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Susceptibility and resistance of brook lamprey, *Lampetra planeri* (Bloch), roach, *Rutilus rutilus* (L.) and perch, *Perca fluviatilis* L. to *Gyrodactylus salaris* Malmberg (Monogenea)

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The susceptibility and resistance of brook lamprey, *Lampetra planeri,* roach *Rutilus rutilus* and perch, *Perca fluviatilis* to *Gyrodactylus salaris* were examined. The level of resistance to the parasite was assessed from counts, made on anaesthetized hosts, of the numbers of *G. salaris* after an initial experimental exposure to salmon infected with *G. salaris.* The results of four experiments carried out at constant temperature (11.5°C) and decreasing temperatures (11.5°C—0.7°C), demonstrated that *G. salaris* attached to the potential hosts but showed no sign of reproduction. The parasites were eliminated within 2—4 days. The three host species tested were clearly highly resistant to *G. salaris.* The restricted attachment frequency and resistance observed, indicate that these fish species play an insignificant role in the dissemination of the parasite.

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INTRODUCTION

The ectoparasitic monogenean *Gyrodactylus salaris* Malmberg, 1957, originally described from hatchery reared Atlantic salmon, *Salmo salar,* in Sweden, has been reported to cause heavy losses of salmon parr in Norwegian rivers (Johnsen and Jensen 1986, Malmberg 1988). In addition to Atlantic salmon, rainbow trout, *Oncorhynchus mykiss* (Walbaum) (see Mo 1988, Eken and Garnås 1989), arctic charr, *Salvelinus alpinus* (L.) (see Mo 1988, 1989) and brown trout, *Salmo trutta* L. (see Tanum 1983, Malmberg 1988) have been reported to be infected with *G. salaris* in natural systems. However, their importance in the ectoparasite maintenance and dispersal is little known. Among non-salmonids, *Platichthys flesus* (L.) (Mo 1987) has been found infected in the wild with *G. salaris,* and it has been possible to infect European eel, *Anguilla anguilla* (L.) experimentally (Bakke et al. 1991). Although reproduction of the parasite was not observed in these cases, Bakke et al. (1991) stressed the possible importance of species other than salmonids in the host-parasite community, either as hosts for parasite reproduction or in parasite transport, and thus for enhanced colonization within or between rivers.

The aim of the present study was to investigate the potential of non-salmonid fish species within the host community, for the circulation and transport of *G. salaris* in the wild. Three species, which consitute a significant part of the community in two *G. salaris* infected rivers, Drammenselva and Lierelva, in south-eastern Norway, Buskerud county (Brittain et al. 1986, Økland 1990), were selected: brook lamprey, *Lampetra planeri* (Bloch), roach, *Rutilus rutilus* (L.) and perch, *Perca fluviatilis* L. Their susceptibility and resistance to *G. salaris* infections were experimentally tested under laboratory conditions.

MATERIAL AND METHODS

Specimens of *Gyrodactylus salaris* Malmberg, were obtained from heavily infected Atlantic salmon, sampled by electrofishing in the Lierelva river (Buskerud county, south-east Norway), during May and from August to October 1990.

Brook lamprey (mean length 11.6 cm, range 10.0—13.2 cm; mean weight 2.4 g, range 1.3—3,7 g) was obtained from Lierelva by electrofishing in May 1990. The fish were disinfected (30 min, 1:4000 formalin) after arrival in the laboratory, although no *Gyrodactylus* infection was observed after surface scanning of 5 randomly selected specimens under a stereomicroscope.

Since young-of-the-year roach from natural systems can be heavily infected with *Gyrodactylus* sp. (not identified, probably a new species), roach and perch were both collected as eggs in lake Gjersjøen in May 1990. The two species were reared seperately in natural dams protected from any *Gyrodactylus* infection until September 1990 when the experiments started. Size of the fish at start of experiments; Roach — mean length 6.8 cm, range 6.7—7.1, mean weight 2.7 g, range 2.3—3.2; Perch — mean length 6.0 cm, range 4.6—8.7, mean weight 1.7 g, range 1.0—2.2. On arrival at the laboratory, five specimens of each species were scanned for skin parasites under a stereomicroscope. Both species were found to be uninfected with ectoparasites and therefore used in the experiments without disinfection, although the roaches had a natural infection of *Diplostomum spathaceum*. The fish were conditioned to the experimental water temperatures (11.5°C) prior to the start of the experiments under continuous, dim illumination. The fish were not fed during the experiments.

Gyrodactylus salaris was transmitted by placing heavily-infected salmon within batches of the host species grouped in small grey tanks (47 x 37 x 8 cm water level) under lentic conditions: (1) 10 brook lamprey + 10 infected salmon for two days; (2) 10 brook lamprey + 10 infected salmon for two days; (3) 10 roach + infected salmon for five days, three days with 15 salmon, the two last days with 20 infected salmon; (4) 10 perch + infected salmon for five days, three days with 15 salmon, the two last days with 20 infected salmon.

The experiments were carried out by individual isolation of fish in small (11 x 17 x 5 cm water level) floating boxes attached together and made of translucent plastic with a base of plastic netting, which allowed free exchange with the water in the main tank, but prevented parasite transmission. Four experiments were designed, each with 10 individually isolated fish: (1) Constant temperature (11.5°C): brook lamprey; (2) Decreasing temperature (11.5°C - Day 0; 2.8°C - Day 2; 1.5°C - Day 3; 0.7°C - Day 4): brook lamprey; (3) Constant temperature (11.5°C): roach; (4) Constant temperature (11.5°C): perch. Some fish died during the experiments, which subsequently reduced the number.

RESULTS

Experiment 1

The prevalence of *Gyrodactylus salaris* on brook lamprey was 100% after two days of exposure at 11.5°C to the infection source, mean intensity 18.1, range in number 12—34 (Tab. 1). However, after two days in the isolated boxes, the prevalence and infrapopulations of *G. salaris* on the 7 surviving brook lamprey had drastically decreased to zero (Tab. 1). No parasite reproduction was observed.

Experiment 2

The prevalence of *Gyrodactylus salaris* on brook lamprey was 100% after two days of

Table 1. The course of infection of *Gyrodactylus salaris* on 10 individually isolated brook lamprey, *Lampetra planeri*, 9 (one died when exposed to the infection source) individually isolated perch, *Perca fluviatilis*, and 7 (three died when exposed to the infection source) individually isolated roach, *Rutilus rutilus*, at a constant temperature of 11.5°C.

	Fish species		
Days	Brook lamprey Mean intensity (Range)	Perch Mean intensity (Range)	Roach Mean intensity (Range)
0	18.1 (12—34)	7.6 (3—11)	2.9 (1—5)
2	0.0 —	0.0 —	0.0 —

Table 2. The course of infection of *Gyrodactylis salaris* on 8 (two died when exposed to the infection source) individually isolated brook lamprey, *Lampetra planeri*, at a decreasing temperature regime from 11.5°C (Day 0), 2.8°C (Day 2), 1.5°C (Day 3) to 0.7°C (Day 4).

Days	Individual fish number								Mean intensity (Range)
	1	2	3	4	5	6	7	8	
0	26	25	53	49	17	14	30	17	28.9 (14—53)
2	3[d]	0	1[d]	2[d]	4[d]	0	3	0	0.4 (0—3)
3	0	—	0	0	0	—	1[d]+1	—	0.1 (0—1)
4	—	—	—	—	—		1[d]	—	0.0 —

[d] Dead parasites *in situ*

exposure at 11.5°C to the infection source, mean intensity 28.9, range in number 14—53 (Tab. 2). Table 2 summarizes the changes in *G. salaris* infection in the 8 surviving brook lamprey subject to decreasing water temperature. This design gave an increased parasite survival on the fish, up to 4 days, although the decline in the infrapopulations on the individually isolated fish was very prominent. No parasite reproduction was observed.

Experiment 3

The prevalence of *Gyrodactylus salaris* on roach was 100% after five days of exposure at 11.5°C to the infection source, mean intensity 2.9, range in number 1—5 (Tab. 1). As shown in Tab. 1, the parasite burden on the individually isolated roach declined to zero after two days. No parasite reproduction was observed.

Experiment 4

The prevalence of *Gyrodactylus salaris* on perch was 100% after five days of exposure at 11.5°C to the infection source, mean intensity 7.6, range in number 3—11 (Tab. 1). During two days the parasite burden dropped to zero on the seven surviving individually isolated perch (Tab. 1). No parasite reproduction was observed.

DISCUSSION

All three fish species, brook lamprey, roach and perch, have a continuous distribution from eastern or south-eastern Norway to the Baltic Sea (Pethon 1985) where drainage systems are infected with *Gyrodactylus salaris* (Malmberg 1988). The resident fish species in rivers and brooks, brook lamprey, has marked contact with the substratum, stressed as a significant indirect route for parasite transmission (Hoffman and Putz 1964, Scott 1982, 1985, Bakke et al. 1991). Roach, a dominant species in many lakes in south-east Norway, is also numerous in the *G. salaris* infected Drammenselva and Lierelva rivers (Brittain et al. 1986, Økland 1990). The roach are salinity tolerant and may form local stocks or roaming stocks in brackish water close to freshwater systems. Also the abundant perch is salinity tolerant, up to 10⁰/₀₀ (Pethon 1985). Both species are potentially significant in *G. salaris* dissemination and colonization in both river systems. The results indicate that although *G. salaris* attached to the skin of brook lamprey, the innate resistance of the fish prevented further establishment, development and reproduction of the parasite. The relatively high frequency of parasite attachment is in accordance with the results of the previously tested salmon-European eel transmission ability of *G. salaris* (Bakke et al. 1991). The prominent bottom substrate contact of this fish species indirectly promotes transfer through dislodged parasites as well as a higher contact rate with the infected salmon parr, which are also bottom dwelling. This may explain the relatively high parasite attachment frequency. However, even at low temperatures, which is postulated to decrease the host responses to *Gyrodactylus* species (Malmberg 1970), the parasite survival period on brook lamprey was very restricted. In contrast to the eel, brook lamprey is nonanadromous, very sedentary with low vagility. Thus, this fish species is judged as insignificant for *G. salaris* dissemination.

Even with increased number of days of parasite exposure and number of heavily infected salmon, roach and perch were very difficult to infect with *G. salaris.* The low attachment rate may indicate, besides a hostility from the fish skin, different behaviour from the salmon in the tanks. Also in large rivers, roach and perch usually occupy slow-flowing areas rich in macrophytes. This will obviously reduce contact with salmon, which have a preference for higher water velocities with cobble substrate (Heggenes and Saltveit 1990). Low parasite establishment, lack of parasite reproduction with complete parasite dislodgement after only two days, demonstrate that roach and perch, although tolerant of brackish water, represent no risk for *G. salaris* dissemination.

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