

## LIFE CYCLE PATTERNS IN NEMATODES

The nematodes are a widespread successful group found in marine, fresh water and terrestrial habitats as well as parasitizing plants and animals. The sexes are usually separate but in some species where males have not been found, reproduction is parthenogenetic. Nematodes are either oviparous or ovoviviparous (forming eggs which develop and hatch whilst still in the body of the female). The larvae are similar in appearance to adult worms but lack gonads. Development into the adult is punctuated by a series of moults, almost always four in number. At each moult a new cuticle is secreted by the underlying hypodermis and the old one is shed. The classification of nematodes is beset with many problems. Not least of these is the remarkable similarity of the body plan throughout the group making the precise identification difficult, particularly of the larval stages. Several groups of nematodes appear to have independently evolved a parasitic way of life. Examples of four types, selected for their medical and veterinary importance, are discussed below.

### **Strongylida**

This group includes the hookworms of man and the gastrointestinal nematodes of grazing animals. The life cycle of *Ancylostoma duodenale* is direct. This nematode, together with *Necator americanus*, is common throughout the tropics and subtropics with an estimated 700 million human cases. The mature worms are about 1 cm long and are attached to the villi of the small intestine by means of chitinous teeth present in the buccal cavity. Thin shelled oval eggs are laid and pass out with the faeces. If they reach water or moist soil, development occurs and a free living, first stage larva hatches. The larva feeds on the faecal material and moults twice to become the third larval stage. The second moult is incomplete, a new cuticle being secreted, although the old is not shed. This ensheathed larva is a non feeding stage, infective to man, and can remain viable for some weeks, depending on environmental conditions. If the third stage larva contacts human skin, usually the feet or legs, it is stimulated to penetrate directly. It enters the bloodstream and migrates via heart to the lungs. There, it breaks out of the capillaries into the alveoli and moults again to become the fourth stage. It is carried up the bronchi and trachea and swallowed. Upon arrival at the small intestine it moults again to become adult.

The mature hookworms, attached to the villi, feed by sucking host blood. The amount of damage they cause depends very much on the numbers present. Although they are small, an individual person can harbour a thousand or more, and the estimated blood loss is about 200 ml/day. This leads to severe anaemia which in turn gives rise to numerous secondary complications.

There is a wide range of genera of Trichostrongyles parasitic in domestic livestock, including *Haemonchus*, *Trichostrongylus*, *Ostertagia* and *Nematodirus*. Their life cycles are identical with that of *Ancylostoma* except for the mechanism of infection. The ensheathed third larval stage migrates onto herbage and is accidentally swallowed by the grazing host. The ingested larva is stimulated to exsheath in the stomach or intestine and moults twice to become an adult. Some of these gut nematodes suck blood; others

damage the intestinal tissues by burrowing in the mucosa. The related nematode *Dictyocaulus* inhabits the lungs of livestock, causing parasitic bronchitis.

### **Ascarida**

Ascarids are common intestinal parasites of vertebrates and *Ascaris lumbricoides*, the large roundworm of man and pig occurs world-wide, with an estimated 1000 million human cases. The mature worms are found in the small intestine and females may measure upto 30cm x 0.5cm. A burden of only a few worms may result in literally million of eggs being voided daily in the faeces. Larval development to infective stage occurs within the egg, which may remain viable in the soil for months. Infection is thought to result most commonly from eating salad vegetables contaminated with eggs. The larva is stimulated to hatch by the conditions in the small intestine. Then, for reasons not understood, it penetrates the wall of the intestine and enters the hepatic portal vessels. It develops to the third stage to the liver and makes its way back to the gut via the heart, lungs and trachea. Development to maturity then occurs in the small intestine. The tissue stage of *Ascaris* may cause some damage, particularly if migrating in large numbers. However, the major effect of the worm is on host nutrition, and blockage of the intestine may occur, particularly in children.

There has been increasing awareness in recent years of the possible hazards to health posed by another ascarid nematode, *Toxocara canis*, a parasite of dog. The adult worms inhabit its small intestine and the life cycle is similar to that of *Ascaris* with tissues- migration phase of long duration. Parental infection of puppies can occur when the larvae cross the placenta. Unfortunately the eggs of *Toxocara* are also infective to man and the larval worms undergo extensive migration through the body. In particular, the eyes may be damaged, causing impairment or loss of vision. The common pinworm of man, *Enterobius vermicularis*, is another ubiquitous ascarid. It parasitizes the large intestine and the female migrates at night to the anus to deposit eggs. The life cycle is direct, with infection resulting from ingestion of these resistant eggs. Unlike *Ascaris* the larvae do not migrate through tissues.

### **Spirurida**

Spirurida nematodes are responsible for some particular unpleasant disease of man, including elephantiasis and river blindness. Their life cycle involve an intermediate host, frequently an insect. That of *Wuchereria bancrofti*, which together with the related *Brugia malayi* causes elephantiasis. The mature worms upto 10cm long, are found in the lymph nodes and lymphatic vessels, particularly in the lower half of the body . In proportion of patients the lymphatics become blocked or atrophied and elephantiasis develops as a result of the build up of fluid in the tissues of the affected organ. The female worms are ovoviviparous, producing sheathed larvae called microfilariae. These pass through the lymphatics to the bloodstream and are taken up by various genera of mosquito vectors, with a blood meal. The larvae exsheath and migrate from the mid-gut to the thoracic muscles. Here they develop to the third larva stage and then migrate to the proboscis. The infective third stage larva is thought to escape onto the host skin when the mosquito feeds, and then enter via the bite wound. It migrates to the lymphatics and develops to maturity in about nine months.

River blindness is caused by the nematode *Oncocera volvulus*. It is commonest in west Africa, the Volta basin having one of the most extensive foci, and has also been introduced into central America. The mature thread like worms upto 50 cm long, are found in nodules of connective tissue beneath the skin. The females release unsheathed microfilariae which accumulate in large number in the vicinity of the nodule and also occur sparsely in peripheral blood. The intermediate hosts are blackflies of the genus *Simulium*. Development in the blackfly and the manner in which man is infected are similar to *Wucheria* in the mosquito. *Simulium* is unusual among insect vectors of parasites in needing well oxygenated running water for its larval development, which accounts for the distribution of *Oncocera* along river systems. In endemic areas, infection with *Oncocera* begins in early childhood and there is a cumulative build – up in worm burden with increasing age. Blindness results when microfilariae invade eye causing localized inflammatory lesions. In some areas more than 40% of the over- fifty age group may be blind and whole villages have been abandoned because of the disease. The Guinea worm, *Dracunculus medinensis*, is a parasite of man in Africa, Western Asia and South America. The female worm, upto 1 m long, inhabits subcutaneous tissue. Its uterus become packed with larvae About 0.5 mm long. An irritating ulcer develops on the host skin in the vicinity of the worms head. Contact with water stimulates the body of the worm to contract and expel a stream of larvae. If they are eaten by the crustacean *Cyclops* they will develop in its body cavity and man becomes infected by accidentally swallowing the *Cyclops* in drinking water. The larva makes its way to the subcutaneous tissues by an unknown route and develops to maturity in about one year. The chief harm of infection with *Dracunculus* results from secondary bacterial contamination of the skin ulcer. It is common practice to extract the worm from the wound over several days by carefully winding it out around a stick.

## **Trichinellida**

***Trichinella spiralis***, parasitic in the intestine of many mammals, is the most important member of this group. The ovoviviparous female worms burrow into the mucosa and release larvae into the blood stream. These larvae become encysted in muscles throughout the body and remain infective for long periods. Infections in man are generally thought to be acquired by eating contaminated pork. The migration of the larvae produces characteristic symptoms including fever and swelling of the face. The larvae cause tissue degeneration, and death can result from massive invasions.

Another trichinellid of man, ***Trichuris trichiura***, commonly inhabits the large intestine. The life cycle is direct with infection resulting from ingestion of resistant eggs. The chief symptoms associated with a large worm burden are anaemia and diarrhoea.