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THE EYE FLUKE DISEASE (DIPLOSTOMATOSIS) IN FISHES FROM UTAH

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Abstract.— During 1976 and 1977, 798 fish representing 11 species from eight collection sites in Utah were examined for metacercariae of *Diplostomum spathaceum*, which causes the fish eye fluke disease, diplostomatosis. Eight species were infected. The infection rate ranged from 7 percent of 46 *Salmo gairdneri* from Soldiers Creek Reservoir to 100 percent in 7 species of fish from four collection sites. Summary charts for four years of data are given for collection sites, piscine hosts in Utah, and fish hosts for Strawberry Reservoir, Utah.

During the past four years we have been studying the incidence, life history, morphology, host-parasite relationships, and control of *Diplostomum spathaceum* in Utah fishes. Palmieri et al. (1977) reported on the life history and habitat analysis of the eye fluke. The incidence of infection for 1974 and 1975 was reported in a previous publication (Evans et al. 1976).

Diplostomum spathaceum (Rudolfi 1819), or the fish eye fluke which causes the disease diplostomatosis, was reported in Strawberry Reservoir, Utah, by the Division of Wildlife Resources in 1973. Fish are the most common second intermediate hosts; however, infections in amphibians, reptiles, and mammals have also been reported (Ferguson 1943). Once the cercariae have penetrated the second intermediate host, they lose their forked tails and migrate to the lens tissue, where the metacercariae develop in 50–60 days (Erasmus 1958). Diplostomatosis causes cataracts of the lens tissue, due to the presence of the metacercarial stage of this parasite. Visual acuity for infected fish can be slightly hampered or lost, depending on the number of worms present. In addition to visual loss, fish show retarded growth and a change in food habits. Increase in the incidence of the disease in the state has generated public and academic concern.

The purpose of this paper is to report on the last two years of survey data (1976–1977) for the prevalence of the eye fluke in fish, indicate new hosts for Utah and sites of infection, and summarize four years of data for Strawberry Reservoir, Utah.

Materials and Methods

A survey of piscine hosts was accomplished with the cooperation of the Utah Division of Wildlife Resources. Regional fisheries biologists provided heads of fish sampled during routine and annual investigations of fish populations throughout the state. Arrangements were made to obtain the samples following the inventories accomplished by the state fisheries biologists. Fish were collected by gill net, seine, and hook and line, then placed in ice chests until the senior author obtained the samples for study at Brigham Young University. The species was determined and recorded.

In the laboratory, fish were examined for metacercariae of *D. spathaceum*. Each individual eye was extracted and carefully examined, records of fish and lens condition determined, and individual numbers of worms found infecting the right and left eye recorded.

Results

A total of 798 fish were examined from eight collection sites in Utah during 1976

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and 1977 (Table 1). Of the 11 species of fish, 8 were infected with the metacercariae of *D. spathaceum* (Table 1).

There are 13 known piscine hosts for the eye fluke in Utah (Table 2), which have been found at 14 sites (Table 3). From pre-

Table 1. Location, fish host, and parasite infection data of *Diplostomum spathaceum* for Utah (1976 and 1977).

Collection date	Reservoir collection locality	Hosts collected	Number of fish	Percent infection of fish	Average number metacercariae/host (Range in parenthesis)
27-VI-1976	East Canyon	*Salmo gairdneri*	19	95	7.4 (0–30)
		Salmo clarki	3	100	2.0 (1–3)
		Richardsonius balteatus	6	100	9.7 (1–16)
		Catostomus ardens	7	100	66.7 (7–105)
27-IV-1976	Echo	*Salmo gairdneri*	8	13	1 (0–1)
		Prosopium williamsoni	6	0	0
		Cyprinus carpio	1	0	0
		Catostomus ardens	2	0	0
		Catostomus platyrhynchus	4	0	0
27-IV-1976	Rockport	*Salmo trutta*	3	0	0
		Salmo gairdneri	14	14	1.5 (0–2)
		Catostomus platyrhynchus	1	0	0
		Gila atraria	12	25	1 (0–1)
30-IV-1976	Lost Creek	*Salmo clarki*	13	0	0
		Salmo gairdneri	6	0	0
		Catostomus ardens	14	72	18.0 (0–131)
		Gila atraria	27	48	3.1 (0–6)
14-V-1976	Hyrum Dam	*Salmo gairdneri*	55	100	16.4 (3–42)
		Salmo trutta	5	80	4.3 (0–7)
		Cyprinus carpio	8	50	6.2 (0–10)
13-V-1976	Pineview	*Ictalurus melas*	9	78	2.6 (0–5)
		Salmo gairdneri	16	86	2.7 (0–7)
		Cyprinus carpio	2	50	4.0 (0–4)
		Gila atraria	12	100	3.1 (1–7)
		Lepomis macrochirus	12	100	3.6 (1–10)
19-V-1976	Soldiers Creek	*Salmo gairdneri*	46	7	1.3 (0–2)
		Salvelinus fontinalis	1	0	0
20-V-1976	Strawberry	*Salmo clarki*	19	84	3.0 (0–11)
		Salmo gairdneri	82	100	30.1 (1–200+)
		Catostomus platyrhynchus	15	100	151.5 (58–200+)
		Richardsonius balteatus	18	100	6.3 (1–23)
28-V-1976	Strawberry	*Richardsonius balteatus*	25	100	5.9 (1–72)
28-XI-1976	Strawberry	*Salmo clarki*	30	80	2.6 (0–18)
		Gila atraria	34	97	3.6 (0–10)
		Salmo gairdneri	52	100	85.4 (3–200+)
		Richardsonius balteatus	9	89	2.8 (0–6)
3-VI-1977	Strawberry	*Salmo gairdneri*	27	100	34.2 (1–200+)
		Salmo clarki	15	93	3.4 (0–12)
		Richardsonius balteatus	6	100	4.1 (1–15)
		Gila atraria	20	90	3.6 (0–9)
		Catostomus platyrhynchus	10	100	189.1 (62–200+)
15-VI-1977	Strawberry	*Salmo gairdneri*	31	100	35.2 (1–200+)
		Salmo clarki	14	86	2.8 (0–7)
		Gila atraria	16	100	3.4 (1–14)
		Catostomus platyrhynchus	10	100	176.2 (58–200+)
		Richardsonius balteatus	10	90	3.5 (0–9)
		Catostomus ardens	12	100	12.3 (3–17)
		Salvelinus fontinalis	1	100	168 (168)
		Rhinichthyes cataractae	10	0	0

vious published data (Palmieri et al. 1976b, 1977) we have added 3 additional hosts and included 4 more sites for diplostomatosis in Utah. The rate of infection varied from 7 percent for a *Salmo gairdneri* from Soldiers Creek Reservoir to 100 percent found in seven species of fish (*Salmo gairdneri, Richardsonius balteatus, Catostomus ardens, Gila atraria, Lepomis macrochirus, Catostomus platyrhynchus, Salvelinus fontinalis*) from 4 of the 8 collection sites (Table 1).

To date, a total of 1637 fish, including 22 species from 21 collection sites throughout Utah, have been checked for diplostomatosis. Although the number of metacercariae in the right and left lenses of individual hosts seldom was identical, no significant lens preference was noted. Examination of data related to host-sex susceptibility to infection by metacercariae of *D. spathaceum* revealed no significant correlation.

The rate of infection of *D. spathaceum* across Utah is high, as exemplified by samples from Strawberry Reservoir (Table 4). For this body of water, three species of fish, *Salmo gairdneri, Salvelinus fontinalis,* and *Catostomus platyrhynchus,* have large numbers of metacercariae which probably impair vision.

Discussion

Samples of fish from eight collection sites in Utah were examined for *Diplostomum spathaceum* metacercariae. These data substantiated previous results (Palmieri et al. 1977) that the rate of infection across Utah is high and widespread. Three additional piscine hosts and four reservoirs are included on the lists for intermediate hosts and habitats respectively. There are sites in Utah where the fluke has not been found. The reason for this is indicated by the lack of the needed shoreline and bottom vegetation, so important for the development, growth, and reproduction of snails. The lack of vegetation, snail, and gull hosts, as well as the presence of low water temperatures, probably accounts for the low infection rate in high alpine lakes. The lack of shoreline vegetation is another reason for the absence of the disease in reservoirs and lakes at lower elevations.

There has been an increase in the incidence of metacercariae for fish in Strawberry Reservoir (Table 4). *Salmo gairdneri* has gone through an increase in prevalence and numbers during the last four years. The last samples of this piscine host suggest a stabilization in number of worms per eye (range 1 to 200+). The Utah chub, *Gila atraria*, has become prominent in recent gill net samples from Strawberry Reservoir. All

TABLE 2. Summary of fish hosts positive for metacercariae of *Diplostomum spathaceum* in Utah.

Fish host	Number examined	Range of infection with metacercariae (percent)
Catostomus ardens	42	72–100
Catostomus discobolus	26	0–5.8
Catostomus platyrhynchus	117	60.5–100
Cyprinus carpio	8	0–50
Gila atraria	210	0–100
Ictalurus melas	9	0–78
Lepomis macrochirus	12	0–100
Micropterus salmoides	61	0–49
Salmo clarki	179	0–100
Salmo gairdneri	792	0–100
Salmo trutta	21	0–100
Salvelinus fontinalis	14	0–100
Richardsonius balteatus	91	0–100

TABLE 3. Collecting sites for intermediate hosts (fish) of *Diplostomum spathaceum* in Utah.

Collection site	County
Ash and LaVerkin creeks	Washington
Deer Creek Reservoir	Wasatch
Echo Reservoir*	Morgan
East Canyon Reservoir*	Davis
Fish Lake*	Sevier
Flaming Gorge Reservoir*	Daggett
Hyrum Reservoir*	Cache
Kolob Reservoir	Washington
Lake Powell	Kane and San Juan
Lost Creek Reservoir*	Summit
Mantua Reservoir*	Box Elder
Mirror and Lost lakes	Summit
Nine-Mile Reservoir*	Sanpete
Otter Creek Reservoir*	Piute
Palisade Lake*	Sanpete
Pineview Reservoir*	Weber
Rockport Reservoir*	Summit
Scofield Reservoir	Carbon
Soldiers Creek Reservoir*	Wasatch
Strawberry Reservoir*	Wasatch
Utah Lake	Utah

*Contain infected fish

the chub from the last sample were infected with limited numbers (1 to 14 per host) of metacercariae. There has been no significant change in the infection rate for *Salmo clarki, Catostomus platyrhynchus,* and *Salvelinus fontinalis* during the four-year sampling period for Strawberry Reservoir (Table 4).

The pathological effects of *Diplostomum spathaceum* upon the fish host are many. Examination of those fish blinded with cataract and containing a heavy burden of larval metacercariae revealed stunted growth (length, girth, and weight), abnormal feeding behavior (lack of response to visual stimuli), and decreased vital acuity (Palmieri et al. 1977). Ashton et al. (1969) reported that larvae migrate to the eye via vascular-venous channels and showed that the lens, vitreous, or cortex of the eye may be pro-

TABLE 4. Fish sampled from Strawberry Reservoir, four years.

Host species	Date of sample	Number of fish	Percent infection	Average number of metacercariae (Range in parenthesis)
Salmo clarki	20-IV-74	19	48	3.4 (0–5)
(Cutthroat trout)	6-IX-74	9	56	4.2 (0–6)
	5-VI-75	75	88	7.3 (0–23)
	30-X-75	10	90	2.1 (0.5)
	20-V-76	19	84	3.0 ((0–11)
	28-XI-76	30	80	2.6 (0–18)
	3-VI-77	15	93	3.4 (0–12)
	15-VI-77	14	86	2.8 (0–7)
Salmo gairdneri	20-VI-74	4	75	8.6 (0–20)
(Rainbow trout)	9-VIII-74	49	98	13.4 (0–22)
	6-XI-74	71	98	11.9 (0–27)
	5-VI-75	35	97	40.0 (0–200+)
	8-VII-75	2	100	33.5 (1–200+)
	10-VII-75	2	100	2.0 (1–13)
	30-X-75	53	93	14.5 (0–54)
	20-V-76	82	100	30.1 (1–200+)
	18-XI-76	52	100	85.4 (1–200+)
	3-VI-77	27	100	34.2 (1–200+)
	15-VI-77	31	100	35.2 (1–200+)
Salvelinus fontinalis	30-X-75	3	100	32.6 (5–31)
(Brook trout)	5-VI-75	4	100	140.9 (25–200+)
	15-VI-77	1	100	168 (168)
Catostomus platyrhynchus	20-VI-74	8	100	102.9 (35–200+)
(Mountain sucker)	6-XI-74	15	100	81.1 (6–200+)
	5-VI-75	21	100	112.0 (25–200+)
	30-X-75	9	100	159.6 (39–200+)
	20-V-76	15	100	151.5 (25–200+)
	3-VI-77	10	100	189.1 (62–200+)
	15-VI-77	10	100	176.2 (58–200+)
Catostomus ardens	5-VI-75	11	100	8.8 (2–14)
(Utah sucker)	15-VI-77	12	100	12.3 (3–17)
Richardsonius balteatus	5-VI-75	5	80	30.6 (0–57)
(Redside shiner)	30-X-75	22	95	7.2 (0–16)
	20-V-76	18	100	6.3 (1–23)
	28-V-76	25	100	5.9 (1–22)
	28-XI-76	9	89	2.8 (0–6)
	3-VI-77	6	100	4.1 (1–15)
	15-VI-77	10	90	3.5 (0–9)
Gila atraria	28-XI-76	34	80	2.6 (0–18)
(Utah chub)	3-VI-77	20	90	3.6 (0–9)
	15-VI-77	16	100	3.4 (1–14)
Rhinichthyes cataractae	15-VI-77	10	0	0 0

liferated with metacercariae. In older fish, chronic infections produced subacuate inflammatory reactions in the vitreous involving heterophils and eosinophils, and macrophages with ingested lens material occurred.

There are many possible techniques to investigate concerning the control of diplostomatosis. One that shows promise is biological control by the use of a protozoan hyperparasite, *Nosema strigeoidea* (Protozoa: Microsporida). Hussey reported in 1971 the above species of microsporidia to be host specific for hyperparasitizing sporocysts of *Diplostomum spathaceum*. Palmieri et al. (1976a, 1976c) substantiated Hussey's work for the eye fluke in Utah.

Spores of *N. strigeoideae* were introduced to laboratory-reared snails (*Lymanaea auricularia*) containing sporocysts of *D. spathaceum*. The spores selectively attack the mother and daughter sporocysts as well as the developing cercarial embryos and retard, disfigure, and disrupt normal cercarial development. The microsporidian spores have no outward pathological effect upon the molluscan host. Further work is needed to determine the potential use of this control method for diplostomatosis and investigations pertaining to resistant fish hosts, stimulus for cercarial migration, immune responses, and the potential human health hazard.

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