PICTORIAL KEYS TO THE
AQUATIC MOLLUSKS OF THE
UPPER SUSQUEHANNA

by

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This paper has been written for the use of laymen and students interested in the natural history of the Otsego County area of New York State.

It includes material concerning the phylogenetic and ecological aspects of the biology of our local snails, limpets, clams and freshwater mussels, as well as pictorial "keys" to aid in their identification. A list of the species collected in the County by the author and his students is presented in Table 1. Also included are the species of the Order Stylommatophora or land snails (Table 2) found in the Otsego Lake environs, for those interested in the non-aquatic molluscs.

INTRODUCTION

The freshwater snails and mussels are single-shelled Mollusca of the Class Gastropoda. In contrast to marine representatives of this class, all freshwater Gastropoda have developed internal fertilization, with the production of yolky, encapsulated eggs that are either not fertilized or being laid (Hunter, 1964). They comprise two suborders, the Prosobranchia and the Pulmonata.

The Prosobranchia are represented in central New York by the families Valvatidae, Vivipariidae, Hydrobiidae, and Pleurobranchidae. They are characterized by operculum and foot with sand or velum. The operculum is a rigid or leathery disc pulled from the aperture by a siphon, protecting the snail whenever it is retracted. All freshwater prosobranchs in central New York, except the Valvatidae, have separate sexes, the males being easily recognized because of the large penis organ. Freshwater prosobranchs are closely allied to marine, littoral, gill-breathing snails, and these two groups presumably have descended from the same (marine) ancestral stock (Hunter, 1952). To live in freshwater environments, these snails had to develop an osmoregulatory system capable of operating efficiently in low salt concentrations. After invading fresh waters, the Prosobranchia acquired adaptations for life in particular in that, for example, the Valvatidae have developed gills that can be oriented externally outside their mantle cavities and thus are less affected by running water than those of the substrate. Some members of the Viviparidae and Hydrobiidae feed by means of cilia (Jorgensen, 1966). This avoids the energy costs that other species experience while plowing through the substrate and grazing the surface film in search of food. They are also better hidden from predators because they remain in stationary positions.

The Pulmonata are represented by the Orders Stylommatophora and Basommatophora. Members of the Stylommatophora, the terrestrial snails and slugs, have two pairs of tentacles with the eyes borne at the tips of the longer pair. Freshwater pulmonates belong to the Order Basommatophora. They have only one pair of tentacles, and the eyes are not on them but near the bases (see cover illustration). Land snails and their empty shells frequently are found in water, and anyone who tries to identify aquatic snails should keep them in mind. Most of the errors made by students who have tried to use these keys have resulted from trying to apply them to land snails! If the soft parts are present, the rather to tentacles and position of the eyes can be determined. Empty shells that do not "fit into" the couplets may be those of land snails. For example, any shell having the spire raised only slightly above the body whorl, but too large to be a species of Valvata (greatest diameter not exceeding that must below to the Stylommatophora.

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The basommatophoran families in central New York (Lymnaeidae, Physidae, Planorbidae, and Ancylidae) are characterized by combined sexes (monoecious species), lack of opercula, no true gills, and a highly vascular mantle cavity that is used as a lung. Oxygen is obtained from either air or water, which enters the mantle cavity through an opening known as the pneumostome. The Planorbidae and Ancylidae have developed secondary gills from folds of tissue associated with, but oriented outside, the mantle cavity.

The freshwater pulmonates apparently evolved from ancestors that were air-breathing land snails (Hunter, 1952). These families illustrate different degrees of adaptation to aquatic life, which may represent steps in a process of evolution. Some authors have considered the amphibious members more primitive than the forms that never use atmospheric air (Morton, 1955). But, each family has become well adapted to the environment in which it lives.

The members of the Lymnaeidae (illustrated on the front cover) depend for respiration entirely on the rich vascular tissues of their otherwise simple mantle cavities. This "lung" is functional whether filled with air or water (Hunter, 1953b).

The mantle cavities of the Physidae are similar to those of the Lymnaeidae. In addition, the mantle possesses digitate outgrowths that lie over the outside of the shell and increase surface/volume relationships of the snails, theoretically resulting in less dependence on atmospheric air. However, many species of Physidae seem just as inclined as the Lymnaeidae to remain at the surface, where they can take air into the mantle cavity.

Some species in the family Planorbidae have developed a lobe(s) of tissue that lies outside the mantle cavity and serves as a gill. This advanced modification greatly improves their capability of extracting oxygen from water. Few members of the family voluntarily emerge from the water, but they often remain close to the surface and take air into the mantle cavity.

The Ancylidae, or freshwater limpets, have gills much like those of the planorbid snails. These structures have become so efficient that large mantle cavities are no longer needed. Those of the Ancylidae have become so reduced that they apparently are inadequate to satisfy respiratory needs. Limpets are normally found on hard, salt-free substrates below the water surface.

The mean ratio of shell weight to body weight is appreciably less in the Pulmonata than in the Prosobranchia. The relatively light shells of the Pulmonata were perhaps essential in the development of their common habit of grazing upside down on the surface films of quiet waters. In general the Pulmonata are more active than the Prosobranchia, moving over vegetation, substrate, and surface films at rates of up to 0.5 cm/sec. Because they are not dependent on gill breathing, they tolerate exposure to air better than do most prosobranchs. Buried in mud and organic substrates, many pulmonates can withstand dry conditions over the greater part of the year.

The three factors discussed above - light, weight, rapidity of movement, and ability to withstand exposure to air - result in high dispersal rates of the Pulmonata as compared with those of the heavy, more ponderous, water dependent Prosobranchia. Not only are the Pulmonata transported passively by birds, insects, and other animals, but they disperse actively across marshes and other ephemeral aquatic biotopes. Their ability to move through
marshes provides a particularly important means of dispersal in central New York, where marshes in the "through valleys" serve as portals for migration from one major river system to another.

The Freshwater Clams and Mussels

The fresh-water clams are Mollusca possessing two shells (Class Bivalvia). All local fresh-water bivalves exhibit external fertilization of eggs while stored in pouches within their gills. They comprise two families, the large Unionidae or pearly fresh-water mussels, and the much smaller individuals within the family Sphaeriidae, the finger-nail or pea clams.

The Unionidae are characterized by their large size (up to 15 cm in length) and the fact that during their juvenile stages they are parasitic on fishes. Their life cycles are as follows. Eggs developing in the reproductive organs of the females move from those structures into the mantle cavity, hence to marsupia within the gills. They are fertilized by sperm brought into the mantle cavity during the female's normal respiratory activity. There they develop into two-valved larvae about 1 to 2 mm in length called glochidia. The glochidia are released into the water by the females either passively or actively. In the first instance glochidia are simply spewed out where they remain suspended near the substrate by virtue of their practically neutral buoyancy. Any fishes swimming in the area, taking in water for respiration, inadvertently pick up the larvae and pass them by their gill filaments. Upon contact the glochidia clamp their valves upon the gills of the fish and assume a parasitic existence. In the second situation portions of the mantle of the female mussel are waved about imitating a small fish (inside back cover). When a larger fish attacks the clam forcefully expels glochidia in the predator's face, assuring the future of her young. After a period of development that varies considerably the glochidia drop from the gills, fall to the bottom and take up a free-living existence as adults (Figure 1).

As adults, water continually taken into the mantle cavity for respiration and removal of wastes brings in algae, bacteria and other edible microscopic particles which are filtered on the gills and transported to the oral region for food.

Members of the family Sphaeriidae are not parasitic on fish, the young developing within the gills until the adult stage is reached. Immediately upon release from the female they are able to live independently as filter feeders just as adult unionids.

Both families of bivalves are, for their respective sizes, rather ponderous and water dependent. Therefore the ecology is similar to the prosobranch snails. Importantly, the Unionidae must be in water where their host fishes occur or they cannot complete their life cycles. This phenomenon normally restricts them to larger lakes and streams.

In geological terms, fresh waters are very short-lived. Therefore, populations of fresh-water mollusks rarely remain isolated long enough to become fully speciated, even though temporary isolation is commonplace. For this reason, there are relatively few species of fresh-water snails and clams, but most species are widespread and quite variable. To survive, they must tolerate such conditions as extremes of temperature, dissolved oxygen, alkalinity, and pH. Adaptive plasticity, the ability of evolutionary lines to change when exposed to various stresses, appears to be extremely important in fresh-water gastropods (Hunter, 1964) and bivalves and to be of selective advantage in evolution. Specializations that render a species more efficient in one environment but less capable of colonizing different biotopes are selected against (Rubendick, 1962).
TABLE 1. THE AQUATIC MOLLUSCA OF THE UPPER SUSQUEHANNA.

<table>
<thead>
<tr>
<th>Class GASTROPODA</th>
<th>Family Hydrobiidae</th>
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<tbody>
<tr>
<td>Subclass Pulmonata</td>
<td>Amnicola limosa</td>
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<tr>
<td>Order Basomattophora</td>
<td>Amnicola lustrica</td>
</tr>
<tr>
<td>Family Lymnaeida</td>
<td>Amnicola integra</td>
</tr>
<tr>
<td>Lymnaea humilis</td>
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<tr>
<td>Lymnaea palustris</td>
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<tr>
<td>Lymnaea emerginata</td>
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<tr>
<td>Lymnaea columella</td>
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<td></td>
<td></td>
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<tr>
<td>Family Planorbidae</td>
<td>Family Pleurocerida</td>
</tr>
<tr>
<td>Helisoma trivolvis</td>
<td>Spirodon carinata</td>
</tr>
<tr>
<td>Helisoma anceps</td>
<td>Goniobasis virginica</td>
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<tr>
<td>Helisoma campanulata</td>
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<tr>
<td>Gyraulus parvus</td>
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<tr>
<td>Promenetus exacuous</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Family Physidae</td>
<td>Family Valvatida</td>
</tr>
<tr>
<td>Physa heterostropha</td>
<td>Valvata tricarinata</td>
</tr>
<tr>
<td>Aplexa hypnorum</td>
<td>Valvata sincera</td>
</tr>
<tr>
<td>Physa integra</td>
<td></td>
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<tr>
<td>Physa gyrota</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Family Ancyliida</td>
<td>CLASS BIVALVIA</td>
</tr>
<tr>
<td>Ferrissia parallela</td>
<td>Family Unionida</td>
</tr>
<tr>
<td>Ferrissia rivularis</td>
<td>Lampsilis radiata</td>
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<tr>
<td></td>
<td>Lampsilis cariosa</td>
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<td></td>
<td>Elliptio complanata</td>
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<td>Anodonta cataracta</td>
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<td></td>
<td>Anodontoides ferrussacianus</td>
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<td></td>
<td>Strophitus undulatus</td>
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<tr>
<td></td>
<td>Alasmidonta undulatus</td>
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<tr>
<td></td>
<td>Alasmidonta undulata</td>
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<tr>
<td></td>
<td>Lasmigona compressa</td>
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<tr>
<td></td>
<td>Alasmidonta marginata</td>
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<tr>
<td></td>
<td>Actinonais carinata</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Order Prosobranchia</td>
<td>Family Sphaeriida</td>
</tr>
<tr>
<td>Family Viviparida</td>
<td>Pisidium casertanum</td>
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<tr>
<td>Viviparus georgianus</td>
<td>Pisidium compressum</td>
</tr>
<tr>
<td>Cipangopaludina chinensis</td>
<td>Pisidium subtruncatum</td>
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<tr>
<td></td>
<td>Sphaerium sulcatum</td>
</tr>
</tbody>
</table>

TABLE 2. THE LAND SNAILS OF THE UPPER SUSQUEHANNA (from MacNamara and Harman, 1975)

<table>
<thead>
<tr>
<th>Order Stylomattophora</th>
<th>Striatura nutilium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carychiium exiguum</td>
<td>Striatura exigua</td>
</tr>
<tr>
<td>Gastrocopta pentodon</td>
<td>Stenotrema fraternum</td>
</tr>
<tr>
<td>Vertigo bollesiana</td>
<td>Triodopsis dentifera</td>
</tr>
<tr>
<td>Succinea ovalis</td>
<td>Triodopsis denotata</td>
</tr>
<tr>
<td>Catinella vermeta</td>
<td>Triodopsis tridentata</td>
</tr>
<tr>
<td>Anguispira alternata</td>
<td>Mesodon sayanus</td>
</tr>
<tr>
<td>Discus catskillensis</td>
<td>Triodopsis albolabris</td>
</tr>
<tr>
<td>Discus cronkhitei</td>
<td>Arion fasciatus</td>
</tr>
<tr>
<td>Discus patulus</td>
<td>Deroceras laeve</td>
</tr>
<tr>
<td>Punctum minutissimum</td>
<td>Deroceras cf. agrestes</td>
</tr>
<tr>
<td>Mesovitrea binneyana</td>
<td>Philomyces flexuarius</td>
</tr>
<tr>
<td>Mesomphix inornatus</td>
<td>Philomyces togatus</td>
</tr>
<tr>
<td>Eucomulus chersinus polygyratus</td>
<td>Pallifera dorsalis</td>
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<td>Ventridens intertextus</td>
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<tr>
<td>Zonitoides arboreus</td>
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</tbody>
</table>
Figure 1. The life cycle of a fresh-water clam, Family Unionidae.
REFERENCES


A PICTORIAL KEY TO THE AQUATIC MOLLUSCA OF THE UPPER SUSQUEHANNA WATERSHED

PHYLUM MOLLUSCA

Class GASTROPODA (snails)
  - shell cone shaped
  - Family Ancylidae (the limpets)

Class BIVALVIA (p. 8) (clams)
  - shell coiled
    - whorls in one plane
    - whorls in more than one plane (p. 3)

Family Planorbidae (the rams horn snails) (p. 2)
  - sides of shell parallel, found on vegetation in slow moving water
    - Ferrissia paralella

  - sides of shell not parallel, found on rocks in rapidly flowing streams
    - Ferrissia rivularis
Family Planorbidae (from p. 1)

- Shell large
  - at least 7 mm in diameter
    - Helisoma
      - Whorls flattened on both sides
      - H. anceps
    - Whorls rounded on at least one side

- Shell small
  - Extremely flattened
    - Promenetus exacuous
  - Not extremely flattened
    - Greater than 2 mm in dia.
      - Gyraulus parvus
    - Less than 2 mm in dia.
      - Menetus dilatatus

Whorls flattened on one side
- H. trivolvis

Whorls rounded on both sides
- H. campanulata
whorls on more than one plane (from p. 1)

- whorls sinistral
- whorls dextral
  - not operculate
  - operculate (having a trap door covering the aperture) (p. 5)

Family Physidae (the ear or tadpole snails)

- shell elongate, oily in appearance
  - Aplexa hypnorum

Family Lymnaeidae (p. 4) (the pond snails)

- shell inflated, not oily in appearance

Genus Physa

- spiral sculpture
- lack of spiral sculpture
  - shell moderately inflated
  - shell extremely inflated
  - Physa heterostropha

Physa sayii
Physa integra
Family Lymnaeidae
(from p. 3)
(the pond snails)

shell thin, fragile

*Lymnaea columella*

shell thick, resistant

large, adults
15 mm or more
in height

*Lymanea emarginata*

small, adults
less than 15 mm
in height

Lymanea humilis

shell inflated

shell elongated

*Lymanea palustris*
shells operculate
(from p. 3)

Subclass Prosobranchia

spire only slightly elevated

Family Valvatidae

- shells without carina
  Valvata sincera

- shells carinate
  Valvata tricarinata

spire moderately to extremely elevated

whorls inflated

whorls flattened

Family Pleuroceridae
(p. 6)

adults greater than 15 mm in height

Family Viviparidae (p. 6)
(apple snails)

adults less than 15 mm in height

Family Hydrobiidae (p. 7)
Family Viviparidae
(from p. 5)

- shell with 4 brown bands
  - Viviparis georgianus

- shell without bands
  - Campeloma decisa
    - shell shouldered

Family Pleuroceridae
(from p. 5)

- shell globose
  - Spirodon carinata

- shell elevated
  - Goniobasis virginica
Family Hydrobiidae
(from p. 5)

- shell truncate
  - Amnicola limosa

- shell conic or attenuate
  - shell conic
    - Amnicola integra
  - shell attenuate
    - Amnicola lustrica
CLASS BIVALVIA
(from p. 1)

(clams)

small, less than 10 mm in length
Family Sphaeriidae
(the pea or finger-nail clams)

beaks posterior
animal less than \( \frac{1}{2} \) mm in length
Genus *Pisidium* (pea clams)

large, 15 to more than 100 mm in length
Family Unionidae (p. 9)
(the pearly fresh-water mussels)

beaks anterior or subcentral
adults greater than \( \frac{1}{2} \) mm in length
Genus *Sphaeridium* (finger-nail clams)

The species in these two genera are very difficult to identify and are therefore omitted in this work designed for the layman.
Family UNIONIDAE

(the pearly freshwater mussels) (from p. 8)

hinge with articulating pseudocardinal and lateral hinge teeth present

Lateral hinge teeth

Pseudocardinal hinge teeth

shell without rays, one of our most common mussels

Elliptio complanata

shell with rays (p. 9)

hinge otherwise (p. 12)
Shell with Rays (from p. 9)

- Shell trapazoidal, found only in Canadarago Lake
- Shell ovoid
  - Shell possessing many thin rays, commonly found in lakes and rivers
    - Lampsilis radiata
  - Shell large, yellow with only a few thin rays
    - (p. 11)
- Shell with very few or broad rays, found only in rivers
  - Lasigone compressa
- Shell large, yellow with broad rays, distinct growth lines, background color greenish-yellow, rare in rivers
  - Actinonais carinata
Shell Large, Yellow, With a Few Weak Rays, Only Found in Large Rivers
(from p. 10)

Lampsilis cariosa
Hinge Without Articulating
Lateral and Pseudocardinal Hinge Teeth
(from p. 9)

hinge without teeth

hinge with teeth
(p. 13)

shell small (never exceeding 8 cm in length) found only at the north end of Otsego Lake

shell often large, common on muddy bottoms everywhere

Anodonta cataracta
Hinge With Teeth (from p. 12)

shell smooth

shell corrugated on posterior slope, found only in rivers

inside of shell yellow-pink, pseudocardinal small and smooth

inside of shell reddish-pink, pseudocardinal large and rough

Alasmidonta marginata

Alasmidonta undulata

Strophitus undulatus
ACKNOWLEDGEMENTS

The illustrations contained within this MS are, of course, the single most important part of the work. Although the author is responsible for the front cover and all figures of snails others should be credited as follows:

Ms. Karen Elting, Oneonta, N.Y.
Family Unionidae
Heard and Burch (1975)
Genus Pisidium
Genus Sphaerium

IX