

- ❑ MONOGENEA-TREMATODA (FLAT WORMS)
- ❑ DIGENEA-TREMATODA (FLUKES)
- ❑ CESTODA (TAPEWORMS)
- ❑ NEMATODA (ROUND WORMS)
- ❑ ACANTHOCEPHALA (SPINY-HEADED WORM)
- ❑ HIRUDINEA (LEECHES)
- ❑ CRUSTACEA

□ CLASS TREMATODA

□ MONOGENIC TREMATODES

A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, located in the lower right quadrant of the slide.

DACTYLOGYRUS (Gill, skin and fin flukes)

- *Dactylogyrus* spp. is small (2-3 mm long), flat worm
- Primarily a gill parasite and warmwater, especially cyprinids.
- *Dactylogyrus* is 2-3 mm in length
- The head of the worm is four-lobed and 2 pairs of eye spots. At their posterior end *Dactylogyrids* have a haptor, «hold fast organ» that has 1 pair of anchors, one dorsal transversal bar. They usually have 6-7 pairs marginal hooks.
- *Dactylogyrids* are oviparous, and lay eggs in water (not as explosive as *Gyrodactylus* spp.)
- The length of the life cycle depend on water temperature.
- Transmission from fish to fish is primarily by direct contact.
- The eggs of *dactylogyrids* move in the water or allow them to be easily trapped in mucus or other organic material. When the free-swimming ciliated oncomiracidia emerge from the eggs, they are carried to a new host by water currents as well as by their own movement. Larvae must find a host within 6-8 h of hatching to survive.

- **Gill swollen and pale.** Gills or fins may be **eaten away**
- **Skin may redden** in places. **Scale loss** may occur
- **Increased gill movements, excessive mucous secretion, fast respiration.** The **gills may move rapidly.** In heavy infection, fish can be found **gasping for air** and **jumping out of the water** (fish may gasp at the water surface). So, caused gill damage and symptoms can be mistaken for O₂ problem or other gill infections.
- **Mucus** covering the gills or body. Colour **fades** as damaged areas are covered in mucus.
- The **fish** may be **lethargic, loss of appetite, sit on the bottom** with their fins, swim near the surface. The skin may have a milky appearance due to increase in mucus secretion. They can lead to **secondary infections** by bacteria and fungi.
- **Diagnosis:** Parasites are seen in gill (fin, skin) tissue scrape during microscopic examination (with a light microscope). Skin scraping or a piece of gills arch mounted with a few drops of water and examined under the microscope.

GYRODACTYLUS (Skin, fin and occasionally gill)

- *Gyrodactylus* spp. is **small <1 mm** long, flat worm
- **Primarily a skin parasite** (but also on gills and fins) and **especially freshwater fish (salmonid)** and marine.
- The head of the worm is **bi-lobed**, lacks eye spots (**no eye spot**) and the worm produces live young. At their posterior end Gyrodactylids have a **haptor**, that have **1 large pair of anchors, both dorsal and ventral bars. They usually have 8 pairs marginal hooks.**
- **Transmission** from fish to fish is primarily by **direct contact. Complete life cycle on fish.**
- Gyrodactylids are **viviparous**, and **embryo** with its pair of anchors may be seen **inside an adult**. Adult carry fully developed embryos (identical to the adult), which in turn carry the young of the next generation. This is known as **polyembryony**.★ They multiply very quickly, especially in a closed system. Horizontal transmission occurs between fish by physical contact in crowded environments. Young parasites immediately attach to the host, or may be carried by the water to another host.

- *Gyrodactylus* are live bearers (viviparous) in which the adult parasite can be seen with a fully developed embryo inside the adult's reproductive tract. This reproductive strategy allows populations of *Gyrodactylus* to multiply quickly, particularly in closed systems where water exchange is minimal.
- Infection of the gills often results in hyperplasia, also excessive mucus production and rapid respiratory movements. Gills may be swollen and pale, and fish will be less tolerant of low-oxygen conditions. Piping (gulping air at the water surface) may be observed in fish in severe respiratory distress.
- Skin may vary in color where the parasites have fed. Gray patches and open wounds may appear on the skin. The skin of fish infected with *Gyrodactylus* may become mottled, necrotic and dark with excess mucus production. Heavy body infections cause fins erosion with flashing behavior and lethargy. They can lead to secondary infections by bacteria and fungi.
- **Diagnosis:** Parasites are seen in skin (fin, gill) tissue scrape during microscopic examination (with a light microscope).

DIPLOZOON=TWIN WORM (Gill flukes)

- Primarily a **gill parasite** and especially freshwater fish (salmonid, cyprinid) and marine.
- *Diplozoon* is a relatively **large and interesting parasite**. It is **4-8 mm** long and **gray colour**.
- They have **four pairs of clamps** (four each on the left and right side of the haptor) and **a pair of central hooks** for posterior attachment at the host gill lamellae
- *Diplozoon* **eggs** are typically **oval-shaped** with **a single long filament** opposite the **operculum**.
- **The life cycle is direct**, including free swimming **oncomiracidia**, larval stage (**diporpa**) and **adult**. Larvae of *Diplozoon* spp. is **hermaphrodit**. But, during their **sexual maturation**, two larvae (diporpae) permanently fuse into a pair to form the sexually matured adult (their bodies forming a joint H-shaped body).

- Inside the egg, an **oncomiracidium** with a ciliated surface is formed. After hatching from the egg into the water, the oncomiracidium then actively searches for a suitable host.
- After attachment, the oncomiracidium loses its eye spots and surface cilia and develops into the unpaired post-larval stage, the **diporpa**. Once paired, the diporpa are considered to have entered the juvenile stage. Development of the reproductive tract begins after fusion of the diporpa. Two individuals fuse together and live out the rest of their lives as a remarkable creature called a **twin worm**.
- They are blood-feeding parasites. In the majority of cases, they cause 2 injury to their hosts. Through their hooks and other organs of attachment result is **haemorrhage**. At the time they feed with the blood and cells of ruptured tissue. This may be lead to **anemia**, host **mortality**. Despite its common occurrence, **no significant pathogenic changes have been recorded**. They may be cause **rapid respiratory movements**.
- Diplozoon parasites **are visible to the naked eye in gill examination**.
- **Diagnosis**: They may be diagnosed by performing biopsies of fin, gill, and skin mucus and examining these tissues with a light microscope.

DISCOCOTYLE (Gill flukes)

- Primarily a **gill-fluke** of freshwater salmonid fishes parasite.
- *Discocotyle* spp. is **12 mm long**
- The adhesive apparatus consists of **four pairs of clamps** and **one pair of hooks**.
- **Temperature is the single most important abiotic factor** affecting Egg production, development and viability are highest within the range **13-18°C** and decline at temperatures both below and above this. When the ciliated larvae (**oncomiracidium**) emerge from the eggs, they are carried to a new host, and adult form develops.
- They are **blood-feeders** and are much less motile, generally infecting the gills. When present in high numbers, *D. sagittata* causes serious gill damage (**Anaemia, increased mucus production, epithelial hyperplasia, loss of lamellar structure, clubbing or fusion of gill filaments, haemorrhage**), and secondary invasion by bacteria or fungi
- **Diagnosis:** *Discocotyle* spp. **are visible to the naked eye in gill examination** and are examined in mounts of **gill scrape** with a light microscope.

❑ CLASS TREMATODA

❑ DIGENIC TREMATOD

SANGUINICOLA (Blood fluke)

- *Sanguinicola* spp. is **blood fluke** of salmonid and cyprinids.
- Adult parasites **don't have any suckers or pharynx**, and **don't have the second intermediate host** that other trematodes require.
- They swim actively through the blood by waving movements of their body. They occur most abundantly in the **heart** and in the larger **blood vessels of the gills**. **The eggs** of the worm are transported by **blood stream to capillaries of gills, kidneys, heart, liver and other organs**.
- *Sanguinicola* has a 2-host life cycle, with an **intermediate host snail** and a **definitive host fish**. Miracidia infect the snail, multiply within it and produce **furcocercaria**. Miracidia hatch from the eggs and bore through the wall of capillary of gills to enter snails as intermediate host in water then develop into forked cercariae (**furcocercaria**), where they penetrate the final host of fish through gill and weaker parts of the skin. The furcocercaria emerge and swim until they encounter the fish. In the fish they mature and produce eggs, which then hatch to form the miracidia, which then break out of the fish and swim to find the snail host.

- Eggs are carried through the blood stream to the gill capillaries where they become lodged causing rupture of vessel walls. Miracidia escaping from the gills can also cause severe **mechanical damage, haemorrhage, and necrosis** and calcification **in the heart and kidney**.
- The clinical signs of infested fish showed that fish **swim slowly and listlessly, anaemic** and **gills of infested fish were pale in colour**.
- The examination of gills, heart, kidney, liver and spleen revealed that present blood parasite in some organs e.g. heart.
- **Diagnosis** are determined by morphological identification of adults. Eggs and miracidia are search in scraping tissue prepared from gills.
- The cercariae mostly penetrate through the flank of the fish, often along the lateral line. where the parasites enter, a rough, **sandpaper-like effect** are felt.

DIPLOSTOMUM (Eye fluke)

- The metacercariae parasitizes the **eye lenses** of fish, it can be occasionally found in **other organs**, including the **brain**.
- *Diplostomum* sp. parasites have a complex life-cycle with **aquatic snails** as the first and **fish** as the second intermediate hosts, and **fish eating birds**, such as gulls, as final hosts. The parasites locate in the **eye lenses of fish**. Reduced vision impairs the fish's feeding efficiency and makes the fish more vulnerable to avian predation. Predation of fish by birds completes the life cycle of the parasite.
- *Diplostomum* cercariae cause diplostomiasis, a seasonal disease of freshwater fish. Under farming conditions, *D. spathaceum* is primarily a problem with rainbow trout reared in earth ponds or cages in shallow waters.

- ▶ On its migration through the tissues of the fish to its final destination in the eye, the parasites cause **swimming abnormally** (often side swimming), **lethargic**, **off their** food and often rapidly developing serious **spinal deformities**. **Dark body coloration** can also be observed.
- ▶ The parasites locate in the eye lenses. Infected fish usually show **cataract**, **cloudiness of eye**, **exophthalmia**, **skin petechiae** on the ventral surface, **haemorrhage** in the internal organs. **Reduced growth** and **emaciation** is seen. In chronically infected individuals the transparent lens becomes **whitish** due to proliferation of lens; **capsular rupture** and **detachment of the retina** may **impair host vision (blindness)**. There is a rapid escalation of fish losses due to this extensive tissue damage.
- ▶ **Diagnosis**; The flukes are visible to the naked eye when you squash a fish eye onto a microscope slide. The diagnosis of diplostomiasis is based on clinical observations, demonstration of metacercariae in vitreous or aqueous humours, or in histological sections of the eye.

CLINOSTOMUM (Yellow grubs)

- *Clinostomum* is often called yellow grub. Yellow grub (*C. complanatum*, *C. marginatum*) is a large trematode (3-5 mm diameter). In fish *Clinostomum* larvae are found encysted in various regions of the body, such as muscle, subcutaneous tissue, oral cavity, eyes, gills, gonads, intestines, liver and other organs
- Grubs are endoparasites. Besides fish, aquatic snails and piscivorous birds = fish-eating birds serve as hosts. The adult grub resides and reproduces in the throat of the bird (adults are seen esophageal mucoza, oral cavity and lung). Eggs are released into the water from the bird when the bird thrusts its beak into the water. The eggs hatch in water releasing miracidia. After the miracidia enters the snail, the miracidia transform into free-swimming cercariae (final products of the asexual phase in snails). These cercariae infect the fish by penetrating the skin, then embed themselves into the muscle of infected fish and finally develop into the metacercariae (visible yellow grubs in the fish). When a definitive host consumes an infected fish intermediate host, the bird will be infected with the metacercariae. The cycle is complete when a fish-eating bird consumes the fish.

- The encysted metacercariae of this parasite in fish characterizes the **yellow spot diseases**. Yellow grub is capable of infecting all freshwater fish species (perch, somon). They have been recorded in areas with an average temperature of 10°C, demonstrating its widespread distribution
- The yellow grub is relatively harmless to infected fish, except when they are heavily infected. Although it does not cause any major problems for fish, it is readily seen and will make fish unmarketable for aesthetic reasons. They cause fish producers economic losses. In addition, the infection affects the fish's feeding habit, acquisition of body weight and fecundity, and may culminate in death.
- The **diagnosis** of parasite is based on clinical observations, demonstration of metacercariae in skin, muscle and fin etc. (yellow color) of fish.
- After consumption of raw or undercooked parasitized fish in humans, the metacercariae are freed in the stomach and the parasite migrates towards the esophagus or the oral cavity, usually can cause acute pharyngitis or laryngitis. That can make observation of the parasite difficult, when the cysts are embedded in the muscle, and accidental human infection can most likely occur.

POSTHODIPILOSTOMUM (White grubs)

- Another of a metacercaria that could cause problems in cultured fish is the genus *Posthodiplostomum*.
- **Black grub** (*P. cuticola*) and **White grub** (*P. minimum*) are commonly seen digenic trematodes in fish.
- **White grubs** (usually **no larger than 1 mm**) primarily affect **kidneys, liver** and **heart** but they also occur in **spleen, connective tissue of the gut, ovary**.
- The life cycle of *Posthodiplostomum* is similar to yellow grubs. Eggs are released from adult and are passed through the **bird** by its feces. The eggs hatch in water releasing free-swimming miracidia. It infects an **aquatic snail**. The cercaria infects the **fish** by penetrating the skin and are carried by the circulatory system to related organs (**kidneys, liver, and heart**). In the organs, the cercariae developed into the metacercariae (**white grub**). The cycle is complete when a fish-eating bird consumes the fish.

- **White grubs** can cause **harmful effects** in fish. White grubs primarily affect **kidneys, liver, and heart**, but they also occur in the **spleen, connective tissue of the gut, and ovary (White spots in visceral organs)**. When grubs become too numerous and organs are **compressed grubs affect larval fish**.
- Death occurs if liver or other organs are destroyed by the metacercariae. In cases where mortalities occur, there are unusually high numbers in the **eye, head, and throughout the visceral organs**.
- The white grub affects larval fish when grubs become too numerous and organs are compressed. White grubs cause **hyperemia (bleeding) at fin bases**.
- An unusual case of white grubs **in fish** of striped bass caused **deformation, exophthalmia**, and mortality. Heavily infected fish had **displaced organs**, a build up of **body fluids** in the body cavity, **ruptured abdomens**, and **mortality**.
- The penetration of cercariae impair the immune functions of infected fish; consequently, increasing fish vulnerability to secondary infection, e.g., bacterial and fungal.

POSTHODIPILOSTOMUM (Black grubs)

- **Black grubs** is known black spot disease (1-4 mm) and is seen in the **skin, tail base, fins** and **musculature**. Blackspot is the name given to the cyst formed around the larval stage of the parasite *Posthodiplostomum cuticola*.
- The definitive host is usually the **aquatic bird**; the mature parasite resides in the intestine. Eggs, which develop into miracidia, are released from adult and are passed through the bird by its feces. A **snail**, the first intermediate host, is invaded by the miracidia. The miracidia develop into cercariae. The free-swimming cercariae escape the host and infect the **fish** host by penetrating the skin and transform into metacercariae (visible black encysted). The cycle is completed when a bird consumes an infected fish. Increased melanin deposition.

- Metacercariae become encapsulated by host tissue and melanin surround the outer layers, so dark color of the embedded grub causes affected fish to have a 'peppered' appearance. Blackspot problems are rare, however it can be more damaging to smaller fish or those infected with a large number of parasites.
- Cercariae penetrate through the skin causing mechanical damage and hemorrhage. Black grubs can cause harmful effects and secondary diseases in fish.
- Black grubs have a life span over 4 years in fish maintained at 12° C water.

□ CLASS CESTODA: Tapeworms

