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THE MOLLUSCA OF DICKINSON COUNTY,
MICHIGAN

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INTRODUCTION

The field work on which this report is based was done by the writer while connected with a biological expedition sent out by the Michigan Geological and Biological Survey during the summer of 1909. The original paper was finished in 1912; the present paper is simply a condensation of it, although an attempt has also been made to bring the nomenclature up to date.

The party made their headquarters the hunting camp of Mr. R. C. Flannigan, on the south shore of Brown Lake, about 11 miles north of Waucedah, Dickinson County, Michigan. The work around Brown Lake was done between July and August 2 and between August 13 and 18; the region around Norway was studied from August 3 to August 11.

In pursuing this work, the writer has become indebted to a number of persons. He wishes to express his obligations to Mr. and Mrs. R. C. Flannigan, especially the latter, for acting as guides on several occasions, and for trips to points around Norway, and for their kind hospitality; also to all of the members of the party, with Dr. Ruthven in charge, for assistance in collecting and in finding favorable localities for study. He also wishes to thank Mr. G. H. Coons for the identification of many plants from the various habitats, and Dr. V. Sterki for the identification of the Sphæriidae, which were forwarded to him through Dr. Bryant Walker.

DESCRIPTION OF THE REGION

The region studied (map facing page 44) lies in about 88° longitude by 46° north latitude, and varies from about 900 to 1500 feet above sea-level. The Menominee River forms the boundary line between Wisconsin and the northern peninsula of Michigan, and of the two localities studied, Sand Portage and Upper Twin Falls, the first is about two miles south of Norway, Michigan, and the second about four miles north of the town of Iron Mountain. Pine Creek flows along the border of the granitic hills about two miles north of Norway, where Fern Creek enters it from that region. Hanbury Lake is just southwest of the mining town of Vulcan, and the falls of the Sturgeon are about a mile northeast of the town of Loretto. Brown Lake is about eleven miles north of Waucedah, and the places mentioned from its vicinity are all located on the sketch map of that region, with the exception of Foster City, which is about four miles north-northeast of the lake.

This region is almost entirely underlaid with Archaean and Algonkian formations, although there are patches of Cam-

brian sandstone around Norway, and considerable thicknesses of this rock along the road to Foster City. These earlier rocks form structural, although not necessarily topographic, troughs or "tongues" of Algonkian rocks between the anticlines with Archean exposure.¹

The Menominee River, south of Norway, flows along the southern border of the Menominee Trough, and Brown Lake and the Sturgeon River just below it are near the center of the next trough to the north, the Calumet. These cylindrical troughs are mostly formed of perpendicularly folded, metamorphosed, sedimentary rocks, whereas the remnants of the anticlines consist of huge masses of Laurentian granite. The Cambrian rocks are almost horizontal.

The rivers of the region are mainly directed by the configuration of the glacial deposits; they flow through the sandy, outwash plains between and in front of the moraines, although they are often partially guided by the granite hills, where these project above the more recent deposits. For this reason they often cross the topographic features of the surface of the underlying rocks, and exhibit many rapids and falls where they have eroded down to the bed-rock. The Menominee, for instance, at Upper Twin Falls cuts across the Quinnesec Schist, and at Sand Portage it crosses the Hanbury Slate.

The Sturgeon River leaves the Calumet Trough, which is north of the eroded Archean anticline, about four miles southeast of Brown Lake, and from there flows due south to within a half mile of the Menominee Trough, where it turns west and enters that trough about two miles northeast of the town of Loretto. Here it has formed a gorge at the Falls of the

¹W. S. Bayley, 1904, The Menominee Iron-bearing District of Michigan. *U. S. Geol. Surv.*, Mon. XLVI, p. 34, Pl. ii.

Sturgeon, where it cuts across both the Archean and the Algonkian rocks. This course is due to a clay moraine which lies along the east side of the Sturgeon and the East Branch of that river. Several outlying patches of moraine are on the western side of the river; the largest of these, with an area of about two square miles, is north of Brown Lake and the West Branch. A sandy ridge also lies along the east side of the lake itself.²

At some past time, Brown Lake was apparently considerably larger than at present, as a beach-line extends around it and about half a mile up what is now the valley of the East Branch. At that time the lake appears to have emptied into the East Branch. An old channel connects the East Branch with the main portion of the Sturgeon to the south. This is evidence that the old junction of the East and West branches was about two miles below the present confluence.

This former course of the lake and river was apparently determined by a very low, rounded ridge which lay between Brown Lake and the West Branch. This dammed up the former lake until it rose higher than the outlet to the east; then a channel was eroded across the ridge to form the strikingly recent, short and shallow gorge, through which the waters of the present lake join the West Branch to form the main river. This lowered the lake to such a degree that it diverted the East Branch from its old channel so that it now flows into Brown Lake.

² See Frank Leverett, 1911, *The Surface Geology of the Northern Peninsula of Michigan*. *Mich. Geol. Biol. Surv.*, Publ. 7, Geol. Series 5, Plate I.

HABITAT STUDY

In order to make easier the comparison of the different habitats and also to condense the paper, the lists of species obtained from each habitat are combined into tables (Tables I to V), instead of listing them at the end of each habitat. Following the short descriptions of each habitat, any peculiarities of distribution are mentioned; otherwise it may be taken that any particular species was quite equally distributed throughout the habitat.

For the purpose of making the descriptions of the abundance of the different species as uniform as possible, the writer has confined himself for some time to the following series of terms:

vA—very abundant	F—frequent
A—abundant	qI—quite infrequent
qA—quite abundant	I—infrequent
vC—very common	vI—very infrequent
C—common	qR—quite rare
qC—quite common	R—rare
	vR—very rare

Of course, such terms are at best very vague and indefinite and do not take the place of a statistical study of abundance. They probably do not exactly represent the comparative abundance of very dissimilar habitats. However, as they are all based on the observations of a single person, it would seem that they are accurate enough for the comparison of more or less similar habitats, especially those within a single series.

While doing some statistical work on the distribution of molluscs, the writer noticed that he had a tendency to unconsciously over-emphasize the abundance of the larger forms and to underestimate the comparative numbers of the smaller ones. Fifteen or twenty specimens per square meter give one the impression of considerable abundance in the uniones, more

than do ten times that number of some small species such as *Amnicola limosa*. In addition, the larger forms must actually play a larger part, considering their actual numbers, in any habitat than do the smaller species. In order to obviate this difficulty in part, all of the species are divided into three groups: the Unionidae, the larger (primary) species, and the smaller (secondary) forms. No dominance, in the botanical sense, is to be construed from this division, and the different groups are purely relative.

TABLE I. HABITATS OF THE LAKES (I-II)

	BROWN LAKE								SMALLER LAKES		
	Vegetation		Inner Zones			River Invasion			9	10	11
	1	2	3	4	5	6	7	8			
UNIONIDAE											
<i>Anodonta marginata</i>	R	...	...	...	qC	...	...	...	...	A	...
<i>Anodonta grandis footiana</i>	...	...	...	...	...	...	...	qC	...	...	...
<i>Lasmigona costata</i>	...	...	...	...	...	...	...	I	...	...	...
<i>Lampsilis luteola</i>	...	...	...	...	...	...	...	R	...	...	...
<i>Lampsilis ventricosa</i>	...	...	...	...	...	...	...	R	...	...	...
<i>Alasmidonta calceolus</i>	...	...	...	...	...	...	...	...	A	...	...
<i>Lasmigona compressa</i>	...	...	...	...	...	...	...	...	C	...	...
<i>A. ferussacianus buchanaensis</i>	...	...	...	...	...	...	...	...	qC	...	...
LARGER FORMS:											
<i>Lymnaea megasoma</i>	?	...	...	...	...	...	...	...	...	...	...
<i>Physa gyrina</i>	R	...	vA	...	vI	...	...	...	F	...	F
<i>Physa integra</i>	...	qC	qI	R	qI	...	Rm*	...	...	...	qI
<i>Succinea retusa</i>	...	...	C	...	...	...	...	...	...	...	...
<i>Plan. antrosus striatus</i>	...	...	...	qC	R	...	Am	...	qA	qAm	qI
<i>Planorbis campanulatus</i> , var.	...	...	...	I	qA	...	qI	I	F	qCm	qId†
<i>Sphaerium sulcatum</i>	...	...	...	R	C	...	qAm	...	R	F	...
<i>Lymnaea stagnalis appressa</i>	...	...	...	F	I	...	...	...	...	...	A
<i>Sphaerium stamineum</i>	...	...	...	...	qI	Fm	Im	...	...	...	...
<i>Campeloma decisum</i>	...	...	...	...	qC	...	Rm	qA	...	R	vI
<i>Sphaerium rhomboideum</i>	...	...	...	...	...	...	...	...	A	...	...
<i>Planorbis trivolvis</i>	...	...	...	...	...	...	...	...	...	Rm	A

* m—from marl deposits only.

† d—dead shells only.

	BROWN LAKE								SMALLER LAKES		
	Vegetation		Inner Zones			River Invasions			9	10	11
	1	2	3	4	5	6	7	8			
SMALLER FORMS:											
<i>Amnicola limosa</i>	vA	qA	...	vA	A	Cm	qA	vA	...	Am	....
<i>Amnicola lustrica</i>	I	...	...	vC	A	Cm	C	qC	...	Am	....
<i>Ferrissia parallela</i>	...	qA	...	...	qC	?m	...	I	...	...	....
<i>Planorbis parvus</i>	...	qC	...	...	...	Cm	Am	R	...	...	....
<i>Planorbis umbilicatellus</i>	...	R	...	R	I	...	...	R	...	...	....
<i>Lymnaea obrussa peninsulae</i>	qA	...	...	...	...	...	...	...	....
<i>Lymnaea humilis?</i>	F	...	...	...	...	...	...	...	....
<i>Planorbis exacuons</i>	R	...	A	...	vRm	...	...	...	....
<i>Amnicola limosa porata</i>	C	...	...	...	C	...	...	....
<i>Valvata tricarinata</i>	A	A	F	qA	vC	...	Am	....
<i>Valvata sincera</i>	I	qR	Im	qAm	...	...	...	....
<i>Planorbis deflectus</i>	C	qC	Im	F	R	...	qCm	....
<i>Pisidium compressum</i>	qC	F	Cm	C	C	...	qCm	....
<i>Pisidium variabile</i>	R	I	I	C	C	...	Im	....
<i>Amnicola walkeri</i>	F	...	...	I	...	...	....
<i>Pisidium pauperculum</i>	I	...	...	R	...	qCm	....
<i>P. pauperculum crystalsense</i>	R	...	...	Rm	...	...	....
<i>Musculium rosaceum</i>	R	...	Rm	...	...	...	....
<i>Pisid. variabile brevium</i>	C	...	...	...	....
<i>Pisidium affine</i>	Rm	R	...	...	...	....
<i>Pisidium tenuissimum</i>	qI	...	...	...	....
<i>Pisidium sargenti</i>	R	...	...	...	....
<i>L. humilis modicella</i>	qR	...	qA	....
<i>Pis. punctatum simplex</i>	vR	...	...	....
SHELLS FOUND ONLY IN MARL:											
<i>Lymnaea obrussa decampi</i>	qRm	qAm	...	...	...	....
<i>Pisidium medianum</i>	Rm	qAm	...	...	...	....
<i>Valv. tricarinata confusa</i>	qAm	...	...	...	....
<i>Pisidium vesiculare</i>	qAm	...	...	...	....
<i>Pisidium peraltum, var.</i>	qIm	...	...	...	....
<i>Pisidium splendidulum</i>	qAm	...	...	...	....
<i>Musculium secure</i>	vRm	...	...	...	....
<i>P. compressum laevigatum</i>	Rm	qIm	...	...	...	....

LAKES (TABLE I.)

Brown Lake

In most places, both in the Upper and Lower Lakes, two definite shore zones could be separated. The outermost zone was that of *Potamogeton* and was the more constant of the two, as it occurred throughout the lakes at a depth of water between 6 and 7½ feet. Inside of this zone was that of water-milfoil and hornwort, which extended in to a depth of about 17 inches. Throughout both of these zones the bottom was very soft and mucky.

Besides these two, a third, inner zone could be differentiated in several places. It was very variable in width and biota, but was clearly marked off in most places where it occurred by the lack of the higher plants determining the other two zones.

The main irregularities of these zones could be divided into two classes: the invasions of the river conditions, and the patches of water lilies which occurred throughout the middle zone, but were particularly numerous near these river invasions. Both of these affected the inner zones more markedly than the outer.

Habitat 1. Water-weed Zones. Between the depths of 17 inches and 7½ feet, a luxuriant growth of aquatic vegetation completely covered the bottom and reached to the surface of the lake. Throughout this region and beyond it a deep layer of soft, finely-divided, peaty muck covered the bottom of the lake.

The vegetation of this region could be subdivided into two quite distinct zones, as has already been mentioned. In the outer ones, *Potamogeton richardsoni*, *P. pectinatus* and *P. perfoliatus* dominated near the surface and *Utricularia vulgaris*

americana disputed that dominance below the surface, but *Myriophyllum spicatum* was not very abundant. On the other hand, *Myriophyllum spicatum*, *Ceratophyllum demersum* and *Bidens beckii* predominated in the inner zone and the species characteristic of the outer zone were not prevalent. Additional species of the inner zone were *Potamogeton amplifolius*, *P. zosteræfolius*, *P. filiformis* and *P. natans*, the last being the most abundant. Usually near the inner edge of the vegetation *Philotria canadensis* and *Chara* often occurred in considerable patches, each forming a distinct island from which other species were apparently excluded.

No similar division of the molluscan fauna into zones was noticeable. In addition to the species found in the weeds themselves, *Anodonta marginata* was dredged from deep water just beyond their outer edge. Also a single dead specimen of *Lymnæa megasoma* was found on the Sturgeon River flats below the lake; this also was probably from the central portion of the lake (Table I).

Habitat 2. Water Lilies. Patches of water lilies, mostly *Nymphæa advena*, but with a few *Castalia odorata*, were scattered throughout the inner two zones, but were especially abundant in the Lower Lake, near the straits between it and the Upper. These plants formed distinct islands as apparently no other plants are able to grow among them, probably on account of their large leaves.

The inner zone of Brown Lake, as mentioned above, reached from the shore out to about 17 inches of water. This very variable zone differed so much in the various parts of the lake that it was divided into three habitats. It was wider where the shore was firmer and sandy and had either a sandy marl bottom as along the southern portion of the west shore

of Lower Lake, or the sand was covered with a relatively thin layer of muck as along the north shore of Upper Lake. In all other places around both lakes the inner zone was practically absent and the middle zone reached the swampy shore, except along a few rods of the west shore of Upper Lake, where the inner zone was quite wide, had a mucky bottom and was covered with floating logs.

Habitat 3. Swampy West Shore. Along the northern portion of the west shore of Lower Lake and along the entire west shore of Upper Lake there was a large bog with a floating marsh at its edge. Adjacent to this bog no inner zone occurred, except for a short distance along its southern end and near Habitat 5; here a large number of more or less water-soaked logs were jammed together in shallow water. A few scattered bunches of *Riccia fluitans*, *Spirodela polyrhiza* and other small water-plants were fastened to logs and floating amongst them. The molluscan fauna of this area was poor and resembled that of a pond (Table I).

Habitat 4. North Shore. Along a short portion of the north shore of Upper Lake the bank is high and sandy. Off this region the bottom is also sandy, but is covered with a thin layer of marly muck; the latter varies in depth from one inch near shore to about six inches in a foot of water. The muck is mostly made up of decaying bark and other vegetable materials. The line of distinction between this zone and the inner plant zone was not so well defined as in the other two habitats, and scattered groups of plants, mostly *Chara*, encroached upon it. *Ammicola limosa* was most abundant near these patches.

Habitat 5. Sandy West Shore. In places where the west shore is high and sandy only a very slight layer of marly muck covers the bottom. In these localities the inner zone could

be divided into three quite distinct subzones. The inner of these was characterized by a thin layer of muck, formed of bits of bark, twigs and other organic material, which covered the sand and into which many water-soaked logs have sunk. This reached out into about 12 inches of water, where the mucky bottom became much thinner; here was a narrow zone of a thick, intermeshing growth of aquatic moss. Beyond this moss zone the bottom is of cleaner sand with comparatively little organic material out to the inner plant zone and the thick layer of muck accompanying the latter.

The larger Planorbis, Physa, *Ferrissia parallela*, and *Planorbis excavatus* were mainly found on the logs, etc., of the innermost zone; *Campeloma decisum* and *Sphaerium sulcatum* were the burrowing forms of the same region. The different species of Amnicola and Valvata were more abundant in the outer two zones. Amnicola was more characteristic of the water-moss zone, and Valvata seemed to prefer the sandy bottom itself. *Anodonta marginata*, *Sphaerium stamineum* and the various species of Pisidium were mostly found in the outer zone, burrowed in the sandy bottom.

Habitat 6. Mouth of East Branch. In the mouth of the East Branch the conditions of the river grade into those of the lake. In these places the bottom was clear and sandy, and but little current was discernible. *Valisneria spiralis* was sparsely scattered through the shallow water near the banks.

A large proportion of the molluscs collected consisted simply of dead, chalky specimens forming a sort of marl deposit in the depressions. These might have come originally from almost any aquatic habitat in the region, although the living species were also found in these deposits in even greater abundance. The species that were only found in these deposits

are marked (m=marl) in the list of species (Table I).⁶

Habitat 7. Between Lakes. Upper and Lower Lakes are connected by a channel a few rods wide, about 10 feet long and about 4 feet in depth. A quite considerable current keeps the coarse sandy bottom free from muck. *Valisneria spiralis* was practically the only conspicuous plant in the channel itself, but in the quieter water at either end *Potamogeton zosterifolius* and *P. amplifolius* were quite abundant, and there were a few plants of *Polygonum amphibium*. In addition, the water lilies of Habitat 4 were numerous in the close vicinity. Many of the specimens were dead and chalky; these are marked (m) in the species list (Table I).

Habitat 8. South Shore. In shallow water along the southwest shore near the outlet into the East Branch, a very perceptible current prevents the accumulation of much muck on the sandy bottom. In water less than 12 inches in depth the sand is quite bare, but beyond that depth some muck was held by a dense bed of *Valisneria* with a scattering zone of *Potamogeton amplifolius* and *P. zosterifolius* along its outer edge. This habitat is characterized by a number of species of uniones and by the abundance of *Campeloma decisum*.

Tamarack Lake

Habitat 9. Tamarack Lake and Outlet. Tamarack Lake had apparently been considerably larger at one time, as it is surrounded by extensive tamarack-alder swamps. However, it has reached a late stage in its life history and has become smaller and very shallow, with a soft, mucky bottom composed of decaying plant material. When studied it was covered with the pads of the white and the yellow water lilies, and surrounded by a sedge flora instead of the usual sphagnum bog. For some distance below its source the small creek

that forms the outlet is almost choked by muck washed in from the lake, except in a few places where the current is swift enough to expose a sandy bottom. *Sphaerium sulcatum* was much more abundant in the outlet than in the lake itself.

Jackson Lake

Habitat 10. Jackson Lake and Outlet. This lake is about 200 yards long by about 75 wide, and is in a hollow behind the hill formed by the rock ridge at the Rock Dam. When studied the water was only two or three feet deep in the deepest portion, as the basin is almost completely filled with soft, very finely divided, marly muck; this material must reach a considerable depth at the center, as the marly muck is six feet in depth a yard from the shore. Around the lake was a quite high and dry grass swamp, the flora of which resembled that of stream banks rather than that of the true bog lakes; along the edge there was a considerable growth of *Chara* in shallow water and the yellow water lilies were very abundant near the middle.

Several small spring brooks empty into the lake and its short but quite large outlet drains into the Sturgeon River. From all appearances, this outlet had formerly been quite deep with a rocky bottom, but the marly muck has almost entirely filled it and the conditions are very similar to the lake itself. The living shells were mostly obtained at the entrance into the outlet, as this was the only place where it was possible to reach water of any depth. Many dead shells were found mixed in the mud; all of these types were probably inhabitants of the lake itself at some time, and many of them may have still been living near the center.

Hanbury Lake

Habitat 11. Hanbury Lake. This lake is just southwest of the mining town of Vulcan in the Menominee Trough, and sewage had made the water very turbid. The shores slope gradually into deep water, except in places along the south side where rock outcrops occur. The marly bottom supports a considerable growth of Chara, some Potamogeton and scattered yellow water lilies; it was littered with water-soaked snags and logs.

PERMANENT PONDS (TABLE II)

Habitat 12. Sedge Swamp. Near the main stream of the Sturgeon, below the lower end of the old river channel described in the preliminary discussion, was found a good-sized pond about 2 feet in depth. In most places around its edge the bottom was quite firm, but was somewhat softer toward the center. It was grown up with sedges, etc., and apparently contained water throughout the year. At one end a low strip, grown up with alders, possibly formed a connection between it and the river during periods of extraordinarily high water.

Habitat 13. Pond at the Falls of the Sturgeon. This small pool, which was on a sandy stretch of the gorge of the Sturgeon above Loretto, is apparently fed by springs, although perhaps the river overflows into it at high water. It has a sandy and rock bottom and contained a few sedges and a considerable abundance of algae.

Habitat 14. Bayou off the East Branch. Near the East Branch, about a mile above Brown Lake, a bayou has been formed from an old river channel. The stagnant water was oily at the surface and was from 1 to 2 feet deep, and the bottom was covered by a layer of organic muck of about equal thickness. This pool was choked with *Philotria canadensis*, *Myriophyllum spicatum* and logs, and yellow water

TEMPORARY SWAMPS (TABLE II)

Habitat 16. Swamp in Floating Marsh. A partially flooded area was found in the floating marsh surrounding Tamarack Lake, on the northern side some distance back from the shore line. In this the flora consisted of bladderworts, pitcher plants, water-mosses, sundews, *Galium claytoniana*, *Andromeda perfolia* and *Carex filiformis* and other sedges.

Habitat 17. Beaver Meadow. A short distance below the beaver pond on Hancock Creek an extensive beaver meadow, the site of a former beaver pond, had not as yet been grown over by the surrounding thickets. This was covered with grass, except in a few lower spots where ponds formed after rains. These places were grown up with *Carex lurina* and another large sedge and formed quite typical temporary swamp habitats. The bottom was composed of decaying vegetable material and was damp throughout the year. The dead specimens of *Planorbis trivolvis* seem to indicate former more settled conditions.

Habitat 18. Swamps on McKinnon Brook Flats. On the flats of this brook, but probably too high above the stream itself to be reached by floods, were numerous small swamps. These were filled with an organic muck and formed small, temporary ponds after heavy rains. Ashes, elms and balsam firs were the most common trees over these flats, while *Asclepias incarnata* and *Marchantia polymorpha* were the most prevalent ground plants.

Some of these ponds contained little organic material, but others had a thicker layer and were grown up with *Equisetum* and other amphibious plants. These latter pools were in the damper places and had not been so badly affected by the fire as those nearer the edge.

Habitat 19. Swamp near Rock Dam. A few rods east of the rock ridge at this place a small hollow had in the past held a little bog, grown up with tamaracks, spruces, alders and willows, but the fire of the preceding summer had destroyed all of the trees and burnt away the humus. This depression still gathered little ponds after the heavier rains, but the destruction of the humus allowed the water to penetrate the soil more rapidly, and the loss of the trees increased the rapidity of evaporation. For this reason it had ceased to be a favorable locality for aquatic shells, and all of the specimens obtained were dead and burnt.

SPRING BROOKS (TABLE III)

Habitat 20. Spring Brooks. All through this region are numerous small spring brooks, which almost invariably flow from the hardwoods on to the sandy, outwash plains. These streams are usually only a foot or two wide, and have a soft bottom composed of decaying plant material, except in places where a swift current keeps the muck washed away and exposes the rocky or sandy substratum. None of the streams investigated showed signs of molluscan life, with the exception of one stream which crosses the road to Foster City, about two miles north of Hancock Creek.

This brook has a sandy and pebbly bottom near the culvert. Here *Planorbis parvus* and juvenile specimens of *Physa walkei* were found clinging to the pebbles.

Habitat 21. Fern Creek. This is a small, quite swift stream which flows from between the granite ridges into Pine Creek, in the Menominee Trough. The bottom is composed of gravel and stones, except in a few places where mucky-bottomed pools are formed; in most places the stream is covered over by fallen trees, etc.

Habitat 22. Hardwood Spring. Near the edge of a patch of hardwoods north of Norway a small, swampy spring forms the head of a small brook flowing into Pine Creek. The mucky bottom was carpeted with a thick layer of caddis-fly and annelid tubes, and the swampy banks were grown up with sedges and a few plants of the blue flag (*Iris versicolor*).

TABLE III. HABITATS OF SMALL STREAMS

	BROOKS			CREEKS					
	20	21	22	South 23	Pine 24	Hancock			28
						25	26	27	
UNIONIDAE:									
<i>Anodonta grandis footiana</i>	...	...	...	...	...	I	...	...	...
LARGER SPECIES:									
<i>Physa gyrina</i>	...	...	...	vCd	R	qA	I	vA	C
<i>Sphaerium</i> sp.?	...	...	...	...	R	...	...	...	...
<i>Sphaerium sulcatum</i>	...	...	...	...	...	qC	...	Im	...
<i>Sphaerium acuminatum</i>	...	...	...	...	...	C	...	...	...
<i>Sphaerium stamineum</i>	...	...	...	...	...	...	A	...	...
<i>Sphaerium solidulum</i>	...	...	...	...	...	...	C	...	...
<i>Campeloma decisum</i>	...	...	...	...	...	...	qC	...	...
<i>Planorbis antrosus striatus</i>	...	...	...	...	...	...	...	vC	C
<i>Succinea retusa</i>	...	...	...	...	...	...	...	qC	qC
<i>Physa sayii</i>	...	...	...	...	...	...	...	...	R
SMALLER SPECIES:									
<i>Physa walkeri</i>	I	A	A	...	...	...	...	...	...
<i>Planorbis parvus</i>	I	F	qC	...	...	...	...	qI	...
<i>Lymnaea obrussa peninsulae</i>	...	...	vA	...	...	...	R	vRm	vA
<i>Pisidium abditum</i>	...	...	vA	...	...	...	...	...	I
<i>Vitrea hammonis</i>	...	...	F	...	...	...	...	...	...
<i>Vitrea rhoadsi</i>	...	...	qI	...	...	...	...	...	...
<i>Musculium rosaceum</i>	...	...	...	...	...	...	C	...	...
<i>Pisidium pauperculum</i>	...	...	...	...	...	...	I	Im	...
<i>Pisidium</i> near <i>noveboracense</i>	...	...	...	...	...	...	I	...	...
<i>Musculium pusillum</i>	...	...	...	...	...	...	...	...	C

South Creek

Habitat 23. South Creek. This creek flows through the cedar and tamarack swamps in the valley of the West Branch and empties into that river opposite the mouth of McKinnon

Brook, a little over a mile above the junction with the East Branch. On the sixteenth of August numerous freshly-dead shells were found scattered along the very soft, muddy banks of this creek. All of these were specimens of *Physa gyrina* and had apparently been washed on the banks during a recent flood.

Pine Creek

Habitat 24. Pine Creek. This creek near Norway is about 25 feet wide and about two feet deep, and has quite a swift current and a sandy bottom. A few years before an attempt had been made to float logs down the stream, with the result that it was so choked with them that one could walk over its surface.

Hancock Creek

Habitat 25. Rocky and Stony Bottom. The Foster City road crosses Hancock Creek near the old Hancock mine, around which were considerable outcroppings of iron-bearing rocks. In this place the bottom of the creek is rocky, with sand gathered in the spaces between the rocks; the current is quite swift. *Physa gyrina* was found on the rocks and the other species were burrowed in the sand patches.

Habitat 26. Sandy and Mucky Bottom. Below the beaver pond Hancock Creek meanders through swampy, rich alluvial flats towards the Sturgeon River. The current is not very swift and in many places the sandy bottom is covered with a deposit of organic muck, composed of decaying twigs and leaves which in places reached a depth of a foot.

Habitat 27. Beaver Pond. About two miles above its mouth Hancock Creek has been dammed by the beavers to form a quite extensive pond, which attained a depth of eight feet. This dam had been built quite recently as the flooded tama-

racks, spruces and balsam firs had been killed, but were still standing. A large portion of the pond was covered with floating duckweeds and floating logs, overgrown with fresh-water sponge, even formed small sedge-covered islands. Smartweeds were the main plants growing in the pond itself.

In addition to the living specimens obtained from driftwood, etc., a large number of dead and chalky specimens were collected from the mud which the beavers had brought up from the bottom and built into their lodges. Besides the living species listed in Table III, the following forms were found only in this subfossil condition.

<i>Planorbis campanulatus</i>	Quite common
<i>Amnicola limosa</i>	Very abundant
<i>Valvata tricarinata</i> and var. <i>confusa</i>	Abundant
<i>Pisidium variabile</i> and var. <i>brevium</i>	Abundant
<i>Valvata sincera</i>	Very common
<i>Planorbis deflectus</i>	Very common
<i>Lymnaea obrussa decampi</i>	Very common
<i>Pisidium compressum</i>	Infrequent
<i>Valvata tricarinata unicarinata</i>	Rare
<i>Valvata tricarinata simplex</i>	Rare
<i>Pisidium affine</i>	Rare
<i>Pisidium medianum</i>	Rare

Habitat 28. Swampy Cut-off. Several hundred yards below the beaver pond Hancock Creek had formed a swampy cut-off, which was filled with water only when the creek was in flood. This ditch was about six feet wide and two deep, and was partially choked by logs from a collapsed corduroy road at the place studied. The soft bottom was composed of organic material and was very damp, although the ditch contained no standing water. Marchantia and some sedges were growing here along with a few plants of the blue flag (*Iris versicolor*), but most of the shells collected were from a large, bare patch about six feet from the creek proper. This is the type locality for *Musculium pusillum* Sterki.

RIVERS (TABLE IV)

Sturgeon River

Habitat 29. Rock Dam in the West Branch. About two miles above the two branches of the Sturgeon the West Branch flows across an outcropping ridge of much contorted, tilted and laminated schist. Above the small falls at the downstream edge of the outcrop, the water was about four feet deep in the center of the stream and the current very swift, but in shallow water along the shore the rocks were covered with a thin layer of organic material and sand.

Habitat 30. Falls of the Sturgeon. Some distance above Loretto the Sturgeon River flows through a gorge, as described in the general discussion. Here the current is very swift and there are several small falls. The shells were collected along the edge, where sand had been deposited in the quieter backwaters.

Habitat 31. Below the Lumbering Dam. About two miles below the forking of the Sturgeon a lumbering dam had been built for the purpose of maintaining a good head of water. Below this the water was shallow, with a swift current. Along the shore, in from 4 to 12 inches of water, the bottom was of sandy clay, and here most of the smaller shells were obtained.

TABLE IV. HABITATS OF THE RIVERS

	ROCKY RAPIDS				SANDY BOTTOM		
	29	30	34	35	31	32	33
UNIONIDAE:							
<i>Alasmidonta marginata</i>	C	....	....	....	....	....	R
<i>Lampsilis luteola</i>	R	....	R	....	....	A
<i>Elliptio gibbosus</i>	R	A	....	A
<i>Fusconaia rubiginosa</i>	qC	....	qC
<i>Lasmigona compressa</i>	I	....	R
<i>Strophitus edentulus</i>	R	....	R
<i>A. ferussacianus buchanaensis</i>	R	....	R
<i>Alasmidonta calceolus</i>	R	F
<i>Lasmigona costata</i>	vA
<i>Actinonaias ligamentina</i>	C
<i>Lampsilis ventricosa</i>	C
<i>Anodonta grandis footiana</i>	I
LARGER FORMS:							
<i>Physa integra</i> , var.	I	....	....	....	A	....	....
<i>Physa gyrina</i>	qC	....	....	....	....	....
<i>Sphaerium stamineum</i>	F	C	....	I	vA	....
<i>Campeloma decisum</i>	C	R	vC	C	....
<i>Physa ancillaria vinosa</i>	A	....	....	....	....
<i>Planorbis antrosus</i> , var.	C	....	A	....	....
<i>Physa ancillaria</i>	vA	....	....	....
<i>Sphaerium striatinum</i>	A	....	....
<i>Physa sayii</i>	vR	....	....
SECONDARY SPECIES:							
<i>Amnicola limosa</i>	vA	....	....	F	....
<i>Valvata tricarinata</i>	C	....	....	R	....
<i>Pisidium</i> sp.?	i	....	....	....	....
<i>Amnicola lustrica</i>	I	....	....	C	....
<i>Ferrissia parallela</i>	A	....	....	....
<i>Planorbis</i> sp.?	I	....	....	....
<i>Pisidium compressum</i>	qI	....

Habitat 32. Shallow Water in Sturgeon. The Sturgeon River near Brown Lake and above the level affected by the lumbering dam mentioned in the preceding habitat is about 50 feet wide and attained a maximum depth of about five feet. Throughout this portion the current is not very swift, and the water has a slight reddish tinge which probably came from the cedar swamps and also from the logs in the river

itself. Near shore, in about one foot of water, the bottom is usually composed of fine gravel intermixed with sand, although in places there are slight deposits of organic material, twigs, bark, etc. Practically no vegetation was present.

Habitat 33. Deeper Water in the East Branch. The uniones were the prevalent forms of the deeper waters of the Sturgeon River and were abundant throughout the vicinity of Brown Lake. However, a portion just below Brown Lake was most thoroughly studied, as here the shells were very numerous and collecting was facilitated, as the locality was near the camp and was used for bathing. Here the water contained little sediment, as it had just passed out of the lake, but had the characteristic reddish tinge already mentioned. The water was about five feet deep and bore little vegetation, except zones of *Valisneria spiralis* and *Myriophyllum spicatum* along the sides.

Menominee River

Habitat 34. Twin Falls. Just below the Upper Twin Falls of the Menominee a sandbar separates a small channel, about 30 feet wide and 8 feet deep, from the main river. The rocks forming the shore are coated with a finely-divided deposit containing considerable iron, and small pockets of sand occurred in the hollows. Most of the univalves were obtained from the rocks themselves, but the Sphaeriidae and *Campeloma decisum* were partially buried in the sand pockets.

Habitat 35. Sand Portage. The falls at Sand Portage are about six feet in height, and have a considerable extent of rapids above and below them. In the backwaters below the falls the current is almost imperceptible along the shore, and the outcrops of Quinnesec schist, which forms the bed and the shores of the river, are coated with a deposit of algal material considerably encrusted with iron.

ROCK OUTCROPS (TABLE V)

Habitat 36. Quinnesec Schist. Along the high banks of the river, in the preceding habitat, dead leaves and humus, thickly overgrown with bearberries (*Arctostaphylos uvaursi*), had collected in the crevices and hollows of the rocks. These places were further protected by scattered trees of white birch (*Betula alba papyrifera*), silver maple, poplars (*Populus tremuloides* and *grandidentata*), arbor vitae and hemlock. New Jersey tea (*Ceanothus americanus*), broken fern and sumac were also abundant along the edge of the outcrop, but were rarely found on the rocks themselves.

Habitat 37. Sturgeon Quartzite Cliffs. Along Fern Creek this rock forms quite a steep, white cliff. The dry soil in the crevices under and between the loose rocks on the steep slope provide rootage for a considerable abundance of dwarf honeysuckle (*Diervilla lonicera*), miterwort (*Mitella diphylla*), grass, and patches of wild strawberries (*Fragaria virginiana*); these, with a single large maple (*Acer saccharum*), scattered saplings of basswood and elm, and sumac and hazel, formed its only covering.

SANDY, OUTWASH PLAINS (TABLE V)

Habitat 38. Pine and Second Growth. In the valleys of the rivers and streams, except in those places which were covered with alluvial and peaty deposits, rather extensive outwash plains extended from the higher, clayey moraines. These had been covered with white and red pine (*Pinus strobus* and *resinosa*) and their accompanying floras, but were almost entirely deforested. Those portions which had not suffered during the fires of the preceding year were usually grown up with poplars (*Populus tremuloides*, *grandidentata* and less

commonly *balsamifera*), and with a few young pines; near the rivers often occurred considerable clumps of white birches, with a carpeting of New Jersey tea, blueberry (*Vaccinium pennsylvanicum*), bearberry, sweet fern (*Myrica asplenifolia*), dwarf dogwood (*Cornus canadensis*), pipsissewa (*Chimaphila umbellata*), wintergreen (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*) and the ground pines (*Lycopodium obscurum* and *complanatum*).

In the burnt portions practically everything had been killed. The humus itself had been burned down to the sands and the ashes washed into the river bottoms by the heavy rains. Mar-
chantia practically carpeted these regions; *Epilobium angus-
tifolium* (fireweed) and others had sprung up from seed and a few of the old inhabitants, such as the birch, some poplars and the dwarf honeysuckle, were coming up from the old roots. It will be a long time, nevertheless, before enough humus is formed to allow a reoccupation by the molluscs. These will of necessity come from the unburnt logs, the areas untouched by the fire, and also the adjacent hardwoods and swamps.

HARDWOODS (TABLE V)

Habitat 39. Young Hardwoods. Between the two granitic ridges north of Pine Creek a small hollow held a clump of young hardwoods composed of such trees as the sugar maples, elms, blue beeches and the basswood. The humus had been partially burnt away, but in places still supported a few leeks (*Allium tricoccum*), wind anemones (*Thalictrum*) and blood-roots (*Sanguinaria canadensis*).

Habitat 40. Hardwoods of Menominee Trough. Despite the frequent thinness of the clay soil, the granite ridges north of Pine Creek were covered by a heavy growth of virgin hardwoods. The trees are about the same as those described for

the next habitat (41), except that the yellow birches were almost entirely replaced by the beeches (*Fagus grandifolia*), and the hemlocks were considerably more abundant.

TABLE V. DISTRIBUTION OF LAND SHELLS

	HARDWOOD			Sand Rock Bogs				SWAMPS				FLATS		
	41	40	39	38	37	36	42	43	44	45	46	47	48	49
LARGER FORMS:														
<i>Pallifera dorsalis</i>	R	...	...	...	...	...	...	...	...	...	...	...	...	...
<i>Polygyra profunda</i>	I	...	...	I	...	...	...	...	...	...	...	...	...	...
<i>Polygyra fraterna</i>	F	...	...	qC	qC	...	...	...	...	...	...	...	...	...
<i>Polygyra albolabris</i>	qA	...	...	R	qC	qC	...	...	...	...	...	...	...	...
<i>P. albolabris maritima</i>	...	...	...	A	...	...	...	...	...	...	...	...	...	...
<i>Pyramidula alternata</i>	C	C	C	C	...	qC	...	R	...	...	C	...	...	...
<i>Agriolimax campestris</i>	...	...	...	R1*	...	...	...	...	A	...	A	A	C	F
<i>Succinea avara</i>	...	...	...	...	...	...	...	...	I	...	...	...	C	...
<i>Succinea retusa</i>	...	...	...	...	...	...	...	...	A	...	...	...	...	F
<i>Physa gyrina</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	F
SMALLER SPECIES:														
<i>Zonitoides milium</i>	vR	...	...	...	...	...	...	...	...	...	...	...	...	...
<i>Vertigo tridentata</i>	vR	...	...	...	...	...	...	...	...	...	...	...	...	...
<i>Gastrocopta corticaria</i>	R	...	...	...	...	...	...	...	...	...	...	...	...	...
<i>Vitrea rhoadsi</i>	I	...	...	...	I	...	...	...	...	...	...	...	...	...
<i>P. cronk. catskillensis</i>	C	A	C	Cl*	I	...	...	...	...	...	...	...	...	...
<i>Vertigo gouldii</i>	vR	...	...	...	...	...	A	...	...	...	...	...	...	...
<i>Eu. chers. polygyratus</i>	qI	...	I	?	...	...	...	F	...	...	...	...	...	...
<i>Strobilops virgo</i>	A	A	A	Cl	qC	qC	A	C	C	I	A	I	I	...
<i>Zonitoides arborea</i>	vA	vA	vA	Cl	qC	...	...	...	I	...	F	...	R	...
<i>Helicodiscus parallelus</i>	I	...	...	II	...	I	I	I	...	...	C	C	vC	...
<i>Gastrocopta contracta</i>	C	I	vC	...	...	I	...	...	...	...	...	...	I	...
<i>Euconulus fulvus</i>	R	C	...	...	...	I	...	...	?	...	I	C	R	...
<i>Vitrea indentata</i>	...	...	R	...	C	...	...	...	...	...	...	I	vI	...
<i>Cary. exile canadensis</i>	qC	C	...	...	...	...	R	...	C	A	...	A	vC	...
<i>Vitrea hammonis</i>	vR	F	...	...	...	...	...	...	...	vC	C	qA	C	...
<i>Vitrea ferrea</i>	...	...	...	...	...	...	...	R	R	...	...	...	...	...
<i>Gastrocopta tappaniana</i>	...	...	...	...	...	...	...	...	...	A	...	...	...	...
<i>Vitrea binneyana</i>	...	...	...	...	...	...	...	...	...	...	C	...	...	...
<i>Vert. ventricosa elatior</i>	...	...	...	...	...	...	...	...	?	...	...	...	F	...
<i>Carychium exiguum</i>	...	...	...	...	...	...	...	...	C	...	...	...	R	R
<i>Pisidium abditum</i>	...	...	...	...	...	...	...	...	...	...	...	...	Rd	...
<i>L. obrussa peninsulae</i>	...	...	...	...	...	...	...	...	...	...	...	...	Rd	...
<i>Cochlicopa lubrica</i>	...	...	...	...	...	...	...	...	...	...	...	...	C	...
<i>Zonitoides exigua</i>	...	...	...	...	...	...	...	...	...	...	...	...	R	...

* 1 = locally.

Habitat 41. Hardwoods of Calumet Trough. The higher moraines throughout the Calumet Trough have a more clayey soil than the outwash plains and form conspicuous hardwood ridges. The fires had not affected this habitat as much as they had Habitat 38, although ground fires had killed the underbrush and burned through the upper humus over considerable areas, especially at the edges. Except for this, the woods are practically in their primitive condition and form magnificent and extensive forests. They consist of sugar maples (*Acer saccharum*), yellow birches (*Betula lutea*), basswoods (*Tilia americana*), hemlocks (*Tsuga canadensis*), balsam firs (*Abies balsamea*), blue beeches (*Carpinus caroliniana*), ironwoods (*Ostrya virginiana*) and elms (*Ulmus americanus*), which were abundant in the order named. The hemlocks and balsam firs were most commonly near the edges of the woods, where some arbor vitae (*Thuja occidentalis*) strayed in from adjacent damper habitats. The underbrush consisted mainly of small maples and the whole forest was carpeted with a thick layer of leaves and humus in the unburnt places. In the burnt places the larger logs were usually but little affected and still contained large numbers of living shells.

Most of the snails were obtained from just under the outer bark among the decaying inner bark and the effluvia of beetle larvae, myriapods, etc. The greatest number were found in quite soft and punky logs, whose bark was easily peeled away. Maple logs contained most of them; the hemlocks, especially, have a dry and white or slimy mould growing under the bark, which appeared to be coincident with conditions unfavorable to molluscan life.

Of the larger species, *Pallifera dorsalis* was only obtained from one locality, an especially rich portion of the unburnt

hardwoods along the road to Foster City. Of the smaller forms, *Zonitoides arborea* was as abundant as all of the rest put together; *Strobilops virgo* made up about half of the remainder; and *Gastrocopta contracta* and *Pyramidula cronkhitei catskillensis* together formed the major portion of the remaining fourth, except in one locality where the last two and *Euconulus chersinus polygratus* were about equally numerous.

LACUSTRINE PEAT-BOG (TABLE V)

Habitat 42. Cedar-tamarack Bog. Northeast of Brown Lake a depression in the outwash plain contained a small bog which was grown up with arbor vitae, spruce (*Picea canadensis*), tamarack (*Larix laricina*), with here and there a few balsam firs. A thick undergrowth, especially around the edges, consisted of young trees mixed with tag-alders (*Alnus incana*), willows and dogwoods. The entire bog was carpeted with sphagnum and dwarf cranberry (*Vaccinium oxycoccus*) and considerable growth of Labrador tea (*Ledum groenlandicum*) was present. The shells were found under the bark of quite freshly cut cedar stumps.

STREAM ALLUVIAL (TABLE V)

Swamps

Habitat 43. Arbor Vitae Swamp near Sand Portage. A number of shells were collected in a swampy thicket around the mouth of a small creek near Sand Portage. This thicket consisted mainly of arbor vitae, tag-alders, white birches, balsam firs, poplars and ashes. The shells were found among the leaves and the humus.

Habitat 44. Ash-cedar Swamp. This is the same swamp described in Habitat 15. The land shells were collected in the humus around the bases of the trees.

Habitat 45. Alder Swamp. Along the edge of the swamp bordering the East Branch a thicket was formed of such shrubs as the tag-alder, dogwoods and a few small trees of the white maple (*Acer saccharinum*) and ash. The swamp apparently contained water after heavy rains, although merely damp at the time studied. Such plants as the marsh fern (*Aspidium thelypteris*), meadow rue (*Thalictrum revolution*) and blue flag formed a scanty undergrowth along the edge of and in the thicket.

Habitat 46. Clearing near Foster City. A number of shells were collected in and around old stumps and logs in what appeared to be a cleared and drained tamarack-cedar swamp, near the bank of the East Branch just below Foster City. This was one of the drier alluvial habitats.

STREAM FLATS

Habitat 47. Hancock Creek Flats. The flood plains of this creek, about two feet above the July level of the water, presented two facies: grassy swales and wooded flats. The prominent plants of the former were grasses and sedges, mixed with sensitive ferns (*Onoclea sensibilis*), meadow-rue, swamp milkweed (*Asclepias incarnata*) and Joe-pye weed (*Eupatorium* sp.). The wooded flats were carpeted with leaves and shaded by tag-alders, red dogwoods (*Cornus stolonifera*) and white maples. However, there appeared to be a uniform molluscan fauna throughout the whole.

Habitat 48. Menominee River Flats. In a damp hollow on the flats of the Menominee River numerous shells were collected from thickets under the leaves and sticks. This brush consisted mainly of tag-alders, dogwoods, hazels (*Corylus americana*) and small ashes. The maiden-hair fern (*Adiantum pedatum*) and the poison ivy (*Rhus toxicodendron*, north-

ern bush form) were the most common plants of the undergrowth.

Habitat 49. Sturgeon River Flats. In places along the Sturgeon and its branches are low flats, which were flooded even in slight overflows. These were usually shaded by tag-alders, ashes, red and white maples, arbor vitae and elms, and had a sparse undergrowth of the sensitive weed, Joe-pye weed, etc., with scattered but rank clumps of nettles. These flats appeared to be rather unfavorable to land molluscs, probably on account of the intermittent floods which covered everything with a layer of fine silt. *Lymnaea obrussa peninsulæ* was represented by many living specimens crawling in the newly-drained mud.

LIST OF SPECIES

VIVIPARIDÆ

Campeloma decisum (Say). Habitats: 5, 7m, 8, 10, 11, 26, 31, 32, 34, 35. A specimen from the first locality measured: alt. 30.6 mm.; g. diam. 19.3 mm. Most abundant in river invasions of Brown Lake, next in larger streams.

VALVATIDÆ

Valvata tricarinata (Say). Habitats: 4, 5, 6, 7, 8, 10, 27m, 32, 34. Most abundant on sandy marl bottoms of lake shores.

Valvata tricarinata confusa Walker. Habitats: 7m, 27m.

Valvata tricarinata unicarinata DeKay. 27m.

Valvata tricarinata simplex Gould. 27m.

Valvata sincera Say. Habitats: 4, 5, 6m, 7m, 27m. Ditto preceding species.

Valvata sincera, approaching var. *nylanderi* Dall. A few specimens approaching this form found buried in the soft bottom of an ash-cedar swamp (15).

AMNICOLIDÆ

Amnicola limosa (Say). Habitats: 1, 2, 4, 5, 6, 7, 8, 10m, 32, 34. Very abundant on aquatic vegetation and on rocks, in lakes and large streams.

Amnicola limosa porata (Say). Habitats: 4, 8. Some of the shells approximated this form.

Amnicola lustrica Pilsbry. Habitats: 1, 4, 5, 6, 7, 8, 10m, 32, 34. Found with the preceding species.

Amnicola walkeri Pilsbry. Habitats: 5, 8.

AURICULIDÆ

Carychium exile canadense Clapp. Habitats: 40, 41, 42, 44, 45, 47, 48. Most abundant on stream flats and in swamps.

Carychium exiguum (Say). Habitats: 44, 47, 48. Along streams; much less numerous than preceding.

PHYSIDÆ

Physa gyrina Say. Habitats: 1, 3, 5, 9, 11, 12, 13, 14, 15, 18, 23, 24, 25, 26, 27, 28, 30. The most abundant and widely distributed species of this genus. Most abundant in beaver pond (27); very characteristic of creeks. A peculiarly light-colored and transparent form from the beaver pond and the sedge swamp (12).

Physa integra Haldeman. Habitats: 2, 3, 4, 5, 7m, Brown Lake. Shells fragile, light horn-colored, with very little color along the inside of the callus. One from the water lily patches (2) measured: alt. 12.4 mm.; g. diam. 8.1 mm.; alt. apert. 10.1 mm.

Physa integra var. Habitats: 11, 29, 31, Hanbury Lake and Sturgeon River. Shells heavy and with varicose lines distinctly marked; almost pure white, but usually covered with a coating of foreign material, tinged with light salmon-yellow inside of callus. An abnormally large example measured: alt.

15.9 mm.; g. diam. 10.1 mm.; alt. apert. 11.9 mm.; the next largest: alt. 11.6 mm.; g. diam. 7.9 mm.; alt. apert. 9.7 mm.

Physa sayii Tappan. Habitats: 28, 31. Two specimens only, from Sturgeon River.

Physa ancillaria Say. Very abundant at Sand Portage (35) in the Menominee River. Shells rather fragile; light and dark horn-colored, with callus sometimes tinged with orange. Measurements: alt. 15.5 mm.; g. diam. 10 mm.; alt. apert. 12.6 mm.; and alt. 13.2 mm.; g. diam. 8.7 mm.; alt. apert. 11.4 mm.

Physa ancillaria vinosa Gould. Abundant just below Upper Twin Falls, Menominee River (34). Shells heavy; dark horn-colored to reddish, with purplish line inside of callus. An example: alt. 15.8 mm.; g. diam. 11.7 mm.; aper. alt. 14.8 mm.

Physa heterostropha Say. Habitat 18; a single, juvenile specimen.

Physa walkeri Crandall. Habitats: 20, 21, 22. Quite typical of the brooks. The largest example, from the last habitat: alt. 11.4 mm.; g. diam. 6.2 mm.; alt. apert. 7.9 mm.

Aplexa hypnorum (Linn.). Habitats: 18, 19. Rather local; only from temporary swamps. Specimens rather small; the largest: alt. 12.2 mm.; g. diam. 5.1 mm.

PLANORBIDÆ

Planorbis trivolvis Say. Habitats: 10m, 11, 12, 17. Mainly in small lakes and permanent pools. Specimen from Hanbury Lake: g. diam. 26.2 mm.; l. diam. 22.4 mm.; alt. apert. 12.7 mm.; alt. opposite apert. 10.4 mm.; alt. inside apert. 9.5 mm. The subfossil specimen from Jackson Lake: g. diam. 27.5 mm.

Planorbis antrosus Conrad. Habitats: 11, 31, 34. Hanbury Lake specimen approaches typical form, being quite light in texture and having distinct, but not extremely prominent, growth lines (No. 1). Those from the rocky habitats of the

rivers were heavy shells with distinct growth lines, and were variable in shape and texture, although some approximated typical shells (No. 4 and No. 8). Those from the Upper Twin Falls of the Menominee (No. 2 and No. 3) were large, but quite light, and were not so deeply marked by the growth lines as were the heavier shells from the Sturgeon (Nos. 4-8). The shells from both of these habitats were apt to have the carinae much more distinct than in typical shells, and the lower portion of the apertures were produced and sharply angulated, somewhat after the manner of *P. antrosus portagensis* (Baker). Some even had the aperture elongated, both above and below, so as to more closely resemble that form in general shape. Table VI shows the measurements of some of these shells. These variations were perhaps caused by the direct effect of the physical environment: swift current, an abundance of food and lime, and the shape of the rocks to which they clung.

TABLE VI. MEASUREMENTS OF *P. antrosus*

		g. diam.	l. diam.	alt. apert.	alt. op. apert.	alt. at in- side apert.
Hanbury Lake	1	11.7	8.6	5.8	4.7	3.8 mm.
Upper Twin Falls	2	13.4	9.9	7.4	5.8	4.9 mm.
	3	12.7	9.5	6.8	6.2	4.4 mm.
Sturgeon River	4	14.9	11.3	7.9	6.1	4.9 mm.
	5	12.1	8.4	6.7	6.2	4.5 mm.
	6	13.4	8.7	7.2	6.0	4.0 mm.
	7	15.1	11.3	8.4	6.9	5.4 mm.
	8	15.6	11.8	7.6	6.4	4.6 mm.

Planorbis antrosus striatus Baker. Habitats: 4, 5, 7m, 9, 10m, 11, 14, 27, 28. Preëminently the variety from the sluggish water habitats where the bottom was sandy or mucky. Shells light-colored and fragile; beautifully striated. Beaver pond specimen: g. diam. 14 mm.; l. diam. 11.2 mm.; alt. apert. 7.3 mm.; alt. opposite apert. 5.8 mm.; alt. at inside of apert. 4.2 mm.

Planorbis campanulatus Say. Habitat: 11. One measured: g. diam. 12.6 mm.; lesser diam. 9.8 mm.; alt. apert. 5.2 mm.; alt. opposite apert. 5.4 mm. This specimen was distinctly mal-leated; all of the specimens from this habitat were dead, perhaps killed by sewage.

Planorbis campanulatus minor Dunker. Habitats: 5, 7, Brown Lake. A typical example measured: g. diam. 8.8 mm.; l. diam. 6.6 mm.; alt. apert. 4.1 mm.; alt. opposite apert. 3.8 mm.

Planorbis campanulatus rudentis Dall. Habitats: 4, 5, 7, 8, 10m, 27m. Most of the shells from Brown Lake approached this form. Distinguished by the peculiar shape of the aperture, which faced more directly forward and was indented along the outer portion of the lower side, and by the closely wrapped coils, which had a tendency to be elevated near the center of the shell. An example: g. diam. 13.5 mm.; l. diam. 10.6 mm.; alt. apert. 6.4 mm.; alt. opposite apert. 6.4 mm.

Planorbis exacuus Say. Habitats: 3, 5, 7m, 18. Most abundant in pools and swampy shore of lake. A specimen from temporary swamp (18): g. diam. 7 mm.; l. diam. 5.9 mm.; alt. apert. 1.9 mm.

Planorbis parvus Say. Habitats: 2, 6m, 7m, 8, 13, 18, 19, 27, 20, 21, 22. Widely distributed.

Planorbis deflectus Say. Habitats: 4, 5, 6m, 7, 8, 27m. Mainly in Brown Lake.

Planorbis umbilicatellus Cockerell. Habitats: 2, 4, 5, 8, 12. Less numerous than preceding species.

Planorbula armigera (Say). Habitats: 15, 17. In small pools.

LYMNÆDÆ

Lymnæa stagnalis appressa Say. Habitats: 5, 6, 11, 12. Lakes and large pool; example: alt. 48 mm.; g. diam. 22.8 mm.

Lymnæa megasoma Say. A single dead specimen found on

the river flats, a short distance below Brown Lake. Probably came from the deep waters of the lake (1), as that was apparently the nearest locality in which it could live. Measured: alt. 43.8 mm.; g. diam. 25.4 mm.

Lymnæa kirtlandiana Lea. Habitats: 12, 17. This and the following form appear to replace *Lymnæa palustris* as the typical *Lymnæa* of the temporary swamps of this region. The majority of the specimens of this form were collected from the sedges, on which they were aestivating, often two or three feet above the stagnant water which was still in the pools, in such large numbers that they were most easily collected with an ordinary beating cloth such as used by insect collectors. They were fastened to these sedges by dried mucus, so that the aperture was entirely closed.

These shells were striped with light yellow along the growth lines, as is so often the case with *Lymnæa palustris* var. *zebra* Taylor. All of the striped specimens of either species taken by me have been from these temporary swamps. It seems probable that the stripes are simply the effect of desiccation during aestivating periods.

Shells light straw-color, darker toward tip; first whorl dark indigo. Striated spirally so as to give the shell a satin-like finish, although not so delicate as in the variety. Aperture with a heavy, purplish-white callus, bordered on the inside by a broad, chocolate-colored band. Measurements follow:

TABLE VII. *Lymnæa kirtlandiana*

		alt.	g. diam.	alt. apert.
Sedge Swamp (12)	1	24.1	8.2	11.7 mm.
Beaver Meadow (17)	2	22.4	7.8	10.3 mm.
	3	16.6	6.4	8.6 mm.
	4	10.7	4.4	5.7 mm.
	5	25.8	7.5	11.2 mm.
Brook Flats (18)	6	16.8	6.0	8.6 mm.
	7	12.5	4.6	6.5 mm.

Lymnæa kirtlandiana Lea var. Habitat 18. Shells more elongated and attenuated than preceding (Table VII), with even less convex whorls. Aperture narrower and outside edge approached body whorl at a more acute angle. Finely striated, satin-like in luster; mostly distinctly and regularly but not strongly malleated. Color light-straw, darker toward apex; first whorl dark wine-color; callus white with a slight tinge of reddish purple and a chestnut stripe along inner side.

Measurements shown above (Table VII, Nos. 5-7). The largest shell and another of similar size were slightly scaliform.

Lymnæa obrussa peninsulae Walker. Habitats: 3, 13, 14, 16, 19, 22, 26, 27m, 28, 47, 49. In swampy places.

Lymnæa obrussa decampi (Streng). Habitats: 6m, 7m, 27m. Not found living.

Lymnæa humilis Say? Habitat 3. Four juvenile specimens.

Lymnæa humilis modicella Say. Habitats: 8, 11. Only found in lakes.

ANCYLIDÆ

Ferrissia parallela (Haldeman). Habitats: 2, 5, 8, 35. On logs and vegetation in lakes; rocks in rivers. Most of the specimens were rounded rectangular, but those from Sand Portage (35) were flattened and more nearly oval, perhaps on account of the swift current.

PUPILLIDÆ

Vertigo gouldii (Binney). Habitats: 41, 42. Quite common in the bog (42).

Vertigo ventricosa elatior Sterki. Habitat 47, creek flats.

Vertigo tridentata Wolf. Habitat 41; a single specimen.

Vertigo sp.? Habitat 44; too young to be identified.

Bifidaria contracta (Say). Habitats: 36, 39, 40, 41, 48. One of the more common shells of the hardwoods.

Gastrocopta corticaria (Say). Habitat 41; hardwoods.

Gastrocopta tappaniana (C. B. Adams). Habitat 45; alder swamp.

Strobulops virgo (Pilsbry). Habitats: 36, 37; 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48. The most widely distributed and one of the most common of the smaller land shells. Abundant in the hardwoods and the drier habitats.

COCHLICOPIDÆ

Cochlicopa lubrica (Müller). Habitat 48; Menominee River Flats.

SUCCINEIDÆ

Succinea awara Say. Habitats: 44, 48. Damp places.

Succinea retusa Lea. Habitats: 3, 14, 17, 27, 28, 44, 49. Abundant in wet places.

ENDODONTIDÆ

Helicodiscus parallelus (Say). Habitats: 36, 38, 41, 42, 43, 46, 47, 48. The most abundant species on the Menominee River Flats (48); common in moist places.

Pyramidula alternata (Say). Habitats: 36, 38, 39, 40, 41, 43, 46. Widely distributed. All shells obtained were small; the largest: g. diam. 16.4 mm.; alt. 10.4 mm.

Pyramidula cronkhitei catskillensis Pilsbry. Habitats: 27, 38, 39, 40, 41. In the drier habitats; most common in the hardwoods.

PHILOMYCIDÆ

Pallifera dorsalis (Binney). Habitat 41. Only found in a particularly rich piece of hardwoods along the road to Foster City.

LIMACIDÆ

Agriolimax campestris (Say). Habitats: 16, 38, 44, 46, 47, 48, 49. Prefers damper places; not found in hardwoods,

although several unburned regions were studied. Appears to be especially affected by fire, as it was never found in charred logs, under whose bark small molluscs often escaped extermination.

ZONITIDÆ

Zonitoides arborea (Say). Habitats: 27, 37, 38, 39, 40, 41, 45, 47, 48. By far the most abundant mollusc in the hardwoods and other upland habitats.

Zonitoides exigua (Stimpson). Habitat 48. Two specimens.

Zonitoides milium (Morse). Habitat 41. A single specimen.

Euconulus chersinus polygyratus (Pilsbry). Habitats: 39, 41, 43. Not as widely distributed as *E. fulvus*, but numerous locally in hardwoods.

Euconulus fulvus (Müller). Habitats: 36, 40, 41, 46, 47, 48.

Euconulus sp.? Habitats: 38, 44; juvenile.

Vitrea hammonis (Ström). Habitats: 22, 40, 41, 45, 46, 47, 48. Most abundant in wet places.

Vitrea indentata (Say). Habitats: 37, 39, 48.

Vitrea rhoadsi Pilsbry. Habitats: 22, 37, 41.

Vitrea binneyana (Morse). Habitat 46. Cleared swamp.

Vitrea ferrea (Morse). Habitat 43; swamp.

HELICIDÆ

Polygyra albolabris (Say). Habitats: 36, 37, 38, 41. In the drier habitats. Small, light and fragile; largest: alt. 17.5 mm.; g. diam. 26.9 mm.

Polygyra albolabris maritima (Pilsbry). Habitat 38. Abundant throughout sandy, outwash plains, but mainly dead shells found, as this region was most affected by the fires. A representative example: alt. 13.5 mm.; g. diam. 21.1 mm.

Polygyra fraterna (Say). Habitats: 37, 38, 41. In the drier habitats. An example: alt. 6.8 mm.; g. diam. 11.5 mm.

Polygyra profunda (Say). Habitats: 38, 41. Shells from hardwoods (41) of greater diameter and more flattened than those of sandy, outwash plains (38), where they were more elevated and were more diffusely colored so that in some specimens the stripes were practically obscured.

Shell from hardwoods: alt. 13.4 mm.; g. diam. 26.5 mm.

Shell from sand plains: alt. 14.2 mm.; g. diam. 24.5 mm.

SPHÆRIIDÆ

Sphærium solidulum (Prime). Habitat 26. Hancock Creek, sandy and mucky bottom. Specimen, "near the typical form,"³ measured: l. 10.7 mm.; alt. 8.9 mm.; width 6.6 mm.

Sphærium solidulum, var. Habitat 11. A somewhat different form from outlet to Hanbury Lake. "Somewhat like *solidulum*, but may be distinct"; more rhomboid, with more delicate sulcations than typical form; umbonal regions copper-colored and edge of shell dark brown. An example: l. 12.2 mm.; alt. 10.1 mm.; w. 8.1 mm.

Sphærium stamineum (Conrad). Habitats: 5, 6m, 7, 26, 31, 32. Especially abundant in sandy bottoms of large streams. Adults collected throughout the summer with juvenile shells ready for extrusion; latter are very light in color with heavy, concentric undulations. Juvenile: l. 3.9 mm.; alt. 3.2 mm.; w. 2.3 mm.; adult: l. 11.8 mm.; alt. 10.3 mm.; w. 7.4 mm. Several specimens were found that had the hinges reversed.

Sphærium stamineum, var. Habitats: 30, 34. Specimens from rocky, river habitats not typical, "being somewhat like *solidulum*." An example: l. 8.5 mm.; alt. 6.4 mm.; w. 5.4 mm. "Rather like *S. striatinum*, but apparently somewhat deformed."

Sphærium acuminatum (Prime)? Habitat 25. "Not full

³ Portions in quotation marks, throughout Sphæriidæ, are the identification notes of Dr. Sterki.

grown, possibly *S. acuminatum* Pr., but heavy for that species."

Sphaerium sulcatum (Lam.). Habitats: 4, 5, 7m, 9, 10, 27m. Notably a quiet water species, mainly in mucky or marly bottoms. Often large and globose: l. 18.1 mm.; alt. 13.9 mm.; w. 10.6 mm.

Sphaerium occidentale Prime. Habitat 18. As in Huron County,⁴ this species was quite abundant in the temporary swamps. Quite typical: l. 6.7 mm.; alt. 5.6 mm.; w. 4.2 mm.

Sphaerium rhomboideum (Say). Habitat 9; Tamarack Lake and outlet. Fragile: l. 13.2 mm.; alt. 10.2 mm.; w. 7.9 mm.

Sphaerium sp.? Habitat 24. A single broken valve.

Musculium truncatum (Linsley). Habitats: 13, 15; perennial pools. A specimen: l. 8.1 mm.; alt. 7 mm.; w. 4.4 mm.

Musculium secure (Prime). Habitats: 7m, 17. Quite abundant in a temporary pond. Mostly small and immature.

Musculium rosaceum (Prime). Habitats: 5, 7m, 26. Common in Hancock Creek; an example: l. 6.5 mm.; alt. 5.7 mm.; w. 3.9 mm.

Musculium pusillum Sterki. Habitat 28. Found with *Pisidium abditum* in considerable numbers in a mucky-bottomed cut-off of Hancock Creek. Types of species.⁵

Pisidium abditum Haldeman. Habitats: 22, 26, 28, 47. Not typical; those from hardwood spring (22) heavy and globose, with swollen but less projecting beaks, while those from Hancock Creek (26, 28) were heavy but not so globose and with even less prominent beaks. A specimen from the spring: l. 4.4 mm.; alt. 3.7 mm.; w. 2.8 mm.

Pisidium affine Sterki. Habitats: 6m, 7, 9, 27m.

⁴ H. Burrington Baker, 1911, A Biol. Surv. of the Sand Dune Region on the South Shore of Saginaw Bay, Mich. Mollusca. *Mich. Geol. Biol. Surv.*, Publ. 4, Biol. Series 2, pp. 121-176.

⁵ V. Sterki, 1911. *Nautilus*, XXIV, p. 3.

Pisidium compressum Prime. Habitats: 4, 5, 6m, 7, 8, 10m, 27m, 32, 33. Lakes and large streams.

Pisidium compressum laevigatum Sterki. Habitat 7m.

Pisidium medianum Sterki. Habitats: 6m, 7m, 27m. A "small form" of the species: l. 2.6 mm.; alt. 2.2 mm.; w. 1.8 mm.

Pisidium noveboracense Prime. Habitat 26. "Evidently a variety or possibly distinct." Epidermis light straw-color; shells more elongate and with less prominent beaks than usual. A large example: l. 4.1 mm.; alt. 3.3 mm.; w. 2.7 mm.

Pisidium pauperculum Sterki. Habitats: 11m, 26, 27m. Living example: l. 2.2 mm.; alt. 2.1 mm.; w. 1.5 mm.

Pisidium pauperculum crystalense Sterki. Habitats: 5, 8m.

Pisidium pauperculum nylanderi Sterki. Habitat 5. "Approaching variety *nylanderi* (Northern Maine)"; l. 2.4 mm.; alt. 2.5 mm.; w. 1.9 mm.

Pisidium peraltum Sterki, var. Habitat 7m. "Small and of a shape somewhat different from the typical; evidently a variety."

Pisidium punctatum simplex Sterki. Habitat 8.

Pisidium roperi Sterki. Habitats: 17, 18, 19; temporary swamps. Those from first locality "slightly different, but probably not distinct." A large example: l. 4.1 mm.; alt. 3.5 mm.; w. 2.4 mm.

Pisidium roperi, var. Habitat 16. "A small form, with narrower beaks, which may represent a variety," from sphagnum bog. Largest example: l. 3.9 mm.; alt. 3 mm.; breadth, 2.2 mm.

Pisidium sargenti Sterki. Habitat 7. "Not characteristic."

Pisidium splendidulum Sterki. Habitat 7m. "Small form."

Pisidium tenuissimum Sterki. "Small." Habitat 7.

Pisidium variabile Prime. Habitats: 4, 5, 6, 7, 8, 10m, 27m.

Pisidium variabile brevius Sterki. Habitats: 7, 27m.

Pisidium vesiculare Sterki. Habitat 7m.

Pisidium sp.? Habitat 34; unidentified.

UNIONIDAE

Fusconaia rubiginosa (Lea). Habitats: 31, 33. River species; majority with beaks slightly eroded, but remainder of epidermis with satin-like luster. One specimen with salmon-pink nacre; July 1, gravid specimens with bright crimson embryos. Largest shell: l. 82.5 mm.; alt. 57 mm.; w. 38.2 mm.; smallest: l. 62.5 mm.; alt. 46.3 mm.; w. 30.9 mm.

Amblema undulata (Barnes). A single dead specimen was brought in from a small stream connecting Hamilton and Louis lakes, about two miles southeast of Waucedah: l. 114.5 mm.; alt. 84.1 mm.; w. 41.2 mm.

Elliptio gibbosus (Barnes). Habitats: 31, 33, 35. River species. Specimens larger than in similar streams in southern peninsula; largest: l. 122.7 mm.; alt. 58.7 mm.; w. 36.6 mm. July 1, some specimens with gills padded with yellowish embryos.

Alasmidonta marginata Say. Habitats: 29, 33. Specimens from sandy places with beaks little eroded; those from rock dam with beaks much eroded, and with a tendency to be deformed, probably on account of having been often broken against the rocks. One of the former: l. 81.3 mm.; alt. 44.3 mm.; w. 33.2 mm.

Alasmidonta calceolus (Lea). Habitats: 10, 32, 33. Largest specimen: l. 49.1 mm.; alt. 29.9 mm.; w. 19.8 mm.; beaks considerably eroded.

Strophitus edentulus (Say). Habitats: 31, 33. Two specimens: beautiful and well developed; dark olive-green in color broken into stripes with an orange-yellow background near

the umbones; umbones golden yellow. An example: l. 108.9 mm.; alt. 61 mm.; w. 42.8 mm.

Lasmigona compressa (Lea). Habitats: 10, 31, 33. Shells in soft and mucky bottom of Jackson Lake remained near surface, although younger specimens acted as did other species and buried themselves several inches below the surface, leaving a funnel-shaped hole to obtain water. Specimens beautifully rayed with olive-green on a background of dull gold; adults darker and with wing proportionately less evident than in younger specimens. Largest: l. 101.9 mm.; alt. 53.4 mm.; w. 28.6 mm.

Lasmigona costata (Raf.). Habitats: 8, 33. The most abundant unione, wherever found. Edge of the mantle often contained very irregularly shaped pearls about size of number 4 shot; known locally as the pearly clam. Largest: l. 172 mm.; alt. 96.1 mm.; w. 59.2 mm.; average: l. 150.3 mm.; alt. 82.4 mm.; w. 43.3 mm.

Anodontooides ferussacianus buchanensis (Lea). Habitats: 10, 31, 33. Specimens from the last two localities small and deformed; those from Jackson Lake quite large and heavy, beautifully rayed with light green. The largest: l. 79.3 mm.; alt. 40.8 mm.; w. 29.1 mm.

Anodonta grandis footiana Lea. Habitats: 8, 25, 33. Streams and river invasions. Shells from Hancock Creek (25) light-colored and dwarfed; one measured: l. 49.3 mm.; alt. 25.2 mm.; w. 14.5 mm. Those from the other two localities larger and darker colored; example: l. 83.2 mm.; alt. 42.4 mm.; w. 28.1 mm. Beaks more or less eroded.

Anodonta marginata Say. Habitats: 1, 5, 10. Lake species. Those from Jackson Lake (10) large and lanceolate; an example: l. 120.5 mm.; alt. 60.3 mm.; w. 41.9 mm.

Actinonaias ligamentina (Lam.). Habitat 33. Large: l. 198.7 mm.; alt. 159.6 mm.; w. 62.3 mm.

Lampsilis luteola (Lam.). Habitats: 8, 30, 33, 35. Largest male: l. 113 mm.; alt. 63.5 mm.; w. 48.6 mm.; largest female: l. 88.3 mm.; alt. 57.8 mm.; w. 41 mm.

Lampsilis ventricosa (Barnes). Habitats: 8; 33.

KEY TO MAP

MAP I. SKETCH MAP OF BROWN LAKE AND VICINITY

(As no accurate maps of this region were available, and time could not be taken to make a more precise survey, this map was sketched by the writer to show the approximate shape of the lake and the relations of the various habitats.)

Hardwoods shown by scalloped border.

Pines regions (unburned) by asterisks.

Marsh by conventional symbols.

Extensive rock outcrops (at Rock Dam) by shading.

Numbers refer to those of habitats.

C—Camp; headquarters.

4-8—Brown Lake.

9—Tamarack Lake.

10—Jackson Lake.

12—Sedge Swamp.

15—Former Channel, East
Branch.

18—McKinnon Brook.

23—South Creek.

26, 28—Hancock Creek.

27—Beaver Pond.

29—Rock Dam, West Branch.

32—Sturgeon River.

33—East Branch, below Lake.

45—East Branch, above Lake.

BROWN LAKE AND VICINITY

SCALE: 1/2 M.



