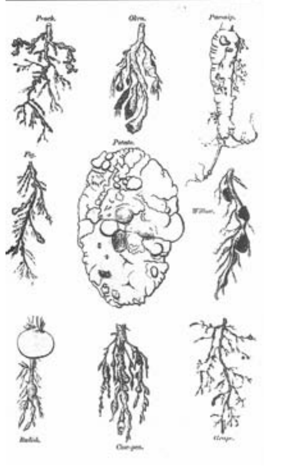
ROOT KNOT: A Classic Plant Disease



Root-knot nematodes were first recorded by Berkeley on cucumber in 1855; the causal agent, *Meloidogyne,* was described by Goeldi on Brazilian coffee in 1892. These parasites, which redirect infected hosts' gene function/ physiology for the nematodes' benefit, have a worldwide distribution and attack most food and fiber crops. The most widespread species, *M. incognita,* attacks thousands of crops and weeds. Although these nematodes cause extensive root galling (the primary but hidden symptom), root-knot infestations often are overlooked. Like most soilborne plant pathogens, they have contagious dispersal patterns. General foliage symptoms include spotty stunting and nutrient (potassium, nitrogen) deficiencies. The associated root knots resulted in research on host resistance in the early 1900s. In addition to inflicting huge, direct economic crop losses (up to 5–20% or more, costing billions of dollars per year), these pathogens predispose plants to infection by fungi and bacteria. The massively rooted root systems are inefficient in water and nutrient update, resulting in limited mineral transport, photosynthesis, shoot growth, and crop yield. All species (100 described to date) exhibit sexual dimorphism: females are pear-shaped, males fusiform. The most common species, *M. arenaria,*

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M. incognita, M. hapla, and *M. javanica*, affect almost all food, fiber, and ornamental crops, usually reproduce via parthenogenesis, and may have numerous life cycles per year. The species typically found on tree roots have fewer life cycles and some reproduce by amphimixis. One female can produce 200 to 3,000 eggs. In the absence of a host crop, low numbers of eggs survive in the soil or continue to reproduce on weed hosts. These species also have great genetic-biological diversity: some have “host races” and some have “cytological races.” Tools utilized in *Meloidogyne* species identification include morphology of adult females (perineal patterns), male heads, and juveniles (size and head shape); selected isozyme patterns (esterases and malate dehydrogenases); differential hosts for species and host races; and DNA analyses. The genetic variability and related adaptability of these nematodes, including their capacity to overcome host resistance, make them difficult to control. Traditional root-knot control tactics include crop rotation, cultural practices, nematicides, and host resistance.

These sedentary obligate parasites, via the products of their highly evolved parasitism genes, transform certain root vascular cells into multinucleate food cells or giant cells that are necessary for completion of their life cycles. These nematodes secrete a large number of parasitism proteins encoded by parasitism genes expressed in their esophageal gland cells. The secretions are released via the nematode stylet into plant tissues that are regulated qualitatively and developmentally during the infection process. Technology to bioengineer resistance to root knot in a variety of crop species via the disruption of the activity of essential nematode-parasitism genes offers increasing promise.

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