fish food supply in this lake. The general conclusion to be drawn from this qualitative investigation is that Lake Nipigon is a body of water relatively poor in plankton, with the exception of the diatomaceous flora. The number of species occurring in the lake itself was not large, and with a few exceptions the number of individuals of a species was not large. This was particularly true of the open-water plankton. Such important forms as the species of *Daphnia* were uncommon, and apparently *Holopedium* was absent. *Leptodora kindtii* was the only cladoceran which was common in the open water. The *Copepoda* were much better represented in point of numbers, especially in the cases of *Diaptomus* and *Limnocalanus*. In the shallow protected bays, where occurred considerable growths of the higher aquatic vegetation, there was a much better representation of species and larger numbers of individuals. This was especially true of the *Rotatoria* and the *Cladocera*. From the standpoint of food-supply for the young of many species of fish, this is important.

The diatoms were vastly more numerous than all the other organisms combined. They are not directly of much value as fish food, and if of importance as food for the animal planktonts should have supported a much larger population than was found to occur. They may, however, be of considerable importance as food for the macroscopic bottom population, especially *Pontoporeia hoyi*, the larvae of the *Chironomidae* and the *Mollusca*, which are of extreme importance as fish food. The interrelations in the food complex are so involved that it is difficult at the present time to judge accurately the significance of certain organisms or groups of organisms, and it is apparent that studies of the food habits of the lower animals which serve as food for fish must be made before satisfactory conclusions may be arrived at in regard to the evaluation of the various constituents of the plankton.

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THE DISTRIBUTION AND ECONOMIC IMPORTANCE OF MOLLUSCA IN LAKE NIPIGON

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THE DISTRIBUTION AND ECONOMIC IMPORTANCE OF MOLLUSCA IN LAKE NIPIGON

The limnobiological investigations carried out in Lake Nipigon during the summer of 1921 involved, amongst other work, a study of the bottom fauna. This was undertaken in order to obtain some knowledge of the species of animals inhabiting the lake bottom and to learn something of their abundance, distribution, and value as fish food. As this phase of the work came largely under the direction of the writer, the methods employed and the results obtained, in so far as they have to do with one group of animals, namely the *Mollusca*, will be given in this paper. For their interest and assistance in the carrying out of this investigation sincere thanks are given to the Honorary Advisory Council for Scientific and Industrial Research.

Methods of Investigation

The method employed in studying the animal life of the bottom was to dredge up samples of the material from the lake floor. For this purpose a small Ekman dredge* which covered an area of 81 square inches, was used. It was lowered open, by means of a small steel cable wound on a windlass, and, when released by a messenger dropped from the boat, its jaws closed upon a sample of the bottom. The material obtained in this manner was hauled up and placed in numbered trays, and data concerning depth, distance from shore, and character of bottom were tabulated in regard to each. Depth was measured directly by a counting machine, over which the cable passed, and distance from shore was estimated as accurately as possible either by judging short distances or by timing the boat. On other

*Dr. C. Juday kindly supplied this dredge.

occasions a drag dredge was used instead of the Ekman dredge. This piece of apparatus consisted of an iron frame to which a sack was attached, and as it was hauled over the bottom it scraped up any loose material with which it came into contact. It was impossible, however, to determine accurately the area of bottom covered by this dredge and it brought up so much material from one spot that the results obtained did not compensate for the time and labour involved in cleaning it. As a result, this dredge was finally abandoned in favour of the Ekman type. At times even the latter could not be used, as, for example, where the bottom was composed of rocks. The dredgings were supplemented by hand collecting along the margin of the lake.

In taking dredgings, a situation was usually chosen where the environmental features made it seem advisable to study the animal population. Then, by beginning in-shore as closely as possible, a series of from 4 to 10 hauls was made, gradually working out into deeper water, along a straight line. The distance between dredgings was governed largely by depth and character of bottom.

The material obtained was taken back to the laboratory and washed through screens of different grades of fineness, so that the loss of smaller organisms was eliminated as much as possible. The cleaned material was carefully sorted while the animals were still alive, and the specimens were preserved in seventy per cent. alcohol in vials.

For the study of the value of bottom organisms as fish food the stomach contents were taken from a large number of fish. This material was sorted over in the laboratory, and the various species of animals in it were identified and their relative importance estimated.

SPECIES OF MOLLUSCA OBTAINED

In the material collected during the summer 44 species of *Mollusca* were identified. Amongst these there are representatives of 8 families and 12 genera. A list of the species obtained is given on the following pages.

GASTROPODA

1. *Lymnaea apicina* Lea.
2. " *emarginata* Say.
3. " *galbana* Say.
4. " *stagnalis appressa* Say.
5. " *vahlii* Moll.

6. *Planorbis antrosus* Con.
   " " approaching *corrugatus* Curr.
   " " *striatus* Baker.
7. " *crista* L.
8. " *exacuous* Say.
9. " *hirsutus* Gld.
10. " *parvus* Say.
11. " *trivolvis* Say.

12. *Segmentina crassilabris* Walker.

13. *Physa ancillaria* Say.
14. " *gyrina* Say.
15. " sp.
16. " sp.

17. *Ferrissia parallela* Hald.

18. *Amnicola limosa* Say.
    " *limosa porata* Say.
19. " sp. possibly *A. pallida* Hald.

20. *Valvata sincera* Say.
21. " *tricarinata* Say.
    " " *perconfusa* Walker.

PELECYPODA

22. *Anodonta kennicotti* Lea.
23. " *marginata* Say.

24. *Lampsilis (Ligumia) superiorensis* Marsh.

25. *Pisidium compressum* Prime. (form of subsp. *pellucidum*).
26. " *fallax* Sterki.

27. *Pisidium idahoense* Roper.
28. " *indianense* Sterki.
29. " *medianum minutum* Sterki.
30. " *monas* Sterki.
31. " *pauperculum* Sterki (near subsp. *nylanderi* Sterki).
32. " *punctatum* Sterki (form *simplex*).
33. " *rotundatum* Prime.
34. " *scutellatum* Sterki.
    " " *cristatum* Sterki.
35. " *splendidulum* Sterki.
36. " *variabile* Prime.
37. " *vexum* Sterki.
38. " *walkeri* Sterki.
39. " sp. (known but not yet published).

40. *Sphaerium crassum* Sterki.
41. " *tenue* Prime.
42. " sp (probably *vermontanum* Prime).
43. *Musculium rosaceum* Prime.
44. " *securis* Prime.

There may be several additional species of *Pisidia*, according to Dr. V. Sterki.

The writer is greatly indebted to Dr. Bryant Walker and Dr. V. Sterki for assistance in the identification of specimens.

TABULATED RESULTS OF DREDGING OPERATIONS

In the following series of tables the results of the dredging operations are given. These show where operations were carried on and give data concerning the molluscan population and environment at each station. Dead specimens are not included in the numbers, but where empty shells were obtained the names have been inserted in the list.

The names of species of *Sphaeriidae* obtained in each locality are noted below each table.

ORIENT BAY AT MACDIARMID — Series II

Station									
Dredging	1	2	3	4	5	6	7	8	9
Depth (in feet)	7	45	120	162	93	72	60	12	11
Character of Bottom	Coarse Grit	Grit on Clay	Clay	Mud	Mud	Sand	Rock	Sand	Sand
Distance from Shore (yds.)	10	30	75	175	600	1200	1400	1800	1900
Planorbis antrosus	:	:	:	:	:	:	:	:	3
Planorbis parvus	6	:	:	:	:	:	:	:	:
Amnicola limosa	3	:	:	:	:	:	:	:	1
Amnicola sp.	1	:	:	:	:	:	:	:	:
Valvata sincera	:	:	:	:	:	:	:	2	5
Valvata tricarinata (var.)	:	:	:	:	:	:	:	:	1
Valvata tricarinata	:	:	:	:	:	:	:	3	3
Sphaeriidae	6	:	:	:	:	:	:	6	8

Pisidium compressum
" *pauperculum*
" *scutellatum*
" *variabile*
" sp.

	SAND POINT BAY Series III				SANDY RIVER TO N. SHAKESPEARE Series IV					
Dredging	1	2	3	4	1	2	3	4	5	6
Depth (in feet)	6	12	21	45	12	21	27	30	48	159
Character of Bottom	Gravel	Gravel	Sand	Mud	Clay	Sand	Sand	Sand	Sand	Mud
Distance from Shore (yds.)	30	60	120	440	150	250	850	1200	2800	4550
Lymnaea galbana	..	..	1	..	..	..	..	..	..	..
Planorbis antrosus	..	2	..	..	..	..	..	..	..	..
Planorbis parvus	1	1	1	..	..	..	..	..	..	..
Amnicola limosa	..	..	..	..	..	1	..	..	..	..
Amnicola sp.	3	..	2	..	..	..	..	..	..	..
Valvata sincera	..	..	..	..	..	..	..	..	2	..
Valvata tricarinata (var.)	..	..	..	..	..	..	..	..	..	..
Valvata tricarinata	1	1	..	..	..	..	..	..	..	..
Physa sp.	..	..	..	..	..	1	..	..	..	..
Planorbis hirsutus	..	..	..	..	..	..	..	..	..	..
Sphaeriidae	1	1	..	..	..	2	..	16	8	..

Pisidium compressum
" *scutellatum*
Sphaerium tenue

SHAKESPEARE ISLAND TO SANDY RIVER

Series V

Dredging	1	2	3	4	5	6	7	8	9	10
Depth (in feet)	150	150	156	163	80	96	78	45	84	192
Character of Bottom	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Gravel	Clay	Mud
Distance from Shore	50 yd.	100 yd	200 yd	400 yd	800 yd	1 mile	2 miles	3 miles	3¼ miles	6 miles
Lymnaea vahlii	..	..	..	..	..	..	..	..	D	..
" *stagnalis*	..	..	..	..	..	..	..	..	D	..
" sp.	..	..	..	..	..	..	..	D	..	..
Segmentina crassilabris	..	..	..	..	..	..	..	D	..	..
Planorbis hirsutus	..	..	..	..	..	..	..	..	D	..
" *parvus*	..	..	..	..	..	..	..	I	..	..
Valvata sincera	..	..	..	..	..	..	D	D	D	..
" *tricarinata*	..	..	..	..	..	..	..	..	D	..
Sphaeriidae	D	D	D	D	D	D	D	7	D	1. D

Pisidium sp.

SAND POINT BAY (OFF McCOLEMAN'S DOCK) Series VI

Dredging	1	2	3	4	5	6	7	8	9
Depth (in feet)	6	9	12	14	15	15	15	15	16
Character of Bottom	Sand	Sand	Sand	Sand & Gravel	Sand & Gravel	Sand & Gravel	Sand & Gravel	Sand & Gravel	Sand & Gravel
Distance from Shore (yd.)	75 ft.	100	150	175	200	225	250	275	300
Lymnaea galbana	..	..	1	..	..	..	..	..	..
" *emarginata*	..	..	..	..	..	..	..	..	..
Planorbis antrosus	..	..	1	1	..	1	..	1	3
Amnicola limosa	..	..	1	..	..	..	..	..	2
" sp.	..	..	..	..	..	..	..	..	3
Valvata sincera	..	..	..	..	1	..	..	1	1
" *tricarinata*	..	..	..	..	1	..	..	1	2
Lymnaea vahlii	..	..	..	..	1	..	..	..	..
Planorbis parvus	..	..	..	..	..	..	..	..	3
Sphaeriidae	..	..	..	..	..	..	..	3	1

Pisidium scutellatum
" sp. juv.
Sphaerium vermontanum

SAND POINT BAY (OFF McCOLEMAN'S DOCK) Series VII

Dredging	10	11	12	13	14	15	16	17
Depth (in feet)	15	21	27	39	53	60	69	75
Character of Bottom	Gravel	Gravel	Mud	Clay	Clay	Mud	Mud	Clay
Distance from Shore (yds.)	330	375	450	600	750	900	1200	1500
Lymnaea galbana	..	..	..	..	..	..	..	..
" *emarginata*	1	..	..	..	..	..	..	..
Planorbis antrosus	3	..	..	..	..	..	..	..
Amnicola limosa	..	..	..	..	..	..	..	..
" sp.	..	..	..	..	..	..	..	..
Valvata sincera	..	..	2	..	..	..	..	..
" *tricarinata*	2	1	..	..	..	..	..	..
Sphaeriidae	..	..	1	..	..	..	..	..

BAY EAST OF COOKE POINT Series VIII

Dredging	1	2	3	4	5	6	7	8	9	10
Depth (in feet)	15	15	18	21	21	18	23	30	33	48
Character of Bottom	Sand	Sand	Sand	Sand	Gravel	Rock	Sand & Rock	Sand & Rock	Sand & Gravel	Mud
Distance from Shore (yds.)	100	150	200	250	325	400	500	880	1100	1800
Planorbis parvus	..	..	..	..	1	..	..	3	..	..
Amnicola limosa	..	..	..	1	..	5	..	..	..	..
Valvata sincera	..	1	..	..	..	..	..	..	..	..
" *tricarinata*	..	..	..	1	..	..	..	..	..	..
Sphaeriidae	2	2	1	1	..	..	..	..	..	..

Pisidium compressum
Sphaerium vermontanum

BLACKWATER BAY Series IX

Dredging	1	2	3	4	5	6	7	8
Depth (in feet)	8	9	18	21	21	27	30	33
Character of Bottom	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Distance from Shore (yds.)	270	300	370	450	525	600	700	880
Lymnaea sp.	..	..	..	..	..	..	..	..
Planorbis parvus	..	..	..	..	..	..	..	..
Amnicola limosa	..	..	..	..	..	1	1	..
Valvata tricarinata (var.)	..	..	..	1	..	..	..	..
" *tricarinata*	..	..	..	..	..	2	..	..
" *sincera*	..	..	..	..	..	2	6	2

Sphaeriidae
Pisidum sp. juv.

BLACKWATER BAY

Series X

Dredging	1	2	3	4	5	6	7	8
Depth (in feet)	12	21	24	27	29	36	39	39
Character of Bottom	Sand	Gravel	Sand	Sand	Sand	Sand	Sand	Sand
Distance from Shore (yds.)	50	100	150	200	300	700	900	900
Lymnaea vahlii	..	..	..	..	..	..	..	1
Planorbis antrosus	..	1	..	..	..	..	..	..
" *parvus*	..	..	..	..	..	2	..	..
Amnicola limosa	..	1	..	..	..	..	..	..
Valvata tricarinata (var.)	..	..	..	..	..	..	..	1
" *sincera*	..	..	..	..	..	1	..	6
" *tricarinata*	..	..	..	..	..	3	..	..
Sphaeriidae	..	2	..	1	..	2	..	1

Pisidium monas
" *medianum minutum*
" *scutellatum*
" sp. juv.

SOUTH SHAKESPEARE ISLANDS

Series XI

Dredging	1	2	3	4	5	6	7	8
Depth (in feet)	3	6	27	48	48	54	51	30
Character of Bottom	Rock	Sand	Clay	Ooze	Ooze	Ooze	Ooze	Ooze
Distance from Shore (yd.)	5	15	80	200	400	600	800	900
Lymnaea vahlii	..	..	..	..	..	..	..	..
Planorbis antrosus	..	1	..	..	..	..	..	..
" *parvus*	..	2	..	..	..	..	..	1
Physa sp.	..	..	..	..	..	..	..	..
Amnicola limosa	1	29	..	..	..	..	..	..
Valvata sincera	..	1	..	..	..	..	..	..
" *tricarinata*	..	..	..	..	..	..	..	..
Sphaeriidae	3	20	..	..	..	..	..	..

Pisidium compressum
" *fallax*
" *pauperculum*
" *scutellatum*
Sphaerium vermontanum (?)

EAST SHAKESPEARE ISLANDS — Series XII

Dredging	1	2	3	4	5	6	7
Depth (in feet)	6	15	21	21	21	18	15
Character of Bottom	Sand among Rocks	Sand	Mud	Algae	Algae	Sand	Sand
Distance from shore (yds.)	15	50	100	200	400	800	1000
Lymnaea emarginata	..	..	..	..	..	..	..
" *galbana*	..	1	..	..	..	..	1
" *vahlii*	..	..	1	..	..	..	..
Planorbis antrosus	..	1	..	..	..	..	1
" *hirsutus*	..	..	..	..	..	..	..
" *parvus*	..	..	1	..	..	..	2
Amnicola limosa	..	5	..	..	..	..	..
" sp.	..	..	..	..	1	1	3
Valvata sincera	..	..	1	5	2	2	3
" *tricarinata*	..	1	1	..	..	..	..
Physa	..	..	1	..	9	1	..
Sphaeriidae	4	7	1	3	..	21	5

Pisidium compressum
" *medianum minutum*
" *scutellatum*
" *splendidulum*
" *variabile*
" sp.

NORTH SHAKESPEARE—HAT MOUNTAIN — Series XIII

Dredging	1	2	3	4	5	6	7	8
Depth (in feet)	3	15	18	24	33	57	63	69
Character of Bottom	Sand	Ooze	Mud	Ooze	Gravel & Sand	Mud	Mud	Mud
Distance from shore (yds).	15	80	130	430	530	730	900	1100
Lymnaea galbana	..	..	..	..	..	..	..	..
" *emarginata*	..	..	..	..	..	..	..	..
" *vahlii*	..	..	..	..	..	..	..	..
Planorbis antrosus	..	..	..	1	..	..	..	..
" *parvus*	..	3	3	3	..	..	..	..
Physa	..	..	..	..	..	..	..	..
Amnicola limosa	..	..	..	..	..	..	..	..
" sp.	..	3	..	5	..	..	..	..
Valvata sincera	..	5	7	5	..	..	..	..
" *tricarinata*	..	1	..	1	..	..	..	..
Sphaeriidae	..	6	5	14	1	1	..	..

Pisidium compressum
" *medianum minutum*
" *pauperculum*
" *scutellatum*
" *splendidulum*
" *variabile*

McL. BAY Series XIV

Dredging	1	2	3	4	5	6	7	8
Depth (in feet)	3	3	6	6	9	15	30	36
Character of Bottom	Wood, Debris, & Mud	Mud	Mud	Mud	Mud	Mud	Sand	Clay
Distance from Shore (yds).	15	40	75	150	200	250	350	450
Lymnaea galbana	..	..	..	..	..	..	..	..
" *vahlii*	..	..	..	1	..	..	..	..
" sp.	..	..	..	..	..	..	..	..
Planorbis parvus	1	..	2	1	2	..	..	..
" *antrosus*	1	1	2	1	3	..	..	..
Segmentina crassilabris	..	..	..	..	..	..	..	..
Amnicola limosa	..	1	1	..	13	..	..	..
" sp.	..	3	14	7	39	..	..	..
Valvata sincera	..	..	6	2	6	..	..	..
" *tricarinata*	1	..	..	1	4	..	..	..
Sphaeriidae	1	2	8	2	18	2	..	..

Pisidium compressum
" *pauperculum*
" *scutellatum*
" *variabile*
" *walkeri*

FOOT OF ORIENT BAY Series XV

Dredging	1	2	3	4	5	6	7	8	9	10
Depth (in feet)	12	3	2	5	3	5	9	69	51	27
Character of Bottom	Gravel	Sand	Sand	Sand	Sand	Sand	Sand	Mud	Mud	Mud
Distance from Shore (yds.)	..	100	200	300	400	550	700	800	900	1000
Lymnaea galbana	..	..	..	1	1	..	..	..	..	..
Planorbis antrosus	..	..	..	..	2	1	..	..	..	..
Segmentina crassilabris	..	..	..	..	..	..	2	..	..	..
Planorbis hirsutus	..	..	..	3	1	5	..	..	..	..
" *parvus*	..	..	..	2	1	1	..	..	..	..
Amnicola limosa	..	..	..	3	2	1	..	..	..	..
" sp.	1	..	..	1	2	..	16	..	..	..
Valvata sincera	..	..	..	..	..	..	2	..	..	..
" *tricarinata*	..	..	..	..	..	1	2	..	..	..
Sphaeriidae	2	..	..	3	..	..	5	5	..	13

Pisidium scutellatum
" sp. juv.
Musculium rosceum
" *securis*

BLACKWATER BAY

Series XVI

Dredging	1	2	3	4	5	6	7	8	9
Depth (in feet)	12	21	21	21	39	90	117	147	178
Character of Bottom	Sand	Mud & Gravel	Mud & Gravel	Mud & Gravel	Mud	Clay	Mud	Mud	Mud
Distance from Shore (yds.)	50	150	250	350	450	550	650	750	1000
Planorbis parvus	..	..	..	..	1	..	..	..	..
Amnicola limosa	..	..	..	..	1	..	..	..	..
" sp.	..	..	..	2	..	..	..	..	..
Valvata sincera	..	..	..	..	4	..	..	..	..
" *tricarinata* (var.)	..	..	..	1	..	..	..	..	..
" *tricarinata*	..	..	..	..	1	..	..	..	..
Sphaeriidae	..	1	..	1	..	2	..	..	..

Pisidium sp. juv.
Sphaerium sp.

SECOND CHANNEL W. OF NIPIGON RIVER

Series XVII

Dredging	1	2	3	4	5	6	7	8	9
Depth (in feet)	18	18	12	12	12	3	27	28	..
Character of Bottom	Mud	Mud	Mud	Mud	Mud	Sand	Gravel	Mud & Sand	..
Distance from Shore (yds.)	25	75	150	250	350	550	750	1150	..
Lymnaea vahlii	..	..	..	..	..	..	..	..	..
Planorbis antrosus	..	..	..	..	3	..	2	..	..
" *parvus*	..	..	1	2	..	2	1	..	..
Physa	..	..	..	..	..	..	..	..	..
Amnicola limosa	3	4	2	7	2	..	5	..	..
" sp.	..	3	3	1	4	3	13	..	..
Valvata sincera	1	4	5	..	..	2	2	..	..
" *tricarinata* (var.)	..	..	1	..	4	..	4	..	..
" *tricarinata*	1	..	..	2	..	..	..	..	..
Sphaeriidae	..	1	7	14	2	..	6	1	..

Pisidium compressum
" *pauperculum*
" *scutellatum*
" *variabile*
" sp. (known, not published)
" sp. juv.
Musculium sp.

SOUTH BAY (WEST SHORE) — SOUTH BAY (WEST SHORE)

	Series XVIII				Series XIX			
Dredging	1	2	3	4	1	2	3	4
Depth (in feet)	1½	3	6	6	2	4	5	5
Character of Bottom	Sand	Sand	Mud & Gravel	Mud & Gravel	Mud & Sand	Mud	Mud	Mud
Distance from Shore (yds.)	25	50	75	200	15	25	40	65
Lymnaea galbana	..	..	1	..	7	..	..	..
Planorbis antrosus	..	..	1	..	..	..	..	..
" *parvus*	..	..	1	..	1	..	..	..
Amnicola limosa	..	..	..	..	..	2	3	..
" sp.	..	..	11	3	..	1	5	..
Valvata sincera	..	..	4	..	..	..	..	..
" *tricarinata*	..	..	1	..	..	..	1	..
Physa gyrina	..	..	..	..	..	..	..	..
Lymnaea emarginata	..	..	..	..	..	..	..	..
Sphaeriidae	..	..	5	7	37	12	15	6

Pisidium compressum
" *pauperculum*
" *scutellatum*
" *variabile*

Pisidium compressum
" *medianum minutum*
" *pauperculum*
" *scutellatum*
" *variabile*
" sp.
" sp.
Sphaerium tenue

SECOND BAY WEST OF NIPIGON RIVER — Series XX

Dredging	1	2	3	4	5	6	7	8	9
Depth (in feet)	5	18	18	33	33	33	12	6	5
Character of Bottom	Mud	Mud	Mud	Mud	Mud	Mud	Mud	Mud	Mud
Distance from Shore (yds.)	15	50	150	250	300	350	400	450	550
Lymnaea galbana	..	..	..	..	..	..	..	..	..
" *vahlii*	..	..	..	..	..	..	1	..	..
" sp.	..	..	..	..	..	..	..	..	..
Planorbis antrosus	..	..	..	..	..	..	..	..	..
" *hirsutus*	..	..	..	..	..	..	..	..	..
" *parvus*	2	..	..	..	..	..	..	1	..
Amnicola limosa	1	..	1	..	..	..	3	2	..
" sp.	2	1	..	..	..	..	4	8	..
Valvata sincera	1	..	..	..	..	..	2	..	..
" *tricarinata*	..	1	..	..	..	..	..	..	..
Sphaeriidae	17	..	1	..	..	..	1	3	..

Pisidium scutellatum
" *vexum*
" *variabile*
" sp. juv.

BEAR CREEK

Series XXI

Dredging	1	2	3	4	5	6
Depth (in feet)	18	9	9	9	9	9
Character of Bottom	Mud	Mud & Debris	Sand & Debris	Sand	Sand	Sand
Distance from Shore (yds.)	20	300	600	900	1300	1700
Segmentina crassilabris	..	..	..	..	..	..
Plano bis exacuous	..	..	..	..	..	..
" *parvus*	..	..	..	..	..	..
Amnicola limosa	..	..	..	..	..	..
" sp.	..	..	..	..	..	..
Valvata sincera	..	..	..	..	..	..
" *tricarinata*	..	..	..	..	..	..
Sphaeriidae	1	2	..	..	..	1

Pisidium variabile
Musculium juv. (apparently *rosaceum*)
Sphaerium sp. juv.

NORTH SHAKESPEARE BAY

Series XXII

Dredging	1	2	3	4	5	6	7	8	9
Depth (in feet)	4	18	18	36	24	15	9	6	2½
Character of Bottom	Mud	Mud	Mud & Gravel	Mud	Mud	Mud	Mud	Sand	Sand
Distance from Shore (yds.)	10	60	110	210	610	710	760	810	840
Lymnaea galbana	..	..	..	..	..	..	..	..	..
" *vahlii*	1	..	..	..	..	..	..	..	..
Planorbis antrosus	2	..	..	..	..	..	..	..	..
" *hirsutus*	4	..	..	..	..	..	..	..	..
" *parvus*	..	..	..	..	..	1	..	..	..
Amnicola limosa	8	..	..	..	..	1	2	20	..
" sp.	14	..	1	..	..	..	1	11	..
Valvata sincera	3	3	..	..	..	..	..	..	..
" *tricarinata*	1	..	1	..	..	..	2	1	..
Sphaeriidae	14	2	..	6	..	1	3	4	..

Pisidium pauperculum
" *punctatum* (f. *simplex*)
" *scutellatum cristatum*
" *variabile*
" sp. juv.
Sphaerium crassum
" sp. juv.

NORTH SHAKESPEARE ISLANDS

Series XXIII

Dredging	1	2	3	4	55	6	7	8
Depth (in feet)	5	17	21	21	15	9	42	42
Character of Bottom	Gravel among Rocks	Sand	Sand	Sand	Sand	Sand	Mud	Mud
Distance from Shore (yds.)	10	40	40	60	100	130	230	380
Lymnaea galbana	1	1	..	..	..	..	..	..
" *vahlii*	..	..	..	..	..	..	..	..
Planorbis antrosus	..	..	..	..	..	3	..	..
" *parvus*	..	..	..	..	..	7	..	..
Segmentina crassilabris	..	..	..	..	..	..	..	..
Physa	..	..	..	..	..	1	..	..
Amnicola limosa	..	..	..	..	..	11	..	..
" sp.	..	1	..	..	..	12	..	..
Valvata sincera	1	..	1	..	..	6	..	..
" *tricarinata*	..	1	..	..	..	5	..	..
Sphaeriidae	..	12	..	..	..	15	..	3

Pisidium compressum
" *pauperculum*
" *rotundatum*
" *scutellatum*
" *variabile*
" sp.
Sphaerium tenue
" *vermontanum* (?)

ORIENT BAY (AT MACDIARMID)

Series XXIV

Dredging	1	2	3	4	5	6	7	8	9
Depth (in feet)	6	39	90	150	87	69	63	11	9
Character of Bottom	Sand	Mud	Mud	Mud	Mud	Mud	Clay	Sand & Clay	Mud
Distance from Shore (yds.)	10	30	60	160	800	1000	1100	1500	1700
Lymnaea galbana	..	..	..	..	..	..	..	..	..
" *vahlii*	..	..	..	..	..	..	..	..	1
Planorbis antrosus	..	..	..	..	..	..	..	..	1
" *parvus*	1	..	..	..	..	..	..	..	..
Segmentina crassilabris	..	..	..	..	..	..	..	..	..
Amnicola limosa	2	..	..	..	..	..	..	..	1
" sp.	1	..	..	..	..	..	1	4	2
Valvata sincera	1	1	..	..	..	..	..	4	..
" *tricarinata*	..	..	..	..	..	..	..	1	..
Sphaeriidae	4	1	..	..	..	2	4	7	2

Pisidium compressum
" *monas*
" sp. juv.
Sphaerium sp. juv.

	NAONAN IDS.	NIPIGON HOUSE		MACDIARMID HARBOUR		
	Series I	Series VII		Series XXV		
Dredging	1	1	2	1	2	3
Depth (in feet)	150 (?)	144	36 (?)	9	8	5
Character of Bottom	Mud & Shells	Clay	Mud	Mud	Mud	Mud
Distance from Shore (yds.)	800	800	125	100	75	25
Lymnaea galbana	..	..	..	1	..	..
" *emarginata*	..	..	..	1	..	1
Planorbis antrosus	..	..	..	11	..	..
" *parvus*	..	..	..	2	..	..
Amnicola limosa	..	..	1	2	..	..
" sp.	..	..	..	2	..	..
Valvata sincera	..	..	2	3	..	..
" *tricarinata*	..	..	..	..	..	..
Physa gyrina	..	..	..	..	3	1
Sphaeriidae	..	..	..	15	..	..

Pisidium compressum
" *pauperculum*
" *punctatum* (f. *simplex*)
" *variabile*
" sp.?

ORIENT BAY and NORTHWARD—EAST SHORE									Series XXVI
Dredging	1	2	3	4	5	6	7	8	9
Depth (in feet)	9	18	8	12	13	24	27	48	129
Character of Bottom	Sand	Sand	Sand	Sand	Gravel	Sand	Sand	Sand	Mud
Distance from Shore (yds.)	30	60	85	130	230	280	330	380	430
Lymnaea vahlii	..	..	..	..	..	..	..	..	..
Planorbis antrosus	..	..	..	..	..	..	..	..	..
" *exacuous*	..	..	..	..	..	..	..	..	..
" *parvus*	..	..	..	..	..	..	..	1	..
Physa gyrina	..	..	..	..	..	..	..	..	..
Amnicola limosa	2	4	..	..	..	..	..	..	..
" sp.	2	..	..	..	..	..	..	..	..
Valvata sincera	1	..	..	..	..	..	1	..	..
" *tricarinata* (var.)	1	1	..	..	..	..	..	..	..
Sphaeriidae	2	1	1	..	..	..	..	3	..

Pisidium compressum
" *pauperculum*
" sp. juv.
Sphaerium sp. juv.

VIRGIN ISLANDS — Series XXVII

Dredging	1	2	3	4	5	6	7	8	9
Depth (in feet)	6	12	15	150	15	12	9	5	3
Character of Bottom	Sand	Sand	Sand	Sand	Sand	Mud & Sand	Mud & Sand	Mud & Sand	Mud
Distance from Shore (yds.)	10	50	100	150	200	300	400	500	600
Lymnaea emarginata	1	..	..	..	..	..	..	..	..
" *galbana*	..	..	..	1	..	..	..	1	..
" *vahlii*	..	..	..	..	..	..	..	1	..
Planorbis antrosus	18	..	..	..	..	..	..	1	6
" *hirsutus*	..	..	..	..	..	..	..	..	..
" *parvus*	..	1	..	..	3	..	..	3	7
Amnicola limosa	16	2	..	1	..	..	2	9	48
" sp.	11	..	..	..	3	1	5	7	62
Valvata sincera	..	1	..	..	3	3	1	..	..
" *tricarinata*	9	1	..	..	1	1	1	..	17
Sphaeriidae	41	9	..	1	..	7	1	9	3

Pisidium compressum
" *indianense*
" *pauperculum*
" *scutellatum*
" *variabile*
" sp.?
" sp ?

McINTYRE BAY (SOUTH END) — Series XXVIII

Dredging	1	2	3	4	5	6		8	9
Depth (in feet)	1	3	9	12	15	18	21	24	24
Character of Bottom	Sand	Mud on Sand	Mud & Gravel	Mud & Sand	Mud & Sand	Mud	Mud	Mud	Mud
Distance from Shore (yds.)	23	75	125	175	225	325	425	525	625
Lymnaea galbana	..	..	..	..	..	1	1	..	..
Planorbis antrosus	..	..	..	1	1	1	..	..	..
" *hirsutus*	..	..	2	3	1	..	..	..	..
" *parvus*	..	..	..	1	2	..	1	1	..
Amnicola limosa	..	..	2	..	..	..	..	1	..
" sp.	..	..	4	2	1	1	..	..	1
Valvata sincera	..	..	1	1	..	..	2	..	4
" *tricarinata* (var.)	..	..	..	..	1	1	..	..	..
" *tricarinata*	..	..	1	..	..	..	..	..	1
Sphaeriidae	4	1	7	4	..	2	2	1	2

Pisidium compressum
" *medianum minutum*
" *monas*
" *pauperculum*
" sp.?
" sp.?
Sphaerium vermontanum

McINTYRE BAY (EAST SIDE AMONG ISLANDS) Series XXIX

Dredging	1	2	3	4	5	6	7	8
Depth (in feet)	3	6	12	18	18	21	21	15
Character of Bottom	Mud	Mud	Mud	Mud	Mud	Mud	Mud	Mud
Distance from Shore (yds.)	10	60	110	160	210	260	310	360
Planorbis antrosus	..	..	..	..	..	..	..	..
" *parvus*	..	..	..	..	..	..	..	..
Amnicola limosa	..	..	..	..	..	..	..	5
" sp.	4	4	..	1	..	1	..	..
Valvata sincera	..	1	..	..	..	..	..	..
" *tricarinata* (var.)	..	..	2	..	..	..	..	1
" *tricarinata*	..	..	..	..	2	2	..	..
Sphaeriidae	12	3	1	2	4	7	5	3

Pisidium compressum
" *medianium minutum*
" *pauperculum*
" *punctatum*
" *scutellatum cristatum*
" *variabile*
" sp.?
Sphaerium vermontanum

McINTYRE BAY (NORTH END) Series XXX

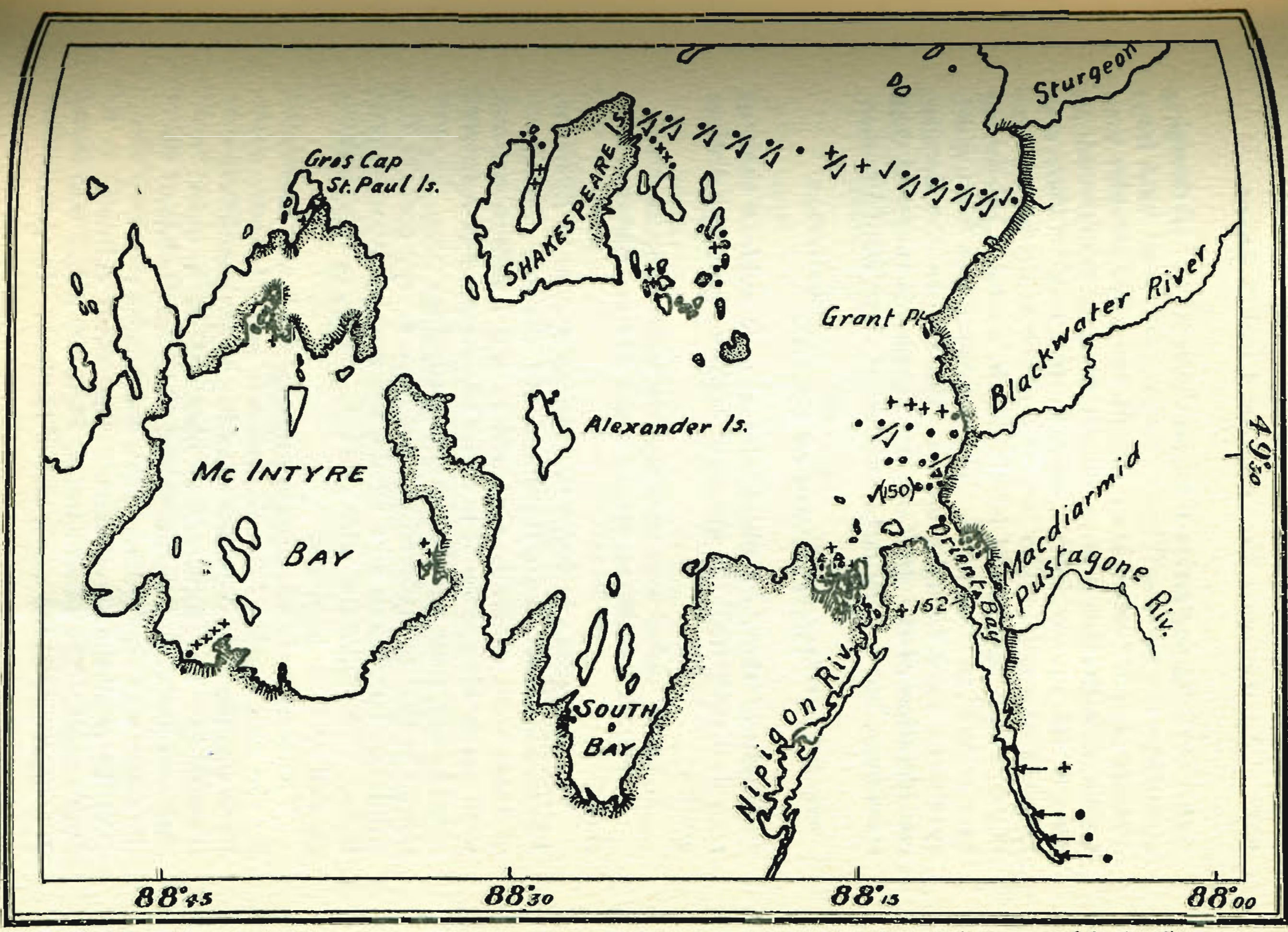
Dredging	1	2	3	4	5	6
Depth (in feet)	6	9	9	21	45	48
Character of Bottom	Mud	Mud	Mud	Mud	Mud	Mud
Distance from Shore (yds.)	30	80	130	180	230	280
Planorbis trivolvis	..	..	..	..	..	..
" *hirsutus*	..	..	2	..	..	..
" *parvus*	..	..	1	1	2	..
Amnicola limosa	24	2	1	..	..	..
" sp.	20	14	4	..	..	..
Valvata sincera	..	..	..	..	..	..
" *tricarinata* (var.)	..	1	1	1	..	..
Sphaeriidae	3	..	..	..	..	..

Pisidium variabile
" sp.?

GROS CAP			Series XXXI			ALEXANDER ID.		Series XXXII	
Dredging	1	2	3	4	5	1	2	3	4
Depth (in feet)	3	9	15	24	30	1	4	6	9
Character of Bottom	Mud	Mud	Mud	Mud	Mud	Mud	Sand	Sand	Sand
Distance from Shore (yds.)	10	35	60	110	210	10	25	50	100
Lymnaea vahlii	..	..	..	..	..	..	..	1	1
" *galbana*	..	..	..	..	..	..	5	14	..
Segmentina crassilabris	..	..	..	..	..	..	..	..	..
Planorbis antrosus	..	..	..	..	..	..	..	2	..
" *hirsutus*	..	..	1	..	..	..	..	..	..
" *parvus*	4	3	..	..	..	1	2	12	1
Amnicola limosa	3	19	..	..	..	..	..	6	2
" sp.	15	8	..	3	..	..	..	..	..
Valvata sincera	1	..	1	1	..	1	1	..	1
" *tricarinata* (var.)	..	5	..	..	..	..	2	1	..
" *tricarinata*	..	..	2	..	..	..	..	..	..
Sphaeriidae	15	3	1	1	..	1	40	16	15

Pisidium medianium minutum
" *pauperculum*
" *splendidulum*
" *variabile*
Sphaerium vermontanum

Pisidium compressum
" *idahoense*
" *medianum minutum*
" *pauperculum*
" *scutellatum*
" *variabile*
" sp.?
" sp.?



Map of the southeastern portion of Lake Nipigon showing the localities where dredgings were taken and the character of the shore line.
Shore: dots indicate rock; lines indicate sand. *Bottom:* + = mud; • = sand; ν = clay; △ = rock; •/ν = sand on clay.

In the foregoing series of tables the results of all dredging operations are given. These were supplemented by a large number of shore collections. In all, some 235 samples were obtained with the dredge. Each sample represented an area of 81 square inches, and in the results that area is taken as a unit. The largest number of dredgings were made in water down to 21 feet in depth, a total of 144 having been secured in this range. The greatest depth from which specimens were brought up was 192 ft. In the detailed consideration of the *Mollusca*, no account is taken of dead specimens, but a very large number of them were obtained.

DISTRIBUTION OF SPECIES

Study of the data obtained makes it evident that, as regards distribution, the species of *Mollusca* form two distinct groups:

1. Species inhabiting very shallow water close to shore.
2. Species inhabiting deeper water at some distance from shore.

The first group includes the various species of *Lymnaea*, *Physa*, and all but two of the species of *Planorbis*. Specimens of these were generally obtained in shore collections, and were nearly always found in rocky situations or in restricted areas having some peculiar environmental features. In most cases the species involved did not have a very general distribution, but, taken as a whole, the group cannot be neglected. The following table gives the species of this division, as well as their habitats.

The peculiar localization of some species is well illustrated by the two species *Planorbis trivolvis* and *Planorbis crista*. Each was found in only one situation where conditions were favourable. The former was obtained in a quiet, well-sheltered harbour at the north end of Alexander Island where the water was very calm. Here the species was very abundant because the environment was quite suitable to its fragile shell. The other species, *Planorbis crista*, was found in a small bay at the south end of the lake. Large numbers

of the minute spiny shells occurred on stones in very shallow water close to shore. Of the other members of the group, some were found in protected shallow bays, but the majority of them inhabited rocky, exposed shores, often where they were scarcely covered with water.

Species	Character of Bottom	Remarks
Lymnaea apicina	Rock	Exposed shores, water 1-3 ft. deep.
" *emarginata*	"	" "
" *galbana*		
" *stagnalis* (var.)	Rock, Sand, Mud	Common in water, 1-12 ft. deep.
" *vahlii*		
Planorbis crista	Rock	Limited to one locality—very shallow water.
" *exacuous*	"	Common in shallow water only.
" *hirsutus*	"	Frequent in shallow water.
" *trivolvis*	Mud	Limited to one locality—water 4 ft. deep.
Physa ancillaria	Rock	Exposed shores.
" *gyrina*	"	" "
" sp. (1)	"	Taken only in Pustagone River.
" sp. (2)	"	" " " " "
Segmentina crassilabris	Mud	Rare.
Ferrissia parallela	Rock	In streams.

The species included in the second group, which is composed of forms inhabiting deeper water, are much more abundant and widely distributed. Consequently, they will be considered in more detail.

Genus Amnicola

The two species of *Amnicola* were obtained in the dredging operations in considerable numbers. From the data secured in this manner the following table has been prepared to show the distribution according to depth and character of bottom. The averages given were obtained by dividing the number of specimens from any particular depth by the total number of dredgings for that depth and for the kind of bottom considered. Intervals of three feet were taken because the counting machine, which registered depth, gave the distance in yards, and, as fractions had to be estimated, personal error resulted in most of them coming near an even number of yards.

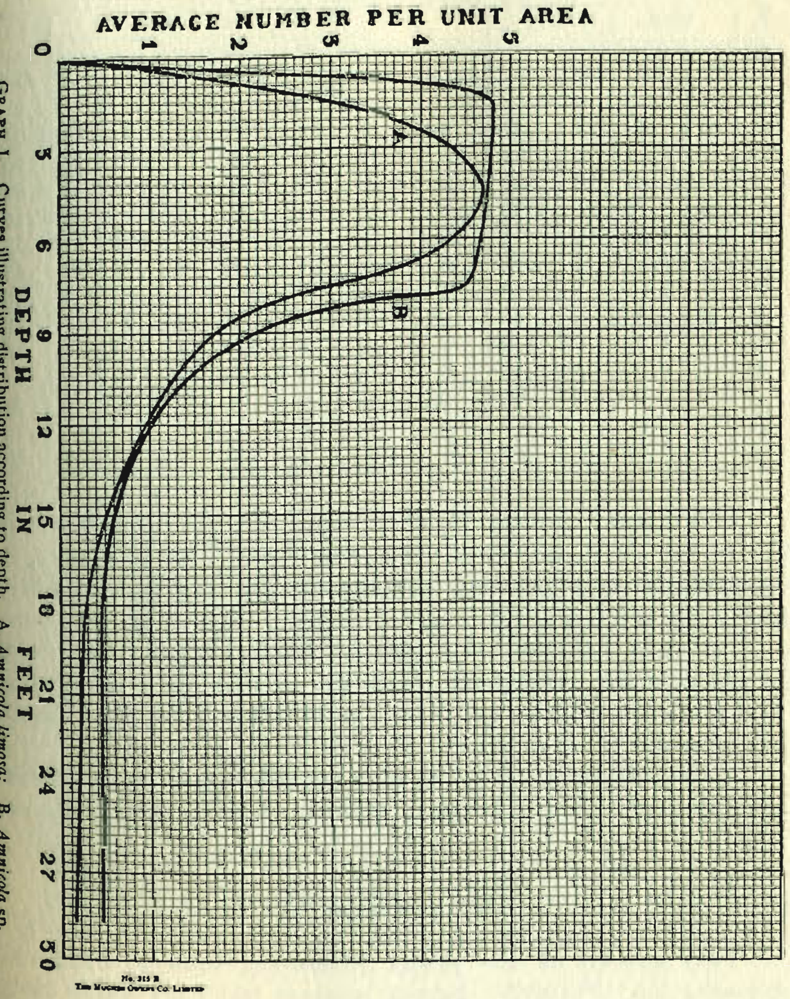
Depth.	*Amnicola limosa*						*Amnicola* sp.					
	Mud		Sand				Mud		Sand			
	No.	Av.	No.	Av.	Total	Av.	No.	Av.	No.	Av.	Total	Av.
0-3	52	6.50	3	.33	55	3.05	84	10.5	5	.55	89	4.94
3-6	50	3.33	77	6.42	127	4.70	96	6.4	27	2.25	123	4.55
9	44	4.9	17	1.42	64	3.05	69	7.7	31	2.6	100	4.76
12	14	1.55	4	.40	18	.90	15	1.7	1	1.0	16	.80
15	6	1.0	6	.43	12	.60	4	.66	6	.43	18	.90
18	8	.72	11	1.57	18	1.0	7	.64	5	.70	12	.66
21	0	0	3	.30	3	.15	4	.50	2	.20	6	.30
24	1	.2	0	0	1	.12	6	1.2	0	0	6	.75
27	0	0	6	1.2	6	.75	0	0	10	2.00	10	1.2
30	0	0	1	.2	1	.12	2	.66	0	0	2	.25

From the results given in the preceding table, curves have been drawn (Graph 1), which illustrate the distribution of these species according to depth. A study of these curves shows that, whereas the optimum depth for *Amnicola limosa* (and its variety) is between 0-9 ft., the other species reaches a maximum between 3-6 ft. Both species, however, are about equally abundant at their optimum depth.

The table brings out another peculiar feature, in that both species are most abundant at a depth between 0-3 ft. on mud bottoms, and at a depth between 3-6 ft. on sand bottoms.

Genus Valvata

Two species of *Valvata*, namely, *Valvata sincera* and *Valvata tricarinata*, were fairly common. In working out the distribution according to depth, the last species and its variety are considered together because of their similarity



GRAPH 1. Curves illustrating distribution according to depth. A. *Amnicola limosa*; B. *Amnicola* sp.

and because the total number of specimens was not very great.

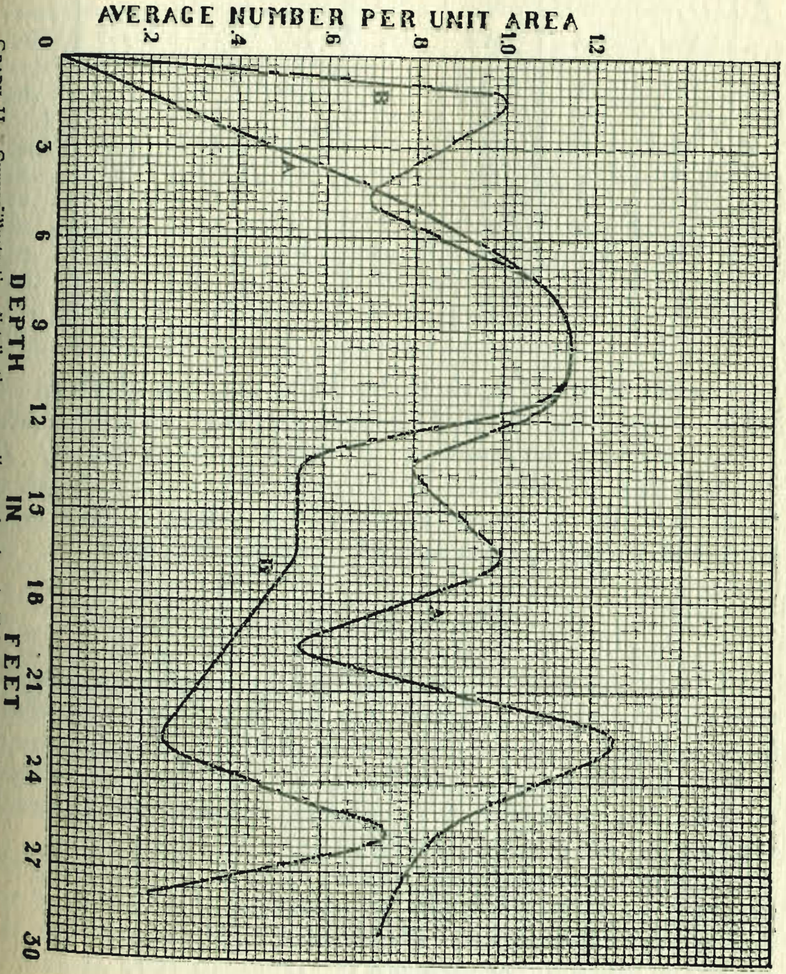
Depth	*Valvata sincera*						*Valvata tricarinata*					
	Mud		Sand				Mud		Sand			
	No.	Av.	No.	Av.	Total	Av.	No.	Av.	No.	Av.	No.	Av.
0-3	2	.25	2	.22	4	.22	18	2.25	0	0	18	1.00
3-6	17	1.13	4	.33	21	.74	4	.27	15	1.25	19	1.70
9	13	1.44	10	.83	23	1.09	15	1.66	8	.66	23	1.09
12	11	1.22	12	1.20	23	1.15	10	1.11	13	1.30	23	.15
15	6	1.00	10	.71	16	.80	5	.83	6	.43	11	.55
18	15	1.36	3	.43	18	1.0	6	.55	4	.57	10	.55
21	10	1.25	1	.10	11	.55	5	.62	3	.30	8	.40
24	10	2.0	0	0	10	1.25	2	.40	0	0	2	.25
27	2	1.0	5	1.0	7	.87	4	2.0	2	.40	6	.75
30	0	.0	6	1.20	6	.75	0	0	0	0	0	0
33	0	0	2	.66	2	.33	0	0	0	0	0	0
36	2	1.0	1	1.0	3	.75	0	0	3	3.0	3	.75
39	5	1.66	6	3.0	11	1.83	1	.33	1	.5	2	.33

The curves (Graph 2), obtained from the data given in the above table, are both very irregular. This indicates, in all probability, that the two species are distributed fairly uniformly over a large range of depths. There is, however, a difference between the two in that *Valvata tricarinata* becomes quite abundant between depths of 0-3 ft. but *Valvata sincera* does not reach a maximum until a depth between 6-9 ft. is reached.

If the averages are taken into consideration, both species are apparently more abundant on mud than on sand bottoms.

Genus Planorbis

Two species of the genus *Planorbis*, namely, *Planorbis antrosus* and *Planorbis parvus*, extend out into fairly deep waters. A table showing the relation of the abundance of these two species to depth is given below.



GRAPH II. Curves illustrating distribution according to depth. A. *Valvata sincera*; B. *Valvata tricarinata*.

Depth	*Planorbis antrosus*				*Planorbis parvus*			
	Mud	Sand			Mud	Sand		
	No.	No.	Total	Av.	No.	No.	Total	Av.
0-3	8	2	10	.55	14	3	17	.88
3-6	7	22	29	1.07	10	21	31	1.15
9	15	3	18	.86	8	14	22	1.05
12	4	6	10	.50	4	2	6	.30
15	1	8	9	.45	6	5	11	.55
18	1	3	4	.22	3	1	3	.33
21	0	1	1	.05	33	2	5	.25
24	1	0	1	.12	4	0	4	.50
27	0	2	2	.24	0	1	1	.12
30	..	..	..	..	1	3	4	.50

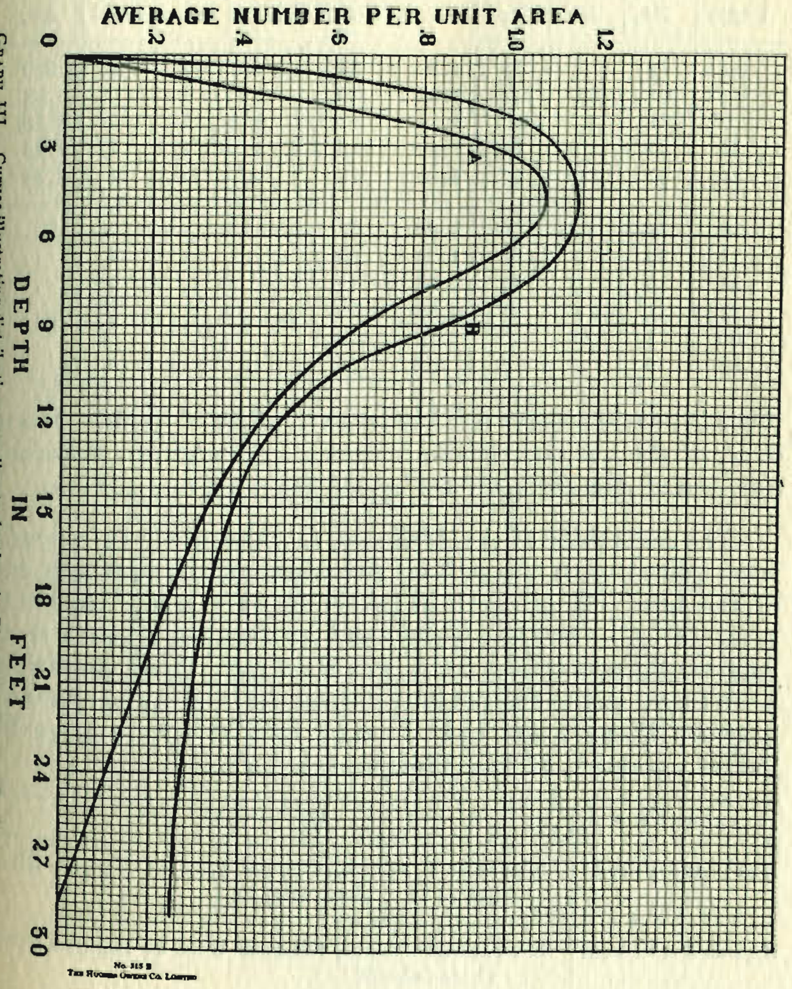
Curves drawn (Graph 3), by using the data given in the table, show that both *Planorbis antrosus* and *Planorbis parvus* reach a maximum in a depth between 3-6 ft. *P. antrosus* and its varieties do not extend beyond a depth of 27 ft. but the other species goes on out into much deeper water, some having been taken from a depth of 45 ft.

Family Sphaeriidae

The species belonging to this family have all been grouped together in drawing up tables showing their relation to depth. This was done because there were only a few specimens of some species, and also because, in general, the species seem to live under similar environmental conditions. The summarized results are given in the following table.

A graph has also been drawn (Graph 4), by using the averages given in this table, to show the distribution of the *Sphaeriidae* with depth. From this it is apparent that the optimum depth is between 3-6 ft., although they extend, in fair numbers, into depths of over 30 ft. Some specimens were also obtained at a depth of 192 ft.

A consideration of all the curves shows that the optimum depth for most species of *Mollusca* inhabiting deep water is from 3-6 ft., but, in the range of depths between 0-12 ft.,



GRAPH III. Curves illustrating distribution according to depth. A. *Planorbis antrosus;* B. *Planorbis parvus.*

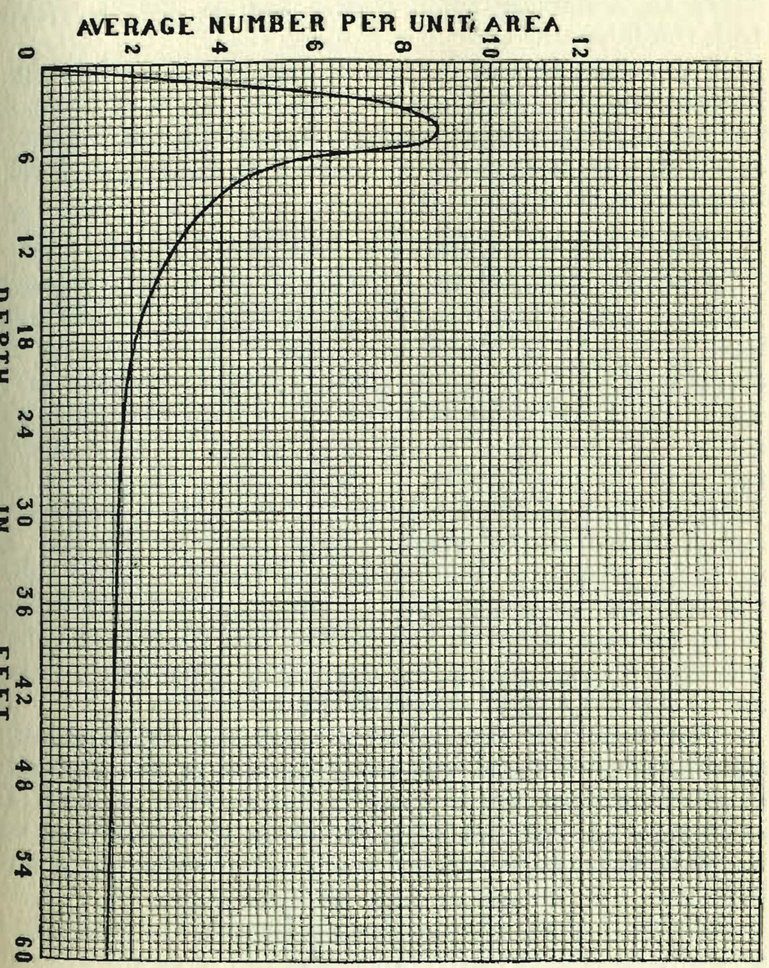
	Sphaeriidae					*Sphaeriidae*			
	Mud	Sand				Mud	Sand		
Depth	No.	No.	Total	Av.	Depth	No.	No.	Total	Av.
0-3	72	7	79	4.39	36	6	2	8	2.0
3-6	104	133	237	8.85	39	1	1	2	.33
9	61	45	96	4.57	42	3	0	3	1.50
12	36	30	66	3.30	45	0	7	7	1.75
15	13	20	33	1.65	48	0	11	11	1.83
18	18	37	55	3.05	57	..	..	1	..
21	20	5	25	1.25	63	..	..	4	..
24	18	0	18	2.25	69	..	..	7	..
27	14	7	21	2.62	90	..	..	2	..
30	1	16	17	2.12	117	..	..	2	..
33	0	2	2	.33	192	..	..	1	..

there is nearly always a fairly large number of them. Moreover, of the various species obtained in dredgings, *Amnicola limosa* and *Amnicola sp.* are by far the most numerous.

The remainder of the *Mollusca, i.e.*, the larger *Pelecypoda*, were quite scarce throughout the whole of the southern end of the lake. They were obtained in only a few restricted areas in fairly shallow water, and in situations where there was ample protection from wave action. Such conditions were found at the ends of long narrow bays or in the channels between islands, and only in such locations were large bivalves obtained, as the following table shows.

Species	Where found
Anodonta kennicotti	Shakespeare Islands, Channel West of Nipigon River. Orient Bay, Virgin Islands.
Anodonta marginata	Shakespeare Islands, Channel West of Nipigon River. Virgin Islands.
Lampsilis (Ligumia) superiorensis	Pustagone River.

Because of the great scarcity of these animals in the south end of the lake it was not thought advisable to make any estimate of their numerical abundance. The work done by



GRAPH IV. Curve illustrating distribution according to depth. *Sphaeriidae.*

Muttkowski (1918) shows a similar rarity of the larger *Pelecypoda* in Lake Mendota, although there was an abundance of the small *Sphaeriidae*. This is almost identical with conditions in Lake Nipigon.

The reason for the infrequent occurrence of these forms in Lake Nipigon is doubtless due to the fact that areas, furnishing a suitable habitat, where there is quiet water and an abundance of food material as well as the proper kind of bottom, are very restricted.

ENVIRONMENTAL FACTORS LIMITING DISTRIBUTION

A consideration of the habitats of the various species of *Mollusca* shows that the ecological features, which might have a bearing on the distribution of these animals, are: abundance of food, temperature, chemical content of the water, depth, character of bottom, and protection from wave action. Temperature would not appear to be a limiting factor in the distribution of the species occurring in Lake Nipigon, since all the species are subjected to a temperature at least as low as 4° C. during a large portion of the year, and up to the present no species has been found to occur only in the cold waters of the lake. Temperature, however, may be an indirect factor in view of the fact that, in depths of less than 30 feet, all species have their maximum numbers, and this is the zone of highest temperatures.

The amount of oxygen in the water was seemingly of no significance, for there was no deficiency in the amount of dissolved oxygen at any depth during this season. The amount of carbon dioxide dissolved in the water was very small during this season, and would not therefore be a factor either.

Depth of water is, of course, a feature which indirectly, at least, has to do with the distribution of *Mollusca*. This has been amply demonstrated (1) in the division of *Mollusca* into the two groups of shore and deep water forms, a grouping having its basis largely, no doubt, on the differences in the respiratory system, and (2) in the variation of the optimum depth for the various species.

The character of the bottom also influences the abundance of *Mollusca*. This is evident in the fact that the shore forms are nearly always found among rocks, while those inhabiting deeper water prefer mud or sand. Furthermore, as the consideration of the *Amnicolas* showed, the optimum depth may vary with the bottom according to the species.

Protection from wave action and abundance of food would seem to be the most important factors which influence the distribution of *Mollusca*. The shore forms have a good supply of food in the filamentous algae on the rocks, and when violent storms come up they are able to retreat into crevices amongst the boulders. Their shells are, moreover, solid enough to withstand moderate wave action, and as a result they are found in large numbers on more exposed parts of the shore. The species inhabiting deeper water appear to choose, uniformly, sheltered locations in which an ample supply of food material is available on the bottom. This is shown by the fact that dredgings taken in exposed places or where the bottom was composed of clean sand were nearly always poor in animal life, not only in regard to *Mollusca* but in regard to other forms as well.

VALUE OF MOLLUSCA AS FISH FOOD

The number of species of fish found in Lake Nipigon during the past season was not large. In all only about 25 or possibly 26 species were obtained, and nearly half of these were small forms such as sticklebacks, darters, minnows, etc. As a result the number of species which might feed on *Mollusca* was correspondingly limited and, in fact, only five were found to contain them. From the work done with a view to finding out the extent to which *Mollusca* are taken as food by fish, the following summary of the results obtained is given.

Sturgeon (Acipenser rubicundus Le Sueur)

The sturgeon is the largest food fish caught in Lake Nipigon. It is confined largely to shallow water near shore.

Unfortunately, the fish obtained were caught in the pound nets, and, as a result, the digestive tracts were often empty. Enough specimens were obtained, however, to show conclusively that the sturgeon subsists to a very large extent upon *Mollusca*. Nearly all the smaller *Gastropoda* and *Pelecypoda* fall prey to it. A total of 16 species of *Mollusca*, as listed below, were taken from sturgeon stomachs.

Lymnaea galbana	*Planorbis antrosus*
" *emarginata*	" *exacuous*
" *stagnalis appressa*	" *hirsutus*
" *vahlii*	*Physa ancillaria*
	" *gyrina*
Valvata sincera	*Sphaeriidae 3 sp.*
" *tricarinata*	
Amnicola limosa	
" *sp.*	

The extent of the list given above proves that *Mollusca* are very important as food for the sturgeon, and indeed may constitute almost 100% of the material present. But often other animals which live on the bottom are eaten, and hence the proportion of *Mollusca* varies greatly.

Common Whitefish (*Coregonus clupeaformis Mitchill*)

The common whitefish is the most abundant and important food fish taken in Lake Nipigon. It lives mostly in deep water, but occasionally it comes into shallower areas. At such times it feeds extensively on *Mollusca*, but only upon the smaller species, as can be seen from the list following. Out of a total of 155 whitefish examined, the stomachs of all but one contained *Mollusca* and in amounts estimated to range all the way to 100%. The importance of *Mollusca* can be better appreciated if exceptional cases are considered. Two specimens are very impressive examples. In one of these over 4000 *Mollusca* were counted, and in the other over 1800, besides fragments of hundreds more. The species of *Mollusca* found in whitefish stomachs are as follows:

Lymnaea vahlii	*Valvata sincera*
" *apicina*	" *tricarinata*
" *galbana*	*Amnicola limosa*
Planorbis antrosus	" " *porata*
" *parvus*	" *sp.*
Physa gyrina	*Sphaeriidae 4 sp.*
" *sp.*	

Round Whitefish (*Coregonus quadrilateralis Richardson*)

This species was fairly abundant in the lake, although it was not of commercial importance, since it was not large enough to be caught in the $4\frac{1}{2}$ inch gill-net. A total of 41 stomachs were examined, and in 37 of these it was estimated that less than 1% of the food material consisted of *Mollusca*. In the remaining four, the amount was considerably greater, being estimated at 5%, 10%, 20%, and 75% of the total. From this it appears that while *Mollusca* are eaten by the round whitefish to some extent, they are not, as a general rule, a very important constituent.

The following species were identified:

Lymnaea vahlii	*Valvata sincera*
" *galbana*	" *tricarinata*
Physa gyrina	*Sphaeriidae* 1 *sp.*
Amnicola sp.	

Common Sucker (*Catostomus commersoni* (*Lacépède*))

While having no commercial value, the sucker is very abundant in Lake Nipigon. It apparently consumes a large number of *Mollusca*, for 24 out of 25 stomachs which were examined contained them. In 19 of these the amount was estimated to range from 1% to 25%: in the remainder, less than 1%. The species represented are:

Physa gyrina	*Valvata sincera*
Planorbis hirsutus	" *tricarinata*
" *parvus*	*Sphaeriidae* 1 *sp.*

Northern Sucker (Catostomus catostomus (Forster))

Twenty-two stomachs of this species were examined and from these it is apparent that the northern sucker takes *Mollusca* in quantity only on rare occasions. Of the material examined 10 stomachs contained no *Mollusca*, 11 less than 1%, and one 20%. The species identified are as follows:

Lymnaea sp.? fragmentary	*Valvata sincera*
Planorbis antrosus	*Sphaeriidae 2 sp.*
" *parvus*	

Ciscoes

Among the ciscoes of Lake Nipigon there are probably three species, two of which reach such a size as to make them commercially important. They are caught in considerable numbers and are a valuable food fish. They generally inhabit very deep water, and are plankton feeders. In the stomachs examined, 3 out of 47 contained *Mollusca*, and these were small *Sphaeriidae*. Their presence was probably due to the fact that the ciscoes feed at times on the bottom and hence take in *Sphaeriidae* with other small organisms.

The other large fish in the lake are mostly piscivorous and do not, except accidentally or on very rare occasions, take *Mollusca* as food. Included in this group are the pike perch, pike, ling, lake trout, and brook trout. The smaller species, such as the darters and sticklebacks, live on small organisms such as insects and larvae of various kinds, and do not make much use of *Mollusca*.

COMPARISON OF LAKE NIPIGON WITH OTHER LAKES

Work similar to that done in Lake Nipigon has not, as yet, been carried out very extensively in North America, except in Lake Mendota in Wisconsin and Lake Oneida in New York. It is desirable, therefore, that some comparison should be made between these lakes and Lake Nipigon.

As regards physical features Lake Nipigon appears to have very little in common with the other two, which are both small shallow lakes, whereas Lake Nipigon is both very

large and very deep. The greatest depth from which dredgings were taken in Lake Nipigon was 192 ft., but depths of over 300 ft. were sounded, and McInnes (1894) records a depth of 402 ft. In Lakes Mendota and Oneida work does not appear to have been carried on much below 30 ft. Moreover, Lake Nipigon is largely open water, and the only situations which correspond, in general, with conditions in the other two lakes are the small sheltered bays. Even in these, Lake Nipigon has not the large masses of higher vegetation and abundance of algae which is apparently a characteristic feature of the other lakes. The contrast between the Canadian and United States lakes is that between a young primitive lake, and old highly evolved lakes, as defined by Pearsall (1921).

Corresponding with the difference in physical features, there is also a difference in the distribution of animals, and particularly *Mollusca*, in the lakes considered. The number of species of *Mollusca* found in Lake Oneida was 91 (Baker, 1918), whereas in Nipigon the total was 44. Figures from Lake Mendota are apparently not available. In regard to distribution of species, it appears that in Lake Nipigon most forms are found in greatest abundance in shallower water than in the other lakes. This may be due to the fact that Lake Nipigon is subject to storms of considerable violence, with the result that the *Mollusca* seek the shallower water of protected bays. The storms, moreover, result in a washing of the exposed shores and a gradual transfer of food material and débris to quiet bays. Furthermore, the total average number of *Mollusca* per unit area in Lake Nipigon is intermediate between that of the other two—the results from dredging operations showing an average of 165 *Mollusca* per square metre in the Canadian lake.

While the results of stomach analysis show that *Mollusca* are a very valuable component of fish food, it is also evident that the number of species which feed on them is less in Lake Nipigon than in Lake Oneida, where some 18 out of 41 species consume them (Baker, 1916). This is, of course, due to the limited number of species in Lake Nipigon.

CONCLUSION

The results considered as a whole bring out several important facts: 1. As regards animal life, and particularly *Mollusca*, the most productive parts of the lake are small sheltered bays and the channels between islands. This is true especially where the bottom is covered with sand or mud, on which there is much organic débris to furnish food material. A depth of less than 30 ft. is the optimum, in general, for bottom organisms. Clean sand or clay bottoms, exposed points, and very deep water are relatively unproductive.

2. The fact that there is an average of 165 *Mollusca* per sq. metre of bottom shows that there must be an enormous number available in the lake. Nearly all species represented are valuable as food for whitefish and sturgeon, and these are the two most valuable fish in the lake.

3. The large molluscan resources suggest that sturgeon could be supported in much larger numbers than occur at the present time. As a result, some attempt should be made to propagate this fish artificially, as is done in the case of the whitefish.

While the work done makes no pretence of being exhaustive, nevertheless, the results afford some idea of the productivity of the lake in regard to *Mollusca*. The dredging operations give an accurate and efficient quantitative method of studying the animal population of the lake bottom. The importance of this work can be realized when it is considered that the bottom organisms furnish a large part of the fish food of the lake. Hence, in the intensive cultivation of any body of water, including re-stocking and the introduction of new species of fish, a knowledge of the food resources is absolutely essential. In this report an attempt has been made to furnish this information with respect to the *Mollusca* of Lake Nipigon.

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