half-cultures were produced from eggs maturing subsequent to shipment. In 2-wk-old cultures, few if any eggs are mature (1), which suggests that the observed losses (29%) were a result of damage to either maturing and ovipositing adults or to immature eggs.

These data suggest that if *R. culicivorax* is to be successfully shipped, methods must be found to prevent disturbance of cultures being prepared for shipment and to pack cultures so as to prevent shock and shearing by the culture sand during shipment. Also a culture medium other than sand must be found to reduce shipping weight and damage to the nematodes. Until these are developed, shipment of very young cultures (2–4 wk) is recommended to increase the chances of successful delivery of *R. culicivorax* eggs.

**LITERATURE CITED**


**Observations on the Cuticle Ultrastructure of *Meloidogyne hapla* Males**

P. W. Johnson

The cuticle ultrastructure of males of *Meloidogyne incognita* (Kofoid and White) Chitwood and *M. javanica* (Treub) Chitwood has been described by Baldwin and Hirschmann (1) and Bird (2), respectively. The structure reported for the two species was in general agreement: the external cortex in *M. incognita* could be resolved into five layers, similar to those observed in the second stage larvae of *M. javanica* (2). This report presents observations on the cuticle ultrastructure of males of *M. hapla* Chitwood.

Nematodes used in this study were cultured (5), extracted from soil and killed, fixed, and embedded in water agar as previously described (4). Specimens were prepared and examined as described by Johnson and Graham (5). Layers observed in the cuticle are numbered and described in centripetal order and named according to the cuticular nomenclature system—cortex, median, and striated zones—proposed by Johnson and Graham (5) and adopted by Bird (3).

The cuticle structure of *M. hapla* males is shown in Figs. 1–3. The cuticle averages approximately 1.5 μm in total thickness and consists of eight layers divisible into three zones: a five layered cortex (layers 1–5), a two-layered median zone (layers 6 and 7), and a striated basal zone (layer 8).

The five-layered cortex (Fig. 1) consisted of 1) a thin electron dense layer, 2) a thin electron transparent layer, 3) a thin electron dense layer, 4) a thicker moderately electron dense layer, and 5) an electron dense inner layer. The five layers average approximately 0.1 μm in total thickness. Layer 5 is well defined at its outer edge but more diffuse at its inner boundary with the median zone.

The outermost layer of the median zone (layer 6) is of moderate electron density, appears to be of a fibrillar nature, and averages approximately 0.5 μm in thickness (Figs. 2, 3). Layer 7 appears as a fluid-filled region frequently crisscrossed with fibrillar-like material originating from layer 6. This layer, averaging approximately 0.4 μm in thickness is variable in width and actually...
Figs. 1-3. 1) Transverse section of *Meloidogyne hapla* showing the five layers of the cortex (1–5 in centripetal order). 2) Cross section through the body wall of *M. hapla* showing cortex (c), median zone (m) (layers 6 and 7), and striated basal layers (s) (layer 8). 3) Transverse section of *M. hapla* at the edge of the lateral field showing the cuticle zones, cortex (c), median (m), and basal striated layer (s) which becomes forked at the edge of the lateral field and is replaced by two fiber layers (F1 and F2).
dissappears at the base of the incisures in the lateral field.

The basal layer, averaging 0.5 μm in thickness, has vertical striations with a periodicity of approx. 0.025 μm. At the edges of the lateral field this layer becomes forked and is replaced, under the field, by two obliquely oriented fiber layers (Fig. 3), each of which appears to be composed of many fibrils. A thin, often discontinous electron-transparent zone separates the striated basal layer from the underlying hypodermis.

Beneath the cuticle is a membrane-bound hypodermis and basal lamella similar to that reported for *M. incognita* by Baldwin and Hirschmann (1).

The observations reported here for *M. hapla* males are in agreement with those of Bird (2) and Baldwin and Hirschmann (1) for *M. javanica* and *M. incognita*, respectively. The cortex could be resolved into the same five layers as observed by Baldwin and Hirschmann (1) in *M. incognita*. The author (unpublished data) has also observed these five layers in the cuticle of *M. javanica* males. The cuticle structure of *M. arenaria* (Neal) Chitwood males is also similar (Johnson, unpublished data). It appears that the cuticle structure of all *Meloidogyne* species males is very similar, if not identical, in structure and differs from that of the second-stage larvae only in the thickness of the various layers. A five-layered cortex has been observed in both the second-stage larvae and males in some species. It seems likely that this structure is consistently present and that poor preparation and/or poor resolution is the reason for its apparent absence in some species.

**LITERATURE CITED**


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**A Technique for Establishing Microplots in the Field**

J. T. Johnson, J. R. Rich, and A. W. Boatright

Microplots have been shown to be useful in studying the biological interactions of plant-parasitic nematodes and crop plants (1,3,4). They offer advantages of field growing conditions while allowing inoculation of plants or infestation of soil with known numbers of nematodes. Barker et al. (2), who were among the first in the United States to utilize large numbers of fiberglass microplots in nematological research, have developed a tool, the M-cutter, for their installation. The M-cutter, however, does not perform satisfactorily in the deep sand of Northern Florida. These sands are poorly aggregated and cause excessive resistance to motion of the machine. We developed an alternative technique for inserting cylinders into the soil that is satisfactory for sandy soil and, with some modifications, would be acceptable for use on heavier soils. Our system uses water pressure to displace the soil in a 4-cm band on the perimeter of a 76-cm-d circle to a depth of 50 cm. We developed two tools for this purpose.

**Small WJM-Placer:** The small WJM-Placer (waterjet microplot) was constructed...