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Meloidogyne artiellia: A Root-knot Nematode Parasite of Cereals and Other Field Crops

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INTRODUCTION: The British root-knot nematode, *Meloidogyne artiellia*, was described by Franklin in 1961 (7) from cabbage (*Brassica oleracea* cv. *capitata*) in England and redescribed by Esser *et al.* (6) using the original paratypes. This root-knot nematode has been reported as a damaging pest of cereals and leguminous crops in European and Middle Eastern countries (9). As with other plant pests occurring in the Middle East, there is risk of introducing *M. artiellia* into the United States because of the intensification in the movement of machinery and personnel between the United States and Middle Eastern countries as a result of the recent Persian Gulf conflict. Egg masses of *M. artiellia* can be easily transported long distances in soil particles and root fragments adhering to vehicles or clothing materials. The purpose of this circular is to provide information about the morphology and biology of *M. artiellia* to facilitate the detection of this nematode in the event of its accidental introduction into the United States and particularly into Florida.

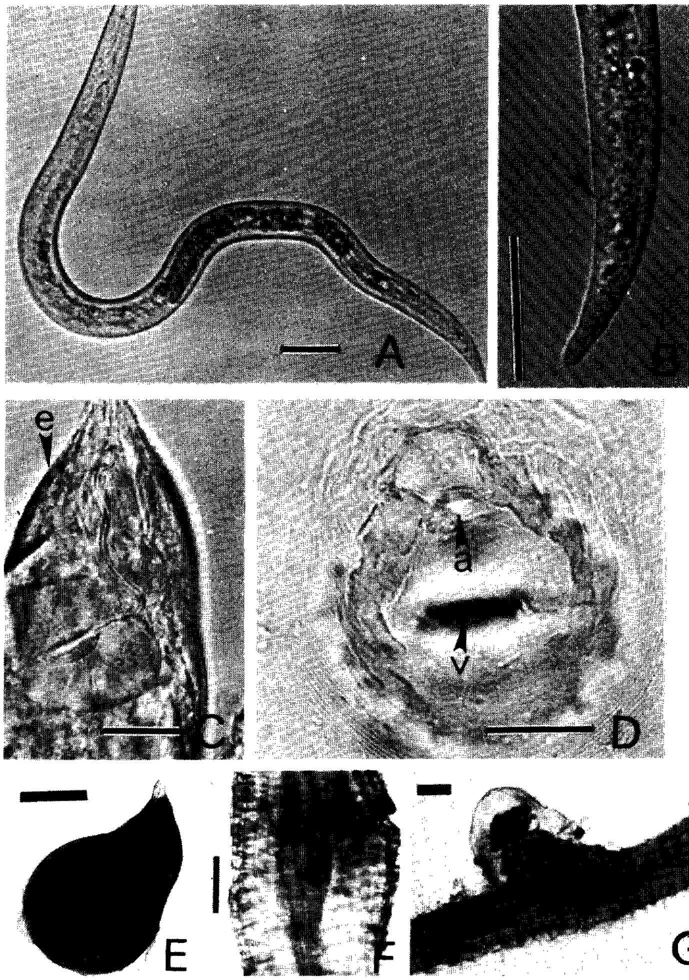

Figure 1. Photomicrographs of *Meloidogyne artiellia* life stages. Scale bars=20 m in A-D and 200 m in E-G. A) Entire body of second-stage juvenile (J2). B) Posterior body portion of J2. a=anus. C) Anterior body portion of a swollen female. E=excretory pore. D) Perineal pattern showing the eight-shaped inner area marked by coarse lines and containing vulva (v) and anus (a). Note the fine and continuous striae surrounding the inner area. E) Entire body of swollen female. F) Slight swelling induced by a J2 on a chickpea root. G) Large egg mass covering a swollen female which protrudes with its posterior portion of the body from the surface of a chickpea root.

MORPHOLOGICAL CHARACTERS: *Meloidogyne artiellia* can be easily distinguished from other root knot nematodes reported in Florida (8, 10, Bureau of Nematology records) as follows: *M. artiellia* second-stage juveniles (J2) (Fig. 1A) have tail 18-26 m long (Fig. 1B) whereas the J2 of *M. acrita* Chitwood, 1949, *M. arenaria* Chitwood, 1949, *M. christiei* Golden and Kaplan, 1986, *M. cruciana* Garcia *et al.*, 1982, *M. megatyla* Baldwin and Sasser, 1979, *M. hapla* Chitwood, 1949, *M. incognita* Chitwood, 1949, *M. graminis* Sledge and Golden, 1964, *M. javanica* Chitwood, 1949, *M. querciana* Golden, 1979, and *M. thamesi* Chit-wood, 1949 have tail

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length >30 m. The short tail of *M. artiellia* allows easy separation of this species from other root-knot nematodes reported in Florida. Body length parameters of *M. artiellia* J2 range 300-370 m and overlap with those of *M. acrita* (345-396 m), *M. incognita* (360-393 m), and *M. javanica* (340-400 m) J2, but they are smaller than those (>370 m) of other root-knot nematode J2 reported in Florida. Mature females of *M. artiellia* are saccate, 340-460 m wide and 650-760 m long (Fig. 1C,E). They can be completely embedded in the root tissues (Fig. 1F) or can protrude with their posterior body from the root surface (Fig. 1, G). *Meloidogyne artiellia* females have a ratio between excretory pore- anterior body terminus distance and the stylet length of 1.8 (11). They also have characteristic cuticular perineal patterns different from those of other root-knot nematode species. These perineal patterns show a very distinct inner area which contains vulva and anus and is marked by a few coarse lines arranged in an eight-shaped figure with a large base and a small top (Fig. 1D). The inner eight-shaped area is surrounded by fine and continuous striae (Fig. 1D).

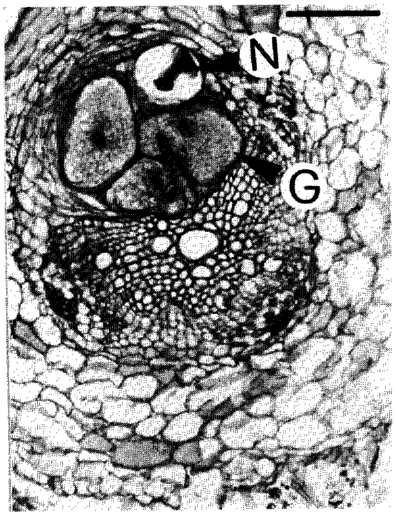

Figure 2. Cross section of a chickpea root infected by *M. artiellia*. Scale bar=70 m. Note the specialized giant cells (G) which provide nutrients to the nematode (N).

GEOGRAPHICAL DISTRIBUTION: *Meloidogyne artiellia* has been reported in Algeria, France, Greece, Italy, Morocco, Spain, Syria, and Tunisia (9 and records of the Agricultural Nematology Institute, Bari, Italy).

HOST RANGE: *Meloidogyne artiellia* infects and damages cereals such as barley (*Hordeum vulgare*), sorghum (*Sorghum vulgare*), and wheat (*Triticum durum* and *T. vulgare*); crucifer crops such as cabbage (*Brassica oleracea*), cauliflower (*B. oleracea* var. *Botrytis*), radish (*Raphanus sativus*), rashad (*Nasturtium fontanum*) and turnip (*Brassica rapa*); and leguminous crops such as alfalfa (*Medicago sativa*), broad bean (*Vicia faba*), chickpea (*Cicer arietinum*) clovers (*Trifolium incarnatum* and *T. repens*), dogtooth pea (*Lathyrus sativus*), and vetch (*Vicia sativa*) (1).

BIOLOGY: *Meloidogyne artiellia* J2 emerge from the eggs, migrate through the soil and penetrate host roots. Inside root tissues, J2 become sedentary and swollen and complete their development by feeding on specialized stelar cells (Fig. 2). Swollen females produce very large egg masses that protect their bodies (Fig. 1G). Prolonged egg hatch occurs at temperatures as low as 5-10° C (41-50° F), but this biological process is much faster at 15-25° C (59-77° F) (5). Root penetration by J2 occurs at 10° C (50° F). At this temperature, however, nematode development is slow, requiring more than 55 days for the appearance of immature females, whereas at 25° C (77° F) it takes 20 days (2). At this favorable temperature the immature females reach maturity and produce egg masses with 500-1000 eggs per female in 2 weeks. Temperatures above 30° C (86° F) are unfavorable for nematode infection and development (2). Eggs do not hatch under

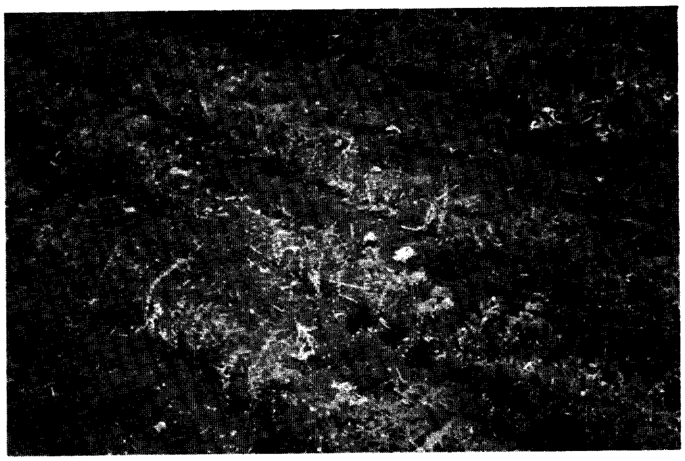

Figure 3. A large patch of stunted plants in a chickpea field heavily infested by *M. artiellia* in Syria.

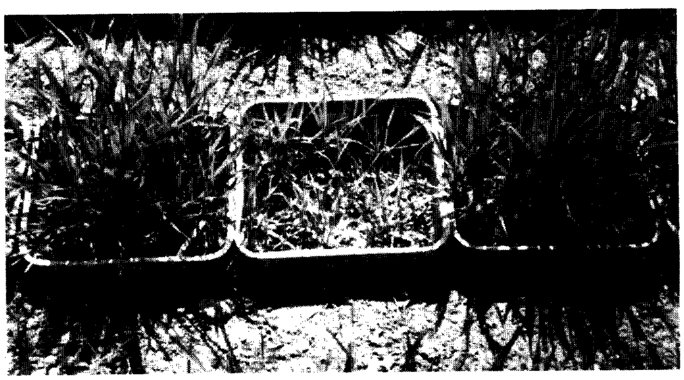

Figure 4. Stunted hard wheat plants in a microplot heavily infested by *M. artiellia* (center), compared to healthy plants in a noninfected control plot (right) and in a plot slightly infested with the nematode (left).

dry weather conditions and persist in egg masses in soil or dry roots after harvest. J2 emerge in concomitance with the first rainfall and become inactive if dry weather returns. In the Mediterranean climate, characterized by cool and wet winters and by dry and warm summers, the nematode is active during the winter and spring months and becomes quiescent during late spring and summer. With these conditions, and in the absence of supplemental irrigation, *M. artiellia* completes one generation on winter host crops (2).

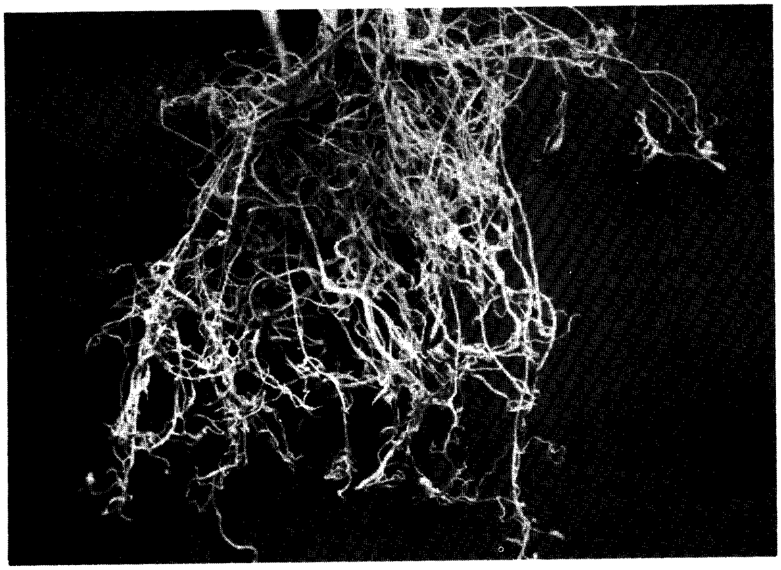

Figure 5. Hard wheat roots infected by *M. artiellia*. Note the small galls (arrows) and root proliferation induced by the nematode infection.

SYMPTOMS AND DAMAGE: Above ground symptoms induced by *M. artiellia* are not very specific. Therefore, roots must be examined to verify nematode infection. Infected plants show chlorotic leaves (reddish in radish) and poor growth (Figs. 3, 4). Chickpea pods are few, small and without seeds. Wheat spikes are sparse and reduced in size. Root galls induced by *M. artiellia* are very small (Fig. 5) and often are covered by large egg masses that represent the only visible symptoms of the nematode infection (Fig. 1G).

Damage induced by *M. artiellia* is severe and can cause complete crop failure in heavily infested fields (Fig. 3). Chickpea is severely damaged by *M. artiellia*, especially in Middle Eastern countries such as Syria where this crop is rotated with wheat, which is also susceptible to this nematode . This cropping system favors nematode density increase in the soil. In the Mediterranean region, short-cycle chickpea crops grown in the spring (March-June) are more severely damaged by *M. artiellia* than long-cycle chickpea crops grown in winter-spring (December-June). Spring-sown chickpea are more adversely affected by the nematode because optimal moisture and temperature conditions for nematode development occur soon after seed germination when the plants are more sensitive to nematode infection. Winter-sown chickpeas are less injured by the nematode because the most favorable conditions for nematode infection and damage occur late in the season when plants are more developed and more tolerant to nematode attack. However, complete chickpea crop loss can occur in winter-sown fields infested with 8 eggs/cc of soil; whereas, densities as low as 1 egg/cc of soil may result in heavy crop loss for spring-sown chickpea (3). Adverse effects of nematode infection on protein content of chickpea seeds has been demonstrated (3). Wheat is also damaged by *M. artiellia* especially under conditions of persistent monoculture. Nematode reproductive rate is three times greater on wheat than on chickpea (4).

NEMATODE MANAGEMENT: The management of *M. artiellia* on cereals and food legumes by chemical methods is not economically feasible. Crop rotation with non-host crops is the most effective and economically sound measure to limit *M. artiellia* damage. Both abiotic (low soil moisture and high temperatures above 30° C or 86° F) and biotic (nematophagous fungi) factors suppress soil densities of *M. artiellia*. The average nematode density decline in the soil is respectively 40-45, 87 and 97% after 45 days, 5 and 15 months from the harvest of a susceptible crop (2). Good nematode control can be obtained with a 6-8 weeks soil solarization period. This method is, however, too costly for food legumes and cereal crops. So far, no resistant cultivars to *M. artiellia* are available for the host crops of this pest.

SURVEY AND DETECTION: The outdoor climatic conditions of Florida are conducive to the establishment of *M. artiellia* because optimal soil moisture and temperature (15-25° C/59-77° F) conditions occur during winter months and also in early spring and late fall. Hot summer temperatures above 30° C/86° F are, however, unsuitable for nematode infection and development. In case of accidental, introduction of *M. artiellia* into Florida the nematode can become a threat to legumes such as clover and vetch, and crucifers such as cabbage, cauliflower, radish and turnip. These crops should be checked during cool months for patches of stunted plants with chlorotic leaves or other nutrient deficiency symptoms. Soil and roots from these plants should be collected and roots examined with the aid of a stereomicroscope for presence of nematode egg masses adhering to the small galls. The standard procedure of egg mass staining with phloxine B cannot be used for *M. artiellia* detection because the egg masses of this nematode do not retain this stain.

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