The role of season, habitat, host age, and sex on gill parasites of *Lepomis gibbosus* (L.)[1]

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One thousand and forty pumpkinseeds (*Lepomis gibbosus* (L.)) were collected from May 1970 through October 1972 from the Bay of Quinte, Ontario. Also, 1018 specimens of the same host were collected during the same sampling period from West Lake, Prince Edward County, Ontario.

Data were collected on three groups of gill parasites, Monogenea (seven species), Copepoda (three species), and glochidia (one species). The data, treated synecologically, were analysed using a two-factor ANOVA and Duncan's multiple range test. The roles of season, habitat, host age, and sex on parasite load were analysed. Host sex was found to have no effect on the three groups of parasites. The abundance of parasites increased with host age ($P < 0.001$). A marked seasonal effect was noted for all three groups of parasites ($P < 0.001$), all three being most abundant during the summer period. A eutrophic habitat, West Lake, was found significantly more favourable ($P < 0.001$) for all three parasitic groups.

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Mille quarante crapets-soleil (*Lepomis gibbosus* (L.)) ont été capturés de mai 1970 à octobre 1972, dans la Baie de Quinte en Ontario; un échantillonnage parallèle dans le lac West, comté Prince Edouard, en Ontario, a donné 1018 spécimens de la même espèce.

Trois groupes de parasites branchiaux de ces poissons ont été étudiés; ce sont les monogènes (sept espèces), les copépodes (trois espèces) et les glochidies (un espèce). Les données, considérées de façon synécologique, ont été étudiées par une analyse de variance à deux caractères et par le test de Duncan. Ont pu être déterminés de cette façon les rôles respectifs de la saison, de l'habitat, de l'âge et du sexe de l'hôte sur l'abondance des parasites. En revanche, l'abondance des parasites augmente selon l'âge de l'hôte ($P < 0.001$). Le temps de l'année a un effet marqué sur l'abondance ($P < 0.001$), les trois groupes étant plus abondants durant l'été. Un habitat eutrophe, le lac West, semble significativement plus profitable ($P < 0.001$) aux trois groupes de parasites.

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Introduction

The gill parasite fauna of *Lepomis gibbosus* (L.) (pumpkinseed) is well documented, with about 30 species of Monogenea, 5 Copepoda, and 1 glochidia being listed by Hoffman (1967). There is, however, a paucity of ecological studies on the ectoparasite fauna of this host. The present study provides data on the ecology of gill parasites of this fish based on a 2-year study.

Materials and Methods

Fish were collected monthly between May 1970 and October 1972 from two localities: (*a*) a proximate portion of the Bay of Quinte ('Glenora') (44°03′ N; 76°48′ W and 44°06′ N; 76°51′ W) showing typical oligotrophic features, and (*b*) West Lake (44°14′ N; 77°40′ W and 43°57′ N; 77°46′ W) exhibiting typical eutrophic features.

Fish were weighed, measured, sexed, and scale samples for age determination taken from the left dorsolateral surface just below the dorsal fin and above the lateral line. Gill arches were separated and placed in small Petri dishes in water from their locality of origin. Numbers of Monogenea, Copepoda, and glochidia were recorded.

Seasonal divisions were established as follows: spring (March–May), summer (June–August), fall (September–November), and winter (December–February). Host age groups were set up as follows: age 2: 2 and 2+ years; age 3: 3 and 3+; age 4: 4 and 4+; age 5: 5 and 5+; and age 6: 6 and 6+.

A two-factor ANOVA was run to test the role of season, habitat, host age, and sex on each group of parasites (synecological approach). Significance was noted on 0.05, 0.025, and 0.001 levels to indicate degree of the role. An F value significant at the 0.10 level was noted only as an indicator that some sort of relationship might exist.

When effects were noted, Duncan's multiple range test was employed ($P < 0.05$ and $P < 0.01$) to determine more specifically where the significance lay.

Results

Gill Parasite Spectrum

The gill parasite spectrum consisted of the following: (*a*) seven species of Monogenea, viz. *Actinocleidus gibbosus* Mizelle and Donahue 1944, *Actinocleidus recurvatus* Mizelle and Donahue, 1944, *Cleidodiscus robustus* Mueller 1934, *Uro-*

[1]Based in part on a paper read at the 50th meeting of the American Society of Parasitologists, 9–13 November 1975, New Orleans, LA, U.S.A.

cleidus acer (Mueller, 1936) Mizelle and Hughes, 1938, *Urocleidus attennatus* Mizelle, 1941, *Urocleidus dispar* (Mueller, 1936) Mizelle and Hughes, 1938, and *Urocleidus ferox* Mueller, 1934; (*b*) three species of Copepoda, viz. *Achteres ambloplitis* Kellicott, 1880, *Ergasilus caeruleus* Wilson, 1911, and *Ergasilus centrarchidarum* Wright, 1882; and (*c*) one species of glochidia, viz. glochidia of *Lampsilis radiata* (Gmelin 1792).

A synecological approach, treating communities and their constituent species in general terms and comparing ecological differences between groups of parasites, viz. Monogenea, Copepoda, and glochidia, was adopted and is used throughout this presentation.

Sex of Host

Host sex is not statistically significant for any group of parasites under consideration.

Host's Age

An age effect was noted for Monogenea (F = 4.192; $P < 0.001$). Duncan's multiple range test ($P < 0.05$) indicates 2 to 2+ group to be significantly different from the other age groups.

An age effect was also noted for Copepoda (F = 45.403; $P < 0.001$). Duncan's test ($P < 0.01$) indicates 2 to 2+ and 3 to 3+ age groups significantly different from the other age groups.

A significant relationship was noted for glochidia of *L. radiata* (F = 36.927; $P < 0.001$). Duncan's test ($P < 0.01$) indicates (*a*) 2 to 2+ age group significantly different from the other age groups; and (*b*) 3 to 3+ and 4 to 4+ age group significantly different from the other age groups.

The total parasite load (Monogenea, Copepoda, and glochidia) showed an F value of 92.648 ($P < 0.001$) with Duncan's ($P < 0.05$) indicating 2 to 2+ and 3 to 3+ age groups significantly different from the other age groups.

Season

A definite seasonal effect was noted for all three groups of parasites: (*a*) Monogenea (F = 85.836; $P < 0.001$); Duncan's test ($P < 0.01$) indicates 'summer' significantly different from the other seasonal divisions; (*b*) Copepoda (F = 54.671; $P < 0.001$); Duncan's test ($P < 0.01$) indicates (i) seasonal divisions 'winter' and 'spring' different from the others; (ii) 'spring' and 'fall' significantly different from the others; and (iii) 'summer' significantly different from the other seasonal divisions; (*c*) glochidia of *L. radiata* (F = 58.887; $P < 0.001$); Duncan's test ($P < 0.01$) indicates (i) 'fall' and 'winter' significantly different from the other two 'summer' significantly different from the other seasonal divisions; (*d*) the total parasite load (Monogenea, Copepoda, glochidia) followed naturally the pattern exhibited by Monogenea showing an F value of 75.48 ($P < 0.001$) with Duncan's test ($P < 0.01$) clearly showing 'summer' significantly different from the other seasonal divisions.

Habitat

A marked effect of the host's habitat was detected for all three groups of parasites, viz. Monogenea (F = 32.461; $P < 0.001$); Copepoda (F = 21.497; $P < 0.001$); and glochidia of *L. radiata* (F = 27.633; $P < 0.001$). Duncan's test (both at P 0.05 and $P < 0.01$) indicates significant differences between the two localities.

Discussion and Conclusions

Sex of Host

While the effects of the homeothermic verteb... host sex on its parasite load have been the subj... of considerable research, poikilothermic ho... have received little attention so far. Thomas (19... noted that the trematode *Mesocoelium mon...* *Agama* lizards occurred most frequently ... females. Further, Thomas (1964) noted greater ... tensity of helminth infestation in brown ... *Salmo trutta*, females 3 years and older d... spawning or immediately after. During the pe... of growth and gonad maturation this trend ... either reversed or less marked. Lawrence (1... examined the relationship between the sex of ... host, *Catostomus commersoni*, and ... caryophyllaeid cestodes, *Glaridactis catos...* *Glaridactis laruei*, and *Isoglaridactis bulbo...* and concluded that no clear pattern was observ... to indicate that sex of host was a major fact... determining the parasite load.

The present study, the first to conside... phenomenon for ectoparasites with direct ... cycles in two limnologically different trophic ha... clearly indicates that the sex of *L. gibbosus* is ... factor in determining the parasite load.

Host's Age

Gorbunova (1936) distinguished three groups among the parasites infesting *Esox luc...* and *Rutilus rutilus*: (*a*) parasites independent of the ag... of the host; (*b*) parasites decreasing in abundance with the age of the host; and (*c*) parasites inc... in abundance with the age of the host.

While the third group is undoubtedly predomin... ent (Bauer and Nikolskaya 1957; Dub...

...sity of infestation also tends ...age in some cases (Byc... 1940; Bychowsky 1936; La... 1970; Thomas 1964) or no ...Awachie 1965; Gorbunova ... Thomas 1958).

Factors responsible for in... intensity comprise, among ... the amount of food consu... hardly applies to gill paras... apparent from the above, al... dealt with endoparasites. ... available on the dynamic... parasites in particular, in re... influence. The hypothesis ... ...s and incidence with the ... generally accepted (Dogiel ... the basis of increase in size ... attachment. A longer life its... opportunity for infestation ...

The results of our study, ... results obtained for Mono... clearly indicate the increa... age of *L. gibbosus*, particul...

...son

Studies on seasonal dyn... ...respect to the fluctuati... ... of any host species ... in the Neartic regio... The majority of th... carried out during th... ...ber, these investigatio... ... on seasonal cycles ... ...sitic species (Conn... ... 1937; Fischer and ... and others).

The three groups of par... in the present study ... naturally determi... ...wsky (1929, 1933, 19... Izjumova (1956), K... ...ane (1964), Rawso... and others have co... species of Monoge... phenomenon.

The seasonal abundance ... related to their breed... affected by the be... ...berg 1949; Hergenr... period of ... over several mont... Clarke and Berg (19...

es of infestation also tends to decrease with host's ge in some cases (Bychowskaya-Pavlovskaya 940; Bychowsky 1936; Layman 1955; Lawrence 970; Thomas 1964) or no age effect is detectable Wachie 1965; Gorbunova 1936; Lawrence 1970; Thomas 1958).

Factors responsible for increase in incidence and ntensity comprise, among others, an increase in he amount of food consumed by older fish. This ardly applies to gill parasite larvae however. As pparent from the above, all of these investigations ealt with endoparasites. Virtually no data are vailable on the dynamics of ectoparasites, gill arasites in particular, in regard to their host's age nfluence. The hypothesis of the increase in inten- y and incidence with the age of host, however, is enerally accepted (Dogiel *et al.* 1958), merely on he basis of increase in size of surface available for ttachment. A longer life itself would provide more pportunity for infestation of gills.

The results of our study, based primarily on the esults obtained for Monogenea and Copepoda, learly indicate the increase in intensity with the ge of *L. gibbosus*, particularly of those 3 to 3+ and lder.

eason

Studies on seasonal dynamics of fish parasites ere respect to the fluctuation of the entire parasite auna of any host species are still meagre, espe- ally in the Nearctic region (Tedla and Fernando 969*b*). The majority of these investigations have een carried out during the spring and summer. urther, these investigations have been limited to tudies on seasonal cycles of a single, mainly en- parasitic species (Connor 1953; DeGiusti 1949; Tarbum 1937; Fischer and Freeman 1969; Hopkins 969, and others).

The three groups of parasites under considera- ion in the present study exhibit an annual cycle which naturally determines their abundance. Bychowsky (1929, 1933, 1957), Crane and Mizelle 1957), Izjumova (1956), Kulwiec (1929), Mizelle nd Crane (1964), Rawson and Rogers (1972*a*, 972*b*) and others have considered this aspect for arious species of Monogenea and have noted this henomenon.

The seasonal abundance of Copepoda appears to e correlated to their breeding season; it might be lso affected by the behaviour of the host Smaldeberg 1949; Hergenrader and Hasler 1965).

The gravid period of lampsiline glochidia is pread over several months (Lefevre and Curtis 912). Clarke and Berg (1959) noted that glochidia of *L. radiata* are retained in the marsupium of the mussel from the 1st week of August to the middle of the following July. It was noted by Tedla and Fernando (1969*b*), however, that the release of glochidia may not take place in all individuals of *L. radiata* at the same time but, on the contrary, spawning may extend over a considerable period throughout the spring and summer.

The results of our study indicate that Monogenea were clearly a dominant group of parasites, with Copepoda encountered at moderate levels throughout the entire sampling period and the abundance, however sporadic, of glochidia of *L. radiata* restricted to the late spring and summer. Each of the three groups of parasites exhibited a distinct summer peak. This phenomenon was followed by a sharp decline during the fall and a slow buildup during the winter and spring for Monogenea. Copepoda exhibited a gradual decline to a fairly constant level which remained until the next upswing. These patterns of infestation naturally reflect the patterns of the dominant species of either Monogenea or Copepoda, since groups as such were considered. Naturally, some species of Monogenea and Copepoda exhibited quite different infestational patterns. This aspect will be dealt with in other publications.

Habitat

Within many aquatic ecosystems, a specific combination of biotic and abiotic factors produces a unique state of ecological succession. In a descriptive sense, these bodies of water may be termed eutrophic, mesotrophic, or oligotrophic, depending upon the specific combination of factors (Allee *et al.* 1949). It is generally accepted that a parasite fauna in an aquatic ecosystem is determined by interaction of various biotic and abiotic forces (Fischthal 1950).

A basis for this hypothesis, with regard to endoparasites, was provided by works of Esch (1971), Tedla and Fernando (1970), and particularly by Wisniewski (1955, 1958).

The results of our work clearly indicate that the eutrophic habitat, West Lake, was significantly more favourable for all three groups of parasites, particularly for Monogenea, than the oligotrophic habitat (Glenora). It might, therefore, be suggested that besides other factors, faster water warm-up during the spring and early summer combined with higher water temperatures during the summer months in West Lake generated more favourable conditions for the parasites under consideration.

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ALLEE, W. C., A. E. EMERSON, O. PARK, T. PARK, and K. P. SCHMIDT. 1949. Principles of animal ecology. W. B. Saunders Co., Philadelphia.

AWACHIE, J. B. E. 1965. The ecology of *Echinorhynchus truttae* in a trout stream in North Wales. Parasitology, **55**: 747–762.

BAUER, O. N., and N. N. NIKOLSKAYA. 1957. The dynamics of the parasite fauna of *Coregonus* in Lake Ladoga and its epizootical importance. (In Russian.) Izv. Vniorch, **42**: 227–242.

BYCHOWSKAYA-PAVLOVSKAYA, I. E. 1940. The influence of age on parasite fauna of perch. (In Russian.) Parazitol. Sb. **8**: 99–130.

BYCHOWSKY, B. E. 1929. Trematodes of fishes in the environs of the township Kostroma. (In Russian.) Trav. Soc. Nat. Leningr. **59**: 13–27.

——— 1933. Die Bedeutung der monogenetischen Trematoden fur die Ertorschung der systematischen Beziehungen der Karpenfische. Zool. Anz. **105**: 243–251.

——— 1936. Monogenoidea of the river Chu. (In Russian.) Tr. Kirg. Kompleksn. Eksped **3**: 245–275.

——— 1957. Monogenoidea, their taxonomy and phylogeny. (Transl. from Russian). *Edited by* W. J. Hargis and P. C. Oustinoff. American Institute of Biological Sciences, Washington, D.C.

CLARKE, A. H., JR., and C. O. BERG. 1959. The freshwater mussels of central New York. Cornell Univ. Agric. Exp. Stn., Coll. Agric. Mem. 367.

CONNOR, R. S. 1953. A study of the seasonal cycle of a proteocephalan found in yellow pike-perch, *Stizostedion v. vitreum* (Mitchill). J. Parasitol. **39**: 621–624.

CRANE, J. W., and J. D. MIZELLE. 1968. Studies on monogenetic trematodes. XXXVII. A population study of two species of Ancyrocephalinae on the bluegill in California. J. Parasitol. **54**: 49–50.

DEGUISTI, D. L. 1949. The life cycle of *Leptorhynchoides thecatus* (Linton), an acanthocephalan of fish. J. Parasitol. **35**: 437–460.

DOGIEL, V. A., G. K. PETRUSHEVSKI and YU. I. POLYANSKI (*Editors*.) 1958. Parasitology of fishes. Leningrad Univ. Press, Leningrad. (Translated (1961) by Z. Kabata. Oliver and Boyd Ltd., Edinburgh and London).

DUBININ, V. B. 1936. The study of the parasite fauna of grayling at different periods of its life. (In Russian.) Uch. Zap. Leningr. Univ. Biol. **7**: 31–48.

EKBAUM, E. 1937. On the maturation and hatching of eggs of the cestode *Triaenophorus crassus* Forel, from Canadian fish. J. Parasitol. **23**: 293–295.

ESCH, G. W. 1971. Impact of ecological succession on the parasite fauna in centrarchids from oligotrophic and eutrophic ecosystems. Am. Midl. Nat. **86**: 160–168.

FISCHER, H., and R. S. FREEMAN. 1969. Penetration of parental plerocercoids of *Proteocephalus ambloplitis* (Leidy) into the gut of smallmouth bass. J. Parasitol. **55**: 766–774.

FISCHTHAL, J. H. 1950. Parasites of northwest Wisconsin fishes. II. The 1945 Survey. Trans. Wis. Acad. Sci. Arts Lett. **45**: 87–113.

GNADEBERG, W. 1949. Beiträge zur Biologie und Entwick. des *Ergasilus sieboldi* v. Nordmann (Copepoda Parasit. Z. Parasitenkd. **14**: 103–180.

GORBUNOVA, M. N. 1936. Changes in the parasite fauna of and roach with age. (In Russian.) Uch. Zap. Leningr. Biol. **7**: 5–30.

HERGENRADER, G. L., and A. D. HASLER. 1965. Diel ac and vertical distribution of yellow perch (*Perca flav* under the ice. J. Fish. Res. Board Can. **23**: 499–509.

HOFFMAN, G. L. 1967. Parasites of North American fresh fishes. University of California Press., Berkeley and Angeles.

HOPKINS, S. H. 1959. Seasonal variation in the incidenc *Proteocephalus fillicolis* (Rud. 1810) in *Gaster aculeatus* L. Parasitology, **49**: 529–542.

IZJUMOVA, N. A. 1956. Biology of *Dactylogyrus vastator* N lin. (In Russian.) Sb. Zool. Inst. Acad. Sci. USSR 229–243.

KULWIEC, Z. 1929. Observations on the evolution of *tylogyrus vastator*. (In Polish.) Nyb. Arch. Hydrob 277–281.

LAWRENCE, J. L. 1970. Effects of season, host age, and s endohelminths of *Catostomus commersoni*. J. Parasit 567–571.

LAYMAN, E. M. 1955. The age dynamics of infestation with parasites. (In Russian.) Tr. Mosrybvtuza, **7**: 38–4

LEFEVRE, G. C., and W. C. CURTIS. 1912. Studies on the duction and artificial propagation of freshwater mussels N.S. Bur. Fish. **30**: 105–201.

MEYER, M. C., and R. VIK. 1968. Observation on *Dip rium sebago* plerocercoids in the fish hosts. Proc. He Soc. Wash. **35**.

MIZELLE, J. D., and J. W. CRANE. 1964. Studies on mo tic trematodes. XXIII. Gill parasites of *Microge moides* (Lacépède) from a California pond. Trans crosc. Soc. **83**: 343–346.

RAWSON, M. V., and W. A. ROGERS. 1972*a*. The s abundance of the Ancyrocephalinae (Monoge largemouth bass in Walter F. George Reservoir. P minthol. Soc. Wash. **39**: 159–162.

——— 1972*b*. Seasonal abundance of Ancyroce (Monogenea) parasites of bluegill, *Lepomis ma* (Raf.). J. Wildl. Dis. **8**: 255–260.

TEDLA, S. and C. H. FERNANDO. 1969*a*. Observation seasonal changes of the parasites of yellow perc *flavescens*) from the Bay of Quinte, Lake Ontario Res. Board Can. **26**: 833–843.

——— 1969*b*. Observation on the glochidia of *Lampsi* (Gmelin) infesting yellow perch, *Perca flavescens* M the Bay of Quinte. Can. J. Zool. **47**: 705–712.

——— 1970. On the characterization of the parasit yellow perch (*Perca fluviatilis* L.) in five lakes Ontario, Canada. Helminthologia, **11**: 23–33.

THOMAS, J. D. 1958. Studies on *Crepidostomum* (Braun) and *C. farionis* (Mueller), parasitic in *S.* L. and *S. salar* L. in Britain. Parasitology, **48**: 356

——— 1964. A comparison between the helminth male and female brown trout, *Salmo trutta* L., tro population in the River Teify, West Wales. Parasi 263–272.

——— 1965. Studies on some aspects of the *Mesocoelium monodi*, a trematode parasite of rep amphibia. Proc. Zool. Soc. London, **145**: 471–494

WISNIEWSKI, W. L. 1955. Biocoenological p parasitology. (In Polish.) Wiad. Parazytol. **1**: 7–41

——— 1958. Characterization of the parasitofauna trophic lake. Acta Parasitol. Pol. **6**: 1–64.