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*Triaenophorus* investigation in the Thunder Bay District

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## INTRODUCTION

Investigation of Onaman Lake and Lake Muskeg in this district has established the absence of Triaenophorus crassus Forel in the former and the presence of a high infestation in the latter. A dwarf herring, hitherto unreported, was found in Lake Muskeg. Lake Muskeg studies showed a large relative pike population and a planktonic food habit of the whitefish-factors which may be correlated with the high infestation of the parasite. Ecological attributes of both lakes were compared in the search for differences which might be related to the absence or presence of the cestode.

The party under the direction of Professor J.R. Dymond, University of Toronto, was financed by the Fisheries Research Board of Canada and the Department of Lands and Forests, Province of Ontario. Work on Onaman Lake was commenced June the sixth and completed July the fifteenth, while studies on Lake Muskeg were carried out in the period from the seventeenth of July to the eleventh of August. The party consisted of Mr. Witold Klawe, a second year student at the University of Toronto, and myself. In addition Field Officer G. Clifford of the Department of Lands and Forests rendered valuable assistance and provided transportation in the district.

### Description of the Lakes

Onaman Lake is situated thirty-five miles north-west of Geraldton in the Nipigon-Onaman Crown Game Reserve, its exact location being latitude 50.00°N. and longitude 87° 30'W. It has an area of thirty square miles and drains by the Onaman River to Lake Nipigon. Nine small streams empty into the lake from the surrounding spruce and balsam forest.

Lake Muskeg, located fifty-six miles north-west of Port Arthur, is smaller, its surface area is approximately eighteen square miles. The lake having a latitude of 49.00°N. and a longitude of 90.00°W., is more southerly and drains to Lake Superior via Dog Lake. Numerous streams empty into the lake, many of them having their sources in the surrounding balsam and black spruce muskegs. Kaogomok Creek, draining a series of small lakes to the west, is the largest stream contributing to Lake Muskeg. More hardwood is to be found at Lake Muskeg, where such trees as poplar, birch, and alder form a significant portion of the coverage.

Both lakes represent shallow northern lakes. The maximum depth observed in Onaman Lake was twenty-five feet, while soundings in Lake Muskeg revealed a large hole of forty-five feet. Deep areas in Onaman were restricted to three small depressions, the greater portion of the lake having an average depth of 15 feet. A large area on the east side of Lake Muskeg gave soundings of 36 to 40 feet. Rocky shore line made up the greater percentage of the Onaman Lake shore, while sand and mud banks are common to Lake Muskeg.

Similar topography surrounds both lakes. The terrain consists of low flat lands and rolling hills. Low rocky ridges typical of the Canadian Shield are to be found at Onaman Lake and form the backbone of many of the lake's islands. A peculiar red colour of the rocks is described in the Indian name "Onaman" meaning in the Objibway tongue, "red paint". At Lake Muskeg few rocky ridges were apparent as the lake seems to be located in an area of glacial sand deposits. High bluffs of hard-packed sand make up a portion of the east shore and represent the highest ground adjacent to the lake.

Islands break up the continuity of both lakes. The northern half of Onaman Lake is studded with islands while the southern and deeper half is open and clear. A ridge of islands divides Lake Muskeg into two areas of open water.

Contribution to and Drainage from the Lakes

Onaman Lake is fed by nine small creeks, five of which were found and traced for a short distance by the party. The largest of these is Paska Creek which drains Paska Lake, a small lake lying to the east of Onaman Lake. At its mouth the creek is two feet deep and about twenty feet wide. Of the four other creeks investigated, two have headwaters in small ponds near Onaman Lake, while the other two have their sources in low, swampy ground. The lake itself is drained by the Onaman River which is thirty-four miles long and which empties into Humboldt Bay on Lake Nipigon. Three falls and ten rapids are to be found along

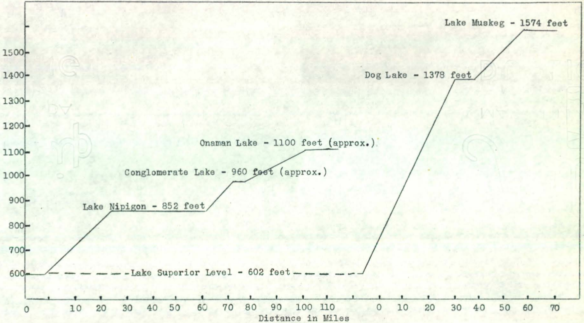


Figure 1. Elevation of Onaman Lake and Lake Muskeg drainage systems. (Elevations supplied by Dominion geodesist).

the course of the river which drops 300 feet between its source and mouth. Fourteen miles from its mouth the river widens to form Conglomerate Lake, a lake similar in character to Onaman Lake. Seven miles from the mouth, the river is met by the North Onaman River which drains another chain of lakes farther to the north.

Kaogomok Creek is the largest of the many creeks which drain into Lake Muskeg. It drains Ricestalk and Upper and Lower Kaogomok Lakes. At its mouth the creek is four to five feet deep and twenty to thirty feet wide. In the last two miles of its course it meanders through desolate muskeg. Numerous other streams empty into Lake Muskeg, but these are small local streams having their sources in the surrounding bogs and muskegs. A small creek with several rapids and falls drains Lake Muskeg into the Dog River and thence to Dog Lake which is 196 feet lower in elevation. Dog Lake drains via the Kaministikwia River into Lake Superior with a drop of 706 feet in elevation.

## Migration of Fish Bearing *Triaenophorus*

There is a heavy *Triaenophorus* infestation of fish in Lake Nipigon and in several other lakes of this district; for example, North Wind Lake. The parasite appears to be absent from Onaman Lake. Onaman Lake is situated near the apex of three drainage systems; namely, the drainages to Lake Superior, to James Bay, and to Lake Nipigon. This indicates that it has a limited drainage area. There are no significantly large lakes or rivers emptying into Onaman Lake. Thus, infestation from other bodies of water is limited to those fish which may enter via the Onaman River from Lake Nipigon, or from the North Onaman drainage system. I think that few, if any, enter by this river. A climb of 300 feet, through ten rapids and up three falls would deter any migratory movement in this direction. Evidence supporting this view was given to me by commercial fishermen at MacDairmid, who reported that herring in spawning runs do ascend the Onaman River, but that spawning occurs below the first large rapids situated six miles from the mouth. Here the river falls 108 feet in elevation in the short distance of fifty-five chains.

Lake Muskeg, on the other hand, might receive fish from the series of lakes above it. Kaogomok Creek with its slow meandering course would provide an excellent route for the migration of pike into the lake. Herring might use this creek in their spawning runs. Migration from Dog Lake, via the Dog River might be a possiblity, although I have no evidence to support it. No large falls or rapids occur along its course. It rises only 196 feet along its twenty-mile course. This approximate rise of ten feet per mile would present no barrier to fish migration.

Onaman Lake would appear to be a closed lake to the entrance of Triaenophorus-bearing fish, while Lake Muskeg seems to have two possible routes of entrance for infested fish.

Morphometry

There is a distinct difference in the shore lines of the two lakes. Almost all of Onaman Lake's shore is composed of a beach of large boulders. At a short distance from shore the bottom usually drops to a depth of four to six feet, and then slopes gently down to the average depth of twelve to fifteen feet. The shore at Lake Muskeg is characterized by sand beaches. The bottom slopes gradually from the shore line, and at a depth of about three feet changes from sand to a muddy clay.

Little of Onaman Lake had visible aquatic vegetation at the time of the project. Indications pointed to the growth of *Juncus* sp. in small sheltered bays. Vegetation in Lake Muskeg, on the other hand, covered roughly one-fifteenth of the Lake's area. Two forms of *Potomogeton* were found in the open water, while *Juncus* sp. and *Phragmites communis* were found along the shore.

Physical and Chemical Features of the Water

Temperature readings showed the usual seasonal fluctuations. Readings in early June at Lake Onaman showed the bottom temperatures to range from $10^\circ$ C. to $14^\circ$ C. Later, on the fifteenth of July, surface temperatures had climbed to $18.5^\circ$ C. to $19.5^\circ$ C. The temperatures in Lake Muskeg were higher since they were taken later in the summer. Here, surface temperatures ranged from 19.0° C. to 21.5° C. with a high of 23.2° C. recorded at one station on the fifth of August. Bottom temperatures at a depth of seven fathoms ranged from 16.1° C to 17.5° C. Thermal stratification was not apparent at Onaman Lake, but a thermocline was located at the seventeen to nineteen foot depth in Lake Muskeg on the tenth of August. These temperatures may be slightly under the normal averages for these lakes, as summer temperatures throughout the North were lower than usual during the past summer.

PH readings varied little between the two lakes and remained constant throughout the duration of the investigation. A surface pH of 7.5 ± .1 was found in both lakes. There was a variation with depth. A pH reading of 6.8 units was found at the forty-two foot depth in Lake Muskeg, and a reading of 7.2 units was taken at a depth of twenty feet in Onaman Lake.

The water of Lake Muskeg is a darker brown shade than that of Onaman Lake. Visibility is restricted in both lakes to an approximate depth of six feet (Secci disc). Deeper readings were taken at times on Onaman Lake. Rich phytoplankton in Onaman Lake was an equalizing factor serving to give a similar reading to those of Muskeg Lake with its darker brown coloured water.

Limited bottom observation indicated different types of bottom in each lake. Onaman Lake had a gyttja layer of three to six feet covering a large area of the bottom. On one occasion the nets were completely fouled with the benthotic matter. A greater portion of the bottom of Lake Muskeg was covered with a

Table I. Whitefish infestation by <u>Triaenophorus</u> in Lake Muskeg.

| Year Class | No. of fish Sampled | No. of cysts | Av. Wt. of fish (lb.) | Infestation /100 lb. | Infestation /100 fish | Per cent Infested of sample |
|---|---|---|---|---|---|---|
| 1+ | 12 | 6 | .094 | 531 | 50 | 33 |
| 2+ | 18 | 12 | .222 | 300 | 67 | 44 |
| 3+ | 58 | 107 | .46 | 400 | 184 | 71 |
| 4+ | 130 | 369 | .79 | 360 | 284 | 76 |
| 5+ | 54 | 125 | 1.27 | 183 | 231 | 85 |
| 6+ | 21 | 75 | 1.91 | 187 | 357 | 91 |
| 7+ | 15 | 103 | 2.66 | 258 | 687 | 93 |
| 8+ | 9 | 81 | 2.99 | 300 | 900 | 89 |
| 9+ | 3 | 22 | 4.04 | 181 | 733 | 66 |

blue clay containing considerable quantities of phytoplankton. This layer measured six to twelve inches in depth.

Plankton

Samplings of the plankton in both lakes revealed differences in quantity and in type. Onaman Lake showed a richer culture of phytoplankton than Lake Muskeg. In general, the plankton of Lake Muskeg did not appear as heavy as that of Onaman Lake in either phyto or zooplankton. No lists of the plankton are available at present, but will be tendered in a supplementary report at a later date.

Triaenophorus Life History Study

Cuttings on two hundred whitefish from Onaman Lake showed no *T. crassus* cysts. All other hosts of the parasite's life history are present with the exception of herring. *Cyclops* sp. and *Esox* were taken in all sections of the lake. Examination of cysts from the liver of *Perca* and from the gut of *Stizostedion vitreum* have not been made yet, so that it is difficult to say if the other two members of the genus exist in the lake. These parasites are to be examined later, and the supplementary report will contain their identification.

Examination of three hundred and twenty whitefish and thirty-eight herring from Muskeg Lake revealed a seventy-two per cent and a ninety-six per cent infestation respectively. All animals necessary to the life history of the cestode are present

Table II. Herring infestation by <u>Triaenophorus crassus</u> in Lake Muskeg.

| Year Class | No. of fish | No. of cysts | Av. wt. of fish (lb.) | Infestation /100 lb. | Infestation /100 fish | Per cent Infestation of sample |
|---|---|---|---|---|---|---|
| 1+ | 1 | 1 | .0625 | 1600 | 100 | 100 |
| 2+ | 8 | 15 | .082 | 2280 | 188 | 100 |
| 3+ | 28 | 56 | .105 | 1960 | 200 | 85 |
| 4+ | 1 | 2 | .125 | 1600 | 200 | 100 |

in the lake. Perch livers examined macroscopically showed the presence of a parasite. These also will be examined at a later date. The absence of Stizostedion vitreum in this lake excludes the presence of Triaenophorus stizostedionensis.

Infestation of Triaenophorus crassus in Coregonus clupeaformis and Leucichthys sp. in Lake Muskeg

Counts of cysts were made in the usual manner and are tablulated here (Table I) to show the relative infestation of each year class for both whitefish and herring. In the case of the whitefish, 403 fish were actually examined, but eighty-three of these were rejected on the grounds that their damaged condition prohibited accurate determination of the cyst count. Similarly fifty-two herring were examined and fourteen discarded.

Table I shows some interesting facts. Percentage infestation increases with age until the seventh year, at which point it decreases. The number of cysts per hundred fish show a similar increase and decrease, but the decrease does not occur until the eighth year.

The number of herring taken in the nets is too small to derive much statistical information of value, but Table II shows an increase with age in the number of cysts per hundred fish. The difference of infestation between the herring and whitefish is interesting when considered on the basis of the number of cysts per one hundred pounds of fish.

Table III. Relative abundance of fish in the lakes. Calculated number is per 100 gill-net sets.

| Species | Lake Onaman | | Lake Muskeg | |
|---|---|---|---|---|
| | Actual catch | Calculated number | Actual catch | Calculated number |
| Coregonus clupeaformis | 219 | 348 | 389 | 393 |
| Leucichthys sp. | - | - | 55 | 56 |
| Esox lucius | 49 | 78 | 337 | 344 |
| C. commersoni | 238 | 378 | 280 | 286 |
| Moxostoma aureolum | 5 | 8 | - | - |
| Moxostoma anisurum | 4 | 6 | - | - |
| Stizostedion vitreum | 700 | 1111 | - | - |
| Perca flavescens | 64 | 98 | 110 | 111 |
| Lota lota maculosa | 2 | 3 | - | - |

Relative Abundance of Fish in the Lakes

Nine fifty-yard nets of meshes 1½", 2", 2¼", 2½", 2¾", 3", 3½", 4" and 4½", were used to sample the fish population of each lake. Sixty-three individual gill-net sets were made in Onaman Lake, while ninety-three were made in Lake Muskeg. In order to secure an index of relative abundance, I have resolved the gill-net records to a common denominator for each lake. Table III gives the results.

No herring were taken in the nets at Onaman Lake. There seems to be sufficient evidence that this fish does not occur in the lake. Mr. McKirdy, the commercial fisherman on the lake, reported to me that in his fifteen years of fishing he had taken no herring. This forbids any comparison with Lake Muskeg.

The population of whitefish in both lakes would seem to be about equal, while the relative pike population shows considerable difference. In Onaman Lake there seems to be five times as many whitefish as pike, whereas their relative populations are about equal in Lake Muskeg.

Seining and gill-netting has revealed the following species from each lake.

| Onaman Lake | Lake Muskeg |
|---|---|
| Coregonus clupeaformis | Coregonus clupeaformis |
| Catostomus commersoni | *Leucichthys sp. |
| Moxostoma aureolum | Catostomus commersoni |
| Moxostoma anisurum | Notropis hudsonius |
| Notropis hudsonius | Notropis heterolepis |
| Esox lucius | Esox lucius |
| Perca flavescens | Percopsis omiscomaycus |
| Stizostedion vitreum vitreum | Perca flavescens |
| Lota lota maculosa | Poecilichthys exilis |
| Eucalia inconstans | Eucalia inconstans |

* Further identification on this species is being carried out at the Royal Ontario Museum of Zoology under the direction of Dr. W.B. Scott.

Table IV. Whitefish stomach analyses. (Fifty-five stomachs constituted sample for Onaman Lake, forty stomachs for Muskeg Lake).

| Food Item and Classification | Lake Onaman Frequency | Lake Onaman Frequency as per cent of whole | | Lake Muskeg Frequency | Lake Muskeg Frequency as per cent of whole | |
|---|---|---|---|---|---|---|
| Planktonic | | | | | | |
| Holopedium | 7 | 4.3 | | - | - | |
| Daphnia | 7 | 4.3 | | 22 | 38 | |
| Cyclops | 2 | 1.2 | | 1 | 1.7 | |
| Diptera larvae-Choaborus | 28 | 17.2 | | 13 | 22.3 | |
| Gyrinid beetles | 2 | 1.2 | | - | - | |
| Hydrophilid adult | 2 | 1.2 | | - | - | |
| Leeches | 7 | 4.3 | | - | - | |
| | | | 33.0 | | | 62.0 |
| Benthotic | | | | | | |
| Nemerteans | 2 | 1.2 | | - | - | |
| Unid Amphipoda | 1 | .6 | | 1 | 1.7 | |
| Hyallella | 27 | 16.3 | | - | - | |
| Cladocera winter eggs | 3 | 1.7 | | 1 | 1.7 | |
| Odonata | 1 | .6 | | - | - | |
| Mayfly larvae | - | - | | 11 | 19 | |
| Caddis fly larvae | 15 | 9.1 | | 1 | 1.7 | |
| Insect remains | 2 | 1.2 | | 2 | 3.5 | |
| Mites | 17 | 10.4 | | 1 | 1.7 | |
| Amnicola | 17 | 10.4 | | - | - | |
| Pisidium | 17 | 10.4 | | 5 | 8.7 | |
| Planorbis | 2 | 1.2 | | - | - | |
| Plant parts | 4 | 4.3 | | - | - | |
| | | | 67.0 | | | 38.0 |
| Total | 163 | 100 % | | 58 | 100 % | |

Table V. Pike stomach analyses from Lakes Onaman and Muskeg (Forty-six stomachs constituted the sample from Onaman, 329 from Muskeg).

| Food item | Lake Onaman No. of stomachs | Lake Onaman No. as per cent of sample | Lake Muskeg No. of stomachs | Lake Muskeg No. as per cent of sample |
|---|---|---|---|---|
| Empty | 20 | 44 | 196 | 59.6 |
| *Coregonus clupeaformis* | - | - | 4 | 1.2 |
| *Leucichthys* sp. | - | - | 26 | 7.9 |
| *C. commersoni* | 4 | 8.6 | 8 | 2.4 |
| Minnow | - | - | 1 | .3 |
| *Esox lucius* | - | - | 4 | 1.2 |
| *P. omiscomaycus* | - | - | 4 | 1.2 |
| *Perca flavescens* | 5 | 10.7 | 27 | 8.0 |
| *Stizostedion vitreum* | 2 | 4.3 | - | - |
| *Eucalia inconstans* | - | - | 4 | 1.2 |
| Unid. fish remains | 3 | 6.5 | 32 | 9.8 |
| Arthropod | 2 | 4.3 | - | - |
| Dragon fly nymphs | 7 | 15.1 | - | - |
| Mayfly larvae | - | - | 5 | 1.5 |
| Insect larvae | - | - | 12 | 3.6 |
| Leeches | - | - | 2 | .6 |
| Unid. remains | 3 | 6.5 | 4 | 1.2 |

Stomach Analysis

In an effort to gather data on the food habits of whitefish, stomachs were analysed for planktonic or benthotic matter. In Table IV the frequency of the food items are listed for both lakes. The table shows that two thirds of the food items of Onaman Lake whitefish were of a benthotic nature. The food items of the Lake Muskeg whitefish are sixty-two per cent planktonic. This difference in food habit may be an important factor in the infestation of whitefish.

Pike stomach analyses are shown in Table V. In Onaman Lake there appears to be no predation by the pike on the whitefish, however, pike predation on whitefish occurs in Lake Muskeg. Of the fish items of diet for the pike in Lake Muskeg, *Leucichthys* sp. holds an equal position with that of *Perca*. Whitefish form one per cent of the pike diet.

It must be remembered that these food lists are only valid for restricted time periods.

Conclusions

The similar physical, chemical, and geographical features of the two lakes suggest that the difference in the infestation is a biotic problem. Of the biotic considerations, the absence of herring in Onaman Lake is the most significant fact. In the author's opinion this is the determining factor in the presence or absence of *T. crassus*. Assuming the distribution of herring throughout the country in early times, the problem becomes concerned with the absence of herring in Onaman Lake. Assuming, then, a primeval stock, what factors caused its disappearance? Recalling the temperature and depth data of Onaman Lake, could the warm summer temperatures of this shallow lake have caused the disappearance of this species? This offers a probable solution, since the herring is a stenothermal cold tolerant species. Once the population was destroyed, there could be no re-establishment, as Onaman Lake appears to be a closed lake to the migration of fish from other waters.

The finding of a small dwarf species of herring on Lake Muskeg--sexually mature at five inches--is important since it gives another example of the copepod, herring, and pike association in the parasite's life history.

Evidence indicates that the whitefish-pike population balance if of great importance. Where the pike population is relatively small compared to the whitefish there are no occurrences of pike predation on whitefish as in Onaman Lake. Here, possibly, the pike-perch population is important in the control of pike.

The planktonic food habit of whitefish in Lake Muskeg is undoubtedly a factor which leads to their high infestation. The importance of this fact, must be considered in relation to the time of year. Cyclops carry the procercoid during May and June.

Another conclusion which may be made, in the author's opinion, concerns the probable position of whitefish in the life history of the parasite. Assuming that the whitefish holds the same rank in the life history of the parasite as the herring, one would expect to find the pike-whitefish tapeworm in Onaman Lake, but this is not the case and the original premise must be incorrect, leading one to suspect the whitefish of holding an accidental position in the parasite's life cycle. This conclusion is drawn indirectly and as such cannot be accepted.