

Observations on the Cuticle Ultrastructure of *Meloidogyne hapla* Males

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The cuticle ultrastructure of males of *Meloidogyne incognita* (Kofoid and White) Chitwood and *M. javanica* (Treb) 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).

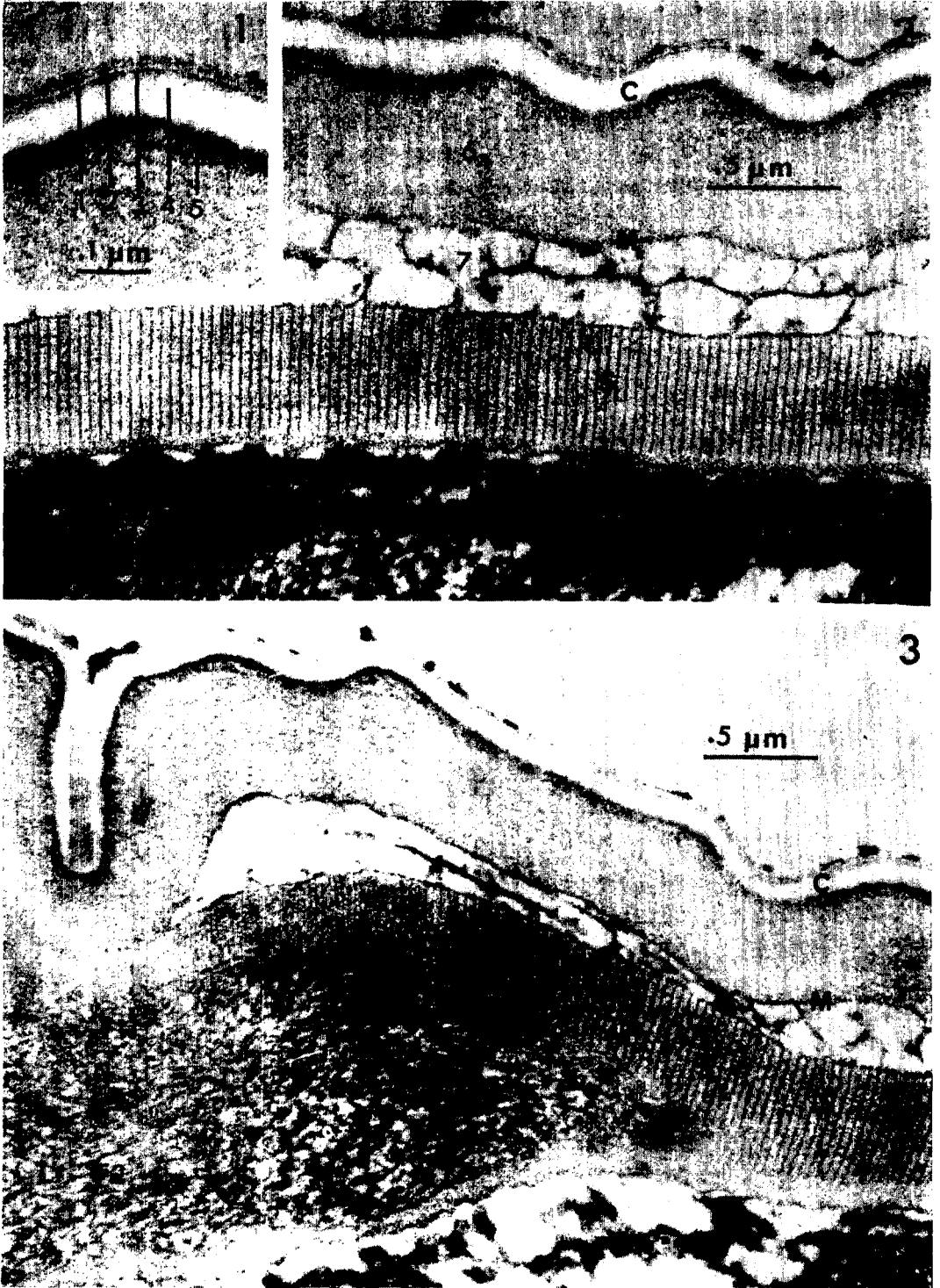
The cuticle structure of *M. hapla* males is shown in Figs. 1–3. The cuticle averages approximately 1.5 μm in total thickness and consists of eight layers divisible into three zones: a five layered cortex (layers 1–5), a two-layered median zone (layers 6 and 7), and a striated basal zone (layer 8).

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

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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 layer (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).

disappears at the base of the incisures in the lateral field.

The basal layer, averaging $0.5 \mu\text{m}$ in thickness, has vertical striations with a periodicity of approx. $0.025 \mu\text{m}$. 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 discontinuous 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

1. Baldwin, J. G., and H. Hirschmann. 1975. Body wall fine structure of the anterior region of *Meloidogyne incognita* and *Heterodera glycines* males. *J. Nematol.* 7:175-193.
2. Bird, A. F. 1971. The structure of nematodes. Academic Press, New York.
3. Bird, A. F. 1979. Ultrastructure of the tail region of the second stage parasitic larva of the root-knot nematode. *Int. J. Parasitol.* 9:357-370.
4. Johnson, P. W., S. D. Van Gundy, and W. W. Thomson. 1970. Cuticle ultrastructure of *Hemicyclioophora arenaria*, *Aphelenchus avenae*, *Hirschmanniella gracilis* and *Hirschmanniella belli*. *J. Nematol.* 2:42-58.
5. Johnson, P. W., and W. G. Graham. 1976. Ultrastructural studies on the cuticle of the second-stage larvae of four root-knot nematodes: *Meloidogyne hapla*, *M. javanica*, *M. incognita* and *M. arenaria*. *Can. J. Zool.* 54:96-100.