PAST VS. PRESENT: A SURVEY OF THE FISH PARASITES OF THE TRIBUTARIES OF ONEIDA LAKE, NY

BY

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THESIS

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Preface

The following study developed from a difference in the parasite community between Oneida Lake and one of its tributaries, Chittenango Creek, and the frustration of not knowing why they were so different. In 2016, Dr. Reyda started a parasite survey looking at the fishes of Oneida Lake in conjunction with Cornell Biological Field Station's gill net activities. His goal was to document the parasite community of Oneida Lake to see how it had changed in the last ninety years since Van Cleave and Mueller's (1934) parasite survey of Oneida Lake. In the years following, he and several undergraduates started to survey one of Oneida Lake's larger tributaries, Chittenango Creek. During their survey efforts, it was observed that the parasite community had been much different in Chittenango Creek than it was in the lake. There were two species of trematode that made this difference most notable. These two species of trematode, *Bunodera sacculata* and *Rhipidocotyle papillosa*, were supposed to be "common" or occasional" in their hosts, *Perca flavescens* and *Micropterus dolomieu* respectively, according to Van Cleave and Mueller's (1934) survey of Oneida Lake. However, during the four years that Dr. Reyda and his undergraduate students surveyed Oneida Lake, there was no documentation of either species from their hosts, but they were able to document these two species in Chittenango Creek.

The surveys of Oneida Lake and Chittenango Creek continued for two more years, yielding the same results with a hypothesis that these results were due to a life cycle interruption at the first intermediate host. Both *B. sacculata* and *R. papillosa* use the same first intermediate host, *Sphaerium* species (Hoffman, 1999). This project was conducted to see if these results were the same in additional tributaries of Oneida Lake and if there were any other differences in parasite fauna.

In the following thesis I document four major groups of parasites from thirty-three fish species in twelve of Oneida Lake's tributaries. For this thesis, I discuss the differences in the parasite community since Van Cleave and Mueller's (1934) survey and how these differences illustrate bigger ecosystem changes within the Oneida Lake watershed.

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Abstract

In 1934, Van Cleave and Mueller completed a study of the parasite fauna of the fish in Oneida Lake and its tributaries, where they documented over eighty species of parasites, thirty-three of which were new descriptions. Since 1934, the lake has undergone many environmental changes which have impacted the invertebrate fauna, mollusks in particular. The present study is a fish parasite survey of twelve tributaries of Oneida Lake undertaken to compare our results to Van Cleave and Mueller's survey. The methods of this study included the collection of thirty-three fish species via backpack shocking, e-boat and hook and line fishing, partial necropsy of fish to collect parasites and the mounting of parasites for identification using light and scanning microscopes. During the recent survey of the lake, certain species of trematodes that had been reported by Van Cleave and Mueller were considered 'missing'. Some of the missing species of parasites were found in the survey of the tributaries. For example, we encountered the trematode *Bunodera sacculata* in seven of twenty-six *Perca flavescens*. *Bunodera sacculata* uses a native clam as its first intermediate host, which is thought to have been extirpated from the lake due to invasive species. Additionally, thirty-two species were documented from three other major groups. This survey fills a knowledge gap on the fish parasite data in the tributaries and will add to the current survey knowledge of the lake system. Through an extensive survey of the fish parasites in Oneida Lake's tributaries, the comparison of my results to Van Cleave and Mueller's study demonstrates the parasite community in the tributaries are differs from those found in the lake because of several years of change to the watershed.

`Introduction

Parasites play important ecological roles in economically and culturally valuable natural systems such as lakes but are often understudied compared to other ecological changes that occur in these systems over time. Classification and characterization of fish parasite communities has the potential to provide important insight into these changes and a more holistic understanding of aquatic systems. In 1934, Van Cleave and Mueller (1934) completed a study of the parasites of the fishes in Oneida Lake, in which they documented over eighty species of parasites and described thirty-three new species. Since then, the lake has undergone significant environmental changes, from physical modification, pollution, and the introduction of invasive species. Although these changes are well-documented, there has only been a single published study on the fish's parasites of Oneida Lake since 1934, and it focused on only two species of centrarchid fishes (Bauer & Whipps, 2015).

Oneida Lake is located northeast of Syracuse and is the largest in-state lake in New York (Figure 1). Oneida Lake is considered one of the state's most popular fishing destinations, bringing in millions of dollars in revenue to the surrounding area (Connelly & Brown, 2008). It has approximately seventeen tributaries and one natural outlet, the Oneida River, that connects it to Lake Ontario via the Oswego River. The lake is mesotrophic and polymictic. On the east end of the lake there is a connection to the Erie-Barge dating back to 1918. Before the construction of the canal, Baker (1916) characterized the abundance of the molluscan community and its relation to the fish community in Oneida Lake. Baker determined that the molluscan fauna was rich, varied and widely distributed within the lake (Baker, 1916). Directly after the canal was built, Baker (1918) conducted another fauna survey and determined that the benthic community had been enriched by bivalves endemic to the Great Lakes.

While the construction of the canal had briefly enriched the lake with the connection to the Great Lakes, it also contributed to multiple invasive species introductions that adversely affected the mollusk community. Since the first survey of the fauna over 50 years ago, a European gastropod, *Bithynia tentaculata*, increased its population size which led to the decline of the native molluscan community due to competition (Harman & Forney, 1970). Around the same time, the lake underwent a period of cultural eutrophication which impacted the gastropods even further (Karatayev et al., 2014). Harman (1992) continued to document these changes and found that, after 30 years, areas of the lake that once supported populations of gastropods and fingernail clams now appear devoid of mollusks. In the late 1990s, *Dreissena polymorpha* (zebra mussel) was introduced and colonized the lake in numbers that exceeded all other molluscan species combined (Harman, 1998). In 2010 there was the first documentation of *Hemimysis anomala* (invasive crustacean) in Oneida Lake introduced by boats using the canal system (Brooking et al, 2010). In 2013 Oneida Lake became vulnerable to another invasive species, the Round Goby *Neogobius melanostomus*, which has proven to be one of the most prolific and problematic invasive species in North America (George et al., 2021).

In the past several decades, parasitology research has paid more attention to the phylogenetic relationships, physiology, and biochemistry of parasites rather than survey-oriented research (Scholz & Choudhury, 2014). This has caused a knowledge gap in systems such as Oneida Lake. This study focuses on the fish parasite communities in twelve of Oneida Lake's tributaries. The objective of this survey is to report all taxa found and serve as a reference point for future research on the tributaries. These data will help us understand the ecosystem disturbances in the context of parasites and predict future large-scale ecosystem disturbances (Bauer & Whipps, 2015).

Methods

Sample collections

Fish were collected via backpack electrofishing, boat electrofishing (in conjunction with Cornell Biological Field Station), hook and line, and haul seine in accordance with a NYS DEC collecting permit LCPSCI-1647. Fish were transported live to a laboratory and handled in accordance with the guidelines of SUNY Oneonta IAUCUC protocol 2023-60. The fish were identified using Peterson (1998) and either immediately examined or maintained in aquarium for 2-3 days before examination. All fish were photographed and given individual field codes. Fish were euthanized in 3 g/L Tricaine Methanosulfonate (MS-222) or double-pithed and dissected by performing a ventral incision and removing the digestive system. Examination of the digestive system and occasionally other organs was aided with the use of a Zeiss Stemi 2000 stereomicroscope. Trematodes and cestodes were removed, heat fixed in near boiling water, and transferred to 4% buffered formalin for at least one week and stored in 70% ethanol at room temperature (Chervy, 2024). Acanthocephalans were removed and relaxed in tap water for 24-72 hours before being transferred into 70% ethanol and stored at room temperature. Nematodes were removed and heat fixed, then transferred to 70% ethanol at room temperature. All parasites that were saved were stored in 2-dram vials with fully detailed labels, including individual host field codes (ex. FR23_1040).

Morphological study

Whole mounts of trematodes and cestodes were prepared by being rehydrated in a graded ethanol series, stained in filtered and diluted Delafield's hematoxylin, dehydrated in a graded ethanol series, cleared in methyl salicylate and mounted under a coverslip on individually labeled glass microscope slides in Damar gum (Pritchard & Kruse, 1982). Acanthocephalans were prepared by staining in filtered Semichon's acetocarmine, dehydrated in a graded ethanol series, cleared in methyl salicylate and mounted under a coverslip on individually labeled glass microscope slides in Damar gum (Pritchard & Kruse, 1982). Nematodes were temporarily mounted in lactophenol; a mixture of 40 mL glycerin, 20 mL lactic acid, 20 mL phenol, and 20 mL deionized water, heated to 35-40 ºC. The nematodes were subsequently returned to vials of 70% ethanol. A subset of worms was saved for imaging using a scanning electron microscope (SEM) (Reyda & Caira, 2006).

Data analysis

Prevalence of worms from each host was calculated by dividing the number of infected individuals and dividing it by the total number of individuals (Bush et al., 1997). Prevalence was only calculated for 2023 samples (Table 4). To analyze the number of fish where parasites were observed or not observed by fish species, we used a stacked bar graph; R (version 4.2.2; R Core Team 2022).

Results

Fish examined

Four-hundred and sixty-two fish representing thirty-three species (Table 2) were collected between June 2020 and November 2023 during a fish parasite survey of Oneida Lake's tributaries. The tributaries that had the largest sample sizes were Chittenango Creek and Scriba Creek, the tributaries with the smallest sample sizes were Little Bay Creek and Vly Creek (Table 1). The fish labeled as parasitized below are categorized by having only intestinal helminths. Parasites found outside of the digestive system, besides body cavity nematodes and some juvenile trematodes were not included in the category of parasitized.

Parasites encountered

Forty-five species of parasites were recovered from the 462 fish examined in the present survey. These include twenty-two species of digenean, eleven species of acanthocephalan, ten species of cestodes, and ten species of nematodes. The species of adult endohelminths were the majority in numbers of individuals and species diversity due to the emphasis on the digestive system during fish dissections. Helminths are listed in a table below by species, or to most specific category to which they were identified and compared to Van Cleave and Mueller's (1934) results (Table 3).

Discussion

Past vs. present

While considering the parasite diversity of Oneida Lake's tributaries 90 years after Van Cleave and Mueller's original survey (1934), it becomes clear that the relative species prevalence has changed. With invasive species introductions before, during and after Van Cleave and Mueller's survey (1934), it is no surprise that certain parasite prevalences are low. The invasive species introductions could be contributing to interruptions in the life cycles of certain parasite species causing such low prevalence. While only the tributaries were sampled during this survey, the change still seems to be apparent in the parasite community as discussed below for each of the major groups of parasitic worms.

In our survey, eleven species of acanthocephalan were documented, compared to Van Cleave and Mueller's report of only four species of acanthocephalan (1934). This purported strong difference between Van Cleave and Mueller's survey (1934) and our survey is not considered a reflection of natural change and is instead attributed to three different aspects of the studies. First, it could be sampling bias. The sampling in our study locations held greater numbers of fish hosts of certain species, such as *Umbra limi*. Our study included fifty-six total

Umbra limi, while Van Cleave and Mueller (1934) only examined fourteen total. The prevalence of *Neoechinorhynchus limi* in 2023 was relatively low at 23%. Given this low prevalence, it is possible that Van Cleave and Mueller (1934) did not find *N. limi* because they didn't examine enough fish specimens, or because they did not examine the fish during the season where the parasite would have the highest prevalence, March through June (Muzzal, 1984). Second, Van Cleave and Mueller (1934) could not have reported some of the fish acanthocephalan species because they were not described until after Van Cleave and Mueller's survey (1934), such as *N. saginatus* Van Cleave & Bangham, 1949*, N. notemigoni* Dechtiar, 1967*,* and *N. bullocki* Doolin & Reyda, 2018. Finally, the difference in some cases may be due to identification errors by Van Cleave and Mueller (1934). For example, *N. tenellus* was described by Van Cleave in 1913 in the Illinois River, but Van Cleave and Mueller (1934) did not report it at Oneida Lake, in spite of collecting *Neoechinorhynchus* species from known hosts of *N. tenellus* such as *Esox niger*. We examined fishes reported to host *N. tenellus,* including *Esox niger* and *Sander vitreus*, and in fact we encountered *N. tenellus*. We examined specimens of *Neoechinorhynchus* from *S. vitreus* deposited by Van Cleave and Mueller at the Justus F. Mueller Parasitology Collection at SUNY ESF. The specimens we examined were in fact *N. tenellus* that had been incorrectly identified as *Neoechinorhynchus cylindratus*. It is not possible to know what could have caused this identification error, but one possibility is that the authors had bias about parasite distributions that precluded their recognition of the appropriate species.

Only twenty-two species of trematode were found in the present study compared to Van Cleave and Mueller's (1934) thirty-two species found in the digestive system. The difference of ten species might not seem drastic, but examination of the numbers of trematode species that used to be "common" or "occasional" ninety years later and finding that they are no longer in those categories, causes concern. Prevalence of parasitic worms from Van Cleave and Mueller's study (1934) were reported in one of four categories: "abundant, common, occasional, and rare". They didn't explicitly state what prevalence values these categories represented, but Bauer and Whipps (2015) determined that "abundant" meant a prevalence greater than 50%, "common" was 25 – 50%, "occasional" was 10 – 25%, and "rare" was less than 10%. Our examination of *Micropterus dolomieu* over a period of three years was limited to only eleven fish. We found *Rhipidocotyle papillosa* to be "common" like the lake survey in 2020 and in 2021, but not again in the following years. *M. dolomieu* seemed to be few and far between during sampling, and collaborators at Cornell are concerned about its low population size. Cornell Biological Field Station has been conducting gill-net surveys on Oneida Lake since 1957 and in 2023, their catch of *M. dolomieu* was only fourteen fish, which was the lowest observed since the 1980s (VanDeValk et al., 2024). While we were able to examine seven *M. dolomieu* in 2023, none of the fish hosted *R. papillosa.* We also examined twenty-six *Perca flavescens* in 2023 and found *Bunodera sacculata* in only seven fish, a relatively low prevalence of 27%. As previously mentioned, the introduction of invasive species has altered the abundance of the mollusk community and both *R. papillosa* and *B. sacculata* use sphaeriid clams as first intermediate hosts to carry out their life cycle (Hoffman, 1999). We hypothesize that the introduction of invasive species of mollusks combined with the decreased population of the native mollusks that serve as intermediate hosts is interrupting the life cycles of *R. papillosa* and *B. sacculata*.

Trematodes found in this survey that were found previously Van Cleave and Mueller (1934) serve as evidence of other lesser observed intermediate hosts such as fingernail clams of the genera *Musculium* and *Sphaerium*. This is evidenced by our recovery of two species, *Phyllodistomum brevicecum* and *Phyllodistomum etheostomae.* Both species were documented from *Umbra limi*. *U. limi* is a definitive host for *P. brevicecum* and its intermediate hosts include Musculium and Spaerium species, i.e. fingernail clams, and various arthropods (Hoffman, 1999). One of the definitive hosts for *P. etheostomae* is *Percina caprodes* and it has the same intermediate hosts as *P. brevicecum*, species of *Musculium* and *Sphaerium*. Therefore, our recovery of *P. brevicecum* and *P. etheostomae* serve as evidence of the presence of populations of fingernail clams of species of *Musculium* and/or *Sphaerium*.

We encountered ten species of cestodes compared to Van Cleave and Mueller's eighteen species (1934). The differences between the two surveys are attributed to a few different explanations. First, out of the ten species found in the tributaries, only two species overlap with the species found by Van Cleave and Mueller (1934), *Proteocephalus ambloplitis* and *Glaridacris catostomi.* Considering that twenty-three of the thirty-three species we examined in the tributaries were also examined by Van Cleave and Mueller (1934) in the Oneida Lake, this low overlap in cestode species between the two studies is surprising. However, our survey also reported more juvenile cestodes. This leads us to our second explanation of the differences between the two surveys, identification issues. There were several cestodes that we could only identify to genus because they were juvenile and lacking mature reproductive organs, thereby precluding identification to species. These included *Proteocephalus* sp. from *M. dolomieu, E. lucius,* and *P. flavescens*. Some of the cestodes only identified to genus may match some of the species that Van Cleave and Mueller (1934) reported from those hosts, such as *Proteocephalus pinguis* from *E. lucius*, *Proteocephalus pearsi* from *P. flacescens*, and *Proteocephlaus ambloplitis* from *M. dolomieu*, but this cannot be verified without the presence of mature cestodes with fully developed proglottids. For the life cycle of these cestodes, their definitive hosts are the fish they were found in, but as mentioned before they were juvenile. This is not uncommon as the transition from juvenile to adult happens in the intestine of their definitive host and time to maturation depends on multiple factors such as diet of the host and presence of other parasitic worms (Schmidt et al., 2009). Additionally, the intermediate host of these species of cestode is a species of free-living copepod (Hoffman, 1999) that might occur in higher abundance in lentic water such as the lake rather than moving water like creeks (Phillips, 1995). Finding mostly juvenile cestodes that are harder to identify because they are new infections in the fish, combined with a difficult to follow and influx taxonomy, made our identification to species more difficult. Lastly, of the 18 species of cestodes reported by Van Cleave and Mueller (1934), there were three species of cestode that we couldn't have acquired because we did not examine their hosts, *Lingula intestinalis* from *Etheostoma olmstedi* and *Hybognathus regius, Bothriocestus formosus* from *Etheostoma olmstedi* and *Percopsis omiscomaycus*, and larval *Triaenophorus crassus* from *P. omiscomaycus*. We also enountered an invasive cestode species, *Schyzocotyle acheilognathi*, first documented in New York around 2009 in *N. chrysoleucus* (Reyda et al., 2019).

Lastly, we also encountered ten species of nematodes compared to Van Cleave and Mueller's nineteen species (1934), not all of which were identified to species. Notably, we did not encounter specimens of any of the four nematode species described as new by Van Cleave and Mueller (1934). For *Hedruris tiara,* Van Cleave and Mueller reported a low prevalence of it in *E. niger* and *Erimyzon oblongus,* and in fact only obtained two specimens of the nematode. While we were unable to examine *E. oblongus*, we were able to examine 10 *E. niger* and did not find *H. tiara*. The same was true for the other newly described species of nematodes in which we examined the fish species reported as hosts by Van Cleave and Mueller (1934) without encountering those nematodes. However, we documented four species of nematodes that were from the original survey, *Camallanus oxycephalus*, *Dichelyene cotylophora, Spinitectus carolini,* and *Spinitectus gracilis.* The fish hosts for all four species overlapped as well. Although our focus in this survey was on parasites of the digestive system of fish, we did in some cases examine other regions of the body in which immature nematodes were encountered. Body cavity nematodes occurred in high prevalence and in more of our fish species than intestinal nematodes. In the case of *Eustrongilides tubifex*, Van Cleave and Muller (1934) only reported *Eustrongylides* sp. out of *Fundulus diaphanus* while we report *E. tubifex* in *Ambloplites rupestris, Lepomis gibbosus,* and *Perca flavescens.*

Biases of the data

There are several aspects of our survey that could have colored our results. First, our survey efforts were not distributed evenly across the many tributaries of Oneida Lake. Some of our sampling locations like Black Creek and Little Bay Creek were so silty that it was almost impossible to walk through while backpack shocking. Those same creeks were also too small to sample via electrofishing boat or too full of debris to sample via seine net. The West Branch of Fish Creek was also too deep to sample via backpack shocker so biases may have resulted because the tributary was only suitable for hook and line fishing. Black Creek was dammed by a beaver, essentially turning the Creek into a small pond that was too deep and silty to walk through safely. Second, the different fish species we collected varied greatly. For example, we collected quite a few *Ameiurus nebulosus* (N = 48, see table 2) but only a few of *Ameiurus natalis* (N = 3, see table 2). In addition, there were also certain species of fish that we couldn't get in comparison to Van Cleave and Mueller's study (1934) because they either don't swim into the tributaries as far upstream as we sampled, are rare or we just didn't see them. The species we didn't encounter were *Anguilla rostrata, Erimyzon oblongus, Hybognathus regius, Pimephales promelas, Notorus flavus, Notorus gyrinus, Notorus miurus, Morone chrysops, Etheostoma* *olmstedi, Percopsis omiscomaycus, Petromyzon marinus,* and *Coregonus artedi.* Other species such as *A. rostrata* which seemed more abundant in the lake during Van Cleave and Mueller's survey (1934) were not found in the creeks. This is most likely because of dams impeding migration and possibly contributing to their population decline across their range (Mack & Cheatwood, 2022). Another species of fish that Van Cleave and Mueller (1934) examined was *Etheostoma olmstedi.* They were able to examine 25 fish, while we weren't able to examine any because we were unable to locate any while sampling. According to biologists at Cornell Biological Field Station, *E. olmstedi* may have been functionally extirpated by the introduction of Round Goby, *N. melanostomus.* As previously mentioned, *N. melanostomus* has become one of the most prolific invasive species in the Great Lakes and other river basins (George et al., 2021).

Finally, seasonality could have influenced out results. Some parasitic worm species have been shown to have marked seasonal patterns such that they cannot be found in fish hosts year-round (Muzzal, 1984). Most of our samples occurred in the summer months of June, July and August.

Looking forward

With the data collected from the survey of the tributaries, it seems as though there is still much to be done. There hasn't been an updated mollusk survey of Oneida Lake since 2014 (Karatayev et al., 2014) and no surveys of the mollusks that reside in the tributaries of Oneida Lake. The present observed reduction of trematode species diversity in the tributaries compared to Van Cleave and Mueller's survey (1934) necessitates a mollusk survey. An up-to-date survey on mollusks will help shed light on why the prevalence of certain trematode species were so low. The interruptions in these parasite life cycles indicate that the invasive species introduced are having an impact on the food web interactions in the lake and the tributaries. In addition, continued survey work on the fish parasites in the lake throughout the calendar year will help clarify some of the patterns we report here.

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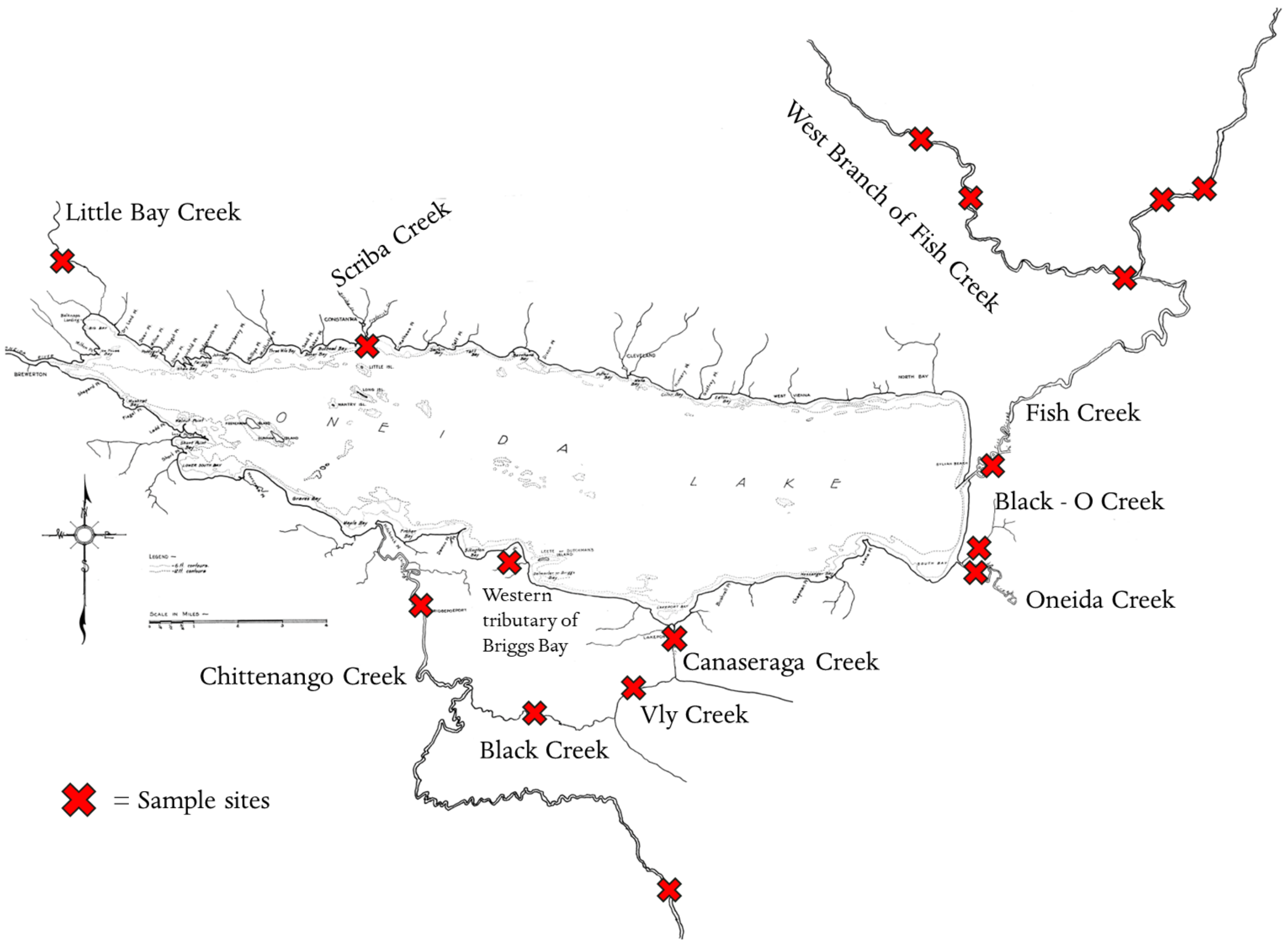

Figure 1. Map of Oneida Lake and its tributaries reconstructed from Van Cleave and Mueller's (1934) original map from the Oneida Lake survey.

Water body	Locality	Coordinates	Collection dates	Sample size
Black Creek	Black creek rd, Chittenango, NY	43.11207 N, 75.90084 W	June 2023	26
Black - O Creek	Verona State Beach Park, NY	43.16671 N, 75.73262 W	October 2023	21
Canaseraga Creek	Above 31 W bridge over Canaseraga creek	43.14363 N, 75.86473 W	October 2023	19
Chittenango Creek	Behind Dollar General, Bridgeport, NY	43.920 N, 75.5821 W	June 2020 - August 2023	180
	5990 Olmstead rd, NY	43.01064 N, 75.85042 W		
East branch of Fish Creek	4422 Palmer rd, NY	43.31568 N, 75.59523 W	June - August 2023	24
	Mouth of Furnace creek, NY	43.30258 N, 75.61789 W		
Fish Creek	Sylvan Beach Sewer Treatment, NY	44.53938 N, 75.48709 W	October 2023	36
Little Bay Creek	Central Square, NY	43.28569 N, 76.13639 W	June 2023	3
Oneida Creek	3999 NY-31, NY	43.16173 N, 75.73188 W	October 2023	10
Scriba Creek	50 County Rt. 23, NY	43.25102 N, 76.00038 W	September 2023	75
	110 County Rt. 23, NY	43.25573 N, 76.00349 W		
Vly Creek	8145-8227 Lakeport rd, NY	43.12697 N, 75.87205 W	June 2023	4
West branch of Fish Creek	8372-8398 Blossvale creek rd	43.26844 N, 75.63992 W	July 2023	6
Western tributary of Briggs Bay	Hamilton Brown rd, NY	43.959 N, 75.5556 W	June 2020 - August 2023	41
			Total	462

Table 1. Water bodies and localities collected from with their geographic coordinates, collection dates and number of sample sizes (number of fishes collected).

Fish family	Fish species	Fish common name	Sample size
Amiidae	*Amia calva*	Bowfin	4
Catostomidae	*Catostomus commersonii*	White Sucker	60
Catostomidae	*Hypentelium nigricans*	Northern Hogsucker	6
Centrarchidae	*Ambloplites rupestris*	Rock Bass	53
Centrarchidae	*Lepomis cyanellus*	Green sunfish	21
Centrarchidae	*Lepomis gibbosus*	Pumpkinseed	27
Centrarchidae	*Lepomis macrochirus*	Bluegill	7
Centrarchidae	*Micropterus dolomieu*	Smallmouth Bass	11
Centrarchidae	*Micropterus salmoides*	Largemouth Bass	7
Centrarchidae	*Pomoxis nigromaculatus*	Black Crappie	3
Cyprinidae	*Cyprinus carpio*	Common Carp	2
Cyprinidae	*Exoglossum maxillingua*	Cutlips Minnow	11
Cyprinidae	*Luxilus cornutus*	Common Shiner	1
Cyprinidae	*Notemigonus crysoleucas*	Golden Shiner	5
Cyprinidae	*Pimephales notatus*	Bluntnose Minnow	2
Cyprinidae	*Rhinichthys cataractae*	Longnose Dace	1
Cyprinidae	*Semotilus atromaculatus*	Creek Chub	10
Cyprinidae	*Semotilus corporalis*	Fallfish	26
Esocidae	*Esox lucius*	Northern Pike	2
Esocidae	*Esox niger*	Chain Pickerel	10
Fundulidae	*Fundulus diaphanus*	Banded Killifish	1
Gobiidae	*Neogobius melanostomus*	Round Goby	16
Ictaluridae	*Ameiurus natalis*	Yellow Bullhead	3
Ictaluridae	*Ameiurus nebulosus*	Brown Bullhead	48
Ictaluridae	*Ictalurus punctatus*	Channel Cat	1
Ictaluridae	*Noturus insignis*	Margined Madtom	1
Lotidae	*Lota lota*	Burbot	1
Percidae	*Perca flavescens*	Yellow Perch	53
Percidae	*Percina caprodes*	Log Perch	27
Percidae	*Sander vitreus*	Walleye	3
Salmonidae	*Salmo trutta*	Brown Trout	14
Sciaenidae	*Aplodinotus grunniens*	Freshwater Drum	2
Umbridae	*Umbra limi*	Central mudminnow	26
		Total	462

Table 2. Fish families collected with their species, common names and sample sizes equaling a total of 462 fishes collected.

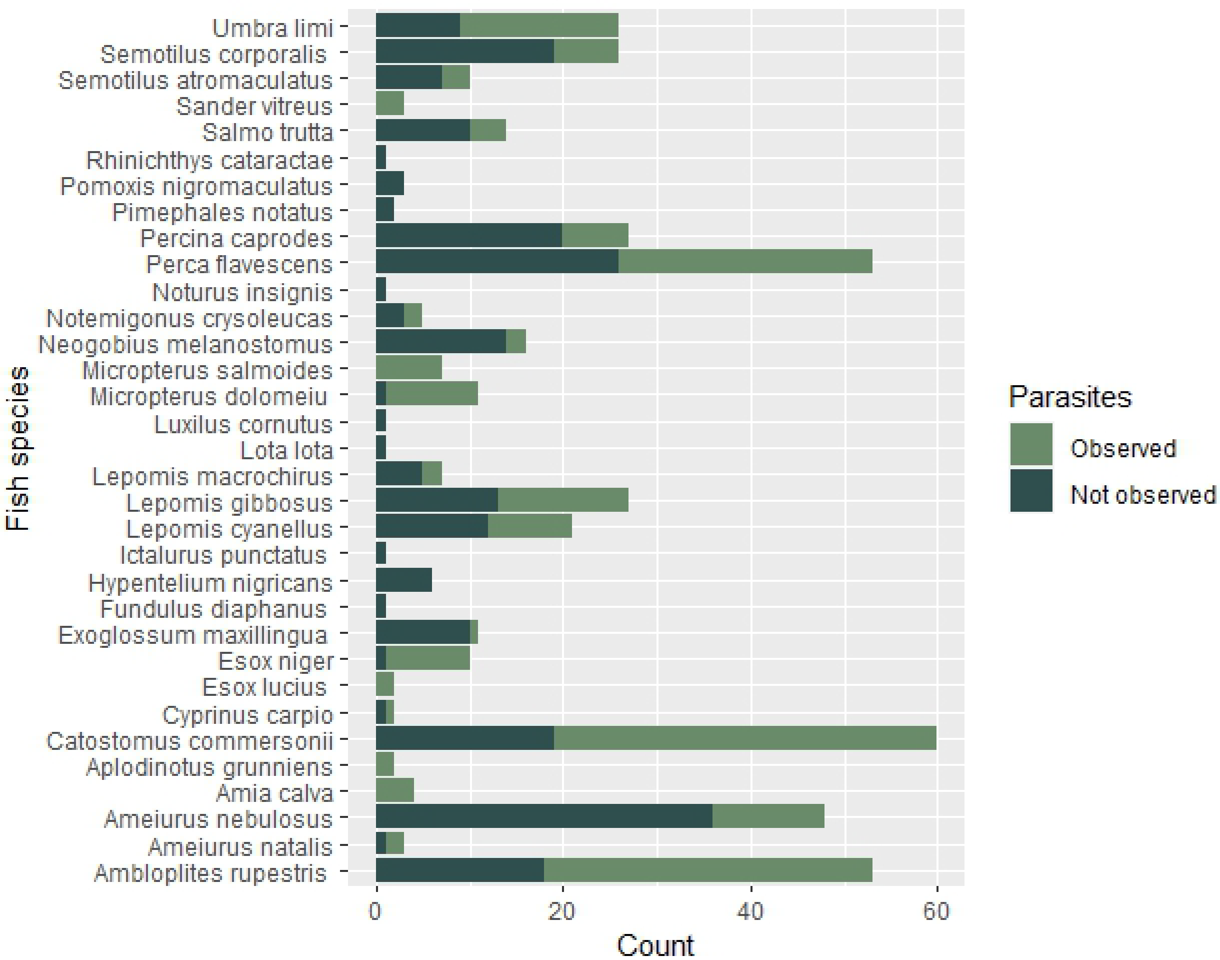

Figure 2. Stacked bar graph of fish species in which parasites were observed or not observed.

Host family	Host - species	Helminth group	Helminth species	Van Cleave & Mueller, (1929-1931)	Current Oneida tributary survey (2020-2023)
Amiidae	*Amia calva*	acanthocephalan	*Leptorhynchoides thecatus*	X	X
		acanthocephalan	*Neoechinorhynchus cylindratus*		
		acanthocephalan	*Neoechinorhynchus tenellus*		
		cestode	*Haplobothrium globuliforme*	X	
		cestode	*Proteocephalus* sp.		
		cestode	*Laruella perplexa*	X	
		digene	*Azygia longus§*	X	
		digene	*Azygia* sp. *§*		X
		digene	*Plesiocreadium typicum*		X
Anguillidae	*Anguilla rostrata*	acanthocephalan	*Leptorhynchoides thecatus*	X	-
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	-
		acanthocephalan	*Neoechinorhynchus rostratum*		
		cestode	*Bothriocestus claviceps*	X	-
		cestode	*Bothriocestus* sp.		
		cestode	*Proteocephalus macrocephalus*	X	-
		digene	*Azygia longa§*	X	-
		nematode	*Haplonema aditum**	X	-
		nematode	Nemtoda sp.		
Catostomidae	*Catostomus commersonii*	acanthocephalan	*Neoechinorhynchus bullocki*		X
		acanthocephalan	*Neoechinorhynchus* c.f. *salmonis*	X	X
		acanthocephalan	*Neoechinorhynchus tenellus*		X
		acanthocephalan	*Octospinifer macilentus*		X
		acanthocephalan	*Pomphorhynchus bulbocolli*		X

		cestode	*Biacetabulum infrequens*	X	
		cestode	*Biacetabulum biloculoides*		
		cestode	*Glaridacris catostomi*	X	X
		cestode	*Glaridacris confusus*	X	
		cestode	*Hunterella nodulosa*		X
		cestode	*Isoglaridacris bulbocirrus*		X
		cestode	*Promonobothrium ingens*	X	
		cestode	*Pseudoglaridacris laruei*		X
		cestode	*Proteocephalus* sp.		
		digene	*Plagioporus sinitsini*¶	X	
		digene	*Lissorchis attenuatum**	X	X
		digene	*Lissorchis simeri**	X	
		digene	*Lissorchis* sp.		X
		nematode	*Contracecum* sp.		X
		nematode	*Hepaticola bakeri*	X	
		nematode	*Philometra nodulosa*	X	
		nematode	*Spinitectus* sp.		
		nematode	*Rhabdochona* sp.		X
Catostomidae	*Erimyzon oblongus*	acanthocephalan	*Neoechinorhynchus cylindratus*	X	-
		acanthocephalan	*Neoechinorhynchus prolixoides*		-
		acanthocephalan	*Pomphorhynchus bulbocolli*	X	-
		cestode	*Isoglaridacris* c.f. *agminis*		-
		cestode	*Caryophyllidea* sp.		-
		nematode	*Hedruris tiara§*	X	-
	Hypentelium nigricans			-	X
Centrarchidae	*Amblopllites rupestris*	acanthocephalan	*Leptorhynchoides thecatus*	X	X
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	X
		acanthocephalan	*Neoechinorhynchus tenellus*		X
		acanthocephalan	*Pomphorhynchus bulbocolli*	X	
		cestode	*Bothriocestus* sp.		X

		cestode	*Proteocephalus ambloplitis (immature)*	X	
		cestode	*Proteocephalus* sp.		X
		digene	*Alloglossidium corti* (immature)	X	
		digene	*Maritrema obstipum* (immature)*	X	
		digene	*Azygia angusticauda§*	X	
		digene	*Azygia* sp. *§*		X
		digene	*Bucephalus elegans*	X	
		digene	*Clinostomum marginatum* (immature)		X
		digene	*Crepidostomum cornutum*	X	
		digene	*Cryptogonimus chyli*	X	
		digene	*Maritrema medium*	X	
		digene	*Microphallus opacus*	X	
		digene	*Microphallus ovatus*	X	
		nematode	*Dichelyne cotylophora* (immature)	X	
		nematode	*Camallanus oxycephalus*	X	X
		nematode	*Capillaria (Thominx) catenata*	X	
		nematode	*Contracaecum brachyurum*	X	
		nematode	*Contracecum* sp.		X
		nematode	*Eustrongylides tubifex*		X
		nematode	*Spinitectus carolini*	X	X
		nematode	*Spinitectus gracilis*	X	X
		nematode	*Spinitectus* sp.		
		nematode	*Rhabdochona* sp.		
Centrarchidae	*Lepomis cyanellus*	acanthocephalan	*Neoechinorhynchus cylindratus*	-	X
		acanthocephalan	*Neoechinorhynchus tenellus*	-	X
		cestode	*Proteocephalus* sp.	-	X
		digene	*Clinostomum marginatum* (immature)	-	X
		nematode	*Contracecum* sp.	-	X

	Lepomis gibbosus	acanthocephalan	*Leptorhynchoides thecatus*	X	X
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	
		acanthocephalan	*Neoechinorhynchus tenellus*		X
		acanthocephalan	*Pomphorhynchus bulbocolli*	X	
		cestode	*Bothriocestus* sp.		X
		cestode	*Haplobothrium globuiforme* (immature)	X	
		cestode	*Proteocephalus amblopltis* (immature)	X	
		cestode	*Proteocephalus* sp.		X
		digene	*Azygia* sp. *§*		X
		digene	*Clinostomum marginatum* (immature)		X
		digene	*Crepidostomum cornutum (immature)*	X	
		digene	*Crepidostomum cornutum* (adult)		X
		digene	*Azygia angusticauda§*	X	
		nematode	*Capillaria catenata**	X	
		nematode	*Contracecum* sp.		X
		nematode	*Eustrongylides tubifex*		
		nematode	Nematoda sp.		
		nematode	*Spinitectus carolini*	X	
		nematode	*Spinitectus gracilis*	X	
		nematode	*Spinitectus gracilis*	X	
	Lepomis macrochirus	digene	*Azygia* sp.*§*	-	X
		digene	*Crepidostomum cooperi*	-	X
		digene	*Crepidostomum* sp.	-	
		digene	*Diplostomidae* sp.	-	X
		nematode	*Camallanus* sp	-	
		nematode	*Spinitectus* sp.	-	
Centrarchidae	*Micropterus dolomieu*	acanthocephalan	*Leptorhynchoides thecatus*	X	X

		acanthocephalan	*Neoechinorhynchus cylindratus*	X	X
		acanthocephalan	*Neoechinorhynchus tenellus*	X	X
		acanthocephalan	*Neoechinorhynchus* sp. (immature)		
		cestode	*Proteocephalus ambloplitis (immature)*	X	
		cestode	*Proteocephalus* sp.		X
		cestode	*Bothriocephalus claviceps*	X	
		cestode	*Proteocephalus ambloplitis* (adult)	X	
		cestode	*Protecocephalus* sp.		
		digene	*Azygia angusticauda§*	X	
		digene	*Azygia* sp.*§*		X
		digene	*Clinostomum marginatum* (immature)		X
		digene	*Centrovarium lobotes*	X	
		digene	*Crepidostomum cornutum*	X	
		digene	*Cryptogonimus chyli*	X	
		digene	*Phyllodostomum pearsei* (doubtful)	X	
		digene	*Rhipidoctyle papillosum*	X	X
		nematode	*Dichelyne cotylophora*	X	
		nematode	*Spinitectus carolini*	X	
		nematode	*Rhabdochona* sp.		
Centrarchidae	*Micropterus salmoides*	acanthocephalan	*Leptorhynchoides thecatus*	X	
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	X
		acanthocephalan	*Neoechinorhynchus tenellus*		X
		acanthocephalan	*Pomphorhynchus bulbocolli*	X	
		cestode	*Hymenolepis sp.* (immature)	X	
		cestode	*Proteocephalus ambloplitis*		X
		cestode	*Proteocephalus fluviatilis*		
		cestode	*Proteocephalus* sp.		
		digene	*Crepidostomum cornutum* (immature)	X	

		digene	*Azygia angusticauda§*	X	
		digene	*Azygia* sp. *§*		X
		digene	*Bunodera sacculata*	X	
		digene	*Caecincola parvulus*	X	X
		digene	*Clinostomum marginatum* (immature)		X
		digene	*Crepidostomum cornutum* (adult)		
		digene	*Crepidostomum ictaluri*	X	
		digene	*Diplostomidae* sp		X
		digene	*Leucerutherus micropteri*		X
		digene	*Neochasmus umbellus**	X	
		digene	*Ptychegonimus* sp.		
		digene	*Phyllodostomum pearsei*	X	
		digene	*Rhipidoctyle papillosum*	X	
		nematode	*Capillaria catenata* (immature)	X	
		nematode	*Contracaecum brachyurum*	X	
		nematode	*Contracecum* sp.		X
		nematode	*Dichelyne cotylophora*	X	
		nematode	Nematoda sp.		
		nematode	*Spinitectus micracanthus*		
		nematode	*Spinitectus* sp.		
Centrarchidae	*Pomoxis nigromaculatus*	acanthocephalan	*Pomphorhynchus bulbocolli*	X	
		cestode	*Proteocephalus* sp. (immature)		
		nematode	*Camallanus oxycephalus*		
		nematode	*Camallanus* sp.		
		nematode	*Eustrongylides tubifex*		
		nematode	*Spinitectus gracilis*	X	
Cyprinidae	*Cyprinus carpio*	acanthocephalan	*Pomphorhynchus bulbocolli*	X	
		cestode	*Cestoda sp.*	X	
		cestode	*Khawia sinensis*		X

		cestode	*Schizocotyle acheilognathi*		X
		digene	*Crepidostomum cooperi*	X	
		digene	*Plagiocirrus primus*	X	
		nematode	Nematoda sp.		
Cyprinidae	*Exoglossum maxillingua*			-	X
	Luxilis cornutus			-	X
	Notemigonus crysoleucas	acanthocephalan	*Neoechinorhynchus notemigoni*		X
		acanthocephalan	*Pomphorhynchus bulbocolli*	X	
		digene	*Crepidostomum cooperi*	X	
		digene	*Plagiocirrus primus**	X	
		nematode	*Hepaticola bakeri*	X	
	Pimephales notatus			-	X
	Pimephales promelas	digene	*Clinostomum marginatum* (immature)	X	-
	Rhinichthys cataractae			-	X
	Semotilus atromaculatus	acanthocephalan	*Neoechinorhynchus saginatus*		X
		cestode	*Proteocephalus* sp.		X
		digene	*Allocreadium lobatum*	X	X
		digene	*Diplostomidae* sp.		X
		nematode	*Rhabdochona* sp.		X
		nematode	*Spinitectus* sp.		X
	Semotilus corporalis	cestode	*Bothriocestus* sp.		X
		cestode	*Caryophyllidea* sp.		
		cestode	*Proteocephalus* sp.		X
		cestode	*Schizocotyle acheilognathi*		X
		nematode	Nematoda sp.		
Esocidae	*Esox lucius*	acanthocephalan	*Acanthacephalus dirus*		X
		acanthocephalan	*Leptorhynchoides thecatus*	X	
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	
		acanthocephalan	*Neoechinorhynchus tenellus*		

		acanthocephalan	*Pomphorhynchus bulbocolli*	X	
		cestode	*Protecephalus pinguis*	X	
		cestode	*Proteocephalus* sp.		X
		digene	*Azygia* sp. *§*		
		digene	*Phyllodistomum superbum* (ectopic)‡	X	
		digene	*Plagiocirrus primus*	X	
		nematode	*Spinitectus gracilis*	X	
Esocidae	*Esox niger*	acanthocephalan	*Leptorhynchoides thecatus*	X	
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	X
		acanthocephalan	*Neoechinorhynchus tenellus*		X
		cestode	*Proteocephalus ambloplitis (immature)*	X	
		cestode	*Protecephalus pinguis*	X	
		cestode	*Proteocephalus* sp.		X
		digene	*Bucephalus* (elegans type) (immature)	X	
		digene	*Azygia* sp. *§*		X
		digene	*Azygia angusticauda§*	X	
		digene	*Macroderoides flavus**	X	X
		digene	*Clinostomum marginatum* (immature)		
		digene	*Macroderoides* sp.		X
		digene	*Microphallus ovatus*	X	
		nematode	*Contracecum* sp.		X
		nematode	*Eustrongylides* sp.		
		nematode	*Hedruris tiara*§*	X	
		nematode	*Spinitectus gracilis*	X	
		nematode	*Rhabdochona* sp.		
Fundulidae	*Funudulus diaphanus*	digene	*Creptotrema funuduli**	X	
		nematode	*Camallanus oxycephalus*		
		nematode	*Contracecum* sp.		

		nematode	*Eustrongylides tubifex*		
Gobiidae	*Neogobius melanostomus*	acanthocephalan	*Neoechinohynchus tenellus* (immature)	-	X
		acanthocephalan	*Neoechinorhynchus* sp.	-	
		cestode	Cestoda sp.	-	
		cestode	*Proteocephalus* sp. (immature)	-	
		nematode	Nematoda sp.	-	X
Ictaluridae	*Ameiurus natalis*	acanthocephalan	*Leptorhynchoides thecatus*	X	
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	
		acanthocephalan	*Neoechinorhynchus* sp.		
		cestode	*Esexiella fimbriatum*	X	
		cestode	*Esexiella* sp.		
		cestode	*Proteocephalus* sp. (immature)		
		digene	*Acetodextra amiura*	X	
		digene	*Alloglossidium corti*	X	
		digene	*Alloglossidium geminus*	X	
		digene	*Alloglossidium* sp.		X
		digene	*Azygia* sp. *§*		X
		digene	*Centrovarium lobotes*	X	
		digene	*Clinostomum marginatum* (immature)		
		digene	*Crepidostomum cornutum*	X	
		digene	*Crepidostomum ictaluri*	X	
		nematode	*Contracecum* sp.		
		nematode	*Dichelyne cotylophora*	X	
Ictaluridae	*Ameiurus nebulosus*	acanthocephalan	*Leptorhynchoides thecatus*	X	
		acanthocephalan	*Pomphorhynchus bulbocolli*	X	
		acanthocephalan	*Neoechinorhynchus cylindratus*		
		acanthocephalan	*Neoechinorhynchus tenellus*		
		cestode	*Esexiella fimbriatum*	X	

		cestode	*Esexiella* sp.		X
		cestode	*Proteocephalus ambloplitis*	X	
		cestode	*Proteocephalus* sp.		
		digene	*Azygia* sp. §		
		digene	*Bucephalus* (elegans type) (immature)	X	
		digene	*Acetodextra amiura*	X	
		digene	*Alloglossidium corti*	X	
		digene	*Alloglossidium geminus*	X	X
		digene	*Crepidostomum cooperi*	X	
		digene	*Crepidostomum cornutum*	X	
		digene	*Crepidostomum ictaluri*	X	
		digene	*Cryptogonimus chyli*	X	
		digene	*Diplostomidae* sp.		X
		digene	*Microphallus opacus*	X	
		digene	*Phyllodistomum staffordi*	X	
		digene	*Polylekithum halli* *	X	
		digene	*Polylekithum halli*	X	
		digene	*Polylekithum ictaluri*		X
		nematode	*Camallanus* sp.		X
		nematode	*Contracecum* sp.		X
		nematode	*Dichelyne cotylophora* (immature)	X	X
		nematode	*Dichelyne* sp.		X
		nematode	*Dacnitoides robusta**	X	
		nematode	*Dichelyne cotylophora*	X	X
		nematode	*Spinitectus gracilis*	X	
		nematode	*Rhabdochona* sp.		X
Ictaluridae	*Ictalurus punctatus*	acanthocephalan	*Neoechinorhynchus tenellus*		
		cestode	*Bothriocestus* sp		
		cestode	*Esexiella fimbriatum*	X	

		cestode	*Proteocephalus ambloplitis*	X	
		cestode	*Proteocephalus* sp.		
		cestode	*Megathylacoides giganticum*		
		digene	*Alloglossidium corti*	X	
		digene	*Alloglossidium* sp.		
		digene	*Crepidostomum ictaluri*	X	
		digene	*Vietosoma parvum**	X	
		nematode	*Cucullanellus cotylophora*		
		nematode	*Dichelyne* sp.		
		nematode	*Rhabdochona decatorensis*		
		nematode	*Rhabdochona* sp.		
Ictaluridae	*Notorus miurus*	digene	*Alloglossidium corti*	X	-
Ictaluridae	*Noturus flavus*	acanthocephalan	*Leptorhynchoides thecatus*	X	-
		digene	*Crepidostomum ictaluri*	X	-
Ictaluridae	*Noturus gyrinus*	cestode	*Esexiella fimbriatum*	X	-
		digene	*Alloglossidium corti*	X	-
	Notorus insignis			-	X
Lotidae	*Lota lota*	acanthocephalan	*Leptorhynchoides thecatus*	X	
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	
		acanthocephalan	*Neoechinorhynchus tenellus*		
		acanthocephalan	*Pomphorhynchus bulbocolli*	X	
		cestode	*Eubothrium crasssum*	X	
		cestode	*Proteocephalus* sp.		
		digene	*Azygia angusticauda§*	X	
		digene	*Leucerutherus sp.*		
		nematode	*Camallanus oxycephalus*		
		nematode	*Spinitectus gracilis*	X	
	Morone chrysops	acanthocephalan	*Leptorhynchoides thecatus*	X	-
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	-
		cestode	*Proteocephalus pearsei*	X	-

		digene	*Bucephalus* (elegans type) (immature)	X	-
		digene	*Allacanthochasmus artus**	X	-
		digene	*Allacanthochasmus varius*	X	-
Percidae	*Etheostoma olmstedi*	acanthocephalan	*Leptorhynchoides thecatus*	X	-
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	-
		digene	*Azygia angusticauda§*	X	-
		digene	*Neochasmus umbellus*	X	-
Percidae	*Perca flavescens*	acanthocephalan	*Leptorhynchoides thecatus*	X	
		acanthocephalan	*Leptorhynchoides thecatus* (immature)		
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	
		acanthocephalan	*Neoechinorhynchus tenellus*		
		acanthocephalan	*Neoechinorhynchus* sp.		
		acanthocephalan	*Pomphorhynchus bulbocolli*	X	
		cestode	*Bothriocestus* sp.		X
		cestode	*Proteocephalus ambloplitis* (immature)	X	
		cestode	*Proteocephalus pearsei*	X	
		cestode	*Proteocephalus* sp.		X
		digene	*Apophallus americanus* (immature)	X	
		digene	*Bucephalus* (elegans type) (immature)	X	
		digene	*Maritrema medium* (immature)*	X	
		digene	*Azygia angusticauda§*	X	
		digene	*Azygia* sp. *§*		X
		digene	Allocreadiidae sp.		
		digene	*Bunodera luciopercae*	X	
		digene	*Bunodera sacculata**	X	X
		digene	*Centrovarium lobotes*	X	

		digene	*Clinostomum marginatum* (immature)		X
		digene	*Crepidostomum cooperi*	X	
		digene	*Crepidostomum solidum**	X	
		digene	*Crepidostomum* sp.		
		digene	*Phyllodistomum superbum‡*	X	
		nematode	*Camallanus oxycephalus* (immature)	X	X
		nematode	*Camallanus* sp.		
		nematode	*Spinitectus sp.* (immature)	X	
		nematode	*Dichelyne cotylophora*	X	
		nematode	*Eustrongylides tubifex*		X
		nematode	Nematoda sp.		
		nematode	*Philometra cylindracea*	X	
Percidae	*Percina caprodes*	acanthocephalan	*Neoechinorhynchus cylindratus*	X	
		acanthocephalan	*Leptorhynchoides thecatus*		X
		cestode	*Bothriocephalus formosus*	X	
		digene	*Azygia longa§*	X	
		digene	*Azygia* sp. *§*		X
		digene	*Crepidostomum isotomum*	X	
		digene	*Diplostomidae* sp.		X
		digene	*Phyllodistomum etheostomae‡*		X
		digene	*Phyllodistomum superbum* (ectopic?)‡	X	
		nematode	*Spinitectus gracilis*		X
Percidae	*Sander vitreus*	acanthocephalan	*Leptorhynchoides thecatus*	X	
		acanthocephalan	*Neoechinorhynchus cylindratus*	X	
		acanthocephalan	*Neoechinorhynchus tenellus*		X
		cestode	*Bothriocestus cuspidatus*	X	
		cestode	*Bothriocestus* sp.		X
		cestode	*Proteocephalus* sp.		X

		cestode	*Proteocephalus macrocephalus*	X	
		cestode	*Proteocephalus luciopercae*		
		cestode	*Triaenophorus nodulosus*		
		cestode	*Triaenophorus* sp.		
		cestode	*Schizocotyle acheilognathi*		
		digene	*Azygia* sp. *§*		X
		digene	*Apophallus americanus**	X	
		digene	Allocreadiidae sp.		
		digene	*Azygia angusticauda§*	X	
		digene	*Bucephalus pusilla*	X	
		digene	*Centrovarium lobotes*	X	
		digene	*Phyllodistomum superbum‡*	X	
		digene	*Sanguicola* sp.		
		nematode	*Capillaria catenata*	X	
		nematode	*Dichelyne cotylophora*	X	
		nematode	*Spinitectus* sp.	X	
		nematode	*Rhabdochona* sp.		X
Percopsidae	*Percopsis omiscomaycus*	acanthocephalan	*Neoechinorhynchus tenellus*		-
		cestode	Cestoda sp. (immature)		-
		cestode	*Bothriocephalus formosus**	X	-
		cestode	*Triaenophorus* sp		-
		digene	*Crepidostomum percopsisi*	X	-
		digene	*Crepidostomum* sp.		-
		digene	*Phyllodistomum superbum* (ectopic?)‡	X	-
		digene	Trematoda sp.		-
		nematode	*Rhabdochona* sp.		-
Salmonidae	*Coregonus artedi*	digene	*Crepidostomum cooperi*	X	-
		nematode	*Hepaticola bakeri**	X	-
		nematode	*Spinitectus gracilis*	X	-

Salmonidae	*Salmo trutta*	acanthocephalan	*Neoechinorhynchus cylindratus*	X	X
		acanthocephalan	*Neoechinorhynchus tenellus*		X
		digene	*Azygia longa§*	X	
		digene	*Phyllodistomum superbum‡*	X	
		nematode	*Cystidicoloides harwoodi*	X	
		nematode	Nematoda sp.		X
		nematode	*Spinitectus gracilis*	X	
Sciaenidae	*Aplodinotus grunniens*	acanthocephalan	*Neoechinorhynchus tenellus*	-	X
		cestode	Cestoda sp. (immature)	-	
		cestode	*Proteocephalus* sp.	-	
		digene	*Azygia* sp.	-	
		digene	*Crepidostomum aritum*	-	
		digene	*Crepidostomum* sp.	-	
		digene	*Homalometron armatum*	-	X
		digene	*Homalometron* sp.	-	X
		nematode	*Camallanus* sp.	-	
		nematode	*Cucullanellus* sp.	-	
		nematode	*Dichelyne* c.f. *robustus*	-	
		nematode	*Eustrongylides tubifex*	-	
Umbridae	*Umbra limi*	acanthocephalan	*Neoechinorhynchus limi*		X
		cestode	*Proteocephalus sp. (immature)*	X	
		digene	*Paracreptotrema limi*		X
		digene	*Phyllodistomum brevicecum ‡*		X
		digene	Trematoda sp.		
		nematoda	*Eustrongilides tubifex*		

X Documented this species

- Couldn't document this species

Blank Did not document this species

*species that were described as new as part of the Van Cleave and Mueller (1932) study

†Species names used by Van Cleave and Mueller (1932) that have no obvious contemporary equivalent

‡ Species obtained from the urinary bladder

§ Species obtained from the stomach

¶ Species obtained from the gall bladder

Table 3. A comparison of parasites encountered from Van Cleave and Mueller's (1934) survey and the current survey of Oneida Lake's tributaries by fish species.

Host family	Host species	Helminth group	Helminth species	Prevalence (2023)
Amiidae	*Amia calva*	trematode	*Plesiocreadium typicum*	2/2
Catostomidae	*Catostomus commersonii*	acanthocephalan	*Octospinifer macilentus*	2/37
		acanthocephalan	*Neoechinorhynchus bullocki*	9/37
		acanthocephalan	*Neoechinorhynchus* c.f. *salmonis*	1/37
		acanthocephalan	*Neoechinorhynchus tenellus*	1/37
		cestode	*Glaridacrsi catostomi*	1/37
		cestode	*Hunterella nodulosa*	1/37
		cestode	*Isoglaridacris bulbocirrus*	2/37
		cestode	*Pseudoglaridacris laruei*	12/37
		nematode	*Contracecum* sp.	1/37
		trematode	*Lissorchis attenuatus*	3/37
		trematode	*Lissorchis* sp.	2/37
Centrarchidae	*Ambloplites rupestris*	acanthocephalan	*Leptorhynchoides thecatus*	10/42
		acanthocephalan	*Neoechinorhynchus cylindratus*	4/42
		acanthocephalan	*Neoechinorhynchus tenellus*	7/42
		cestode	*Bothriocestus* sp.	3/42
		cestode	*Proteocephalus* sp.	1/42
		nematode	*Camallanus oxycephalus*	2/42
		nematode	*Contracecum* sp.	1/42
		nematode	*Eustrongilides tubifex*	1/42
		nematode	*Spinitectus carolini*	4/42
		nematode	*Spinitectus gracilis*	3/42
		trematode	*Azygia* sp.	2/42
		trematode	*Clinostomum marginatum* (immature)	4/42

Centrarchidae	*Lepomis cyanellus*	acanthocephalan	*Neoechinorhynchus cylindratus*	3/14
		acanthocephalan	*Neoechinorhynchus tenellus*	1/14
		nematode	*Contracecum* sp.	2/14
		trematode	*Clinostomum marginatum (immature)*	2/14
Centrarchidae	*Lepomis gibbosus*	acanthocephalan	*Leptorhynchoides thecatus*	2/23
		acanthocephalan	*Neoechinorhynchus tenellus*	1/23
		nematode	*Eustrongilides tubifex*	5/23
		trematode	*Azygia* sp.	2/23
		trematode	*Clinostomum marginatum (immature)*	1/23
		trematode	*Crepidostomum cornutum*	3/23
Centrarchidae	*Lepomis macrochirus*	trematode	*Azygia* sp.	1/7
		trematode	*Crepidostomum cooperi*	1/7
Centrarchidae	*Micropterus dolomieu*	acanthocephalan	*Leptorhynchoides thecatus*	2/7
		acanthocephalan	*Neoechinorhynchus cylindratus*	2/7
		acanthocephalan	*Neoechinorhynchus tenellus*	3/7
		cestode	*Proteocephalus* sp.	4/7
		trematode	*Clinostomum marginatum (immature)*	1/7
Centrarchidae	*Micropterus salmoides*	acanthocephalan	*Neoechinorhynchus cylindratus*	7/7
		cestode	*Proteocephalus ambloplitis*	1/7
		trematode	*Azygia* sp.	1/7
		trematode	*Caecinocla parvulus*	1/7
		trematode	*Clinostomum marginatum (immature)*	1/7
		trematode	Diplostomidae sp.	1/7

		trematode	*Leuceruthrus micropteri*	1/7
Cyprinidae	*Notemigonus cryoleuscas*	acanthocephalan	*Neoechinorhynchus notemigoni*	2/3
Cyprinidae	*Semotilus atromaculatus*	acanthocephalan	*Neoechinorhynchus saginatus*	1/10
		cestode	*Proteocephalus* sp.	1/10
		nematode	*Spinitectus* sp.	2/10
		trematode	*Allocreadium lobatum*	1/10
Cyprinidae	*Semotilus corporalis*	cestode	*Proteocephalus* sp.	1/19
Escocidae	*Esox lucius*	acanthocephalan	*Acanthocephalus dirus*	1/1
		cestode	*Proteocephalus* sp.	1/1
Escocidae	*Esox niger*	acanthocephalan	*Neoechinorhynchus tenellus*	6/10
		cestode	*Proteocephalus* sp.	5/10
		nematode	*Eustrongilides tubifex*	1/10
		trematode	*Azygia* sp.	4/10
		trematode	*Macroderoides* sp.	1/10
Ictaluridae	*Ameiurus natalis*	trematode	*Alloglossidium* sp.	2/3
		trematode	*Azygia* sp.	1/3
Ictaluridae	*Ameiurus nebulosus*	cestode	*Essexiella fimbriata*	1/16
		nematode	*Contracecum* sp.	1/16
		nematode	*Rhabdochona* sp.	1/16
		trematode	*Alloglossidium geminum*	1/16
		trematode	*Polyekithum ictaluri*	2/16
Percidae	*Perca flavescens*	cestode	*Bothriocestus* sp.	9/26
		cestode	*Proteocephalus* sp.	9/26
		nematode	*Camallanus oxycephalus*	1/26
		nematode	*Eustrongilides tubifex*	5/26
		trematode	*Azygia* sp.	1/26
		trematode	*Bunodera sacculata*	7/26

		trematode	*Clinostomum marginatum (immature)*	1/26
Percidae	*Percina caprodes*	acanthocephalan	*Leptorhynchoides thecatus*	1/7
		nematode	*Spinitectus gracilis*	1/18
		trematode	Diplostomidae sp.	1/18
		trematode	*Phyllodistomum ehteostomae*	2/18
Percidae	*Sander vitreus*	acanthocephalan	*Neoechinorhynchus tenellus*	3/3
		cestode	*Bothriocestus* sp.	2/3
		cestode	*Proteocephalus* sp.	3/3
		nematode	*Rhabdochona* sp.	1/3
		trematode	*Azygia* sp.	2/3
Salmonidae	*Salmo trutta*	acanthocephalan	*Echinorhynchus salmonis*	1/12
		acanthocephalan	*Neoechinorhynchus tenellus*	1/12
		nematode	Nematodae sp.	1/12
Sciaenidae	*Alpodinotus grunniens*	trematode	*Homalometron armatum*	1/2
		trematode	*Homalometron* sp.	1/2
Umbridae	*Umbra limi*	acanthocephalan	*Neoechinorhynchus limi*	6/26
		trematode	*Paracreptotrema limi*	11/26
		trematode	*Phyllodistomum brevicecum*	2/26

Table 4. Prevalence of parasite species in 2023 by host species.