STERKIANA

NUMBER 48 .... COLUMBUS, OHIO .... DECEMBER 1972

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ANNOUNCEMENT

STERKIANA is named after Dr. Victor Sterki (1846-1933) of New Philadelphia, Ohio, famed for his work on the Sphaeriidae, Pupillidae, and Valloniidae. It is fitting that this serial should bear his name both because of his association with the Midwest and his lifelong interest in non-marine Mollusca.

The purpose of STERKIANA is to serve malacologists and paleontologists interested in the living and fossil non-marine Mollusca of North and South America by disseminating information in that special field. Since its resources are modest, STERKIANA is not printed by conventional means. Costs are kept at a minimum by utilizing various talents and services available to the Editor. Subscription and reprint prices are based on cost of paper and mailing charges.

STERKIANA accepts articles dealing with non-marine Mollusca of the Americas in English, French, or Spanish, the three official languages of North America. Contributors are requested to avoid descriptions of new species or higher taxa in this serial as the limited distribution of STERKIANA would probably prevent recognition of such taxa as validly published. Papers on distribution, ecology, and revised checklists for particular areas or formations are especially welcome but those on any aspect of non-marine Mollusca will be considered.

STERKIANA will appear twice a year or oftener, as material is available. All correspondence should be addressed to the Editor.

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STERKIANA est une collection de travaux sur les Mollusques extra-marins des deux Amériques, distribuée par un groupe de malacologues du centre des Etats-Unis. STERKIANA publie des travaux en anglais, en français et en espagnol acceptés par le conseil de rédaction. Prière d'adresser toute correspondance au Rédacteur.

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PRECIO: 50¢ el número.

THE EBER HYDE MOLLUSK COLLECTION

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ABSTRACT

Remnants of the Eber Hyde collection of terrestrial and freshwater mollusks have recently come to light in the Department of Geology collections, Case Western Reserve University. Collected during the latter part of the nineteenth century, much of the material is from Ohio, particularly Fairfield and Scioto counties. Other specomens occur from various localities in the eastern United States, though many of these were presumably acquired by trade. The Hyde Collection provides documentation of several new county records for Ohio, and topotypes of *Pleurocera labiatum* Lea permit the resolution of the question of that species' identity. It is here considered a junior subjective synonym of *P. acutum* Rafinesque.

INTRODUCTION

Eber Hyde is remembered chiefly as the father of geologist and paleontologist Jesse Earl Hyde (1884-1936). Although the senior Hyde never published, father and son together formed an outstanding collection of Mississippian and Pennsylvanian invertebrates from Ohio. Following the death of J.E. Hyde in 1936, this valuable collection became scattered and much of it was lost, mixed, or dissociated from its labels. Remnants of the Hyde paleontological collection exist at Orton Museum, Columbus, in the Cleveland Museum of Natural History collections, and in the collections of the Department of Geology, Case Western Reserve University.

In the course of moving collections of the Department of Geology from one building to another, several drawers of Recent Mollusca were discovered, many bearing labels in the handwriting of Eber Hyde. Unfortunately, the specimens in open trays had been badly jumbled during previous moves, so that many specimens could not be associated with their proper labels. A considerable portion of the collection was stored in boxes, however, so that Hyde's identifications and provenience data are available. Associated botanical and insect specimens suggest that Hyde possessed a general interest in 'natural history,' but only the molluscan material bears labels.

The shell collection is small, consisting of 76 lots, with a total of 1632 specimens. The collection is of some value, however, in establishing Ohio county records and in providing material from localities that no longer sustain extensive molluscan populations. It is curious that no freshwater bivalves, with the exception of a few specimens of *Sphaerium*, occur in the Hyde collection. Possibly Hyde simply did not collect freshwater naiads; more likely, his naiad collection was segregated, then lost or discarded, or lies tucked away in some museum.

Eber Hyde never published on the mollusks, and his interest in this particular field does not seem to have been shared by his son. One brief note on the label of 'Pleurocera neglecta' is of interest, indicating that Eber Hyde was a rather assiduous collector and that only a portion of his collection remains extant. Hyde notes that 'Lea caled /sic/ this *P. labiata* and Tryon endorses him. I collected hundreds of these for Anthony and he always caled /sic/ them neglecta.' Only two specimens accompany this label; as these shells are from the type locality of *P. labiatum* ('Great Miami River Dayton O'), *P. labiatum* may be relegated to the synonymy of *P. acutum* Rafinesque or possibly its variety *tracta*.

Another label, unfortunately unaccompanied by any specimens whatsoever, indicates that Hyde was not an unconscionable 'splitter': 'Vivipara viviparis Say. Wabash River Ind. Some say difers /sic/ from contectoides but I cant see it.' Most of Hyde's identifications seem accurate and suggest that he was a careful student of the Mollusca. One peculiar lapse is hid labelling of specimens of *Stagnicola palustris elodes* as *Limnaea clocles* Say. No species of this name has been noted in the literature and, as Hyde's handwriting is in this instance quite legible, *clocles* must be considered a *lapsus calami* or perhaps simply a copying error.

Extant molluscan material in the Hyde collection is being transferred to Orton Museum, Ohio State University. This material is listed below. Hyde's identifications are listed (in parentheses) only when there is a significant difference between his species determination and that of the author. Locality data and notes are copied *ad litteram*, preserving Hyde's peculiar orthography—he rarely used double letters, even in species names, thus *'Mesodon pensylvanicus'*—and his inordinate use of capital letters. In the following list, asterisks denote new county records for Ohio, *i.e.* county occurrences not included in Taft (1961) or La Rocque (1966-1970.

TERRESTRIAL GASTROPODS

Glyptostoma newberryanum (Binney) California	2
Polygyra cereolus (Mühlfeld) (*Polygyra septemvolva* Say). Florida	1
P. septemvolva Say. Florida	11
P. septemvolva volvoxis (Pfeiffer) Mobile, Alabama	5
P. texasiana texasiana Pilsbry Fort Worth, Texas	6
P. fatigiata Say. Tennessee	3
Stenotrema stenotrema (Pfeiffer) Tennessee	6
S. hirsutum (Say). Ohio	43
S. monodon (Rackett). Vermont	11
Mesodon thyroidus Say. Louisiana	4
M. thyroidus Say. Rushville, Ohio	6
M. clausus (Say). Chattanooga, Tenn.	6
**M. mitchellianus* (Lea). Newark, /Licking Co./, Ohio	11
M. pennsylvanicus Green. Scioto Co., Ohio	5
M. appressus (Say). Chattanooga, Tenn.	12
M. appressus (Say). W. V.	1
M. sayanus (Pilsbry). West Virginia (*Mesodon sayii* Binney)	4
M. inflectus (Say). Ohio	35
Triodopsis tridentata Say. Fairfield Co. Ohio. Rushville	13
T. tridentata Say. Vermont	3
T. denotata (Férussac). Vermont (*Triodopsis palliata* Say)	3
**T. denotata* (Férussac). Fairfield Co. Ohio (*Triodopsis palliata* (Say)	10
T. albolabris Say. Fairfield Co., Ohio	4
T. multilineata (Say). Lancaster, Ohio	8
**Allogona profunda efasciata* Walker. Fairfield Co., Ohio	1
Bulimulus dealbatus (Say) Nashville, Tenn.	8
Bulimulus dealbatus mooreanus (Pfeiffer) Ft Worth, Texas	7
Euglandina rosea (Férussac) Mobile, Ala. (*Glandina turris* Pfeiffer?)	1
E. rosea bullata Gould. Mobile, Ala.	2
Haplotrema concavum (Say) Fairfield Co., Ohio	16
Retinella indentata (Say). Columbus, ('Look sharp for these I want some')	3
Gastrodonta interna (Say). Burning Springs W Va /Wirt Co./	14
Ventridens demissus (Binney). Mobile, Ala.	27
V. demissus (Binney). Fairfield and Perry Cos., Ohio	105
V. ligera (Say). Scioto and Fairfield Cos., Ohio	34
V. intertextus (Binney). Ohio	4
Zonitoides arboreus (Say). Tenn.	191
Z. arboreus (Say). Fairfield Co., Ohio	1
**Z. limatulus* (Binney). Scioto Co., Ohio	116
Anguispira alternata Say. Fairfield Co., Ohio	8
A. kochi (Pfeiffer). Fairfield Co., Ohio	4
Discus cronkhitei (Newcomb). Fairfield Co., Ohio Berne Station (*Patula striatella* Anth.)	81
D. patulus (Deshayes). Fairfield Co., Ohio	99
**Succinea ovalis* Say. Rushville, /Fairfield Co./ Ohio	62

Gastrocopta armifera (Say). Fairfield Co., Ohio 110

**G. procera (Gould)*. Scioto Co., Ohio 2

**Pupoides albilabris* (C. B. Adams) Fairfield Co., Ohio 1

Cionella lubrica (Müller). Vermont and Ohio 35
(Coniella subcylindrica Lin)

Helicina orbiculata tropica Pfeiffer Texas 23

AQUATIC GASTROPODS

Valvata bicarinata Lea. Little Lakes, N. Y. 3

Lioplax subcarinata (Say). Ohio River Cin Ohio /topotypes/ 15

Campeloma decisum (Say). Vermont 2
(Melantho ponderosa Say)

C. decisum (Say). Sharon /Shenango/ R., Penn. 3
(Melantho ponderosa Say)

C. decisum fecunda (Lewis). Canal. Columbus O. /Franklin Co./ 6

C. ponderosum (Say). Sharon /Shenango/ R. Penn. 2

C. ponderosum (Say). Ohio riv. Cin. Ohio 2

**Pomatiopsis lapidaria* (Say). Fairfield Co. /A few specimens may represent *P. cincinnatiensis* (Lea)/. 78

Pleurocera acutum Rafinesque. Great Miami River. Dayton 2
(Pleurocera neglecta Anthony) /Topotypes of *P. labiata* Lea/.

P. canaliculatum (Say). Little Kanawha W. Virg. 5
(Goniobasis)

Goniobasis livescens (Menke) Scioto Riv Columbus O 19
(Goniabasis depygis Say)

Nitocris trilineata (Say) Ohio River 92
(Anculosa praerosa Say) /Immature? revolving color bands lacking./

**Stagnicola caperata* (Say). Scioto Co Ohio. 69

S. catascopium (Say). Hudson River, Hudson, N.Y. 5

S. palustris elodes (Say). Vermont. 4
(Limnea clocles Say)

S. palustris elodes (Say). Near Lancaster /Fairfield Co./ 1

S. reflexa? (Say). Columbus, Ohio 1

S. umbrosa (Say). Near Lancaster, /Fairfield Co./ 14

S. umbrosa (Say). Columbus, Ohio 6

Helisoma anceps (Menke). Rush-creek Ohio /Fairfield Co./ 12
(Planorbis bicarinatus Say)

H. trivolvis (Say). Vermont 11

H. trivolvis (Say). Sharon, Penna. 7

Physa gyrina Say. Neely's spring, Rushville Ohio 63

**P. heterostropha* Say. Coll. near Lancaster /Fairfield Co./ 13

P. heterostropha Say. Ohio 14

P. heterostropha Say. Vermont 12
(Physa ancillaria Say)

PELECYPODS

**Sphaerium occidentale* (Prime). Coll. near Lancaster, Fairfield Co. 3

ACKNOWLEDGEMENTS

Miss Susan Warford first called my attention to that portion of the Case Western Reserve University geology department's collections which included the Eber Hyde mollusks. The remnants of the collection which have been salvaged are being transferred to Orton Museum through the courtesy of Dr. F. G. Stehli, chairman of the Department of Geology, Case Western Reserve University.

REFERENCES CITED

LA ROCQUE, Aurèle (1966-1970) Pleistocene Mollusca of Ohio. -- Ohio Geol. Survey Bull. 62, 800 p.

TAFT, Celeste (1961) The Shell-bearing Land Snails of Ohio. -- Ohio Biol. Survey Bull., v. 1, no. 3, 108 p.

MANUSCRIPT APPROVED FOR PUBLICATION SEPTEMBER 22, 1972

RARE AND ENDANGERED LAND MOLLUSKS IN CALIFORNIA

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ABSTRACT

The varied snail and slug fauna of California includes species and subspecies whose existence is presently endangered or potentially threatened by habitat destruction. Some of these are vulnerable because of rarity or narrowly restricted ranges; other, wide-ranging, species have been depleted over portions of their ranges. A compilation is supplied of 127 California snails and slugs considered rare and/or endangered, with their geographic ranges, habitat notes, and observed or reported threats to various species and subspecies. Major genera represented are *Helminthoglypta*, with 42 taxa, *Micrarionta*, with 26, and *Monadenia*, with 20.

INTRODUCTION

This report was compiled as part of a 1971-72 study, sponsored by the Sierra Club Foundation, to determine which species of mollusks in the western states could be considered 'endangered' in the sense of the federal Endangered Species Conservation Act of 1969. A similar version has been issued by the California Department of Fish and Game as one of its Inland Fisheries Administrative Reports; and the report has also been transmitted to other governmental agencies concerned with the conservation of wildlife.

The molluscan fauna of California is large and varied; more species and varieties of snails, slugs and clams live here than in any neighboring state. Two genera which include some of the largest and most beautiful North American land snails are almost confined to California---*Helminthoglypta* extending a short distance into Oregon and Baja California, and *Micrarionta* having one species in Arizona and several Mexican species. All forms are of value for studies of ecology and species evolution; and some occur obligingly close to major population centers and educational institutions. By its very existence, each species or subspecies contributes to the diversity--and hence the stability--of the ecosystem. It is the purpose of this report to put on record some of the rarer species and those of limited occurrence, so that future planning can take their presence into account and, hopefully, act for their preservation.

Marine mollusks have been excluded from this compilation. These, in general, occupy rather wide ranges; and their survival is tied to the condition of the coastal environment as a whole. Pending more specific studies, it has not been possible to select any particular marine species as more endangered than any other. While the loss of some species seems inevitable, from the effects of industrial pollution and pesticide runoff, in bay and estuarine areas particularly, it does not seem possible to predict with any assurance which species will be first to go. This is approximately the conclusion reached by Keen (1970).

Terrestrial mollusks, on the other hand, present quite a different picture. The present distribution of California land snails is the result of millions of years of geologic and climatic change. Many species are confined to single mountain ranges, or single canyons, surrounded by miles of territory inhospitable to them. These are generally relict populations of species which once had more extensive ranges. Some mollusks are associated with particular geological formations and soil conditions; snails in the central Sierra Nevada, for instance, tend to inhabit marble or limestone areas, being rare or absent in the surrounding granitic territory. The Channel Islands have a unique snail fauna, consisting of species unknown on the mainland, and reflecting Tertiary geography, when the present islands were part of major emergent land masses.

Published statements that no California land snail is known to be endangered in the same sense as the California Condor or the Trumpeter Swan (*cf.* Smith, 1970a: 40) need to be qualified. Mollusks and other invertebrates have not received the same attention as the more visible birds and mammals, so their survival status is less precisely known. Some of the species listed in this report have not received field study for 30 years. Snails are secretive in habit and sometimes very hard to find, even when present in an area; therefore few estimates of population size are available. Even determining the geographic range of a species is time-consuming. Most snails are exacting in their habitat requirements; but the parameters determining their presence or absence remain in large measure unknown. The published range for a species may seem to cover quite an area; but within this range the snail may inhabit, for example, only rockslides on north-facing canyon slopes--and of these, possibly only slides with a high content of calcium carbonate. Such narrowly ranging or insular species are equivalent to the category 'Rare' defined in the *Red Data Book* of the International Union for Conservation of Nature and Natural Resources (ICUN):

> Category 2. RARE. Not under immediate threat of extinction, but occurring in such small numbers and/or in such a restricted or specialized habitat that it could disappear. Requires careful watching. *(International Union for Conservation of Nature and Natural Resources,* 1966).

A second category includes those species with fairly wide original ranges, which, because of housing and industrial expansion or other causes, have had their numbers and available habitat severely reduced. These are equivalent to the category 'Depleted of the *Red Data Book:*

> Category 3. DEPLETED. Although still occurring in numbers adequate for survival, the species has been heavily depleted and continues to decline at a rate which gives cause for serious concern. *(International Union for Conservation of Nature and Natural Resources,* 1966).

Species occurring around major urban centers are most likely to fit into this category. The broad distribution of a species, in any case, should not be considered *prima facie* an excuse for destruction of one of its local populations. Unsuspected genetic differences may occur between populations within the range of a plant or animal species. If a particular colony is destroyed, the species may suffer an irreparable reduction of its gene pool. Recent discoveries concerning the anatomy of California land snails (*e.g.* Miller, 1970; Berry, 1953) show that more extensive speciation may be present in some cases than previously thought.

In the interest of accuracy, most of the snail and slug species listed herein might best be called *'potentially* endangered.' Those in imminent danger of extinction, as of this writing, are few. But changes in the California landscape take place with great speed, and a population seemingly secure one week may be bulldozed or quarried into oblivion the next. Establishment of protected areas within the ranges of threatened species, as sometimes done for endangered vertebrates, would aid in their preservation.

Beside outright habitat destruction, molluscan populations can be harmed by pesticide residues, weedkills, erosion, and changes in water table or stream flow patterns. Forestry practices, such as clearing of deadwood, can remove cover in which snails survive; and management for the benefit of game or waterfowl may, as a side effect, exterminate the snails and slugs in an area. Many California snails have evolved in localities where brush and forest fires are natural occurrences; their habits--probably chiefly burrowing underground during the dry season--have enabled them to survive under these conditions. It is also probable that extensive unseasonal blazes of human origin strain these survival capacities to their limit.

It should be mentioned that the native snails and slugs of California are not threats to agriculture or gardening. Conversion of land to agricultural use frequently eliminates them from a district.

The large, yellow 'banana slugs,' *Ariolimax*, have been known to feed on field crops; but virtually all the commercially important mollusk pests are introduced species. The brown snail, *Helix aspersa*, and several slugs of the genera *Limax* and *Deroceras* are chief examples, all being native to Europe but widely distributed in cultivated and urbanized areas of California. These and other introduced mollusks were figured by Hanna (1966). Foreign mollusks continue to be intercepted by quarantine and pest-control officials. In contrast to these undesirable immigrants, the native mollusks of the state must be rated a valuable resource.

A worker wishing to familiarize himself with the fauna might well begin with the two-volume monograph, *Land Mollusca of North America (North of Mexico)* by H. A. Pilsbry (1939-1948). This work brought together all previously published records and contributed much new data; California species known at the time were illustrated and described. A number of new studies have appeared since its publication, and several new species have been described. The pertinent literature is somewhat scattered, but important papers have appeared in the NAUTILUS, in the Proceedings and Occasional Papers of the California Academy of Sciences, and in the Bulletin of the Southern California Academy of Sciences. A valuable list of rare and endangered land snails in the western states was compiled by Smith (1970a) and formed the starting point for the present study.

The following compilation, containing 127 species and subspecies, is based upon the literature mentioned above, the mollusk collections of the California Academy of Sciences (cited below as 'CAS'), the author's field experience and that of other workers--Allyn G. Smith, Hugh C. Rawls, and Robert R. Talmadge, in particular--which has been most freely communicated and is gratefully acknowledged. Further field work will be useful in refining the data presented here. The list is systematically arranged as to families and genera, with species and subspecies following in alphabetical order. Each entry contains 1) the name of the species; 2) its geographic range, organized by county and frequently being a series of disjunct localities at which the mollusk has been taken; 3) habitat notes, where available; and 4) an indication of any observed or reported threat to the species. The generic composition of the list is as follows: *Helminthoglypta*, 42 species and subspecies; *Micrarionta*, 26; *Monadenia*, 20; *Sonorelix*, 7; *Haplotrema*, 6; *Vespericola*, 6; *Trilobopsis*, 4; *Glyptostoma*, 3; *Pristiloma*, 3; *Ammonitella*, 2; *Mohavelix*, *Oreohelix*, *Polygyroidea*, *Discus*, *Speleodiscoides*, *Ariolimax*, *Binneya*, and *Sterkia*, one each. A geographic index by county follows the species list; 36 counties are represented.

RARE AND ENDANGERED LAND MOLLUSKS

Family Helminthoglyptidae

GENUS MONADENIA

M. callipeplus Berry. SISKIYOU: Tompkins Creek, one mile bove mouth, elevation 2300 feet (Berry, 1940). Sugar Pine Gulch, off Scott River, amid live oak (R. R. Talmadge *in litt.*)

M. chaceana Berry. SISKIYOU: Shasta River Canyon near junction with Klamath River. Among rocks about half-way up a spur of Badger Mountain on west side of Shasta River Canyon. In lava rockslide one-quarter mile below Copco Diversion Dam (Berry, 1940). Near Yreka (CAS). One and one-half miles southwest of Hornbrook (CAS).

M. circumcarinata (Stearns). TUOLUMNE: limestone along canyon of Tuolumne River south of Paper Cabin Ridge (Hanna and Smith, 1954). 'Possibly a relict species nearing extinction. Not found living in recent years' (Smith, 1970a).

M. cristulata Berry. SISKIYOU: above Pleasant Valley Lakes, elevation about 5800 feet (Berry, 1940). Found higher than *M. callipeplus*; Crapo Creek near Somes Bar (R. R. Talmadge *in litt.*)

M. fidelis klamathica Berry. SISKIYOU: along Oak Flat Creek near Klamath River, under logs. Five miles upstream from forks of Salmon River (Walton, 1963). A high dam on the Klamath River could eliminate this subspecies (Smith, 1970a).

M. fidelis leonina Berry. SISKIYOU: Beaver Creek about one mile above mouth. Along Klamath River (Smith, 1970a). On dead alder leaves near stream and on alder trunks to a height of about 9 feet. Could be eliminated by a high dam on the Klamath River.

M. fidelis pronotis Berry. DEL NORTE: Point St. George, in rocky, moist habitats with *Mesembryanthemum* and other seashore plants (Chace, 1951b). Restricted to coastal habitat.

M. fidelis salmonensis Talmadge. SISKIYOU: Wooley Creek, elevation 1200-3000 feet. Glacial basins and creeks north side of Salmon River. Steinacher Creek, a tributary to Wooley Creek (Talmadge, 1954). Riderhofer Creek, Marble Mountains (CAS).

M. fidelis scottiana Berry. SISKIYOU: Kelsey Creek, one to 2 miles above mouth. Middle Fork of Kelsey Creek on trail 5.5 miles above Scott River. Canyon Creek from near mouth to one mile above. Middle Creek, one-half mile above mouth. Taken on dry sticks and dead leaves on ground (Berry, 1940).

M. fidelis smithiana Berry. DEL NORTE: banks of Smith River from near Hiouchi Bridge to three miles downstream. Near Fort Dick (Berry, 1940).

M. fidelis trinidadensis Talmadge. HUMBOLDT: Little River Rock, about 3 miles south of Trinidad and one-quarter mile out to sea; and an unnamed rock about one-half mile north of Little River Rock. Inhabits only the grass-covered offshore rocks; in grass or natural crevices in the rock (Talmadge, 1947).

M. hillebrandi yosemitensis (Lowe). MARIPOSA: Yosemite Valley, in rockslide near Vernal Falls and at Camp Curry. 'A high dam across the Merced River below the Yosemite Park boundary could eliminate a local race' (Smith, 1970a).

M. infumata alamedensis Berry. ALAMEDA: hills east of San Francisco Bay. Oakland; Hayward Canyon (CAS). CONTRA COSTA: near Moraga. Associated with coast redwoods. Endangered by industrial development and housing expansion (Smith, 1970). Should be safe in regional parks and watershed reserves, but total range probably much diminished.

M. mormonum buttoni (Pilsbry). CALAVERAS: Nassau Valley. Bear Valley, near Emigrant Gap (CAS). EL DORADO: near Riverton (CAS). 'Endangered by construction of both high and low dams causing canyon flooding' (Smith, 1970a).

M. mormonum hirsuta Pilsbry. TUOLUMNE: Mountain Pass (near State Highway 108 southwest of Jamestown). Two miles north of Jamestown (CAS). Associated with basalt of Table Mountain. Endangered 'from possible over-collecting' (Smith, 1970a). Part of range possibly flooded by New Melones Reservoir.

M. mormonum loweana Pilsbry. FRESNO: San Joaquin River canyon, on road to Huntington Lake. Mark Wood Creek, elevation 5600 feet (CAS).

M. rotifer Berry. SISKIYOU: one-half mile west of Whiskey Camp, Salmon Mountains, elevation about 6000 feet (Berry, 1940).

M. setosa Talmadge. TRINITY: Swede Creek, tributary to Trinity River. On moss and in forest duff accumulated under trees on more stable portions of talus (Talmadge, 1952). Would be endangered by construction of proposed Schneiders Bar Reservoir on Trinity River.

M. troglodytes Hanna & Smith. SHASTA: ravine near Samwell Cave (Walton, 1970); otherwise known only as a Pleistocene fossil.

M. tuolumneana Berry. TUOLUMNE: among limestone rocks at top of cliff above Crystal Cave, Baker Ranch, near Tuolumne City (Berry, 1955). Crystal Butterfly Cave and Crystal Tuolumne Cave (Smith, 1957).

GENUS HELMINTHOGLYPTA

H. allynsmithi Pilsbry. MARIPOSA: rockslides in canyon of Merced River, from 3 to 6 miles below El Portal. A high dam across the Merced River canyon could eliminate this species (Smith, 1970a).

H. arrosa holderiana (Cooper). ALAMEDA and CONTRA COSTA: hills along east side of San Francisco Bay, where it has been depleted by housing and industrial expansion. Also occurring in Marin, Sonoma, Mendocino and Humboldt counties, where probably not endangered except locally.

H. arrosa humboldtica Berry. HUMBOLDT: vicinity of Bridge Creek Lumber Camp, south of Scotia. North side of Cape Mendocino and mouth of Mattole River. Near Shelter Cove, and ten miles south of Cape Mendocino. Found among fallen leaves, or in weeds and nettles.

H. arrosa miwoka (Bartsch). MARIN: Point Reyes Peninsula, particularly southern portion, near Point Reyes Light. Intergrades with *H. a. stiversiana* (Cooper). Found both in native plant communities and on grazed land, where succulent weeds such as thistle and cow parsnip *(Heracleum)* may tend to concentrate it.

H. arrosa pomoensis A. G. Smith. MENDOCINO: Big River near mouth of Daugherty Creek, under redwoods. Navarro River at mouth of North Fork. Russian Gulch. Apparently found only near the coast in heavily timbered redwood canyons. In danger from logging operations (Smith, 1970a).

H. arrosa williamsi A.G. Smith. MARIN: Hog Island, a small islet in Tomales Bay. 'Although the colony is a strong one at present, it could be severely decimated, if not completely wiped out by indiscriminate collecting' (Smith, 1938).

H. ayresiana (Newcomb). SANTA BARBARA: San Miguel and Santa Rosa Islands. Under bushes of *Astragalus*. 'Endangered on San Miguel Island, the type locality, from U. S. Navy operations' (Smith, 1970a). Designation of biological preserves on these islands would aid in preservation of the species.

H. ayresiana sanctaecrucis Pilsbry. SANTA BARBARA: Santa Cruz Island. VENTURA: Anacapa Islands. Found in thistles, in rockslides well covered with leaves, sticks and leafmold, and beneath cacti (Williams, 1940).

H. benitoensis Lowe. SAN BENITO: Pinnacles National Monument, probably between 1200 and 2000 feet elevation. Rare.

H. californiensis (Lea). MONTEREY: on coast from Marina to mouth of Little Sur River (Chace, 1941). Found under coastal plants, *Mesembryanthemum*, bush lupine. Some reduction of habitat from urban development in the Monterey area.

H. callistoderma (Pilsbry & Ferriss). KERN: margin of Kern River 2 miles north of Bakersfield, on dead vegetation at the water's edge. TULARE: Hot Springs Ranger Station (Branson, Sisk & McCoy, 1966). Endangered, possibly by a high dam across the lower Kern River canyon (Smith, 1970a).

H. contracostae (Pilsbry). CONTRA COSTA: Byron Hot Springs. The extinction of colonies formerly occurring along east shore of San Francisco Bay (*e. g.*, Point Isabel, Ellis Landing), as a result of industrial expansion, was first reported by Ingram & Lotz (1950). SOLANO: Kirby Hill, north side of Suisun Bay (CAS). Possibly extinct in Grizzly Island State Game Refuge as a result of lowland flooding for waterfowl. LAKE: southern end of Clear Lake. Occurs on mud flats, under low bushes, in tall grass, and under *Salicornia*. Endangered at Byron Hot Springs by resort expansion or over-collection (Smith, 1970a); and probably much depleted elsewhere in its range.

H. cuyama Hanna & Smith. SANTA BARBARA: rockslide on south side of Santa Maria-Maricopa highway, 23.7 miles east of Santa Maria.

H. cuyamacensis avus (Bartsch). KERN: Tejon Ranch, foothills on northwest side of Tehachapi Mountains.

H. cuyamacensis lowei (Bartsch). SAN DIEGO: Palomar Mountain, at elevation 5000 feet. Upper Pwuma Creek near junction of Doane Creek. Observatory Road 3 to 4 miles east of Crestline. Near sawmill east of Palomar P. O. (Berry, 1953). Six miles northwest of Warner's Springs (CAS).

H. cuyamacensis piutensis Willett. KERN: Piute Mountains at a small spring on Piute Mountain road 10.5 miles southeast of its intersection with the Walker Basin-Bodfish road, elevation about 7000 feet. Found under and along fir logs, in pine and fir timber.

H. cuyamacensis venturensis (Bartsch). LOS ANGELES: Oak Flat Ranger Station (Angeles National Forest), 12 miles north of Castaic (CAS). Reported also from Ventura County, exact locality not specified.

H. euomphalodes Berry. KERN: Blodgett's Camp, Greenhorn Mountain. Known from 6500 to 7000 feet elevation (CAS).

H. fontiphila Gregg. LOS ANGELES: Little Rock Creek Canyon, north side of San Gabriel Mountains. Soledad Canyon, 5.5 to 8.5 miles from Mint Canyon highway. Eleven miles from Palmdale toward Saugus, under dead *Yucca whipplei*. Acton (CAS).

H. graniticola Berry. SAN BERNARDINO: south end of Granite Mountains in vicinity of Victorville. Found 'beneath rock piles or large flat rocks but in dry weather it burrows beneath the surface of the soil under the rocks. I have also found it buried among the roots of desert plants' (Gregg, 1961).

H. greggi Willett. KERN: three and one-half miles south of Mojave, about one-half mile west of the Mojave-Los Angeles highway. Soledad Mountain, near Mojave (CAS). Hillside rockslides.

H. hertleini Hanna & Smith. SISKIYOU: near mouth of canyon of Shasta River. Also ranges a short distance into Oregon. Found in lava rock slides.

H. inglesi Berry. KERN: Horse Meadows, on trail to Sunday Peak, Sierra Nevada Mountains.

H. isabella Berry. KERN: two miles east of Isabella, under dead yuccas. One and one-half miles east of Weldon (CAS).

H. liodoma Berry. KERN: North Fork of Cottonwood Creek on road to Breckenridge Mountain.

H. micrometalleoides Miller. KERN: El Paso Mountains, in north-facing, high rockslide of small rocks, between crag outcroppings on south side of Iron Canyon Road, at a point 3 miles up the canyon from junction of the road with the Garlock-Goler highway (Miller, 1970).

H. mohaveana Berry. SAN BERNARDINO: Victorville grade, east side of Victor Mountains. At base of rocky cliffs on right bank of Mojave River just above Victorville. Rocky outcrop on west bank of Mojave River, above Oro Grande. Aestivates among and under loose rocks on dry hillsides. Could be endangered by quarrying operations.

H. nickliniana awania (Bartsch). MARIN: Point Reyes Peninsula. This form is of most consistent occurrence in the vicinity of Point Reyes Light, especially where native plant communities persist. Inland on the Peninsula, intergradation with typical *H. nickliniana* (Lea) occurs. Found both in native scrub and among pasture weeds.

H. nickliniana bridgesi (Newcomb). ALAMEDA and CONTRA COSTA: open hillsides of west slope of Berkeley Hills. Along San Pablo Creek. East slope of Mount Diablo. Other specific localities were given by Ingram & Lotz (1950). Endangered, by industrial and building expansion (Smith, 1970a).

H. petricola sangabrielis (Berry). LOS ANGELES: Monrovia Canyon, San Gabriel Mountains. Millard Canyon and Eaton Canyon, north of Pasadena. West fork of San Gabriel River just below divide. Other subspecies of *H. petricola* (Berry) may be locally endangered in Orange, San Bernardino, and Los Angeles counties.

H. sequoicola consors (Berry). MONTEREY: south slope of San Juan Grade, near foot, eight miles northwest of Salinas. Endangered by expansion of farming and industrial operations (Smith, 1970a).

H. stageri Willett. KERN: southwest side of Erskine Creek, Piute Mountains, elevation about 5500 feet.

H. thermimontis Berry. SAN DIEGO: gulch on southeast side of Hot Springs Mountain, Los Coyotes Indian Reservation, elevation 5000 to 5500 feet (Berry, 1953).

H. traski coelata (Bartsch). SAN DIEGO: Torrey Pines, La Jolla, and Pacific Beach. Habitat much diminished by housing expansion.

H. traski fieldi Pilsbry. SANTA BARBARA: Surf. SAN LUIS OBISPO: Pismo Beach (CAS). A snail of coastal and strand vegetation.

H. traski pacoimensis Gregg. LOS ANGELES: Pacoima Canyon, San Gabriel Mountains. Found mostly under bark and fragments of rotten logs.

H. traski tejonis Berry. KERN: two miles above Grapeville Station, old State Highway, Tejon Pass. Grapevine Station. San Emigdio Creek 15 miles southeast of Maricopa. Found in rockslides.

H. traski willetti (Berry). VENTURA: Pine Canyon, Sespe Creek, elevation 3500 feet. Sulphur Mountain Springs; Wheeler's Spring; Matilija Hot Springs. Fillmore, Sespe Canyon (CAS). SANTA BARBARA: Arroyo Burro, head of Santa Ynez River (CAS). Endangered, 'possibly by severe forest fires (Smith, 1970a). Proposed reservoirs on Sespe Creek would cut into range of this subspecies.

H. tudiculata angelena Berry. 'Throughout the Los Angeles Basin and its tributary canyons, its range thus covering a good part of Los Angeles County and adjoining areas in Ventura, Orange, Riverside, and San Bernardino Counties .... as far east as lower Mill Creek Canyon in the San Bernardino Mountains, Tremont Park and Perris in Riverside County, as far south as the vicinity of Anaheim, and as far west and north as Bardsdale in Ventura County' (Berry, 1938). Endangered, by industrial expansion (Smith, 1970a). The subspecies has suffered local habitat destruction practically throughout the range reported above.

H. tudiculata grippi (Pilsbry). SAN DIEGO: San Diego River gorge. Santee. Habitat diminished by housing and industrial expansion.

H. walkeriana (Hemphill). SAN LUIS OBISPO: Morro Peninsula. Town of Halcyon. Found on sand dunes under *Haplopappus* at Morro Bay, under cactus at Halcyon. Should be safe in Morro Bay and Montana de Oro State Parks.

GENUS MICRARIONTA

M. aquaealbae Berry. RIVERSIDE: Whitewater Canyon, San Bernardino Mountains, elevation 1700-1800 feet. Near Cabazon, north side of San Jacinto Mountains. Found in talus and under fallen leaves.

M. brunnea Willett. RIVERSIDE: near Chuckwalla Spring, Little Chuckwalla Mountains. Little Chuckwalla Mountains 6.5 miles west and south from Wiley Well (CAS).

M. facta (Newcomb). LOS ANGELES: Santa Barbara Island. May be extinct on San Nicolas Island (Smith, 1970a); considered to be endangered because of insular habitat.

M. feralis (Hemphill). VENTURA: San Nicolas Island, where it could be endangered by military operations.

M. gabbi (Newcomb). LOS ANGELES: San Clemente Island. Santa Barbara Island (CAS). Establishment of biological reserves on San Clemente Island would aid preservation of this and other species *(Micrarionta intercisa, M. redimita, Sterkia clementina)* occurring there.

M. harperi (Bryant). SAN DIEGO, IMPERIAL: south end of Laguna Mountains, from one mile west of Mountain Springs to 3 miles east of that point. Mountain Springs and 3 miles east of Jacumba (Smith, 1970b). Among rocks and mats of dead agave plants.

M. immaculata Willett. RIVERSIDE: east slope of Riverside Mountains 7 miles south of town of Vidal. Found in rockslides. Could be endangered by quarrying.

M. indioensis cathedralis Willett. RIVERSIDE: in rockslides at head of Cathedral Canyon.

M. indioensis remota Willett. SAN DIEGO: Borego Mountain. Other subspecies of *M. indioensis* (Yates) may be endangered locally in the Coachella Valley area, Riverside and San Diego counties.

M. intercisa (W.G. Binney). LOS ANGELES: San Clemente Island. Largest colonies found in crevices in cliffs at southwest part of the island (Kanakoff, 1950); also found under thick layers of cacti, *Opuntia littoralis*. Kanakoff (1950) commented on the significance of the several named varieties of this species.

M. kelletti (Forbes). LOS ANGELES: Santa Catalina Island. Usually on or under prickly-pear cacti. Endangered 'from possible destruction of its cactus-patch habitat' (Smith, 1970a).

M. melanopylon Berry. SAN BERNARDINO: Black Rock Hills, west side of Black Canyon near mouth, 9 miles north of Hinkley. Taken among black basalt rocks on mountainside.

M. millepalmarum Berry. RIVERSIDE: Thousand Palms Canyon, Indio Hills. Intergrades with *M. brunnea* in some localities (Pilsbry, 1939). Found under rocks piled up by storm waters along edges of gullies (Willett, 1939).

M. morongoana Berry. SAN BERNARDINO: gulch on north side of Morongo Pass, 2 miles below the Morongo Inn, Colorado Desert.

M. orocopia Willett. RIVERSIDE: rockslide, south side of canyon on south slope of Orocopia Mountains, about 2.5 miles north of Dos Palmas Spring. Also near northeastern extremity of Orocopia Range (Willett, 1939).

M. redimita (W.G. Binney). LOS ANGELES: San Clemente Island. Found in crevices in cliffs of southwest portion of the island, and northwest portion (Kanakoff, 1950).

M. rowelli acus Pilsbry. SAN BERNARDINO: Mohave Mountains, opposite Topock, Arizona. Mountains northeast of Essex. Also occurs in Arizona. Possible danger from quarrying operations.

M. rowelli amboiana Willett. SAN BERNARDINO: among rocks on a small hill about 6 miles northwest of Amboy. About one mile north of highway from Amboy to Needles.

M. rowelli bakerensis Pilsbry & Lowe. SAN BERNARDINO: north slope of small range of limestone hills west of the highway, about half a mile south of Baker. Found in rockslides. Quarrying of limestone in the area would endanger the subspecies.

M. rowelli chocolata Willett. IMPERIAL: near Beal's Well, Chocolate Mountains. Possible danger from military operations.

M. rowelli chuckwallana Willett. RIVERSIDE: Chuckwalla Mountains, near Corn Springs and near Chuckwalla Spring. (Willett, 1939).

M. rowelli granitensis Willett. RIVERSIDE: northwest end of Granite Mountains, about one mile southwest of Desert Center-Rice highway. Found in rockslides on mountain slopes.

M. rowelli mccoiana Willett. RIVERSIDE: Mc Coy Well, McCoy Mountains. Various sites in McCoy Mountains and Big Maria Mountains;

possibly also Palen Mountains (Rawls, 1971). Rockslides in gullies. 'Very definitely endangered: the commercial mining of building-stone in the vicinity of my collections in the Big Marias (and in the McCoys) certainly will remove the habitat. In the McCoy Mountains, especially, the mining of uranium and other minerals is already responsible for some degree of habitat-loss' (H. C. Rawls, *in litt.*).

M. rufocincta (Newcomb). LOS ANGELES: Santa Catalina Island. The Isthmus, Silver Canyon, Cape Canyon, and Johnson's Landing (CAS) are among the localities. Endangered, from resort expansion (Smith, 1970a).

M. stearnsiana (Gabb). SAN DIEGO: Point Loma; Pacific Beach; Imperial Beach, near San Diego. Hill back of Scripps Institute, near La Jolla. Below Murray Dam, near Found on or under prickly-pear cacti, under stunted bushes (Pilsbry, 1939). Habitat diminished by housing expansion.

M. tryoni (Newcomb). VENTURA: San Nicolas Island. LOS ANGELES: Santa Barbara Island. Found on *Opuntia* cacti. The form *M. tryoni hemphilli* (Hannibal), rare on both islands, was considered by Smith (1970a) to be endangered, especially on San Nicolas Island.

GENUS MOHAVELIX

M. micrometalleus (Berry). KERN: El Paso Mountains, 3.5 miles south of Petrified Forest. Southern part of Last Chance Canyon (Miller, 1970). Found deep in granitic rockslides.

GENUS SONORELIX

S. angelus Gregg. LOS ANGELES: hillsides on north side of west end of Soledad Canyon; under dead yuccas within 300 yards of canyon floor; elevation about 1700 feet (Gregg, 1948). Mint Canyon (Gregg, 1961).

S. avawatzica (Berry). SAN BERNARDINO: Avawatz Mountains, rocky point west of road in pass at junction of Barstow and Silver Lake roads, 5 miles south of Cave Spring. Possibility of other localities discussed by Berry (1943).

S. baileyi (Bartsch). INYO: Resting Springs, among rocks on a dry hill 900 feet above the spring. Gunsight Mountains, 3 miles south of Resting Springs. Under dead agave plants (Gregg, 1961).

S. borregoensis (Berry). SAN DIEGO: mountain slopes surrounding the upper end of Borrego Valley from Coyote Mountain to the San Ysidro Mountains (Berry, 1943). Under loose slabs of rock, among rubbish and in rock slides, not deeply burrowing.

S. borregoensis carrizoensis (Willett). IMPERIAL: hills above Painted Gorge, Carrizo Mountain.

S. borregoensis ora (Willett). SAN DIEGO, IMPERIAL: near north end of Fish Mountains, about 3 miles from the settlement of San Felipe. Vallecito (including Fish Creek) Mountains, north to San Felipe Narrows; Sentenac Canyon; head of Blair Valley; and northeast side of Laguna Mountains (Agua Caliente Springs) (Pilsbry, 1939). Yaqui Well (CAS). Found in rockslides. Relationships of this subspecies and *S. borregoensis* were discussed by Berry (1943).

S. rixfordi (Pilsbry). RIVERSIDE, SAN BERNARDINO: northern outliers and canyons of the Little San Bernardino Mountains, west and south of Twentynine Palms; and extending southeastward to the Eagle Mountains (Berry, 1943). Northeast end of Orocopia Mountains (Willett, 1939).

Family Camaenidae

GENUS OREOHELIX

O. avalonensis Pilsbry. LOS ANGELES: Santa Catalina Island. 'Where on Catalina /it was found/ is still unknown' (Pilsbry, 1939). 'Endangered, if not already extinct, the single known colony having been wiped out by the original collector many years ago' (Smith, 1970a).

Family Ammonitellidae

GENUS AMMONITELLA

A. yatesi J.G. Cooper. CALAVERAS: cave at Cave City. Near Murphys and one to 2 miles northward, near Mercer Cave. Cave of the Catacombs (Smith, 1957). EL DORADO: Pioneer Cave (Smith, 1957). Associated with limestone; found in humus around limestone outcroppings; favors north-facing slopes. A relict genus, possibly on the way to extinction, though common at present, where found; endangered from possible over-collecting (Smith, 1970a).

A. yatesi allyni Chace. FRESNO: near

Boyden's Cave, Kings Canyon (Chace, 1951a). Church Cave (Smith, 1957). Collected under dead leaves.

GENUS POLYGYROIDEA

P. harfordiana (J. G. Cooper). FRESNO: Big Trees, elevation 6500 feet. MARIPOSA: Big Trees west of Wawona Point, elevation 6000-7000 feet. One-quarter mile above junction of Alder Creek with South Fork of Merced River, elevation 4000 feet. Found in overgrown mossy rockslides; shade and northern exposure reported (Pilsbry, 1939). 'Appears to be becoming increasingly rare at Mariposa Big Trees because of its extremely limited habitat. Also occurs in the Merced River Canyon below Yosemite Park, where it could be endangered by a high dam' (Smith, 1970a).

GENUS GLYPTOSTOMA

G. gabrielense Pilsbry. LOS ANGELES: San Gabriel Range, canyons back of Pasadena; Millard Canyon, Monrovia Canyon, Winters Creek. A smaller form occurs in the Dominguez Hills. Found under vegetable debris on surface of soil. Endangered 'from industrial development in the Dominguez Hills' (Smith, 1970a); and probably much depleted throughout the rest of its range.

G. newberryanum (W.G. Binney). SAN DIEGO: southwestern part of the county. Published localities include Mussey Grade, Jamul, Ramona, Mission Gorge, El Cajon. 'The colonies .... are small and in part rather widely separated by areas where it is not known to exist' (Pilsbry, 1939).

G. newberryanum mimus Pilsbry. SAN BERNARDINO: east slope of Blue Mountain west of Loma Linda (CAS). RIVERSIDE: mountains west of Riverside. Localized and rare (Smith, 1970a).

Family Polygyridae

GENUS TRILOBOPSIS

T. penitens (Hanna & Rixford). SACRAMENTO: formerly found on south bank of South Fork of American river near the hamlet, Mormon Island, living among rocks and plant debris on dry but shady hillside. Inundation of this locality by waters of Folsom Reservoir was reported by Webb (1970).

T. roperi (Pilsbry). SHASTA: Redding, in drift of Sacramento River. Six miles north of Ingot. Found among limestone outcroppings and talus slopes over which there is some protective shade.

T. tehamana (Pilsbry). TEHAMA: Battle Creek. SISKIYOU: Shasta River Canyon (Smith, 1960).

T. trachypepla (Berry). HUMBOLDT: vicinity of Bridge Creek Lumber Camp, south of Scotia.

GENUS VESPERICOLA

V. columbiana oria (Berry). EL DORADO: South Fork of American River Canyon near Riverton. Pleasant Valley. Near Eagle King Mine, 2.5 miles south of Grizzly Flat (CAS). Further damming of American River could threaten this species.

V. hapla (Berry). BUTTE: Butte Creek Canyon about 10 miles from Chico. Might be endangered by damming of Butte Creek.

V. karokorum Talmadge. HUMBOLDT: Sawmill Gulch, a narrow fissure on north side of Klamath River, on Ishi Pishi Road 2 miles east of Orleans Ranger Station; also similar fissures 1.5 to 2.5 miles east of Orleans. 'Seems to prefer only the deepest, narrowest, fissure-like gorges .... always extremely close to water' (Talmadge, 1962); limitations of dispersal by current discussed in same article. 'When one considers that only the edges of the stream beds in the narrow side gorges are used for a habitat, then the restriction /of range/ is much greater' (R. R. Talmadge, *in litt*.

V. megasoma euthales (Berry). DEL NORTE: Chaffey Ranch, 7 miles above mouth of Klamath River; in redwoods.

V. shasta (Berry). SHASTA: La Moine. EL DORADO: roadside spring 24 miles east of Placerville.

V. sierrana (Berry). SISKIYOU: 2 miles north of Weed. Shasta River Canyon (Smith, 1960). Found under logs in a swampy meadow.

Family Haplotrematidae

GENUS HAPLOTREMA

H. catalinense (Hemphill). LOS ANGELES: Santa Catalina Island.

H. costatum A. G. Smith. TULARE: 'Cave No. 12-19', about 14 miles north-northeast of Springville (Smith, 1957).

H. duranti (Newcomb). LOS ANGELES: Santa Barbara Island. SANTA BARBARA: Santa Cruz Island at Scorpion Harbor, Pelican Bay, Canada del Puerto and Prisoners Harbor. In pockets of leaves in dry stream beds, usually found in the upper strata, rather than deeper in the damp leaf mold (Williams, 1940). Considered by Smith (1970a) to be endangered.

H. keepi (Hemphill). ALAMEDA: hills near Oakland. MENDOCINO: one mile west of Cold Creek Fish Hatchery between Blue Lake and Ukiah.

H. transfuga (Hemphill). SAN DIEGO: San Diego. Also ranges some distance down west coast of Baja California.

H. voyanum (Newcomb). TRINITY: Canyon Creek. Trinity River one-half mile north of Trinity Alps Camp. Grass Valley Creek, 4 miles west of summit of Redding-Weaverville road (CAS). SHASTA: 6 miles east of Ingot. 'No typical specimens found in recent years. May be extinct. (Smith, 1970a).

Family Zonitidae

GENUS PRISTILOMA

Pristiloma juniperum A.G. Smith. PLUMAS: Cavern Room of Juniper Cave, on floor and under rocks of cave (Smith, 1957).

P. nicholsoni H.B. Baker. MARIN: hillside near spring brook (first small branch below Big Carson Creek) about 2 miles south of Lagunitas. Found under pieces of wood on hillside.

P. shepardae (Hemphill). LOS ANGELES: Santa Catalina Island. SANTA BARBARA: Scorpion Harbor, Santa Cruz Island (Williams, 1940). On Santa Cruz Island 'a pair of living snails were taken from beneath a leaf in debris under a toyon berry shrub. The locality was well trampled by sheep which may partly explain the scarcity of the species in the locality' (Williams, 1940).

Family Endodontidae

GENUS DISCUS

D. (?) selenitoides (Pilsbry). MARIPOSA: area of Mariposa Big Trees, both within and outside Yosemite National Park boundaries. Junction of Alder Creek and South Fork of Merced River. Reported as very rare.

GENUS SPELEODISCOIDES

S. spirellum A.G. Smith. AMADOR: Violin Cave on South Fork of Dry Creek. Black Chasm, near Volcano, on east side of south branch of Sutter Creek. EL DORADO: two miles south of Coloma (CAS); found under rocks in oak and maple forest along creek. Regarding dead specimens in archaeological sites, Contra Costa County, see Smith & Curtis (1964).

Family Arionidae

GENUS ARIOLIMAX

A. californicus brachyphallus Mead. SAN FRANCISCO: Mount Davidson, Mount Sutro (Mead, 1943). Buena Vista Park. San Francisco Presidio, near Baker's Beach.

GENUS BINNEYA

B. notabilis J. G. Cooper. LOS ANGELES: Santa Barbara Island. Found under soil, under thick succulent roots. Recent collectors have not been able to find this snail on Santa Barbara Island, and it may now be extinct; Baja California records pertain to some other species (Pilsbry, 1948).

Family Pupillidae

GENUS STERKIA

S. clementina (Sterki). LOS ANGELES: San Clemente and Santa Barbara Islands.

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ACKNOWLEDGMENTS

For valued assistance given during this investigation, the author expresses his thanks to the following persons: Earl B. Baysinger, Eugene V. Coan, Leonard O. Fisk, Marc J. Imlay, Hugh C. Rawls, Allyn G. Smith, Robert R. Talmadge, and Kenneth van der Laan. Support for the study came from the Sierra Club Foundation; and the aid of Mr. Colburn Wilbur is gratefully acknowledged.

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ACCEPTED FOR PUBLICATION IN STERKIANA SEPTEMBER 22, 1972.

LISTE DES GASTEROPODES DU FLEUVE SAINT-LAURENT, REGION DE GENTILLY

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RESUME

En vue d'étudier l'écologie des Gastéropodes, les auteurs ont effectué l'inventaire quantitatif et qualitatif des eaux du fleuve Saint-Laurent dans la région de Gentilly, Nous donnons ici la liste des 23 espèces qui ont été inventoriées; elles appartiennent aux familles Amnicolidae, Lymnaeidae, Physidae, Planorbidae, Pleuroceridae, Valvatidae et Viviparidae.

ABSTRACT

In order to study the ecology of Gastropoda, the authors have made the qualitative and quantitative inventory of the waters of the St. Lawrence River in the Gentilly area. We give here the list of the 23 species which have been inventoried; they belong to the families Amnicolidae, Lymnaeidae, Physidae, Planorbidae, Pleuroceridae, Valvatidae and Viviparidae.

INTRODUCTION

Poursuivant l'inventaire exhaustif des peuplements malacologiques du secteur de Gentilly qui subit l'influence d'un apport thermique originaire de la centrale nucléaire, nous avons entrepris l'étude des Gastéropodes Pulmonés et Prosobranches. Comme aucune étude taxonomique de ces espèces n'a été effectuée dans la région, nous espérons contribuer par ce travail à l'étude de la faune malacologique du fleuve Saint-Laurent.

MATERIEL ET METHODE

Le matériel et les méthodes ainsi que les lieux de l'échantillonnage ont déjà été décrits (Vaillancourt et Aubin, 1972). Nous présentons deux nouvelles cartes: l'une (Figure 1) représente la zone des prélèvements, l'autre (Figure 2) indique la bathymétrie du secteur.

Notre étude s'échelonne du mois de juin 1970 à juin 1972. La fréquence des prélèvements s'établit pour chacune des stations de la façon suivante: un prélèvement hebdomadaire de mai à août et un prélèvement mensuel de septembre à avril; dans ce dernier cas, lorsque l'état de la glace le permet.

RESULTATS

Les vingt-trois (23) espèces inventoriées sont:

1. *Amnicola limosa limosa* (Say)
2. *Amnicola limosa porata* (Say)
3. *Probythinella lacustris* (Thiele)
4. *Bithynia tentaculata* (Linné)
5. *Lymnaea catascopium* (Say)
6. *Lymnaea columella* (Say)
7. *Lymnaea elodes* (Say)

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1. Adresse actuelle: 53 Bonn, Venusberg, Universitätskliniken, Wohnhein I, Allemagne.

8. *Lymnaea stagnalis appressa* (Say)
9. *Physa gyrina gyrina* (Say)
10. *Physa jennessi skinneri* (Taylor)
11. *Gyraulus deflectus deflectus* (Say)
12. *Gyraulus deflectus obliquus* (Say)
13. *Gyraulus hirsutus* (Say)
14. *Gyraulus parvus* (Say)
15. *Helisoma trivolvis trivolvis* (Say)
16. *Promenetus exacuous 'megas'* (Dall)
17. *Goniobasis livescens livescens* (Menke)
18. *Pleurocera acutum tractum* (Anthony)
19. *Valvata sincera sincera* (Say)
20. *Valvata tricarinata tricarinata* (Say)
21. *Campeloma decisum* (Say)
22. *Campeloma subsolidum* (Anthony) renversé
23. *Viviparus intertextus* (Say)

Les espèces *Amnicola limosa porata* (Say), *Lymnaea stagnalis appressa* (Say), *Physa*

(Suite du texte, page 19)

TABLEAU I. MOYENNE MENSUELLE DE L'ABONDANCE DE *Bithynia tentaculata* (LINN.)/M^2 DE SURFACE.

1970	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Juin	30	15247	77	444	122	2986	367
Juillet	57	402	153	134	19	2048	115
Août	268	1091	364	2105	115	3502	57
Septembre	3023	1780	153	1129	57	10353	172
Octobre	-	-	230	-	77	2067	0
Novembre	-	-	-	-	-	-	-
Décembre	-	-	-	-	-	-	-
1971							
Janvier	-	6506	-	-	-	-	-
Février	-	3138	0	-	0	9032	-
Mars	0	1148	-	-	77	995	-
Avril	0	-	0	1225	77	9338	6812
Mai	191	7291	249	134	38	1703	134
Juin	899	1397	77	593	57	5932	134
Juillet	153	2832	57	1091	249	8420	1244
Août	0	11596	0	651	344	4038	1072
Septembre	1760	8496	0	2067	0	12553	2220
Octobre	0	10104	1301	230	306	1990	6812
Novembre	0	11252	0	1072	153	4746	1225
Décembre	0	5970	306	1373	306	17758	1531
1972							
Janvier	-	10333	-	-	765	16534	6506
Février	-	-	-	-	-	-	-
Mars	0	2220	-	153	0	33373	16304
Avril	-	-	-	-	-	-	-
Mai	280	280	255	2220	153	22222	3828
Juin	343	2601	134	1072	19	26504	1013

TABLEAU II. MOYENNE MENSUELLE DE L'ABONDANCE DE *Physa gyrina gyrina* (Say)/M^2 de SURFACE.

1970	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
Juin	30	1822	184	260	92	566	415
Juillet	19	325	38	249	115	593	96
Août	134	957	134	306	134	383	249
Septembre	670	651	134	995	249	1072	172
Octobre	–	–	0	–	0	153	77
Novembre	–	–	–	–	–	–	–
Décembre	–	–	–	–	–	–	–
1971							
Janvier	–	77	–	–	–	–	–
Février	–	0	0	–	0	2449	–
Mars	77	0	–	–	0	153	–
Avril	0	–	77	383	0	0	0
Mai	19	478	38	134	0	19	57
Juin	153	1033	19	402	0	115	57
Juillet	38	77	19	670	0	689	230
Août	0	210	0	210	77	365	230
Septembre	0	383	0	306	0	536	1072
Octobre	0	0	0	306	77	0	1301
Novembre	0	612	0	765	0	0	153
Décembre	0	306	77	230	0	460	0
1972							
Janvier	–	0	–	–	0	306	842
Février	–	–	–	–	–	–	–
Mars	0	77	–	0	0	1454	77
Avril	–	–	–	–	–	–	–
Mai	103	179	128	230	307	307	38
Juin	57	134	0	115	0	306	115

jennessi skinneri (Taylor) et *Gyraulus deflectus deflectus* (Say), sont peu abondantes et ne permettent pas une mise en évidence de leur cycle annuel.

Quant aux espèces *Bithynia tentaculata* (Linné), *Physa gyrina gyrina* (Say) et *Helisoma trivolvis trivolvis* (Say) qui sont bien représentées, nous présentons aux tableaux I, II et III leur abondance mensuelle /m^2 de surface et ceci pour les sept (7) stations. Nous trouvons un grand nombre d'individus aux stations 2 et 6. Ce phénomène pourrait être dû d'une part à la texture du fond qui est vaseux et d'autre part à la végétation aquatique qui est bien développée dans les deux zones. Pour ces trois espèces, il semblerait y avoir une reproduction en saison estivale. De plus, des observations sur les lieux de nos travaux nous ont permis de trouver d'abondantes pontes de la mi-juin à la mi-juillet. Cependant, ce n'est qu'après une étude des rythmes de croissance de ces populations que nous serons en mesure de déterminer les cycles saisonniers de la reproduction.

En ce qui concerne l'échantillonage hivernal, nous remarquons l'absence fréquente de prélèvements: formation d'une couche de glace sur les eaux du fleuve. Pendant cette période, nous nous sommes efforcés d'échantillonner aux stations 2 et 6 (Figure 1); toutefois, un unique prélèvement mensuel par station durant les mois d'hiver ne permet pas d'obtenir une estimation précise des populations comparativement aux données recueillies pendant la saison estivale.

DISCUSSION ET CONCLUSION

En examinant l'abondance mensuelle des Gastéropodes/m^2 de surface, (tableaux IV, V, VI, VII, VIII, IX, et X de l'appendice

TABLEAU III. MOYENNE MENSUELLE DE L'ABONDANCE DE *Helisoma trivolvis trivolvis* (Say)/M^2 DE SURFACE

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7
1970							
Juin	474	367	46	168	0	750	245
Juillet	191	115	38	57	19	459	57
Août	421	498	96	325	19	249	115
Septembre	555	517	172	574	38	421	57
Octobre	-	-	306	-	0	306	0
Novembre	-	-	-	-	-	-	-
Décembre	-	-	-	-	-	-	-
1971							
Janvier	-	230	-	-	-	-	-
Février	-	0	0	-	0	1990	-
Mars	153	0	-	-	0	383	-
Avril	153	-	77	0	0	153	383
Mai	19	344	38	77	0	57	38
Juin	0	57	77	172	19	115	57
Juillet	77	19	0	249	0	612	38
Août	0	38	0	134	96	785	57
Septembre	153	153	0	459	0	1072	459
Octobre	153	77	0	230	0	536	77
Novembre	0	0	77	230	77	0	0
Dé embre	0	306	0	383	0	536	0
1972							
Janvier	-	0	-	-	77	842	77
Février	-	-	-	-	-	-	-
Mars	0	77	-	0	0	0	0
Avril	-	-	-	-	-	-	-
Mai	51	51	0	103	38	917	0
Juin	115	57	0	38	0	842	19

A), nous remarquons des variations mensuelles peu explicables de l'abondance des prosobranches et des pulmonés aux différentes stations.

A cette étape de nos recherches, il était important d'avoir une vue d'ensemble sur les espèces de Gastéropodes présentes dans le secteur de Gentilly, et de recueillir des données de chaque espèce aux différentes stations.

Nos prochaines études seront axées en premier lieu sur les corrélations entre les mollusques et les plantes aquatiques, corrélations qui expliqueraient peut-être les variations parfois anarchiques que nous avons notées. En second lieu, nous rechercherons plus précisément le cycle annuel des espèces déjà répertoriées: en nous basant sur des études de croissance et de maturité sexuelle.

REMERCIEMENTS

Les auteurs remercient le Dr A.H. Clarke et M. Smith, du Musée National des Sciences Naturelles du Canada qui ont participé à la vérification de l'identification de nos spécimens. Nous désirons remercier également le professeur Michel Ledoyer de la Station Marine d'Endoume pour ses conseils judicieux ainsi que l'équipe qui travaille au projet Thermo-Pol. Le projet Thermo-Pol est d'autre part subventionné en partie par le Conseil National de la Recherche, l'Energie Atomique du Canada Limitée et le Ministère de l'Education de la province de Québec.

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APPENDICE A

Abondance mensuelle des Gastéropodes/m^2 de surface aux sept stations d'échantillonage.

Pages 21-27

Figures 1 et 2 . . . . Pages 28, 29

ACCEPTE POUR LE NUMERO DE DECEMBRE, LE 27 SEPTEMBRE 1972.

TABLEAU IV. MOYENNE MENSUELLE DE L'ABONDANCE/M^2 DE SURFACE A LA STATION 1

	1970 Juin	Juil	Août	Sept	Oct	Nov	Dec	1971 Jan	Fev	Mars	Avril	Mai	Juin	Juil	Août	Sept	Oct	Nov	Dec	1972 Jan	Fev	Mars	Avril	Mai	Juin
Amnicolidae (famille) Genre Amnicola Gould et Haldeman 1841																									
Amnicola limosa limosa (Say)	0	0	0	0	-	-	-	-	-	230	0	0	19	19	0	306	0	0	0	-	-	459	-	1072	96
Amnicola limosa porata (Say)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Probythinella lacustris (Thiele)	15	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	172
Genre Bulimus Scopoli 1777																									
Bithynia tentaculata (Baker)	30	57	268	3023	-	-	-	-	-	0	0	191	899	153	0	1760	0		0	-	-	0	-	280	343
Lymnaeidae (famille) Genre Lymnaea Lamarck 1799																									
Lymnaea catascopium (Say)	0	0	0	19	-	-	-	-	-	0	0	0	19	38	0	77					-	0	-	0	0
Lymnaea columella (Say)	0	0	0	230	-	-	-	-	-	0	0	0	0	0	0	0					-	0	-	0	0
Lymnaea elodes (Say)	15	19	19	115	-	-	-	-	-	0	0	0	0	0	0	0				-	-	77	-	0	0
Lymnaea stagnalis appressa (Say)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0					-	0	-	0	0
Physidae (famille) Genre Physa Draparnaud 1801																									
Physa gyrina gyrina (Say)	30	19	134	670	-	-	-	-	-	77	0	19	153	38	0	0	0	0	0	-	-	0	-	103	57
Physa jennessi skinneri (Taylor)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Planorbidae (famille) Genre Gyraulus J. de Charpentier 1837																									
Gyraulus deflectus deflectus (Say)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	19
Gyraulus deflectus obliquus (Say)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Gyraulus hirsutus (Say)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Gyraulus parvus (Say)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	153	0	0	0	-	-	0	-	51	38
Genre Helisoma Swainson 1840																									
Helisoma trivolvis trivolvis (Say)	474	191	421	555	-	-	-	-	-	153	153	19	0	77	0	153	153	0	0	-	-	0	-	51	115
Genre Promenetus F.C. Baker 1935																									
Promenetus exacuous "megas" (Dall)	0	0	0	19	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Pleuroceridae (famille) Genre Goniobasis Lea 1862																									
Goniobasis livescens livescens (Menke)	0	0	0	383	-	-	-	-	-	0	0	0	19	153	0	153	0	0	0	-	-	0	-	25	38
Genre Pleurocera Rafinesque 1818																									
Pleurocera acuta tracta (Anthony)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Valvatidae (famille) Genre Valvata Muller 1774																									
Valvata sincera sincera (Say)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Valvata tricarinata tricarinata (Say)	0	0	0	38	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	25	57
Viviparidae (famille) Genre Campeloma Rafinesque 1820																									
Campeloma decisum (Say)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Campeloma subsolidum (Anthony) renversé	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Genre Viviparus Denys de Montfort 1810																									
Viviparus intertextus (Say)	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0

TABLEAU V. MOYENNE MENSUELLE DE L'ABONDANCE/M^2 DE SURFACE A LA STATION 2

	1970 Juin	Juil	Août	Sept	Oct	Nov	Dec	1971 Jan	Fev	Mars	Avril	Mai	Juin	Juil	Août	Sept	Oct	Nov	Dec	1972 Jan	Fev	Mars	Avril	Mai	Juin
Amnicolidae (famille)																									
Genre Amnicola Gould et Haldeman 1841																									
Amnicola limosa limosa (Say)	138	0	0	0	-	-	-	0	0	0	-	536	0	77	115	383	0	2526	4133	153	-	0	-	255	249
Amnicola limosa porata (Say)	0	0	0	0	-	-	-	0	0	0	-	0	57	0	0	0	0	0	0	0	-	0	-	0	0
Probythinella lacustris (Thiele)	0	0	0	938	-	-	-	0	0	0	-	0	19	38	77	0	0	0	0	0	-	0	-	0	96
Genre Bulimus Scopoli 1777																									
Bithynia tentaculata (Baker)	15247	402	1091	1780	-	-	-	6506	3138	1148	-	7291	1397	2832	11596	8496	10104	11252	5970	10333	-	2220	-	280	2601
Lymnaeidae (famille)																									
Genre Lymnaea Lamarck 1799																									
Lymnaea catascopium (Say)	0	0	0	0	-	-	-	0	0	0	-	0	0	19	57	0	0	0	0	77	-	0	-	25	0
Lymnaea columella (Say)	0	0	0	0	-	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Lymnaea elodes (Say)	0	57	0	0	-	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Lymnaea stagnalis appressa (Say)	0	0	0	0	-	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Physidae (famille)																									
Genre Physa Draparnaud 1801																									
Physa gyrina gyrina (Say)	1822	325	957	651	-	-	-	77	0	0	-	478	1033	77	210	383	0	612	306	0	-	77	-	179	134
Physa jennessi skinneri (Taylor)	0	0	0	0	-	-	-	0	0	0	-	0	0	0	19	0	0	0	0	0	-	0	-	0	19
Planorbidae (famille)																									
Genre Gyraulus J. de Charpentier 1837																									
Gyraulus deflectus deflectus (Say)	30	0	0	0	-	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Gyraulus deflectus obliquus (Say)	0	0	0	0	-	-	-	0	0	0	-	19	0	0	0	0	0	0	0	0	-	0	-	0	0
Gyraulus hirsutus (Say)	0	0	0	0	-	-	-	0	0	0	-	0	0	0	0	0	77	0	0	0	-	0	-	0	77
Gyraulus parvus (Say)	582	0	0	0	-	-	-	0	0	0	-	77	0	0	38	0	77	77	77	153	-	0	-	179	0
Genre Helisoma Swainson 1840																									
Helisoma trivolvis trivolvis (Say)	367	115	498	517	-	-	-	230	0	0	-	344	57	19	38	153	77	0	306	0	-	77	-	51	57
Genre Promenetus F.C. Baker 1935																									
Promenetus exacuous "megas" (Dall)	0	0	0	0	-	-	-	0	0	0	-	0	38	0	0	0	0	0	77	0	-	0	-	25	19
Pleuroceridae (famille)																									
Genre Goniobasis Lea 1862																									
Goniobasis livescens livescens (Menke)	0	0	0	0	-	-	-	0	0	0	-	19	0	0	38	0	0	0	0	0	-	0	-	0	0
Genre Pleurocera Rafinesque 1818																									
Pleurocera acuta tracta (Anthony)	0	0	0	0	-	-	-	0	0	0	-	172	0	0	0	0	0	0	0	0	-	0	-	0	0
Valvatidae (famille)																									
Genre Valvata Muller 1774																									
Valvata sincera sincera (Say)	0	19	0	0	-	-	-	0	0	0	-	0	0	0	38	0	77	0	0	0	-	0	-	51	0
Valvata tricarinata tricarinata (Say)	234	19	19	0	-	-	-	0	0	0	-	191	19	19	19	77	77	77	1914	230	-	230	-	204	172
Viviparidae (famille)																									
Genre Campeloma Rafinesque 1820																									
Campeloma decisum (Say)	62	38	19	19	-	-	-	0	0	0	-	0	0	134	96	0	0	77	0	0	-	0	-	0	0
Campeloma subsolidum (Anthony) renversé	0	0	0	19	-	-	-	0	0	0	-	0	0	0	19	0	0	0	0	0	-	0	-	0	0
Genre Viviparus Denys de Montfort 1810																									
Viviparus intertextus (Say)	0	0	0	0	-	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	-	0	0

TABLEAU VI. MOYENNE MENSUELLE DE L'ABONDANCE/M^2 DE SURFACE A LA STATION 3

	1970							1971												1972					
	Juin	Juil	Août	Sept	Oct	Nov	Dec	Jan	Fev	Mars	Avril	Mai	Juin	Juil	Août	Sept	Oct	Nov	Dec	Jan	Fev	Mars	Avril	Mai	Juin
Amnicolidae (famille)																									
Genre *Amnicola* Gould et Haldeman 1841																									
Amnicola limosa limosa (Say)	0	0	0	115	0	-	-	-	77	-	0	0	57	19	0	0	0	0	77	-	-	-	-	0	0
Amnicola limosa porata (Say)	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0
Probythinella lacustris (Thiele)	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0
Genre *Bulimus* Scopoli 1777																									
Bithynia tentaculata (Baker)	77	153	364	153	230	-	-	-	0	-	0	249	77	57	0	0	1301	0	306	-	-	-	-	255	134
Lymnaeidae (famille)																									
Genre *Lymnaea* Lamarck 1799																									
Lymnaea catascopium (Say)	0	0	0	19	0	-	-	-	0	-	0	0	0	19	0	0	0	0	0	-	-	-	-	0	0
Lymnaea columella (Say)	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0
Lymnaea elodes (Say)	46	0	38	19	0	-	-	-	0	-	0	0	0	38	0	0	0	0	0	-	-	-	-	25	0
Lymnaea stagnalis appressa (Say)	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	51	0
Physidae (famille)																									
Genre *Physa* Draparnaud 1801																									
Physa gyrina gyrina (Say)	184	38	134	134	0	-	-	-	0	-	77	38	19	19	0	0	0	0	77	-	-	-	-	128	0
Physa jennessi skinneri (Taylor)	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0
Planorbidae (famille)																									
Genre *Gyraulus* J. de Charpentier 1837																									
Gyraulus deflectus deflectus (Say)	0	0	0	19	230	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	25	0
Gyraulus deflectus obliquus (Say)	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0
Gyraulus hirsutus (Say)	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0
Gyraulus parvus (Say)	15	0	0	230	0	-	-	-	0	-	0	0	19	19	0	0	153	0	0	-	-	-	-	25	0
Genre *Helisoma* Swainson 1840																									
Helisoma trivolvis trivolvis (Say)	46	38	96	172	306	-	-	-	0	-	77	38	77	0	0	0	0	77	0	-	-	-	-	0	0
Genre *Promenetus* F.C. Baker 1935																									
Promenetus exacuous "megas" (Dall)	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0
Pleuroceridae (famille)																									
Genre *Goniobasis* Lea 1862																									
Goniobasis livescens livescens (Menke)	15	77	191	134	153	-	-	-	0	-	0	19	134	421	19	0	0	0	0	-	-	-	-	25	0
Genre *Pleurocera* Rafinesque 1818																									
Pleurocera acuta tracta (Anthony)	0	0	0	0	0	-	-	-	0	-	0	0	19	0	0	0	0	0	0	-	-	-	-	0	0
Valvatidae (famille)																									
Genre *Valvata* Muller 1774																									
Valvata sincera sincera (Say)	0	0	19	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0
Valvata tricarinata tricarinata (Say)	0	0	0	19	0	-	-	-	0	-	0	0	0	0	0	0	0	77	77	-	-	-	-	25	0
Viviparidae (famille)																									
Genre *Campeloma* Rafinesque 1820																									
Campeloma decisum (Say)	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0
Campeloma subsolidum (Anthony) renversé	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0
Genre *Viviparus* Denys de Montfort 1810																									
Viviparus intertextus (Say)	0	0	0	0	0	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-	-	-	0	0

TABLEAU VII. MOYENNE MENSUELLE DE L'ABONDANCE/M^2 DE SURFACE A LA STATION 4

	1970 Juin	Juil	Août	Sept	Oct	Nov	Dec	1971 Jan	Fev	Mars	Avril	Mai	Juin	Juil	Août	Sept	Oct	Nov	Dec	1972 Jan	Fev	Mars	Avril	Mai	Juin
Amnicolidae (famille)																									
Genre Amnicola Gould et Haldeman 1841																									
Amnicola limosa limosa (Say)	0	0	0	0	-	-	-	-	-	-	612	38	19	57	57	230	689	536	765	-	-	0	-	994	325
Amnicola limosa porata (Say)	0	0	0	0	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Probythinella lacustris (Thiele)	0	0	0	0	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	-	-	0	-	0	134
Genre Bulimus Scopoli 1777																									
Bithynia tentaculata (Baker)	444	134	2105	1129	-	-	-	-	-	-	1225	134	593	1091	651	2067	230	1072	1378	-	-	153	-	2220	1072
Lymnaeidae (famille)																									
Genre Lymnaea Lamarck 1799																									
Lymnaea catascopium (Say)	0	0	0	0	-	-	-	-	-	-	842	0	134	115	0	0	77	77	0	-	-	0	-	0	38
Lymnaea columella (Say)	62	19	38	153	-	-	-	-	-	-	0	19	0	0	0	0	0	0	0	-	-	0	-	115	0
Lymnaea elodes (Say)	153	77	77	0	-	-	-	-	-	-	0	0	0	57	96	77	0	77	0	-	-	0	-	0	57
Lymnaea stagnalis appressa (Say)	0	0	134	19	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Physidae (famille)																									
Genre Physa Draparnaud 1801																									
Physa gyrina gyrina (Say)	260	249	306	995	-	-	-	-	-	-	383	134	402	670	210	306	306	765	230	-	-	0	-	230	115
Physa jennessi skinners (Taylor)	0	0	0	0	-	-	-	-	-	-	0	0	0	19	0	77	0	0	0	-	-	0	-	0	19
Planorbidae (famille)																									
Genre Gyraulus J. de Charpentier 1837																									
Gyraulus deflectus deflectus (Say)	0	0	0	0	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Gyraulus deflectus obliquus (Say)	0	0	0	0	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Gyraulus hirsutus (Say)	0	0	0	0	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Gyraulus parvus (Say)	15	0	0	0	-	-	-	-	-	-	383	0	0	57	0	0	0	0	77	-	-	0	-	0	0
Genre Helisoma Swainson 1840																									
Helisoma trivolvis trivolvis (Say)	168	57	325	574	-	-	-	-	-	-	0	77	172	249	134	459	230	230	383	-	-	0	-	103	38
Genre Promenetus F.C. Baker 1935																									
Promenetus exacuous "megas" (Dall)	0	0	0	0	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Pleuroceridae (famille)																									
Genre Goniobasis Lea 1862																									
Goniobasis livescens livescens (Menke)	734	191	402	57	-	-	-	-	-	-	0	0	19	593	134	383	459	0	230	-	-	0	-	268	249
Genre Pleurocera Rafinesque 1818																									
Pleurocera acuta tracta (Anthony)	0	0	0	19	-	-	-	-	-	-	0	0	0	19	0	0	0	0	0	-	-	0	-	134	38
Valvatidae (famille)																									
Genre Valvata Muller 1774																									
Valvata sincera sincera (Say)	15	0	0	0	-	-	-	-	-	-	0	0	0	19	0	0	0	77	0	-	-	0	-	115	38
Valvata tricarinata tricarinata (Say)	15	0	38	115	-	-	-	-	-	-	230	19	0	115	0	0	0	0	0	-	-	0	-	329	38
Viviparidae (famille)																									
Genre Campeloma Rafinesque 1820																									
Campeloma decisum (Say)	0	0	38	0	-	-	-	-	-	-	0	0	19	19	0	77	0	0	0	-	-	0	-	0	0
Campeloma subsolidum (Anthony) renversé	0	0	0	0	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0
Genre Viviparus Denys de Montfort 1810																									
Viviparus intertextus (Say)	0	0	0	0	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	-	-	0	-	0	0

TABLEAU VIII. MOYENNE MENSUELLE DE L'ABONDANCE/M^2 DE SURFACE A LA STATION 5

	1970 Juin	Juil	Août	Sept	Oct	Nov	Dec	1971 Jan	Fev	Mars	Avril	Mai	Juin	Juil	Août	Sept	Oct	Nov	Dec	1972 Jan	Fev	Mars	Avril	Mai	Juin
Amnicolidae (famille)																									
Genre Amnicola Gould et Haldeman 1841																									
Amnicola limosa limosa (Say)	0	0	0	0	0	-	-	-	0	0	0	0	38	0	0	0	459	0	0	0	-	0	-	0	0
Amnicola limosa porata (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Probythinella lacustris (Thiele)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Genre Bulimus Scopoli 1777																									
Bithynia tentaculata (Baker)	122	19	115	57	77	-	-	-	0	77	77	38	57	249	344	0	306	153	306	765	-	0	-	153	19
Lymnaeidae (famille)																									
Genre Lymnaea Lamarck 1799																									
Lymnaea catascopium (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Lymnaea columella (Say)	0	0	0	19	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Lymnaea elodes (Say)	122	77	19	57	0	-	-	-	0	0	0	0	0	38	0	0	77	0	0	0	-	77	-	0	0
Lymnaea stagnalis appressa (Say)	0	0	0	19	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Physidae (famille)																									
Genre Physa Draparnaud 1801																									
Physa gyrina gyrina (Say)	92	115	134	249	0	-	-	-	0	0	0	0	0	0	77	0	77	0	0	0	-	0	-	307	0
Physa jennessi skinneri (Taylor)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Planorbidae (famille)																									
Genre Gyraulus J. de Charpentier 1837																									
Gyraulus deflectus deflectus (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Gyraulus deflectus obliquus (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Gyraulus hirsutus (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Gyraulus parvus (Say)	0	0	19	19	0	-	-	-	0	77	0	0	0	77	38	0	153	0	0	0	-	0	-	0	0
Genre Helisoma Swainson 1840																									
Helisoma trivolvis trivolvis (Say)	0	19	19	38	0	-	-	-	0	0	0	0	19	0	96	0	0	77	0	77	-	0	-	38	0
Genre Promenetus F.C. Baker 1935																									
Promenetus exacuous "megas" (Dall)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Pleuroceridae (famille)																									
Genre Goniobasis Lea 1862																									
Goniobasis livescens livescens (Menke)	15	268	38	57	0	-	-	-	0	0	0	0	19	287	210	0	77	0	0	0	-	0	-	0	0
Genre Pleurocera Rafinesque 1818																									
Pleurocera acuta tracta (Anthony)	0	38	19	57	0	-	-	-	0	0	0	0	0	57	57	0	77	0	0	0	-	0	-	51	0
Valvatidae (famille)																									
Genre Valvata Muller 1774																									
Valvata sincera sincera (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	77	0	-	0	-	0	0
Valvata tricarinata tricarinata (Say)	0	0	0	0	0	-	-	-	77	77	0	0	19	0	0	0	1454	77	77	0	-	0	-	0	0
Viviparidae (famille)																									
Genre Campeloma Rafinesque 1820																									
Campeloma decisum (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	38	0
Campeloma subsolidum (Anthony) renversé	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Genre Viviparus Denys de Montfort 1810																									
Viviparus intertextus (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0

TABLEAU IX. MOYENNE MENSUELLE DE L'ABONDANCE/M^2 DE SURFACE A LA STATION 6

	1970 Juin	Juil	Août	Sept	Oct	Nov	Dec	1971 Jan	Fev	Mars	Avril	Mai	Juin	Juil	Août	Sept	Oct	Nov	Dec	1972 Jan	Fev	Mars	Avril	Mai	Juin
Amnicolidae (famille)																									
Genre Amnicola Gould et Haldeman 1841																									
Amnicola limosa limosa (Say)	275	57	0	1397	0	-	-	-	1148	918	0	268	1416	1684	593	2679	2985	2296	7348	5281	-	4746	-	4388	7942
Amnicola limosa porata (Say)	0	0	96	172	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Probythinella lacustris (Thiele)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	134
Genre Bulimus Scopoli 1777																									
Bithynia tentaculata (Baker)	2986	2048	3502	10353	2067	-	-	-	9032	995	9338	1703	5932	8420	4038	12553	1990	4746	17758	16534	-	33373	-	22222	26504
Lymnaeidae (famille)																									
Genre Lymnaea Lamarck 1799																									
Lymnaea catasconium (Say)	0	0	0	0	0	-	-	-	306	0	0	0	0	57	38	153	0	0	0	77	-	77	-	0	0
Lymnaea columella (Say)	0	19	0	19	0	-	-	-	77	0	0	0	38	0	0	0	0	0	0	0	-	153	-	0	19
Lymnaea elodes (Say)	15	115	0	19	0	-	-	-	0	0	0	19	0	19	0	0	0	0	0	0	-	0	-	0	0
Lymnaea stagnalis appressa (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	57
Physidae (famille)																									
Genre Physa Draparnaud 1801																									
Physa gyrina gyrina (Say)	566	593	383	1072	153	-	-	-	2449	153	0	19	115	689	365	536	0	0	460	306	-	1454	-	307	306
Physa jennessi skinners (Taylor)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Planorbidae (famille)																									
Genre Gyraulus J. de Charpentier 1837																									
Gyraulus deflectus deflectus (Say)	0	0	0	19	0	-	-	-	0	0	0	0	0	C	38	153	0	0	153	612	-	77	-	25	363
Gyraulus deflectus obliquus (Say)	0	19	19	19	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	77	-	383	-	25	0
Gyraulus hirsutus (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	77	230	-	1990	-	76	0
Gyraulus parvus (Say)	0	0	38	77	0	-	-	-	0	383	0	0	19	38	96	153	0	383	383	1148	-	77	-	561	957
Genre Helisoma Swainson 1840																									
Helisoma trivolvis trivolvis (Say)	750	459	249	421	306	-	-	-	1990	383	153	57	115	612	785	1072	536	0	536	842	-	0	-	917	842
Genre Promenetus F.C. Baker 1935																									
Promenetus exacuous "megas" (Dall)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	51	19
Pleuroceridae (famille)																									
Genre Goniobasis Lea 1862																									
Goniobasis livescens livescens (Menke)	0	0	0	0	0	-	-	-	0	0	0	0	38	0	19	0	0	0	0	77	-	0	-	0	0
Genre Pleurocera Rafinesque 1818																									
Pleurocera acuta tracta (Anthony)	15	0	0	57	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Valvatidae (famille)																									
Genre Valvata Muller 1774																									
Valvata sincera sincera (Say)	0	0	0	19	0	-	-	-	0	77	0	0	19	0	19	0	0	0	0	77	-	0	-	203	268
Valvata tricarinata tricarinata (Say)	260	19	0	96	0	-	-	-	536	995	536	383	631	344	804	2449	7654	2908	4899	4363	-	1914	-	8904	13473
Viviparidae (famille)																									
Genre Campeloma Rafinesque 1820																									
Campeloma decisum (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	19	0	0	0	0	0	-	0	-	0	38
Campeloma subsolidum (Anthony) renversé	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Genre Viviparus Denys de Montfort 1810																									
Viviparus intertextus (Say)	0	0	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0

TABLEAU X. MOYENNE MENSUELLE DE L'ABONDANCE/M^2 DE SURFACE A LA STATION 7

	1970 Juin	Juil	Août	Sept	Oct	Nov	Dec	1971 Jan	Fev	Mars	Avril	Mai	Juin	Juil	Août	Sept	Oct	Nov	Dec	1972 Jan	Fev	Mars	Avril	Mai	Juin
Amnicolidae (famille)																									
Genre *Amnicola* Gould et Haldeman 1841																									
Amnicola limosa limosa (Say)	30	19	0	0	0	-	-	-	-	-	0	96	0	0	191	918	4286	2067	460	2143	-	995	-	842	96
Amnicola limosa porata (Say)	0	19	0	0	0	-	-	-	-	-	0	0	57	0	0	0	0	0	0	0	-	0	-	0	0
Probythinella lacustris (Thiele)	0	0	0	0	77	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Genre *Bulimus* Scopoli 1777																									
Bithynia tentaculata (Baker)	367	115	57	172	0	-	-	-	-	-	6812	134	134	1244	1072	2220	6812	1225	1531	6506	-	16304	-	3828	1013
Lymnaeidae (famille)																									
Genre *Lymnaea* Lamarck 1799																									
Lymnaea catascopium (Say)	0	0	0	0	0	-	-	-	-	-	0	0	19	19	0	0	0	0	0	0	-	0	-	0	0
Lymnaea columella (Say)	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	-	25	0
Lymnaea elodes (Say)	0	0	0	0	0	-	-	-	-	-	0	0	0	0	19	0	0	0	0	0	-	0	-	0	0
Lymnaea stagnalis appressa (Say)	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Physidae (famille)																									
Genre *Physa* Draparnaud 1801																									
Physa gyrina gyrina (Say)	415	96	249	172	77	-	-	-	-	-	0	57	57	230	230	1072	1301	153	0	842	-	77	-	38	115
Physa jennessi skinnera (Taylor)	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	77	-	0	-	0	0
Planorbidae (famille)																									
Genre *Gyraulus* J. de Charpentier 1837																									
Gyraulus deflectus deflectus (Say)	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Gyraulus deflectus obliquus (Say)	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Gyraulus hirsutus (Say)	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	77	-	0	0
Gyraulus parvus (Say)	260	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	-	134	38
Genre *Helisoma* Swainson 1840																									
Helisoma trivolvis trivolvis (Say)	245	57	115	57	0	-	-	-	-	-	383	38	57	38	57	459	77	0	0	77	-	0	-	0	19
Genre *Promenetus* F.C. Baker 1935																									
Promenetus exacuous "megas" (Dall)	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Pleuroceridae (famille)																									
Genre *Goniobasis* Lea 1862																									
Goniobasis livescens livescens (Menke)	0	38	0	38	0	-	-	-	-	-	0	38	96	57	19	0	0	0	0	0	-	0	-	0	19
Genre *Pleurocera* Rafinesque 1818																									
Pleurocera acuta tracta (Anthony)	15	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	-	0	77
Valvatidae (famille)																									
Genre *Valvata* Muller 1774																									
Valvata sincera sincera (Say)	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	918	-	918	-	0	0
Valvata tricarinata tricarinata (Say)	30	0	0	0	230	-	-	-	-	-	0	57	38	19	134	230	995	306	0	77	-	306	-	77	57
Viviparidae (famille)																									
Genre *Campeloma* Rafinesque 1820																									
Campeloma decisum (Say)	15	0	19	0	0	-	-	-	-	-	0	57	19	38	0	0	0	0	0	0	-	0	-	0	38
Campeloma subsolidum (Anthony) renversé	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	-	0	0
Genre *Viviparus* Denys de Montfort 1810																									
Viviparus intertextus (Say)	0	0	0	0	0	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	-	0	19

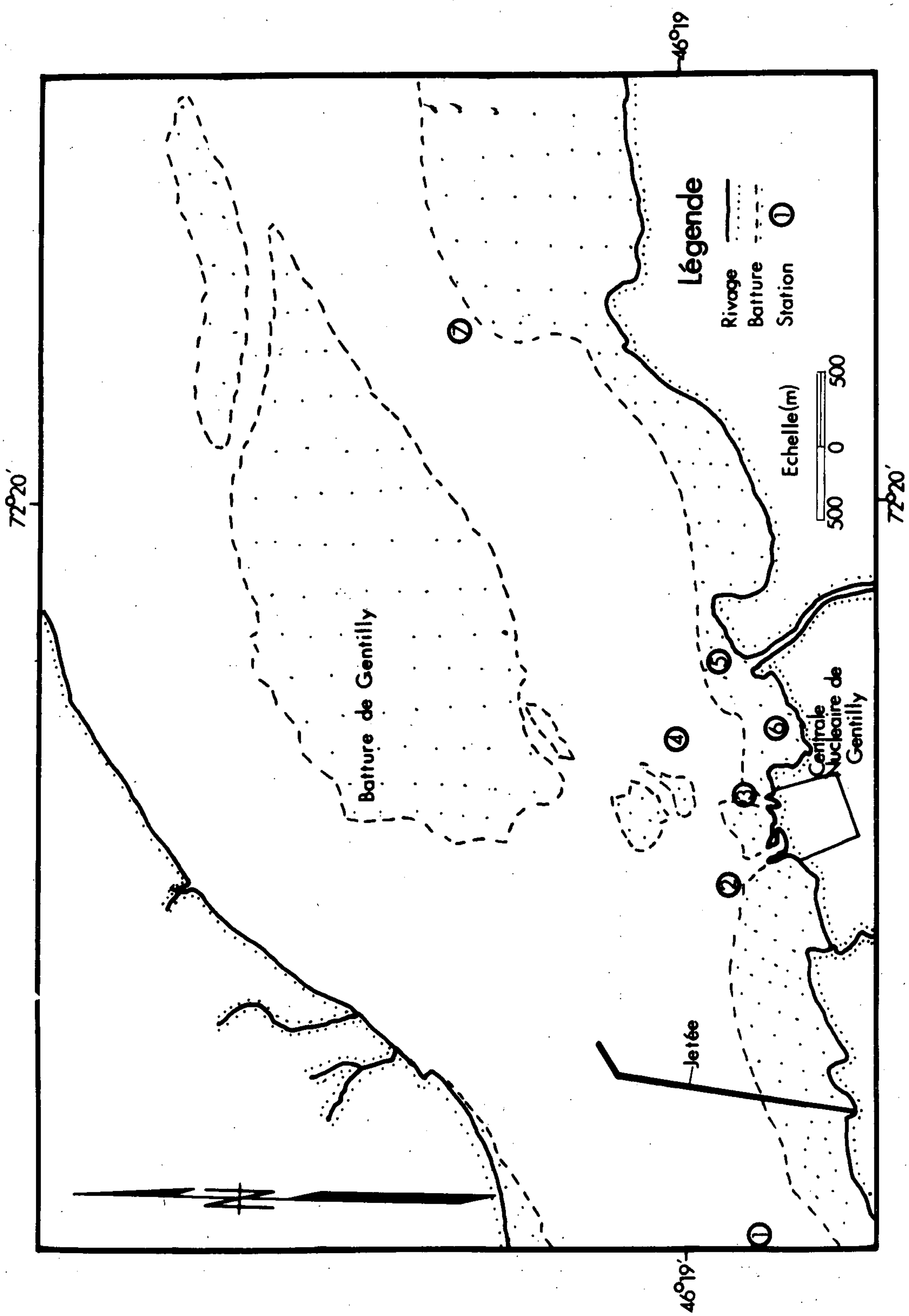

FIGURE 1. REGION D'ECHANTILLONNAGE

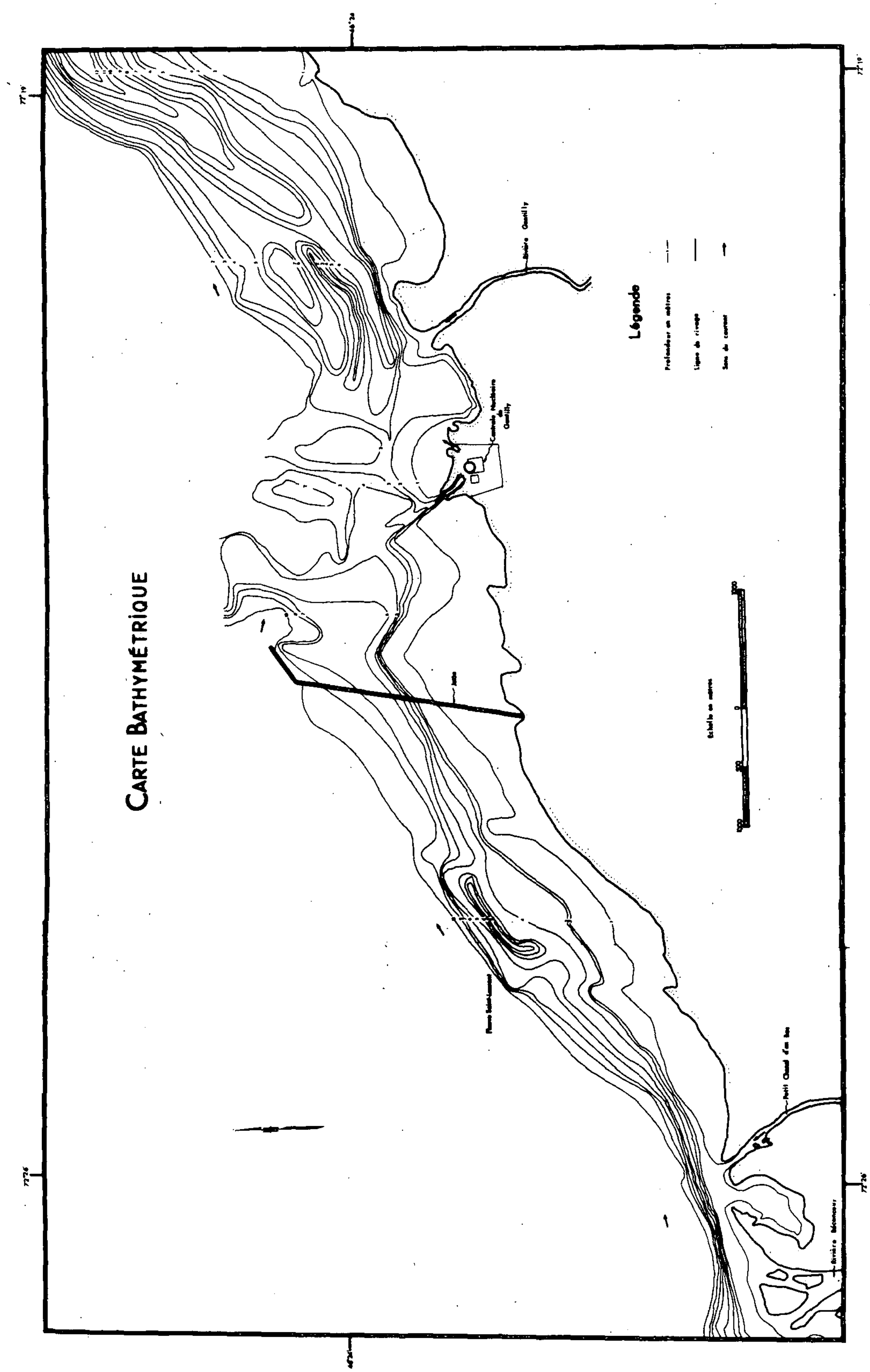

FIGURE 2. CARTE BATHYMETRIQUE

Observations on the passage of the eggs from the ovaries to the gills are extremely meager, and further information is needed concerning the factors involved in directing the stream of eggs from the openings of the oviducts to their final resting place in the water tubes of those regions of the gills which function as brood chambers. We owe to Latter (1891, 1904) the most detailed account of this process which we have, and, in lieu of any direct observations of our own on the subject, we may quote his interesting description (1891) which is based upon *Anodonta:*

If a female be taken from the shell at this season (the spawning season) the eggs may be seen through the transparent wall of the oviduct passing singly, but in a steady stream, to the genital aperture. Their motion is due partly to "labour contractions" of the intrinsic muscles of the foot and partly to the ciliated lining of the oviduct itself. One by one the eggs issue from the genital aperture, whence they are conveyed backwards by the abundant cilia which clothe the external surface of the nephridium. Along the middle line of this surface there is a belt of especially long cilia which appear to be devoted to the transit of the eggs; those dorsal and ventral to the belt work obliquely so as to keep the eggs in contact with it. It is probable that the free dorsal border of the inner lamella of the inner gill plate is, under normal conditions, applied to the visceral mass in this region so as to inclose a temporary tube, one of whose walls is formed by the above-mentioned belt of specialized cilia.[a] In the course of about 50 seconds an egg is thus swept back to the slit between the protractor muscle of the shell and the point of fusion of the right and left inner gill lamellæ; here they meet the stream of ova from the other side of the body and so reach the exhalent current and the cloaca.

The process goes on for some 10 days or more in each individual and the number of eggs is immense * * * probably half a million may be taken as a fair average. On reaching the cloaca * * * their direction is reversed and they pass forward into the cavities of the right and left gill plates, which serve as brood pouches. The method by which this change of direction is accomplished is not quite clear. * * * I have, however, observed on several occasions a violent and sudden reversion of the water currents such as would certainly be fully capable of carrying the eggs forward and into the latticed recesses of the outer gills. This reversion is caused by the animal, firstly, closing all the ventral border of the shell by means of the free edges of the mantle assisted by the flexible, uncalcified rim of periostracum and leaving the siphons alone open, and, secondly, relaxing the adductor muscles so as to allow the elastic ligament to make the valves gape apart. These actions cause the hydrostatic pressure within the shell to be less than that of the water without and consequently there ensues a rush of water into the shell through the open siphons. The whole procedure may be likened to a gulp and is achieved by precisely similar physical forces.

This may possibly be the correct interpretation of the process, but additional observations and experiments should be made for verification. Latter also attempts to account for the fact that the eggs in *Anodonta* pass into the outer gill and not into the inner, but his explanation is unsatisfactory and inadequate. It would be a matter of the greatest interest to discover the mechanism which directs the eggs in the different types of the marsupium into certain water tubes of the gills and not into others. Special structural modifications must be correlated with the particular type as the fundamental cause of these differences, and a very pretty problem is here presented in the determination of such correlations. Since in the genus *Quadrula* all four gills

[a] It is to be remembered that this description is based upon the conditions as they occur in *Anodonta*, in which the inner lamella of the inner gill is not fused to the visceral mass, and the inner suprabranchial chamber is consequently freely open to the mantle chamber; in those forms, however, in which this lamella is fused for a part or all of its length, the eggs are received into the anterior end of the inner suprabranchial chamber, into which the genital apertures open directly, and pass back through this chamber to the cloaca.

become filled with eggs, a directive mechanism is probably absent in this genus, and a careful comparison of the conditions in *Quadrula* with the structure of the gills in those genera in which only a portion of the gills is utilized as a brood chamber might well furnish the clue to the discovery of a special mechanism in the latter.

While as a rule the great majority of the eggs, when a gravid gill is examined, are found to be fertilized, different species differ markedly in the percentage of unfertilized eggs present, and, in fact, a large proportion of the latter seems to be characteristic of certain genera. In *Lampsilis*, *Symphynota*, *Anodonta*, and a number of other genera it has been very unusual in our experience to encounter any considerable number of unfertilized eggs, while, on the contrary, in *Quadrula*, *Pleurobema*, and in some species of *Unio* it is often true that even a majority of the eggs in a gravid female have failed of fertilization; in fact, in these genera one expects to find a large percentage of such eggs as the usual thing.

The entire embryonic development takes place in the gills of the female, and at the close of this period the larva or glochidium is fully formed. The differences in the length of time the glochidia are retained in the gills will be discussed later, but after their liberation the completion of their development occurs while they are living as parasites on the fish in all of the Unionidæ, so far as known, except in the genus *Strophitus*, whose glochidium, we have recently discovered, undergoes the metamorphosis in the entire absence of a parasitic stage. This extraordinary case will be referred to later.

As the embryology of the Unionidæ has been described by Lillie (1895) in great detail, and as Harms (1909) still more recently has published an excellent account of the post-embryonic development, we shall omit all reference to the actual developmental events, and confine ourselves to a discussion of those phases of the reproduction and parasitism of the Unionidæ in which we have been especially interested in connection with the problem of artificial propagation.

THE MARSUPIUM.

The term marsupium has been generally used to indicate those portions of the mussel's gills into which the eggs are received from the suprabranchial chambers after ovulation and which serve as brood pouches for the retention and nurture of embryos and glochidia until the discharge of the latter. As no better name seems to be available, we shall employ it in this paper.

USE OF THE MARSUPIUM IN CLASSIFICATION.

Since the extent to which the gills are specialized for this purpose varies in different groups of the Unionidæ, Simpson (1900), in his "Synopsis of the Naiades," has made use of the marsupium as the chief diagnostic character on which his classification is based. Those groups in which the marsupium comprises the outer or all four gills he designates as the Exorbranchiæ, while those in which the inner gills alone receive the eggs are distinguished as the Endorbranchiæ. All of the European and North American species belong to the former group, while the latter contains forms that are found chiefly in Asia, Australia, Africa, Central America, and South America.[a]

As our observations have been confined to the Exobranchiæ, reference will be made only to this group, the following subdivisions of which are recognized by Simpson, each distinguished by special marsupial characters:

Tetragenæ: Marsupium occupying all four gills.

Homogenæ: Marsupium occupying entire outer gills.

Diagenæ: Marsupium occupying entire outer gills, but differing from that of the Homogenæ in that the egg masses lie transversely in the gills.

Heterogenæ: Marsupium occupying only posterior end of outer gills.

Mesogenæ: Marsupium occupying a specialized portion in the middle region of outer gills.

Ptychogenæ: Marsupium occupying entire lower border of outer gills which is thrown into a series of peculiar folds.

Eschatigenæ: Marsupium occupying the lower border only of outer gills, but not folded.

Simpson has established another group, the Digenæ, for the genus *Tritogonia*, but since its marsupium is constituted by all four gills (Sterki 1907), it should at least be included in the Tetragenæ, if not in the genus *Quadrula*, as Ortmann maintains (1909, 1911). For a complete list of the genera occurring in each of Simpson's groups, reference may be had to his Synopsis (op. cit., p. 514–515).

These groups constitute Simpson's subfamily, Unioninæ, his other subfamily, Hyrianæ (Hyriinæ), coinciding with the Endobranchiæ or those Unionidæ whose marsupium occupies the inner gills only. In all of the Unioninæ except the Heterogenæ and Digenæ (*Tritogonia*), according to Simpson, the sexes are indistinguishable externally.

It will be seen from the above classification that three general conditions exist in the Unioninæ, namely, one in which the marsupial adaptation involves all four gills; one in which the entire outer gills only are utilized; and, lastly, one in which some differentiated portion of the outer gills constitutes the marsupial region. It would, accordingly, be a more logical procedure to make these general marsupial conditions the basis of the classification and to recognize only three main groups corresponding to the three general types of marsupium, to which the names Tetragenæ, Homogenæ, and Heterogenæ might be applied; and since all of the remaining forms have a marsupium which may be readily regarded as a secondary modification of one or another of the three types, they could be arranged in appropriate subgroups. If this were done, the Diagenæ would obviously fall within the Homogenæ, while the Mesogenæ, Ptychogenæ, and Eschatigenæ would be placed under the Heterogenæ, as in all of the latter forms the marsupium is some specialized portion of the outer gills.

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[a] Besides the Unionidæ, a second family, the Mutelidæ, is recognized by Simpson in his classification of the Naiades or pearly fresh-water mussels. In these forms, which belong to Africa and South America, the marsupium is the inner gills only, and the larva is not a glochidium but the so-called lasidium. The genera embraced in this family are not considered in the present account.

Quite recently Ortmann (1910a, 1911) has proposed an entirely different arrangement of the Naiades which is based upon a study of the anatomy and the larval characters of the fresh-water mussels of Pennsylvania. His system also lays especial stress on the marsupial differentiations, but it involves a number of important modifications in Simpson's classification which he maintains must be radically recast, in the light of the facts which he has discovered, if it is to represent the natural affinities of the group.

It is not our purpose to present a critical discussion of the relative merits of the two systems, as our only interest in this connection is concerned with the marsupium as an accessory organ of reproduction, but as Ortmann has added a number of important facts to our knowledge of this structure, it is necessary to state briefly the basis of his classification so far as it has to do with the several marsupial modifications. In addition to the marsupial structure, he makes use in his arrangement of families, subfamilies, and genera of a number of other characters which he considers of systematic value; for example, the degree of fusion of the inner lamella of the inner gill with the visceral mass; the dorsal aperture (supra-anal opening); the siphons; the differentiations of the mantle edge; the structure of the glochidium; and shell characters. In contrasting his arrangement with that of Simpson, however, reference will be made only to the marsupium.

Confining himself to North American forms, he divides the Naiades into two families, the Margaritanidæ and the Unionidæ. His discovery that in *Margaritana margaritifera* there are no distinct interlamellar junctions in the gills, but only scattered interlamellar connections, and consequently no definite water tubes, he considers of sufficient importance to warrant him in creating a new family for this genus, Margaritanidæ, which he has thus sharply set apart from the remaining genera grouped under the Unionidæ, a procedure of doubtful wisdom.[a] The fact that complete interlamellar junctions are absent in *Margaritana*, which is further characterized by certain other apparently primitive features, is of the greatest interest, but that these differences are of sufficient significance to justify a separate family for *Margaritana* is not at all clear.

The Unionidæ, after the removal of *Margaritana*, he divides into three subfamilies, distinguished as seen below by definite marsupial characters:

1. Unioninæ. "Marsupium formed by all four gills, or by the outer gills only; edge of marsupium always sharp and not distending; water tubes not divided in the gravid female."

This subfamily includes the following genera, which, however, he has recast to a considerable extent by subtractions and additions of species: *Quadrula* Rafinesque (including *Tritogonia tuberculata*); *Rotundaria* Rafinesque (established for *Quadrula tuberculata*); *Pleurobema* Rafinesque (including *Q. coccinea, pyramidata, obliqua, cooperi-*

[a] The condition described by Ortmann for *Margaritana* is quite similar to that which is found in the gills of *Mytilus* (cf. Peck, 1877), in which complete interlamellar junctions are absent and the inner and outer lamellæ are connected only by scattered strands of subfilamentar tissue passing across the interlamellar space. This similarity in gill structure would argue strongly for the primitive position of *Margaritana* among the Unionidæ. In *Lucina* these interfilamentar junctions are larger and are provided with blood vessels, while in *Mytilus* they are non-vascular. Ortmann does not state whether or not they contain blood vessels in *Margaritana*.

ana); *Elliptio* Rafinesque (established for the North American species of *Unio* to distinguish them from the European).

2. Anodontinæ. "Marsupium formed by the outer gills in their whole length, distending when charged, and the thickened tissue at the edge capable of stretching out in a direction transverse to the gill, but not beyond the edge (or only slightly so); water tubes in the gravid female divided longitudinally into three tubes, with only the one in the middle used as an ovisac, and closed at the base of the gill."

The following genera are grouped under this subfamily: *Alasmidonta* Say, *Strophitus* Rafinesque, *Symphynota* Lea, *Anodontoides* Simpson, *Anodonta* Lamarck.

3. Lampsilinæ. "Marsupium rarely formed by the whole outer gill, generally only by or within the posterior part of the outer gill; edge of marsupium, when charged, distending, and bulging out beyond the original edge of the gill, generally assuming a beaded appearance; water tubes simple in the gravid female."

The following genera are grouped together under this subfamily: *Ptychobranchus* Simpson, *Obliquaria* Rafinesque, *Cyprogenia* Agassiz, *Obovaria* Rafinesque (including *Lampsilis ligamentina*), *Plagiola* Rafinesque, *Paraptera* gen. nov. (established for *Lampsilis gracilis*), *Proptera* Rafinesque (established for *Lampsilis alata, purpurata, lævissima*), *Lampsilis* Rafinesque (including *Micromya fabalis*), *Truncilla* Rafinesque.

It will be seen by a comparison of the genera which Ortmann assigns to his three subfamilies with the several groups of Simpson, that the most significant change introduced by the former arrangement is the disruption of Simpson's Homogenæ and a redistribution of its genera and those of the Digenæ, Diagenæ, and Tetragenæ among the subfamilies Unioninæ and Anodontinæ, the former receiving all of the genera considered by Ortmann, except *Alasmidonta, Strophitus, Symphynota, Anodontoides*, and *Anodonta*, which, by reason of the peculiar secondary division of the water tubes of the gravid female in all of these genera, he insists should be placed in a subfamily by themselves. Apparently his grounds for the rearrangement are sound. In the Lampsilinæ are included all of the genera of Simpson's Heterogenæ, together with those of the Mesogenæ, Ptychogenæ, and presumably the Eschatigenæ—a procedure which is in harmony with the suggestion made above that the genera in which a differentiated portion only of the outer gill functions as a marsupium should be grouped together.

The reader is referred to Ortmann's monograph for further details and for the considerations which have led him to shift a number of species from one genus to another and to establish certain new genera, while renaming others.

This system has the merit of being based upon a careful study of the anatomy of the species with which he has been concerned, and he has clearly demonstrated the fact that shell characters alone are not sufficient for a determination of true relationships. To what extent his classification will replace Simpson's remains of course to be seen, but in any future discussion of the matter the new facts brought to light by Ortmann in his study of the structural modifications of the marsupium must be reckoned with.

GENERAL STRUCTURE OF THE MARSUPIUM.

In connection with our investigations on fresh-water mussels we have had occasion to give quite a little attention to the anatomical and histological structure of the marsupium in a number of genera, and, furthermore, we have been particularly interested in the changes that occur in the gills during the period of gravidity. We have already published a brief account (1910b) of some of our observations on the marsupium, with illustrations of the more important types, but, as Ortmann has since added a number of new facts to the subject, it is advisable to present our results in greater detail and with additional illustrations. For this purpose it will be more convenient to follow Simpson's arrangement, and we shall refer to the species examined by us under the several groups established by him. It will also be convenient in connection with the description of the marsupium to refer somewhat incidentally to certain observations on breeding habits, characteristics of the embryos, and related matters. The finer structure of the marsupium is reserved for a subsequent section of this report.

Tetragenæ.—The marsupium in these forms comprises all four gills, a condition which is undoubtedly the most primitive one among the Exobranchiæ. It is the condition occurring in the genus *Quadrula*, in which, following Ortmann, we include *Tritogonia*. We have encountered it in the following species: *ebena* Lea, *heros* Say, *lachrymosa* Lea, *metanevra* Rafinesque, *obliqua* Lamarck,[a] *plicata* Say, *pustulosa* Lea, *trigona* Lea, *tuberculata* Barnes (*Tritogonia tuberculata*), and *undulata* Barnes.

No special structural modifications are present beyond the usual glandular folded epithelium covering the surface of the interlamellar junctions which, as has been known since the work of Peck (1877), are closer together in the marsupial than in the purely respiratory gill. The gills when gravid, although somewhat distended and padlike in appearance, never become swollen to the extent that is seen in many other genera. Figure 5, plate VII, which is drawn from a gravid female of *Quadrula ebena*, illustrates the typical appearance of the marsupium in this group, although the gills shown in the figure are not as fully distended as is frequently the case.

In *ebena* and *trigona* the ovarian eggs and the embryos are frequently brilliantly colored red or pink and when the marsupium is charged the color shows through the colorless transparent walls of the gills, which present a striking appearance on removing the shell. In all of the other species of *Quadrula* observed by us the pigmentation is absent, but in *ebena* and *trigona* the color is found in a majority of the gravid females, the number of such cases being somewhat greater in *trigona* (over two-thirds of all gravid females examined in this species) than in *ebena*. The red pigment, however, whenever it occurs, does not persist, but on the contrary totally disappears in the later stages of embryonic development, and by the time the glochidia are fully formed no trace of it is left. We have never seen a single case of a red or pink glochidium either in these two species of *Quadrula* or in any other genus in which pigmented eggs and embryos occur. It is true

[a] Ortmann (op. cit., 1911, p. 330) states that only the outer gills serve as the marsupium in *obliqua*, and on this ground he has removed the species to *Pleurobema*. If we have made no mistake in the identification of our specimens, our observations on this species are not in accord with his.

that the marsupium may still be more or less deeply tinged with red, even when it contains fully developed glochidia, but this is due to its containing a variable number of unfertilized eggs, which do not lose the color, and not to the glochidia which are always, as stated, entirely colorless.

The occurrence of unfertilized eggs is very common in all of the species of *Quadrula* which have come under our observation, and their presence is more characteristic of certain species than of others. They are quite rare in *plicata* and *pustulosa*, for example, less so in *metanevra*, common in *ebena*, while in *trigona*, in which they occur more frequently than in any other species of *Quadrula*, they were found in a large majority of cases. The number of unfertilized eggs in different females of a given species varied from cases in which only a few such eggs were scattered among normal embryos all the way to cases in which the marsupium contained no normal eggs or embryos at all. Eggs which have not been fertilized, after remaining in the marsupium, become swollen and stratified (see below), frequently forming exovates and undergoing fragmentation before final disintegration.

There seems to be a definite correlation between the presence of unfertilized eggs in the marsupium and the occurrence of trematode parasites in the testis of the male; in species like *plicata*, in which unfertilized eggs were rare, only occasionally were the testes infested with worms, but in *trigona*, for example, the trematodes were found in a large number of males. It is not at all improbable that the amount of sperm available in a given locality is greatly reduced as a result of the castration of males by this testis infesting parasite.

The abortion of embryos and glochidia, which is so characteristic of the genus *Quadrula*, and the significance of this peculiarity will be referred to later on.

Homogenæ.—The condition in which the entire outer gills only are utilized as a marsupium is present in 16 genera, according to Simpson.[a] We have verified its occurrence in *Alasmidonta truncata* Wright; *Anodonta cataracta* Say, *grandis* Say, *implicata* Say; *Arcidens confragosus* Say; *Pleurobema æsopus* Green; *Symphynota complanata* Barnes, *costata* Rafinesque; and in *Unio complanatus* Dillwyn and *gibbosus* Barnes.

As has already been stated, Ortmann has disrupted the group, placing *Pleurobema* and *Unio* in his subfamily Unioninæ, while segregating *Alasmidonta*, *Anodonta*, and *Symphynota* in his Anodontinæ. This he has done chiefly because of a differentiation of the ventral border of the marsupium and of a secondary division of the water tubes of the marsupium in those genera included in the Anodontinæ. These differences will be referred to below.

The marsupium when filled with embryos or glochidia may be greatly distended beyond its normal dimensions, and in this condition is an enormously swollen padlike structure, with a smooth surface, filling a large portion of the mantle chamber. Figure 3, plate VI, represents the gravid marsupium of *Symphynota complanata*, which may be taken as typical of the Homogenæ, although in *Pleurobema* and *Unio* the distension is not so great.

[a] *Margaritana* is placed in this group by Simpson, but as it utilizes all four gills as the marsupium it should be included with the Tetragenæ.

In *Pleurobema æsopus* the eggs and embryos, like those of *Quadrula ebena* and *trigona*, are usually, but not always, colored red or pink, but the glochidia are invariably unpigmented. Unfertilized eggs in varying proportions are frequently found in this species either mixed in with embryos at all stages of development or occurring alone; such eggs always show a definite stratification of the egg substances.

Diagenæ.—This group was established by Simpson to receive the genus *Strophitus*, in which the marsupium occupies the entire outer gill and in external appearance is similar to that of the Homogenæ. But it is unique among the Unionidæ in that the embryos and glochidia are embedded in gelatinous cords (called "placentæ" by Sterki, "placentulæ" by Ortmann), which lie transversely in the gills, whereas in all other cases the egg masses are placed vertically, each one occupying an entire water tube. In *Strophitus*, on the other hand, the cords are packed closely together, like chalk crayons in a box, a variable number being contained in a single water tube, while the blunt ends of the cords are distinctly seen through the transparent external lamella of the outer gill. It should be stated that Ortmann (1910b, 1911) has found that the discharge of the cords is not through the lamellæ of the gills, as Simpson (1900) has maintained, but that it occurs in the usual manner through the supra-branchial chambers. A description of the unique cords and the extraordinarily interesting life history of *Strophitus* is reserved for a special section.

Heterogenæ.—In this group the marsupium occupies only the posterior portion of each outer gill, varying in extent from about one-third to two-thirds of the entire length of the latter. In young females the marsupium is shorter and not so fully distended as in older ones. In fact, it is true of all Unionidæ that the marsupium is less heavily charged when the female is young. The differentiation of the posterior region is very conspicuous even in the non-gravid female, as the marsupium is sharply marked off either by a distinct fold or a notch from the anterior respiratory part, and, since it is much deeper dorso-ventrally than the latter, it projects farther down into the mantle-chamber. Its walls are also more membranous in appearance than are those of the respiratory region, and after the discharge of the glochidia it is seen as a flabby collapsed pouch.

When gravid, the marsupium may be enormously swollen, the expansion being greater along the ventral border than above, where, owing to its fixed position, it is incapable of stretching. This greater ventral extension often causes the marsupium not only to assume a fan-shaped form, which is so characteristic an appearance in *Lampsilis*, but also to project forward under the respiratory portion, which in consequence becomes sharply folded over on the outer surface of the marsupium. Not only is the marsupium as a whole expanded in the way described, but each of its swollen water tubes is distended distally beyond the lower extremity of the interlamellar junctions so that the ventral border becomes fluted or corrugated, as shown in figure 2, plate VI. This figure, which illustrates the typical condition in the genus *Lampsilis*, is drawn from a gravid female of *L. subrostrata* when fully charged with glochidia. The folded respiratory portion of the gill, the fan-like expansion of the marsupium, and the corrugated border are all clearly seen.

When the marsupium is less heavily charged, as in young females, the ventral expansion may not be great enough to cause the conspicuous fold just described, and in cases like this the marsupium, which may then appear kidney-shaped, is marked off from the respiratory end merely by a notch by reason of its greater depth. Such a case is seen in figure 6, plate VII which is taken from a gravid female of *L. recta*.

Simpson has included 14 genera in the Heterogenæ, only three of which, however, have come under our observation, namely, *Lampsilis* (including *Proptera*), *Obovaria*, and *Plagiola*. We have recorded this type of marsupium in *Lampsilis alata* Say, *anodontoides* Lea, *gracilis* Barnes, *higginsii* Lea, *lævissima* Lea, *ligamentina* Lamarck, *luteola* Lamarck, *recta* Lamarck, *subrostrata* Say, and *ventricosa* Barnes; in *Obovaria ellipsis* Lea; and in *Plagiola elegans* Lea and *securis* Lea.

No case of pigmented eggs has been encountered by us in this group, and unfertilized eggs in the marsupium are exceedingly rare.

Mesogenæ.—This group is so designated by Simpson to include the genera *Cyprogenia* and *Obliquaria*, in which a variable number of enlarged water tubes in the middle region of the outer gill are specialized as the marsupium, a larger anterior and a shorter posterior portion of the gill retaining the ordinary respiratory character. We have studied the condition in *Obliquaria reflexa* Rafinesque and also in *Cyprogenia irrorata* Lea, in which the structure of the marsupium is essentially the same, although the two cases differ strikingly in general appearance.

The marsupium of *Obliquaria reflexa* is shown in figure 7, plate VII. Here the modified water tubes, which project far down below the border of the rest of the gill, appear enormously swollen when gravid and show a tendency to curve backward, the degree of curvature becoming progressively greater in the tubes from the anterior to the posterior end of the marsupium. A gradual decrease in the length of the tubes takes place in the same direction. The tubes are slightly larger at their distal ends, so that their form is somewhat club-shaped; this is seen more clearly in the shape of the egg masses which form perfect casts of the cavities of the tubes (fig. 42, pl. XI). The corrugation of the lower border of the marsupium is very conspicuous in the figure. The number of water tubes comprising the marsupium in this species is not at all constant, but on the contrary varies in the individuals examined by us from two to eight; according to Simpson, they range from four to seven. During the breeding season each tube is entirely filled with embryos or glochidia which adhere so firmly together that they form a mass of tenacious consistency.

In *Cyprogenia*, the only other genus included in the group, the marsupium may be regarded as a further development of the condition seen in *Obliquaria*. We have observed it in but a single individual of *C. irrorata*, which was kindly sent to us by Dr. R. E. Coker. This specimen, which contained fully formed glochidia, was collected in the Cumberland River, Kentucky, in November, 1910. The tubes of the marsupium, which present a most striking and unusual appearance, spring from near the middle of the outer gill, are enormously elongated, and curved backward into a close coil, a part of the coil passing under the posterior unmodified portion of the gill, as the tubes are turned slightly inward toward the median plane. The marsupium is well shown in figure 8, plate VII. The distension of the marsupial water tubes begins at quite a distance above the ventral border of the rest of the gill, as is seen in the figure. The anterior respiratory portion is sharply separated from the rest of the gill by a cleft which extends almost up to the level of the suprabranchial chamber. At first this was supposed to be an artificial split, but as it occurs on both sides and its edges are perfectly smooth and show no indication of injury, we have concluded that it must be a normal condition. Unfortunately we have had no other specimens with which to compare it.

In our specimen the marsupium is slightly tinged with pink, the color being due to unfertilized pigmented eggs which are scattered among the glochidia. Simpson speaks of the marsupium as being purple.

The unusual form of the marsupium in *Cyprogenia* was originally described by Lea (1827) in *C. irrorata*, but curiously enough he reversed the direction of the coil in his figure, which appears to have been drawn from memory, as such a mistake could hardly have been possible if he had had a specimen before him.[a]

Call (1887) many years later described a similar marsupium in *C. aberti* Conrad, which he very crudely figured. It is strange that, although he reproduces Lea's original figure of *irrorata* by the side of his own, he makes no mention of the error in it. Judging from Call's figure, the number of tubes in the marsupium of *aberti* is much larger than in *irrorata*. He shows about 20, while Lea states that there are 7 or 8 in the latter, and in our specimen there are 7. Simpson gives the number for the genus as 7–23.

Ptychogenæ.—This group contains a single genus, *Ptychobranchus*. The marsupium occupies the lower half of the entire outer gill and is thrown into a series of folds, from 6 to 20 in number, according to Simpson. Each water tube of the marsupium is inflated at its distal extremity to form a globular enlargement projecting beyond the interlamellar junctions—a condition which gives to the free edge of the gill the beaded appearance so characteristic of the genus. This marsupium is well illustrated in figure 1, plate VI, which is drawn from a gravid female of *P. phaseolus* Hildreth. Seventeen conspicuous folds, sharply demarked from each other, are shown in the figure, in which the beaded border of the gill is also clearly seen.

Eschaligenæ.—Simpson has established this group to receive the genus *Dromus* in which the marsupium occupies the ventral half of the outer gill throughout the greater portion of its length. We are indebted to Dr. R. E. Coker for several specimens of *Dromus dromus* Lea, obtained from the Cumberland River in Kentucky in November, 1910, which have furnished the material for our study of this type of marsupium. Three gravid females, all containing glochidia, were included in the lot.

As seen in figure 4, plate VII, the line of demarcation between the dorsal respiratory portion and the ventral marsupial region is quite sharp and regular, owing to a constriction of the gill where the two regions join. Below this line the gill is swollen to an extent varying with the degree to which it is charged with glochidia. The anterior end of the gill is not included in the marsupium and is sharply folded over on the outside of the

[a] We are indebted to Mr. Bryant Walker, of Detroit, for having called our attention to this error in Lea's figure.

marsupium in this region. The depth of this fold varies with the fullness of the marsupium, as the greater is the distension of the latter the farther forward it is tucked under the anterior respiratory region. Posteriorly the two portions of the gill are sharply defined by a deep cleft, as shown in the figure. The surface of the marsupium is thrown into an irregular series of low undulating folds which are more prominent in the more heavily charged females. In two of the females the marsupium is a salmon pink, while the third is colorless, but here, as in the other cases described in which glochidia are present, the color is due to unfertilized eggs.

The record in our notes of the three females is as follows:

No. 1, small specimen, 44 by 39 mm. Marsupium colorless, only slightly distended and not thrown into folds or undulations; no anterior fold, merely a notch; glochidia colorless.

No. 2, larger specimen, 57 by 52 mm. Marsupium salmon pink, much fuller than no. 1, and thrown into distinct folds; deep anterior fold; glochidia colorless, but many pigmented unfertilized eggs and abnormal embryos mixed with them. (This is the specimen from which the figure was drawn.)

No. 3, largest specimen, 58 by 55 mm. Marsupium with just a tinge of pink, more heavily charged than either of the others and showing prominent folds or undulations; deep anterior fold; glochidia colorless, and a few pigmented unfertilized eggs and abnormal embryos present.

It is evident from this comparison that the smaller, and therefore presumably the younger, females are less heavily charged than the larger and older ones; and, furthermore, that those changes in the gill which are the mechanical effects of gravidity, like the folds, vary directly with the degree of distension of the marsupium. This conclusion holds good for all the Unionidæ which we have had an opportunity of examining, and also applies to the experience of other observers.

The glochidia of *Dromus dromus*, which are excessively minute and of unusual form, being kidney shaped, are referred to later.

INTERNAL STRUCTURE OF THE MARSUPIUM.

The marsupium of the Unionidæ furnishes a beautiful illustration of a remarkable diversity of form in the adaptation of an organ for a specialized function. One can not study this structure in the North American Unionidæ without being forcibly impressed with the great variety of detail which one and the same general adaptation is capable of exhibiting. But whatever be the special direction which the modification has taken, even in the most bizarre forms of the marsupium, like that of *Cyprogenia*, there is never any doubt as to the relation between the structural specialization and the function which it is adapted to perform. The structural basis of the marsupium—one might almost say the unit of structure—is the water tube, and it is from an investigation of its finer structure and its relation to other tubes, similarly modified, that an understanding of the unionid marsupium is gained. The fundamental adaptation is a series of compartments in the interior of the gills provided with a specialized glandular epithelium lining the cavity and also with a mechanism in its walls which allows of distension, often to an extraordinary degree.

The various types of marsupium are to be referred to differences in the manner in which these compartments are associated to constitute the marsupium; to different degrees to which the compartments are developed; to differences in the modification of the walls for the purpose of distension; and also to the development of special adaptations in certain forms for increased aeration of the marsupium. Whether in the last specialization the better aeration is needed for the gravid mussel, whose respiration must be considerably interfered with when the entire outer gills are gorged with embryos, as in *Anodonta* and *Symphynota*, or for the embryos themselves, is a question that is discussed later, but from a comparison of the conditions existing in the different types of marsupium it would seem that the respiratory modifications are primarily for the adult and not for the embryos. The reasons for this conclusion should be reserved until the internal structure of the marsupium has been described.

It is chiefly to Peck (1877) that we owe a correct interpretation of the structure of the lamellibranch gill. It was he who first showed that the plate-like gills of the higher forms, consisting each of an outer and an inner lamella, are formed by a series of juxtaposed independent filaments, a fact that was essential to the later recognition of a perfectly regular series of gradations throughout the lamellibranchs from the simple ctenidium of the primitive *Nucula* to the complex double gill of the Unionidæ. In the least modified forms the filaments are straight, either plate-like or filamentous, but in forms above these each filament becomes greatly elongated and bent upon itself to form a compressed U or V, consisting of an inner and an outer limb. One limb, the inner in the outer gill and the outer in the inner gill, is fixed above to the body wall, while the other limb is free in the lower groups (*Arca*, *Mytilus*), fixed in the higher (Unionidæ), although the inner limbs, forming the inner lamella of the inner gill, may not all be fused to the body wall. The filaments constituting a lamella are interlocked either by cilia or by interfilamentar junctions, and the gill may be further strengthened by interlamellar junctions, which are either simple bars (*Mytilus*, *Margaritana*) or continuous septa (Unionidæ, except *Margaritana*).

In his study of the lamellibranch gill Peck described in much detail and with great accuracy the structure of the gills of the Unionidæ, and his account has furnished the basis of all subsequent descriptions. The typical structure of the unionid gill is well known. Each gill consists of two lamellæ, an outer and an inner, composed of series of juxtaposed filaments supported by chitinous rods and fused by the interfilamentar junctions except where the inhalent ostia open into the interlamellar space for the entrance of water. The dorsal edge of the inner lamella of the outer gill and of the outer lamella of the inner gill is fixed to the body wall, while the outer lamella of the outer gill is fused to the mantle (in *Margaritana* it is free posteriorly), and the inner lamella of the inner gill is either free or more or less attached to the visceral mass (cf. Ortmann, 1911). The two lamellæ are continuous along the free ventral borders, and thus form a flattened sac whose cavity opens above throughout its entire length into