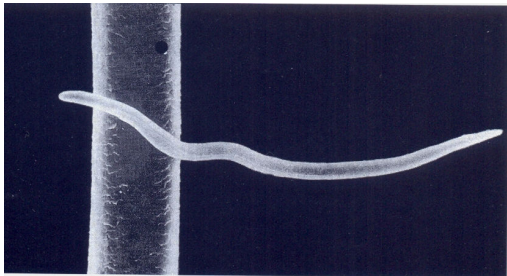
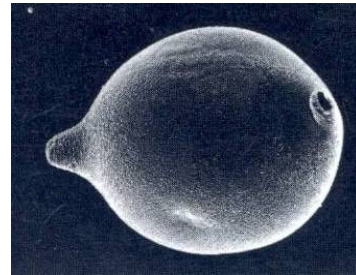


Learning about nematodes

Nematodes are invertebrate, usually microscopic, aquatic animals that inhabit ocean and seas, freshwater courses, body fluids, in the film of water present between soil particles and in plants. They are cylindrical worms, with a body shape that, though it is a little variable (sometimes obese), is described as filiform, *i.e.*, having the shape of a thread. In the following photos are shown (left) a typical, filiform, nematode in contrast with a section of a human hair and (right) an unusual, round, female specimen.



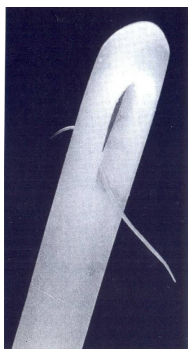
(J. Eisenback)



(J. Maia)

Nematodes can be divided into three groups according to their feeding habits: free-living; zooparasitic; and plant-parasitic or phytonematodes. Nematodes do not vary considerably in size, being microscopic (= invisible to the naked eye) in general (see photo below). Their body length varies from tenths of a millimeter to three millimeters. However, some zooparasitic nematode species are a few centimeters in length and the longest nematode known, *Placentonema gigantissima*, is up to eight meters long.

Most nematodes are free-living, and this is the largest, most heterogeneous, but least studied group. Species in this group are classified according to their feeding preferences on particular types of micro-organisms, *i.e.*, algivorous (algal feeders), bacteriophagous (bacterial feeders), mycophagous (fungal feeders), and nematophagous (that feed on other nematodes; see photo below). Whilst they have little direct effect on man's activities, indirectly they exert a significant influence on important soil processes such as soil mineralization and recycling of carbon- and nitrogen-containing materials. As they occur in large populations in soil and are quite sensitive to the action of chemical compounds, they are also useful organisms for biomonitoring studies of a range of environmental perturbations, and pollution.



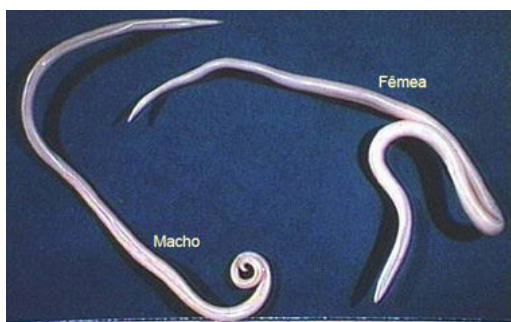
(J. Eisenback)



(FCPS site)

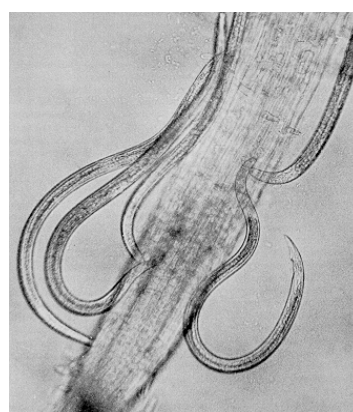
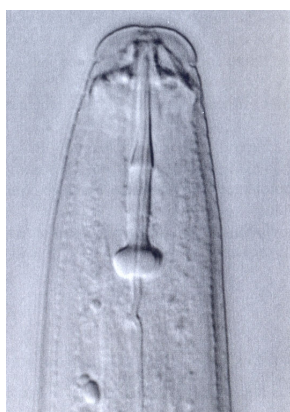
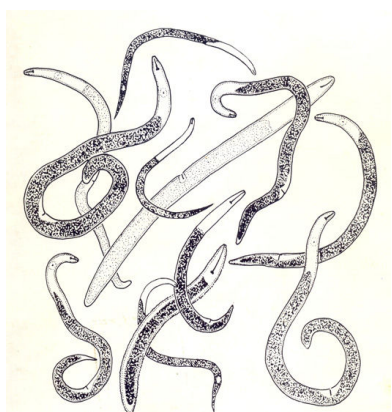
Microscopic nematode in the eye of a needle (left) and predation by a nematophagous nematode (right)

Zooparasitic nematodes have vertebrate or invertebrate animals as hosts, in which they establish themselves either temporarily or permanently in the digestive, circulatory, and respiratory systems, and in some instances in various internal organs. The human intestinal roundworm, *Ascaris lumbricoides*, whose adults are 20-30 cm in length, is a well-known, cosmopolitan, species affiliated to this group. Often asymptomatic, its infection can eventually cause the intestinal occlusion with serious risks to the patient.



Ascaris lumbricoides adults (left) causing intestinal occlusion (right) in human patient (photos by UFRGS)

Plant-parasitic nematodes, which constitute the main, primary, subject for this site, are present in almost every type of habitat, the limiting factors being moisture and food for survival. They represent about 20% of the described species (4,000 among 20,000) within the phylum Nematoda. As with free-living nematodes, relatively little is known about most plant-parasitic species, this despite the enormous damage that they cause in Agriculture. This has led to their being referred to as the ‘unseen enemy, or hidden enemy of plants’. They possess a typical, strong buccal stylet that is essential for plant parasitism, especially in roots. Qualitative and quantitative damage result for the host plants from nematode infection; yield losses for many important crops of tropical and subtropical regions range from 5 to 50%, depending on the nematode species involved and on their population levels. In addition, some genera of phytonematodes can interact with other disease causing organisms, i.e., fungi and viruses, with the result that the losses can become even larger.



Schematic representation of different phytonematodes (left; by M. Sauer); the characteristic buccal stylet (center; by J. Maia); nematode individuals feeding on plant root (by R. Sharma)

Symptoms of nematode attack to field crops are not specific, but are often helpful for diagnosing purposes. Patches of stunted plants are a good example, as well as deformation of roots and other underground organs.



Symptoms of nematode attack to crops: on lettuce (left; by R. Lordello); on carrot (center; by L. Ferraz); and on potato (right; by A. Zem)

The life cycle of nematodes usually comprises of the egg, four juvenile stages (J1 –J4), and the adults, females and males. The biological stages are separated by moults, in which a new cuticle replaces the old cuticle (just like seen in the insects). The juveniles usually are ‘miniatures’, or short-sized copies, of the adults. In the case of the phytonematodes, males in several genera have a shorter life cycle and are not plant-parasitic, whereas the females continue to feed on the host plant until reach sexual maturity, and during the oviposition period. One generation is completed within 3-4 weeks, in general, but this period can be affected by temperature, moisture, host plant, and other factors.



(by A. M. Golden)

Biological stages during nematode life cycle: (left to right => egg; juveniles (4); and adult (female)