# THE RELATIONSHIP OF THE FOSSIL MARL FAUNA OF MACKAY LAKE, OTTAWA, TO THE PRESENT MOLLUSCAN FAUNA OF THE LAKE.*

BY E. J. WHITTAKER.

## PHYSICAL FEATURES OF THE LAKE.

MacKay or Hemlock Lake is a small body of water in Rockcliffe, just east of the city of Ottawa. It is irregular in shape, about 500 yards in length and 215 yards in greatest breadth. The long axis of the lake runs approximately north and south. One eighth of the total water area is occupied by a deep bay indenting the eastern shore to a depth of 150 yards. The surface of the lake is 15 feet above the Ottawa River and its greatest depth is only thirty feet. The history of this basin dates back to the end of the Pleistocene, when the land was emerging from the Champlain sea. The shore on the west side consists in part of bedrock of Chazy age, while on all other sides are marine sands and clays and some small areas of recent deposits. The topography about the lake reflects these two contrasting types. In the part of the lake enclosed by bedrock the shores are high, small ramparts of sandstone outcrop, and there is a complete absence of peaty or mucky deposits. Elsewhere the shores are low and owing to their boggy nature the water cannot be approached on foot. A small area at the extreme southern end where the muck deposits are absent, is the only exception.

At the south end there are two small rills which form the only visible inlets to the lake. A considerable volume of water is brought down by them in time of spring flood, but in summer they are nearly dry, and the only supply comes from seepage and springs from the surrounding land areas. As this is inconsiderable in amount, the water becomes quite stagnant. The waters of MacKay Lake find an outlet through a small stream, half a mile in length, which flows into the Ottawa. This creek has cut a valley from 25 to 40 feet deep and from 80 to 100 feet wide at the top through the Pleistocene clays. Originally, on the emergence of the land from the Champlain Sea, the erosion must have been very rapid through this soft unconsolidated material. At the present time, however, owing to the insignificant volume of water carried the bed of the stream is being lowered very slowly. Its erosive power is further diminished by the abundance of water plants over much of its course.

Though of small extent, the marl deposits of MacKay lake have been known for a long period.** They are very accessible, and new parts of the beds have been constantly brought to view as further advances were made into the sand beds which they overlie. The elevation of the marl beds above the present level of the lake is 18-20 feet, and is without doubt due to the lowering of the lake since their deposition by the cutting down of the outlet. This erosion must have occupied a considerable period of time. Formerly the lake must have been somewhat larger than now, although, at present, the deposits of marl are found only at the south end of the lake, at a distance of about 100 yards from the water. Elsewhere, presumably, the beds have been removed by erosion. The marl is from three to five feet in thickness and is overlain by a small amount of superficial soil and peaty matter on which grows a luxuriant forest of both large trees and undergrowth, whose roots have filled the beds with a network of interlacing fibres. The underlying material is for the most part sand, which frequently shows cross-bedding, and is occasionally replaced by heavy gravel or boulder—suggesting that these lower beds are of fluviatile origin.

The marl was formerly used in making brick and cement but is not being worked at the present time. In appearance it is yellowish-white to pure white, but is occasionally rust-stained from overlying deposits. It is very slightly coherent, crumbling readily between the fingers, and a block placed in water will break down like loaf sugar. It consists of a large proportion of fresh water shells well preserved in a matrix of almost impalpable powder which is not made up of shell fragments as in the case of many marls. Its origin will be discussed later.

A chemical analysis made in 1894* shows over 93% of calcium carbonate, and nearly 5% of organic matter such as root fibres and humus, indicating a very pure marl.

## THE FAUNAS.

The fresh water shell remains in the marl of MacKay Lake are the most modern fossils in the area and belong to a late Pleistocene or early

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**Geol. Survey of Canada Report 1845-46, p. 96.
Report of Progress, 1863, p. 765.
Annual Report 1893, vol. VI, p. 70AA.
Annual Report 1894, vol. VII, pp. 23, 24R. (Chemical analysis).
Annual Report 1899, vol. XII, p. 47.

*Annual Report, Geol. Survey of Canada, 1894, vol. VII, pp. 23-24R.

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Recent fauna. The fauna is somewhat younger than the Pleistocene fauna on Cayuga Lake described by C. J. Maury.† They occur very uniformly distributed throughout the beds. They can be picked up where the marl has weathered out, or can be procured by thousands if a block of unweathered material is soaked in a pail of water. Many of the shells contain quantities of air and, as the block disintegrates, they rise to the top and can be poured off into a sieve. In this way several thousands of specimens were procured for study. The original coloration of the shells has disappeared and they are white and opaque except in two species—*Valvata tricarinata*, which still retains in many cases a tinge of green, and *Physa heterostropha*, which retains a red band inside the callus at the aperture of the shell. The specimens are perfectly preserved for study, as the finest striae remain unabraded.

Along with the fresh water shells were found, rarely, several species of terrestrial gastropods that had evidently been carried into the lake by small rills or in the case of minute delicate shells, by the wind, and deposited with the fresh water forms. As terrestrial shells are rare in the marl and no very definite relationships to living forms can be established in their case, they are not further discussed here.

MacKay Lake with its somewhat stagnant water is not an especially good habitat for the Mollusca and yet we find a considerable assemblage of forms thriving it in. Many of these forms also occur fossil and the following table shows the species common to both. These two lists show a very marked contrast in the composition of the living and fossil faunas of the lake. It may be added that the list of the present fauna is not complete; to make it so would necessitate a larger series of dredgings than it was possible to make at the time.

| MARL FAUNA. | PRESENT FAUNA. |
|---|---|
| GASTROPODA. | |
| *Limnaea galbana** | *Limnaea stagnalis appressa* |
| *Planorbis companulatus.* | *Planorbis companulatus.* |
| *Planorbis bicarinatus.* | *Planorbis bicarinatus.* |
| *Planorbis parvus.* | *Planorbis parvus?* |
| | *Planorbis trivolvis.* |
| | *Planorbis deflectus.* |
| | *Planorbis exacutus.* |
| | *Planorbis hirsutus.* |
| *Physa heterostropha.* | *Physa heterostropha.* |
| *Amnicola porata.* | *Amnicola porata.* |
| | *Pomatiopsis lustrica.* |
| *Valvata tricarinata.* | *Valvata tricarinata.* |
| | *Campeloma decisum.* |
| PELECYPODA. | |
| *Pisidium abditum.* | *Pisidium abditum.* |
| | *Lampsilis radiatus.* |
| | *Lampsilis luteolis.* |
| OSTRACODA** | *Sphaerium simile.* |
| *Cypris* sp. | |
| Several other species. | |

†Interglacial fauna in Cayuga Valley, Jour. of Geol. 1908, vol. XVI, pp. 565-567.

*H. M. Ami lists Limnaea stagnalis and L. dedidiosa from the marl beds, Vol. XII, p. 56G, Ann. Rept. Geol. Surv. of Canada.

It will be seen that seven species only can be used for comparison between the living and fossil forms. Each of these will be taken up in detail to note what differences, if any, have arisen since the deposition of the marl beds. In the case of gastropods, four sets of measurements were made in the following order: (1) Height of shell, (2) Width of shell, (3) Height of aperture, (4) Width of aperture. In the case of the pelecypods, length, height and width were noted. Measurements were made of a series of average individuals and the means of these taken as the measurements of the species. As conditions in MacKay Lake may not be favourable to the growth of a completely normal fauna, the measurements are added of the species recorded by Mr. Frank Collins Baker*** from the region about Chicago, where the conditions are very favourable to molluscan life and individuals may be expected to reach a normal size.

The method employed in determining the measurements was as follows: The specimens of one species were placed on a smooth surface. A straight edge was then pushed through the shells and a dozen or more were separated from the rest and arranged in a row along the rule. This process was repeated until all the specimens were arranged in rows. The individuals at each end and the one in the middle of each line were measured. For instance, if one line contained seventeen shells, numbers 1, 9, and 17 were selected for measurements. Means were calculated for each species. In this way it was thought a fair average would be obtained in lieu of measuring hundreds of specimens.

A second method secured some additional data, and also acted as a check on the first. The shells were spread out and eight of the largest normal individuals both of the living and fossil forms selected and measured. It was found that the measurements taken in this way were slightly greater than those obtained by the first method, but that the ratios of living to fossil forms agreed very closely. In the tables given in this paper the results obtained by the first method are used except where otherwise noted.

**None previously recorded from these beds; all are probably new.

***The Mollusca of the Chicago Area, Chicago Acad. Sciences, Bull. No. 3, Nat. Hist. Survey.

1. *Planorbis companulatus* Say

| | H. | W. | A.H. | A.W.* |
|---|---|---|---|---|
| a. Marl from MacKay Lake | 5.18 | 9.2 | 4.56 | 3.69 |
| b. Living form, MacKay Lake | 6.27 | 11.4 | 5.5 | 4.56 |
| c. Form in Chicago area | 6.63 | 12.75 | 5.19 | 4.69 |
| Ratio b:a | 1.211 | 1.245 | 1.226 | 1.238 |

or an average ratio of 1.23.

In the case of *Planorbis companulatus* we have thus conclusive evidence that the present form is considerably larger (23%) and that the environment of the fossil species was not very suitable to it. But apart from the size the species has not changed at all. The ratios of the four standard measurements are nearly equal showing that the proportions of the shell have remained practically the same. The shell ornamentation remains unchanged also.

2. *Planorbis bicarinatus* Say

| | H. | W. | A.H. | A.W. |
|---|---|---|---|---|
| a. Marl form, MacKay Lake | 4.94 | 8.75 | 4.15 | 3.5 |
| b. Living form, MacKay Lake | 4.75 | 7.83 | 4.17 | 2.917 |
| c. Chicago form | 5.75 | 10.63 | 5.13 | 3.88 |
| d. Form from Presqu'ile Bay, L. Ontario | 6.08 | 11.33 | 5.25 | 4.16 |
| Ratio c:a | 1.164 | 1.215 | 1.231 | 1.09 |

Analysis of the above figures shows that in this case the fossil specimens are slightly larger than the living forms, a conclusion not in harmony with the previous result and, as we shall see, also differing from that reached for the majority of the species. Apparently the quiet water of Mackay lake is not well suited to *Planorbis bicarinatus*. The two broadly funnel-shaped depressions in both sides of the shell expose a very large area to erosion by carbon dioxide, which the water contains in considerable amount. Such erosion is a constant drain on the vitality of the animal, as the lime of the shell must be constantly renewed. We have also abundant evidence that the marl forms themselves were not well adapted to their environment. They show an extreme variation in the shell:—the aperture varies from sub-trigonal to sub-ovate; many specimens show traces of former apertures, as evinced by transverse thickening of the shell at one or more places in the body whorl accompanied by a change in direction in the latter; fully fifty per cent. of the specimens examined show distinct minute revolving lines occurring irregularly over the shell; the shell is also thickened unevenly about the aperture. Specimens from Presqu'ile bay, Lake Ontario, do not show any such irregularities. That the slight diminution in size of the specimens found in the lake as compared with those from the marl is local and is not a constant feature, is indicated by the measurements from the Lake Ontario and Chicago specimens. That the marly bottom of the ancient lake was not very suitable to this form, is evident from the presence of so many abnormalities in the individuals, but it was a little more suitable than the present lake.

*H.—height of shell in millimeters.
W.—width.
A.H.—aperture height.
A.W.—aperture width.

3. *Plenorbis parvus* Say. The fossil form is variable in size. It is impossible to give an exact series of measurements but the average is lower than those of the living forms to-day. This species is found in considerable numbers in the marl bed but is not nearly so abundant as *Valvata tricarinata* and *Amnicola porata*.

4. *Physa heterostropha* Say.

| | H. | W. | A.H. | A.W. |
|---|---|---|---|---|
| a. Marl form, MacKay Lake | 11.38 | 7.38 | 8.69 | 4.08 |
| b. Living form, MacKay Lake | 12.88 | 8.13 | 9.75 | 4.61 |
| c. Chicago form | 13.50 | 8.67 | 10.17 | 4.33 |
| Ratio b:a | 1.132 | 1.102 | 1.122 | 1.111 |

In the case of this species the living form is somewhat larger than the fossils. The ratio agree closely. *Physa heterostropha* shows with the other species the adverse influence of the marly bottom. The fossil form retains some of the original coloring matter in a red band inside the callus at the aperture.

5. *Valvata tricarinata* Say.

| | H. | W. | A.H. | A.W. |
|---|---|---|---|---|
| a. Marl form, MacKay Lake | 2.7 | 3.9 | 1.8 | 1.65 |
| b. Living form, MacKay Lake | 4.41 | 5.47 | 2.67 | 2.28 |
| c. Chicago form (One specimen only.) | 4.00 | 4.00 | 2.00 | 2.00 |
| Ratio b:a | 1.65 | 1.40 | 1.48 | 1.39 |

Of all the species discussed in this paper *Valvata tricarinata* shows the greatest difference in size between the present and fossil specimens. The linear measurements show that the bulk of the living animal is more than twice the size of the fossil form. This species occurs in great abundance in the marl beds and is uniformly small. The marl specimens might be considered a dwarf variety of the species which adapted itself to an unsuitable bottom environment. Many of the shells are slightly green in colour.

6. *Amnicola porata* Say.

| | H. | W. | A.H. | A.W. |
|---|---|---|---|---|
| a. Marl form, MacKay Lake | 4.2 | 3.5 | 2.23 | 1.75 |
| b. Living form, MacKay Lake | 4.2 | 3.62 | 2.1 | 1.73 |
| c. Chicago form | 5.00 | 4.25 | 2.8 | 2.08 |

These figures show that a. and b. are practically identical in measurements.

This species has not changed at all in the area under discussion but neither its marl environment nor its present one in MacKay Lake have allowed it to attain its maximum growth. This is seen by comparing them with normal forms from the Chicago area which are much larger as shown by the figures above.

7. *Limnaea galbana* Say was first described as a fossil and has since been found living. It was not found living in MacKay Lake. The specimens from the marl beds average a little larger than Say's type. This species is such a persistent member of the marl bed faunas throughout the Northeastern United States and Canada that it seems especially fitted for such a habitat. The living species prefers clear water more or less in movement, which fact probably excludes it from the lake at present.

8. *Pisidium abditus* Haldeman.

| | Height | Width | Length |
|---|---|---|---|
| a. Marl form | 2.25 | 1.96 | 2.62 |
| b. Present form | 3.25 | 2.83 | 4.03 |
| c. Chicago form | Measurements not available. | | |
| Ratio b:a | 1.44 | 1.44 | 1.54 |

*P. abditum* is the only pelecypod found common to the fossil and present faunas of MacKay lake. The figures above show the present form to be much larger than the fossil shell.

It is interesting to consider for a moment the pelecypod fauna. *Pisidium abditum*, the only representative in the marl, is uniformly small, and, though fairly abundant, is not comparable in numbers at all with the gastropods. In the present lake fauna *Lampsilis radiatus* and *L. lueolis* are found but in small numbers, and not far from the outlet. These members of the Unionidae cannot thrive apparently in stagnant water. On the other hand, the members of the Sphaeriidae, represented by *Sphaerium simile* and the species of *Pisidium* are to be found in fairly large numbers in these waters.

## DEPAUPERATION.

An examination of the data for the species discussed above shows all the fossil forms with the exception of *Amnicola porata* and *Planorbis bicarinatus* to be smaller than their existing descendants in the lake of to-day. Even these exceptions are smaller than normal. The tables show that exclusive of ostracods only eight species are common in the marl beds while sixteen are found in the present lake and this number would be exceeded if an exhaustive search were made. What caused the depauperation of the marl bed fauna? As noted above it seems probable that the bottom environment had a great deal to do in this connection and that the marly bottom was very unfavourable to most of the species. No marl is being deposited in the lake at the present time. But in the shallow bay to the east the bottom is composed of this material. This represents either an old marl bed in situ below water level or the accumulated wash from higher beds. The water is seldom more than four feet in depth in this bay. A very small amount of muddy sediment overlies this marl and is covered by a scanty aquatic vegetation consisting mainly of algae. The molluscan life in this area is scanty, few living shells were obtained, and these were mostly the ubiquitous species *Valvata tricarinata* and *Amnicola porata*. The latter was mostly found attached to the submerged plant stems and comparatively few were found on the bottom itself. *Pisidium* can live attached to algae and other aquatic plants, and thus remain somewhat away from the influence of the marl. The heavy shelled forms like the Unionidae, however, must live directly on the bottom. The marl acts unfavourably on such species probably by clogging their gills. It is not surprising therefore, that these forms are entirely wanting in the marl fauna.

In contrast, on the western side of the lake there are two different types of bottom, one composed of soft mud with an abundant plant growth, while the other is composed of rock covered with debris both organic and inorganic. The first named area provided every species obtained in the lake in great abundance except *Campeloma decisum*, *Lymnaea stagnalis*, and *Planorbis trivolvis*. The two latter species were found here also but were attached to submerged objects and not on the bottom. The rock covered with debris had also a considerable fauna—much greater than that of the marl beds in the eastern bay so it seems that here at any rate the marl bottom is perjudicial to a flourishing molluscan fauna. The marl bottom is not conducive to growth of many water plants. Certain algae and other low forms are the most common. Such species as *Amnicola*, small forms of *Planorbis* and *Valvata* can attach themselves to these algae but prefer lily stems and pads and other plants with vigorous stem and leaf growth.

As mentioned above the marl matrix is not composed of shell fragments but of a fine impalpable powder of calcium carbonate. Two theories have been propounded to account for such a type of deposition. Both consider the lime to have been precipitated from solution by various agents. The older hypothesis holds that the high percentage of carbon dioxide in spring water is reduced when it enters the lake. As a consequence, the calcium carbonate, which has been held in solution through the presence of the excess carbon dioxide, is precipitated. The other theory attributes the same result to the work of algae which remove the carbon dioxide. It is quite possible that both agencies have been operative at MacKay Lake; but, however precipitated, the marl in a finely divided state, would be injurious to the molluscan fauna and account for its depauperation.

Another factor which no doubt must have exerted considerable influence in this connection was the colder climate which probably existed when the marl was accumulating. Such conditions would tend to make short thick shelled forms with the vital organs concentrated as much as possible. A glance over the marl fauna shows this to be conspicuously true. *Valvata*, *Amnicola*, the represented species of *Planorbis*, all belong to this class. *Lymnaea galbana* with its shouldered thickset whorls is a remarkable contrast to *Lymnaea stagnalis appressa*. *Planorbis trivolvis* a large thin shelled species is missing from these marl beds.

The marl of MacKay Lake, therefore, seems to have a depauperate fauna due to an adverse bottom environment and, probably, to a cold climate. It would be interesting to note if, in other districts, similar results could be obtained from a comparative study of the fossil and recent forms. MacKay Lake, however, lends itself particularly well to this kind of study as the marl beds are in such close proximity to the lake. Instructive results would probably be obtained if the fresh water fauna of the Toronto formation were subjected to this type of study.

NOTE—The writer wishes to gratefully acknowledge the valuable assistance and suggestions received from Dr. E. M. Kindle of the Geological Survey of Canada.

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The Division of Exhibits of the United States Food Administration, Washington, offers to assist any museum to develop a special exhibit to illustrate the need of conserving foods. A handbook of "Graphic Exhibits" has been printed. Mimeograph copies of plans for larger exhibits have been prepared. Copies have been secured of a series of 13 charts, designed and written by Elizabeth C. Watson, under the title, "Why Food Conservation is Necessary." All these are sent to any museum upon request.

## MOST UNUSUAL DEER HEAD WITH EYE TEETH.

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The White-tailed Deer (*Odocoileus virginianus*), is well known as a bearer of great variations. The horns of the older animals exhibit many freak forms but it is not usual that a natural freak is seen in a young deer. The following note is of a freak in a young deer not over four years old and refers to the teeth and not to antlers, in which there are "eye teeth" or tusks (quite well developed for the age); both are evenly matched and slightly curved back, standing out from the jaw about three-eighths of an inch. A characteristic of the deer family is the absence of front teeth in the upper jaw, the only exception being found in the Elk group (*Cervus*), which when over four years usually develop eye teeth in the male sex only. Taking the formation of teeth in all the larger animals, the majority still carry the eye teeth, or show signs that they did in generations of long ago, and I conclude, therefore, that the deer family also had normal teeth in earlier times so it would be hard to say just how many generations this little deer has been thrown back to his former ancestors. I enquired at the Victoria Memorial Museum, Ottawa, if the officers there had ever known of this freak before and the Director replied that he could find no previous record. I also wrote to the U.S.N.M., Smithsonian Inst., Washington, D.C., and was informed that it is of most unusual occurrence, though they have one from Arizona. I gather, however, that the Arizona record is the only one they know of, but, in this, I may be mistaken. The specimen here recorded was killed near Yahk, B.C., in December 1917, and now forms part of my collection.

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As an example of the possibilities of economic zoology, it is interesting to report that the U.S. Biological Survey which has long been engaged in the control of rodent and other pests in various parts of the country, has detailed a staff to France to make similar attempts against the rats that infest the battlefields. These animals, disgusting in themselves, are also a source of danger to the trenches by their habits of undermining and to the troops owing to the food and material they destroy and their potential possibilities as disease carriers. Should even partially effective means of control be evolved they will demonstrate the practical value of scientific research in a most convincing manner.

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Whittaker, E. J. 1918. "The Relationship of the Fossil Marl Fauna of MacKay Lake, Ottawa, to the Present Molluscan Fauna of the Lake." *The Ottawa naturalist* 32(1), 14–18.

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