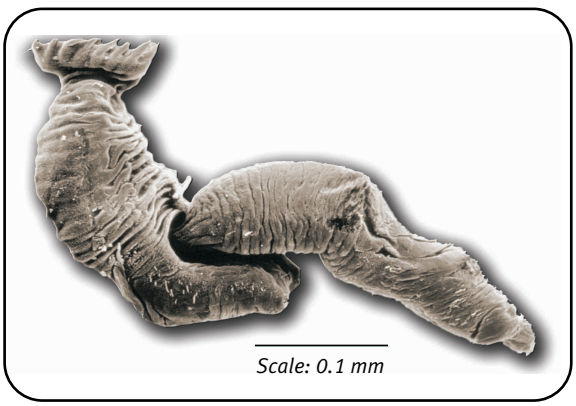
Gyrodactylus salaris

What Is It?

Gyrodactylus salaris is a member of a genus of small parasitic worms that have been studied since the 1880s. Over 400 *Gyrodactylus* species, infesting fish and frogs in both fresh and salt water have been identified. In 1956 *Gyrodactylus salaris* was described in Sweden by Göran Malmberg. *G. salaris* measure approximately 0.5mm, and are visible only with the aid of magnification. In the field, it is possible to see them with a hand lens. Without magnification, salmon parr heavily infected by *G. salaris* appear greyish, with excess mucus, and possibly concurrent fungal infections.

G.salaris attach to the host by means of an organ called the opisthaptor at one end of the body. At the other end of the worm is the mouth. Many *Gyrodactylus* species feed on mucus only, and cause little damage to the host either by feeding or by attachment. However, *G. salaris* can inflict large wounds on the salmon host when feeding. The main body of the parasite contains a developing embryo, and *Gyrodactylus* gives birth to young that are virtually the same size as the mother. In an amazing feat of nature, inside that embryo there is usually another developing worm, forming a 'Russian doll' arrangement. Reproduction occurs rapidly, particularly at high temperature, when populations of parasites can double in four days. Once infected by *G. salaris*, individual young salmon (parr) can soon become almost completely covered by thousands of parasites, giving impression of a thick layer of mucus. These heavy infections damage the skin and enable secondary infection by bacteria, viruses or fungi, which contribute to massive mortalities.



Gyrodactlylus spp. giving birth.
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In Norway, catastrophic losses of Atlantic salmon (*Salmo salar*) were noticed following the introduction of *G. salaris* to the country in the 1970s on imported live fish from an infected area. By 2002, 44 Norwegian rivers had been infected, and their salmon populations decimated. Fishery losses due to the parasite have been estimated at over 40% of total reported catch of wild salmon.

Susceptibility

G. salaris cannot survive full strength sea water, so although adult salmon are not infected, they can become re-infected once they enter a river. Infection spreads to younger fish from parasites that have survived on fish from the previous year, or from other species of fish that harbour the parasite. Although the most severely affected species is Atlantic salmon, *G. salaris* has been reported on rainbow trout (*Oncorhynchus mykiss*), Arctic char (*Salvelinus alpinus*), North American brook trout (*S. fontinalis*), grayling (*Thymallus thymallus*), North American lake trout (*Salvelinus namaycush*) and brown trout (*Salmo trutta*).

Can *Gyrodactylus salaris* be treated?

There is no known treatment for this parasite in wild fish. In hatcheries, routine treatments with a variety of chemicals can control this pathogen. Complete eradication can only be achieved by removing all fish, drying, and a instituting a fallow period.

In an attempt to eradicate *G. salaris*, the Norwegian government is carrying out an extensive and extremely costly programme to treat infected rivers with rotenone, killing all fish able to harbour the parasite. As of 2003, 26 Norwegian rivers have been treated in this way. After a period of monitoring to ensure all fish have been removed,

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the river can be re-stocked using eggs that were removed prior to rotenone treatment. This drastic measure has been successful in about 20 rivers. In a few rivers, the parasite has reappeared following rotenone treatment.

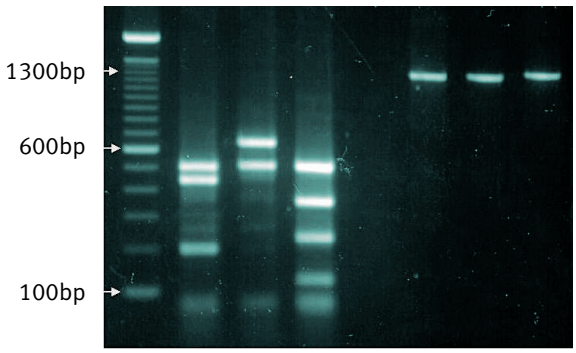
Is *Gyrodactylus salaris* a threat to salmon in Britain?

In an experiment to address this question, experts at Fisheries Research Services (FRS) transported salmon from Scottish rivers to Norway and exposed them to *G. salaris*. The rapid increase in the number of parasites on the fish showed that Scottish fish were highly susceptible, and therefore at risk should the parasite ever be introduced. Movements of live fish from infected areas represent the highest risk to salmon in Great Britain (GB). Legislation to safeguard our fish by preventing these movements has been introduced by the EC (Commission Decision 96/490/EC).

Lower risks of introductions include contact with material from infected waters such as angling equipment and canoes. Practical measures that should be taken to ensure these risks are minimised are set out in the *Code of Practice to Avoid the Introduction of Gyrodactylus salaris to GB* (available from our website) and the leaflet *Keep Fish Disease Out — A guide to protecting freshwater fish stocks from Gyrodactylus salaris*.

DNA analysis

The application of molecular biology to the study of *Gyrodactylus* spp. has enabled scientists at FRS to develop new techniques to differentiate harmful species from those that do not present a threat to salmon in Great Britain. Parts of the ribosomal RNA genes are amplified using the polymerase chain reaction (PCR). This amplified DNA is then digested with restriction enzymes, used as target for DNA probes, or sequenced directly. These tests reveal genetic differences between species that are used as diagnostic markers. Study of the ribosomal RNA gene



DNA amplified from 3 species of Gyrodactylus (right-hand lanes) and digested to reveal species-specific patterns (left-hand lanes).

intergenic spacer has even made it possible to differentiate *G. salaris* and *G. thymalli*; two species that are extremely difficult to separate by microscopic examination alone. DNA sequences have also been used to construct phylogenies that demonstrate genetic relationships between *Gyrodactylus* spp.

On-going FRS research into *Gyrodactylus* spp.

Norwegian scientists have shown that there is a strong genetic component in susceptibility of the host to *G. salaris*. Comparison of *G. salaris* infection and host response at the molecular level, in distinct Atlantic and Baltic salmon stocks, is being carried out to identify differences which form the basis for resistance to *G. salaris*. Through understanding the basis for resistance, natural variation in susceptibility to *G. salaris* infection in Atlantic salmon stocks could allow enhancement, through selective breeding, of *G. salaris* resistance, giving another option for *G. salaris* control. This work is being carried out in collaboration with the University of Aberdeen, the National Veterinary Institute in Oslo, Norway, and the Royal Veterinary and Agricultural University in Copenhagen, Denmark, in the EU-funded project QLRT-2000-1631; 'The Genetic Basis of *Gyrodactylus salaris* resistance in Atlantic salmon (*Salmo salar*)'.

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