

ON THE DEEP WATER CRUSTACEA OF GREEN LAKE.

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During the past two seasons I have become interested in the deep water fauna of Green Lake, and have made a large number of collections. While the results may not be particularly striking, I think they are of sufficient interest to warrant the presentation of a short paper on the subject. Because of its depth, Green Lake resembles, in the conditions controlling animal life, the larger bodies of water, and might be expected to have a fauna somewhat different from that of the shallower lakes. My collections seem to justify this expectation.

It is only within a few years that it has been deemed worth while to make any investigation of the fauna of deep water. Even after the existence of a very rich pelagic fauna in the oceans was recognized, bodies of fresh water were almost entirely neglected. Now, it is well known that our lakes have a pelagic fauna rich in individuals, if not in species, and a less abundant abyssal fauna. Most of the European lakes have been explored with more or less thoroughness. Especially noticeable is the extended work of Prof. Forel upon Lake Geneva and the smaller Swiss Lakes.

In this country comparatively little has been done. Since the initiatory work of Dr. Hoy in Lake Michigan, some twenty years ago, so far as I know, only two persons have published anything on this subject — Prof. S. I. Smith, and Prof. S. A. Forbes.

The bottom of Green Lake, in the deeper parts, is a fine blue clay, in which are great numbers of ostracod shells and some few shells of molluscs. I submitted the molluscs to Mr. C. T. Simpson of the United States National Museum, who tells me that there was nothing of especial interest among them. They were all littoral forms, and, in most cases, probably washed in from shallower water.

There were also several species of hydrachna, worms, and infusoria, which I have not worked out. The crustacean fauna is extremely abundant, although the number of species is small.

The following species were noted:

- Diaptomus sicilis* Forbes.
 " *minutus* Lillj.
Epischura lacustris Forbes.
Limnocalanus macrurus Sars.
Cyclops fluviatilis Herrick
 " *serrulatus* Fischer.
Canthocamptus sp.
Cypris sp.
Daphnella brachyura Baird.
Ceriodaphnia reticulata Jurine.
Daphnia kalbergensis Schoedler.
Bosmina sp.
Alona glacialis Birge.
Leptodora hyalina Lillj.
Pontoporeia Hoyi Smith.
Mysis relicta Loven.

There were, besides, several forms of *cyclops*, which seem to differ from any described American species. As I am now engaged in a study of this genus, I will leave their description for a later publication. None of the species of *cyclops* which I have found is peculiar to the deep water, as I have found the same forms in the littoral zone of the lake, and in smaller bodies of water in the vicinity.

The pelagic fauna consists mainly of the following species: *Diaptomus minutus* Lillj; *Diaptomus sicilis* Forbes; *Epischura lacustris* Forbes; *Limnocalanus macrurus* Sars; *Daphnia kalbergensis* Schoedler; *Leptodora hyalina* Lillj. All of these, with the exception of *limnocalanus macrurus*, come to the surface at night. The species of *cyclops* are represented very sparingly, and *canthocamptus*, *daphnella*, *ceriodaphnia*, and *alona* are quite rare. Evening collections showed vast numbers of *diaptomus minutus* and *epischura lacustris*, and in some cases of *leptodora hyalina*. I found *bosmina* very abundant in November, but rather rare in the summer months. The *abyssal crustacea* are *cypris*, *pontoporeia Hoyi* Smith, *mysis relicta* Loven, and perhaps some of the forms of *cyclops*. Especial interest, perhaps, attaches to three species of the preceding list.

Diaptomus minutus Lillj. is found in great numbers, being much more abundant than *diaptomus sicilis* Forbes. My specimens correspond very closely to the description by Lilljeborg, as given in "Revision des Calanides d'Eau Douce," by Guerne and Richard, differing only in the following particulars. The joints of the right fifth foot of the male are shorter and stouter, and the terminal claw is longer and somewhat more slender; the lateral spine on the last joint is blunt. The inner ramus of the left foot is more nearly elliptical. The animal aver-

ages somewhat smaller than the type. These differences are so minute that I consider them only varietal, although they are constant in the specimens I have examined.

Diaptomus minutus has been found, hitherto, only in Greenland and Newfoundland, although it seems probable that it is widely distributed over the northern part of North America.

Pontoporeia Hoyi Smith, has been found, hitherto, only in Lake Superior and Lake Michigan. A species almost identical with it, *pontoporeia affinis* Kroyer, occurs in the abyssal fauna of the Scandinavian lakes.

Mysis relicta Loven, was first found in the Scandinavian lakes. It is so closely allied to *mysis oculata* Kroyer, a marine form found off the coast of Labrador and Greenland, as to be considered only a variety of that species. It was found in Lake Michigan by Dr. Hoy, receiving the name of *mysis diluvianus* from Prof. Stimpson. Later, Prof. S. I. Smith collected specimens in Lake Superior. I have not had an opportunity to compare my specimens with those from the Great Lakes, or with the original description of the Scandinavian form, but I have little doubt that they are identical with them.

When we compare the deep water crustacea of Green Lake with those of Lake Michigan and Lake Superior, as shown in the lists published by Prof. Smith and Prof. Forbes, we find a striking similarity. That this should be true of the pelagic fauna is not strange, for it is easy to explain the migration of such forms from one body of water to another through the agency of water fowl.

The presence of *pontoporeia Hoyi*, and *mysis relicta* however, is not so easily explained. They are abyssal forms, found only in deep water, and never coming to the surface. Their presence in the Scandinavian lakes is explained by supposing that the bodies of water, in which they are found, were formerly connected with the sea, and that, when the access of salt water was cut off, the change to fresh water was so gradual that the animals accustomed themselves to their new conditions of existence. They belong to the "fauna relegata" or "relictken-fauna" of the Germans. This explanation does not seem to apply to Green Lake. The lake is of glacial origin, a dam of drift at the western end preventing its waters from flowing into lake Puckaway. The outlet of the lake is a small stream flowing through the village of Dartford, and emptying into the Fox River. So far as I know, there is no geological evidence whatever of any connection of Green Lake with either the Mississippi Basin or the Great Lakes, by which these deep water animals could have migrated to their present location.

The problem is one for which I can at present offer no solution.