whorls. The shell is translucent white.
Found in perennial and permanent streams and man-made waterbodies.
Known from Democratic Yemen, Saudi Arabia and Yemen.
B. beccarii can act as an important intermediate snail host of *S. haematobium*.

Genus *Indoplanorbis* Annandale and Prashad, 1920 (Fig. 38, p. 42)

Indoplanorbis exustus (Deshayes, 1834)

13 x 25 mm. The shell discoid, the whorls rapidly increasing, nearly as high as wide. It looks like *Helisoma duryi* but is distinguishable by its anatomy, especially the copulatory organ.
Known from Oman and Pakistan.

Family ANCYLIDAE

Two genera are found in the EMRO Region, both of no medical importance.

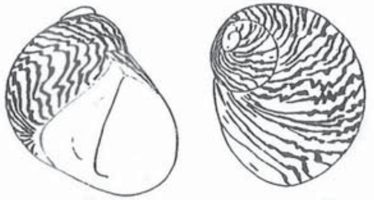
Genus *Ancylus* Müller, 1774 (Fig. 46, p. 43)

Ancylus fluviatilis Müller, 1774
Found in the south-western part of the Arabian Peninsula.

Genus *Ferrissia* Walker, 1903 (Fig. 47, p. 43)

Ferrissia isseli (Bourguignant, 1866)
Known from Egypt

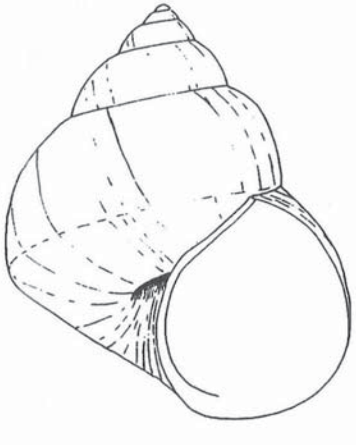
Ferrissia clessiniana (Jickeli, 1882)
Known from Egypt



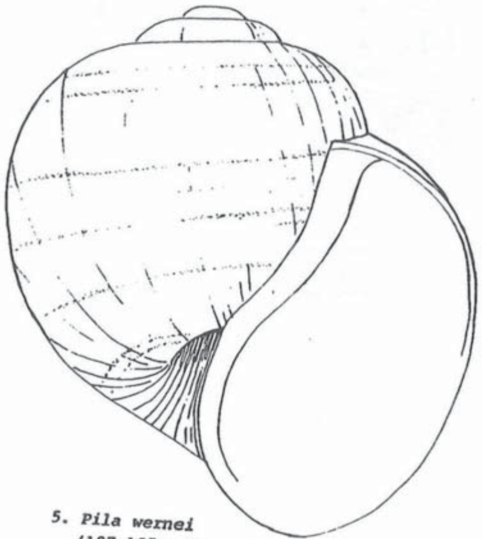
1. *Theodoxus niloticus* (8x8 mm)*

2. *Neritina natalensis* (21x22 mm)

6. *Valvata nilotica* (3x4 mm)



3. *Bellamya unicolor* (25x15 mm)



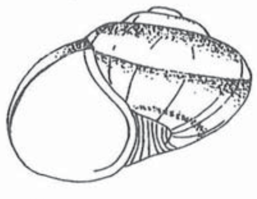
5. *Pila wernei* (127x125 mm)

7. *Hydrobia ventrosa* (4.0x1.8 mm)

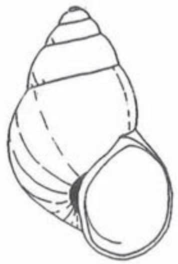
8. *Pseudamnicola solitaria* (1.0x0.7 mm)

9. *Gangetia enzielliana* (6x3 mm)

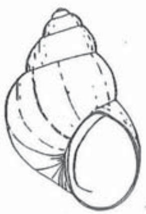
1o. *Pyrgula barroisi* (7x3 mm)



4.. *Lanistes carinatus* (36x45 mm)



13. *Bithynia tentaculata* (15x10 mm)

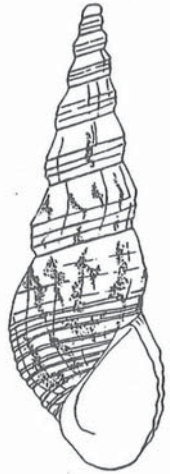


11. *Gabbiella senaariensis* (7.5x4.5 mm) .

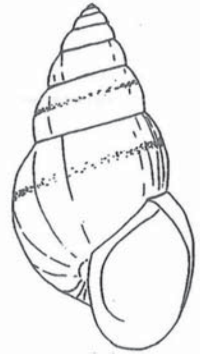
12. *Jubaia excentrica* (6.0x4.2 mm)

14. *Eussoia aethiopica* (6.5x5.0 mm)

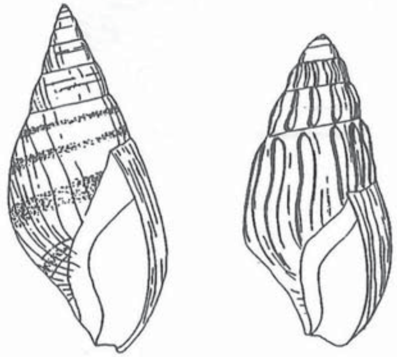
Height x width



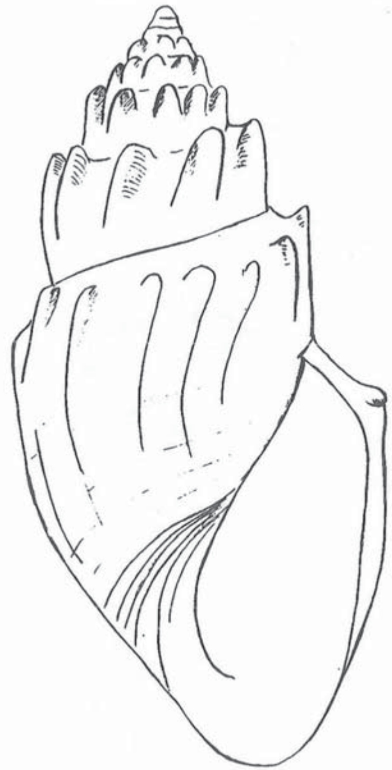
16. *Melanoides tuberculata* (30x9 mm)



15. *Cleopatra bulimoides* (15x8 mm)



18. *Melanopsis praemorsa* (20x11 mm)



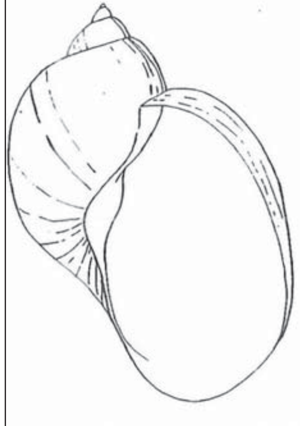
17. *Thiara amarula* (35x17 mm)

19. *Pirenella conica* (20x7 mm)

2o. *Physa acuta* (15x9 mm)

21. *Lymnaea truncatula* (10x5 mm)

22. *Lymnaea palustris* (16x8 mm)



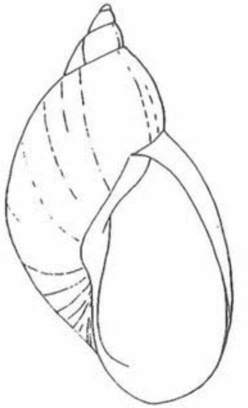
25a. *Lymnaea auricularia*
(17x14 mm)

25b. *Lymnaea auricularia*
(17x14 mm)

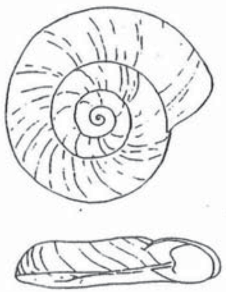
23. *Lymnaea columella*
(17x9 mm)

27. *Lymnaea gedrosiana*
(11x6 mm)

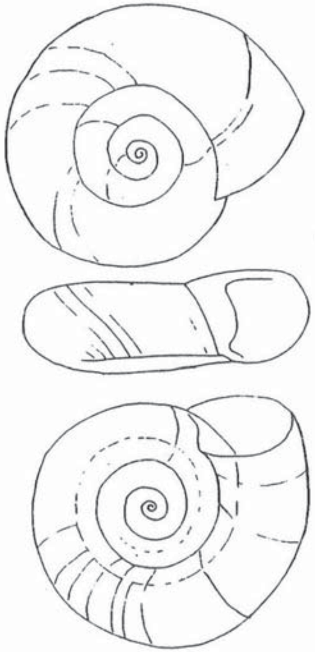
24. *Lymnaea pereger*
(14x8 mm)



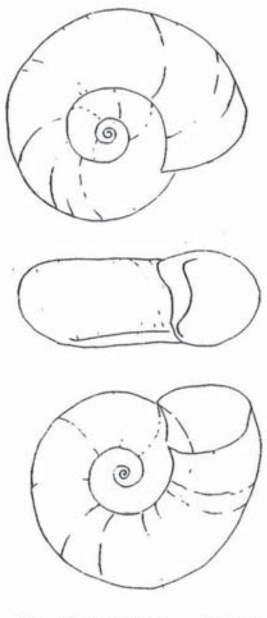
26. *Lymnaea natalensis*
(23x15 mm)



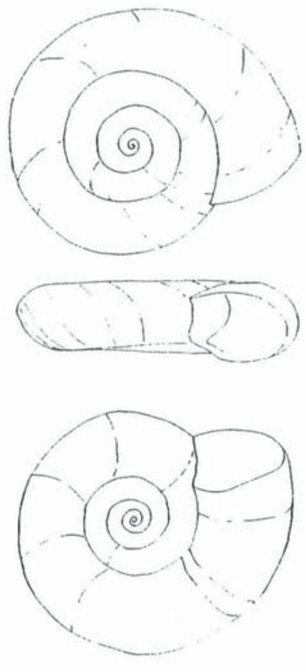
28. *Planorbis planorbis*
(2.5x11.0 mm)



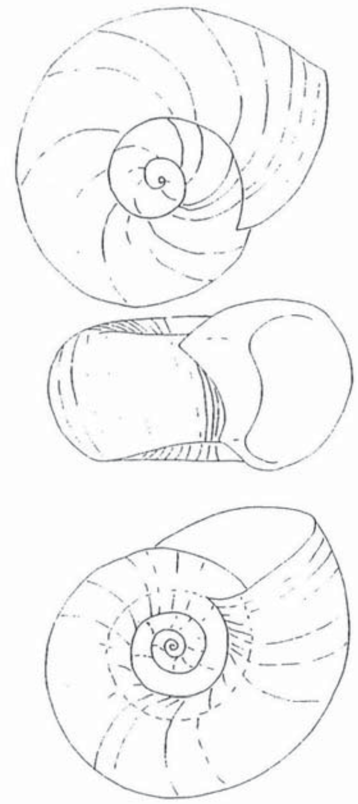
3o. *Biomphalaria alexandrina*
(4.8x14.2 mm)



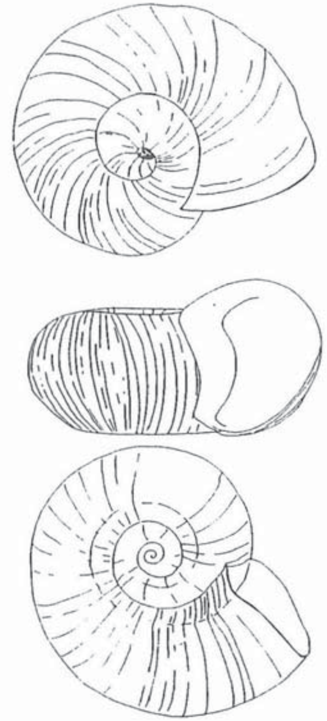
29. *Biomphalaria pfeifferi*
(5.5x16.0 mm)



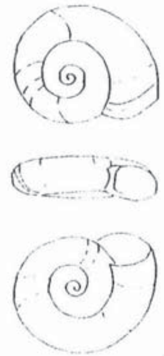
31. *Biomphalaria sudanica*
(4.2x15.1 mm)



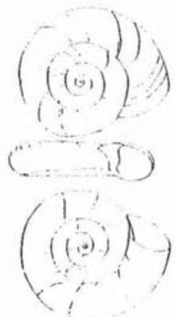
32. *Helisoma duryi*
(9.5x20.0 mm)



38. *Indoplanorbis exustus*
(13x25 mm)

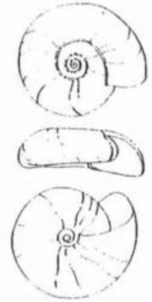


33. *Afrogyrus coretus*
(0.8x4.8 mm)



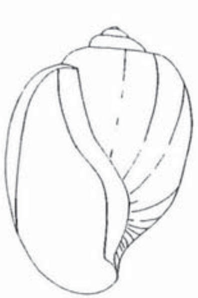
34. *Ceratophallus natalensis*
(1.3x5.8 mm)

35. *Gyraulus costulatus*
(1.4x5.5 mm)



36. *Lentorbis junodi*
(1.7x5.5 mm)

37. *Segmentorbis kanisaensis*
(1.2x4.6 mm)



41. *Bulinus abyssinicus* (14.2x9.0 mm)

4o. *Bulinus umbilicatus* (15x11 mm)

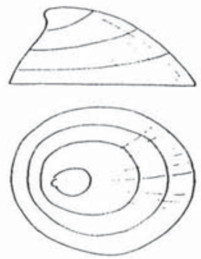
39. *Bulinus wrighti* (7x6 mm)

42. *Bulinus ugandae* (15x11 mm)

43. *Bulinus truncatus* (14.6x10.0 mm)

45. *Bulinus beccarii* (7.0x3.4 mm)

44. *Bulinus forskalii* (10.2x3.8 mm)



46. *Ancylus fluviatilis* (3x7x5 mm)*

47. *Ferrissia clessiniana* (1.8x5.0x2.8 mm)*

* height x length x width

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* A comprehensive list of literature is quoted in this book.