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## Notes on the Tardigrada of Minnesota

The investigations of the Tardigrada of Minnesota on which this report is based are described more completely in two unpublished reports to the National Science Foundation (Boudrye, 1954, 1955). The first detailed the results of a survey of the Itasca State Park region to determine the presence or absence of the common genera. The second study initiated a more intensive investigation of the moss flora of the state as a habitat for tardigrades.

### INTRODUCTION

Tardigrades have been rather intensively studied for many years in Europe; principally by Marcus, Cuénot, Richters, Murray, Thulin, and Remazotti; in South America by Rahm; in the South Pacific by Marcus and Richters; but few investigations on Tardigrades are reported for North America. Early reports by Beal (1880) and Packard (1873) have been followed by a brief note by Hay (1917) and the paper by Mathews (1938) in which are listed the species which have been reported for North America north of Mexico.

The chapter in Pennak (1953) on Tardigrada is the only modern English discussion of the group in the literature and contains a key to the genera. The key to species used during the period of this investigation was that of Cuénot (1932) which is based upon the species found in France. Of the species reported for North America by Mathews (1938), 14 are not keyed in Cuénot.

The 32 species reported from North America north of Mexico by Mathews include 1 species from Alaska, 20 species from British Columbia and the Canadian Rockies, 4 from California, 1 from the

District of Columbia, 1 from Illinois, 1 from Maine, 2 from Michigan, 1 from New York, 1 from North Carolina, 4 from Ontario, 1 from Texas, 3 from Washington, 4 from Wisconsin, and 1 from Vermont.

Mathews, while discussing generally the habitats in which Tardigrada may be found, fails to indicate the types of habitats from which the North American forms were obtained. From the discussion in Pennak and in Cuénot, it is evident that the following should be investigated as possible sources of the animals: Mosses, Lichens, Liverworts, Algae, psammolittoral areas, bottoms of ponds and streams, and the littoral areas of lakes.

#### METHODS

*Collections:* 1. Samples of mosses and lichens were placed in suitable glass, plastic or paper containers, marked with a number corresponding to the field note which recorded the appropriate data of the collecting site and habitat, and returned to the laboratory for study.

2. Littoral vegetation including mosses was washed vigorously in a pail of water, the water then strained through a standard plankton net, and the samples numbered as above.

3. Material was obtained from the bottoms of ponds by means of a bottom sampling net, placed in large glass jars and identified by number.

4. A measured area of the psammolittoral zones was removed to a depth of 4–6 cm, the sand washed in five changes of water and the water strained through a standard plankton net. Samples were numbered as indicated above.

*Examinations:* 1. Mosses and lichens were dried and retained in the dried state until examination of the sample could be accomplished. Placing a portion of the dried sample in water, usually overnight, was sufficient to restore any animals to the active state. Washing of the vegetation was followed by pipetting of the wash water for microscopic examination. Usually ten slides were examined before discarding a sample as negative for the presence of Tardigrades.

2. Washings of littoral vegetation were examined as promptly as possible after returning to the laboratory. Ten slides again constituted the examination sample.

3. Various collections of freshwater algae were preserved by drying after the methods of Drouet and retained for subsequent examination.

4. Bottom samples were spread in large flat-bottomed, white enameled pans. Sub-samples in petri dishes were examined with the dissecting microscope and slide samples of the more promising materials studied with the compound microscope.

5. Psammolittoral samples were examined by means of the dissecting microscope and the compound microscope. Ten slides constituted the sampling unit. Several of these collections were centrifuged in an attempt to concentrate the animals and thus facilitate the examination. No significant differences was observed in the centrifuged samples.

#### DISCUSSION

Three of the genera of Tardigrada are found in the Itasca Park region and one has been found in other parts of the state. The genus *Macrobotus* is found in mosses, in psammolittoral zones, in stream bottoms and in the algae. The genera *Milnesium* and *Echiniscus* have been found in the lichen flora.

The numbers of individual animals found have been very small, only one or two specimens being seen in a single sample. We may, in this case, be dealing with a low level of a fluctuating population. Pennak (1953) has suggested that the aquatic species have a peak abundance between January and May, with a second maximum in the autumn. The species inhabiting mosses are alleged not to fluctuate in abundance, however. It would be interesting if one finds a seasonal fluctuation in the populations inhabiting lichens as one would expect these to behave like the moss dwellers. An improvement in the method of washing the vegetation, employing a small quantity of detergent and centrifuging the washings, has not resulted in a large number of specimens being obtained from the samples.

Collecting during the autumn months and using the improved methods of washing and concentrating, may help to resolve the question of abundance. Certainly there has been no collection as rich in specimens as has been reported from the psammolittoral areas by Pennak and for the moss fauna as reported by various European

investigators. Many of the mosses on which these animals live in Europe are present in Minnesota (Grout, 1903). Probably others listed by Marcus (1929b.) are present also.

On the basis of the initial examination of the moss collections of 1955, it is therefore surprising that no animals were found. It must be remembered, however, that each collection represents only a small fraction of the available flora of a particular type, and that the examinations were made on less than 20 percent of the sample in hand. One has no reason to assume that additional collections and/or examinations will not reveal the presence of the animals.

There would seem to be some indication that other habitats may be richer in Tardigrade fauna. The lichen flora yielded animals in 3 of 10 samples analyzed and the psammolittoral zone in 3 of the 8 samples analyzed.

#### SUMMARY

1. From 125 collections made between June 15 and October 23, 1954, specimens of *Macrobotus* were seen from submerged mosses, algae, and the psammolittoral zone. Specimens of *Echiniscus* and *Milnesium* were found in lichens, principally those growing on *Betula papyrifera*.

2. From 161 collections made between April 10 and August 24, 1955 *Macrobotus* was seen from a single stream bottom sample. No Tardigrades were seen in 91 collections of mosses.

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