C.I.H. Descriptions of Plant-parasitic Nematodes
Set 7, No. 91

HETERODERA ORYZAE

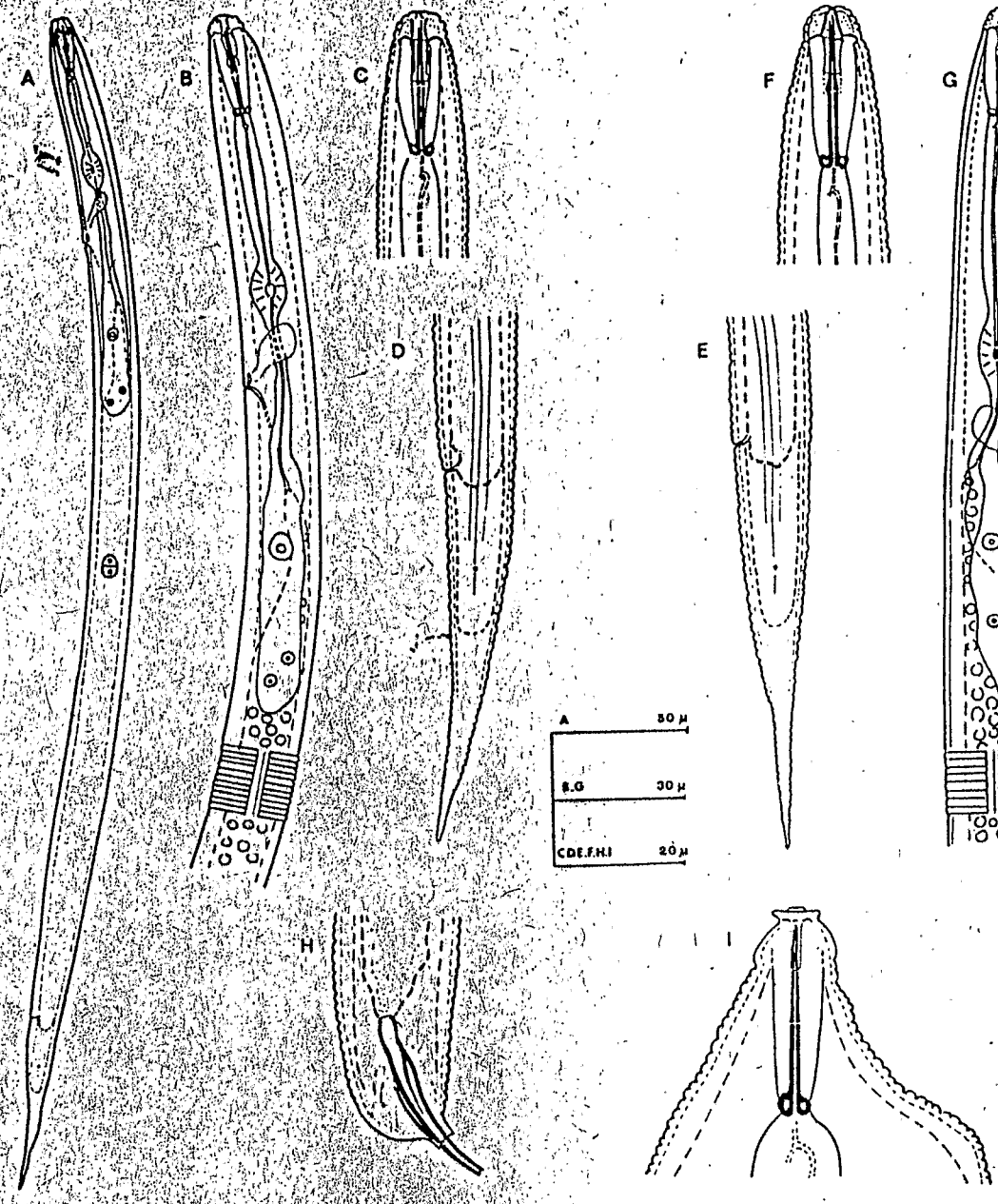

Fig. 1. *Heterodera oryzae* Luc & Berdon. A–E, Second-stage larva. A, Entire larva. B, Oesophageal region. C, Head end. D, E, Tail ends. F–H, Male. F, Head end. G, Oesophageal region. H, Tail end showing spicules and gubernaculum. I, Anterior end of young female. (A, H, I: after Luc & Berdon, 1961; B–G: original).

Heterodera oryzae Luc & Berdon, 1961.

M. Luc, D.P. TAYLOR

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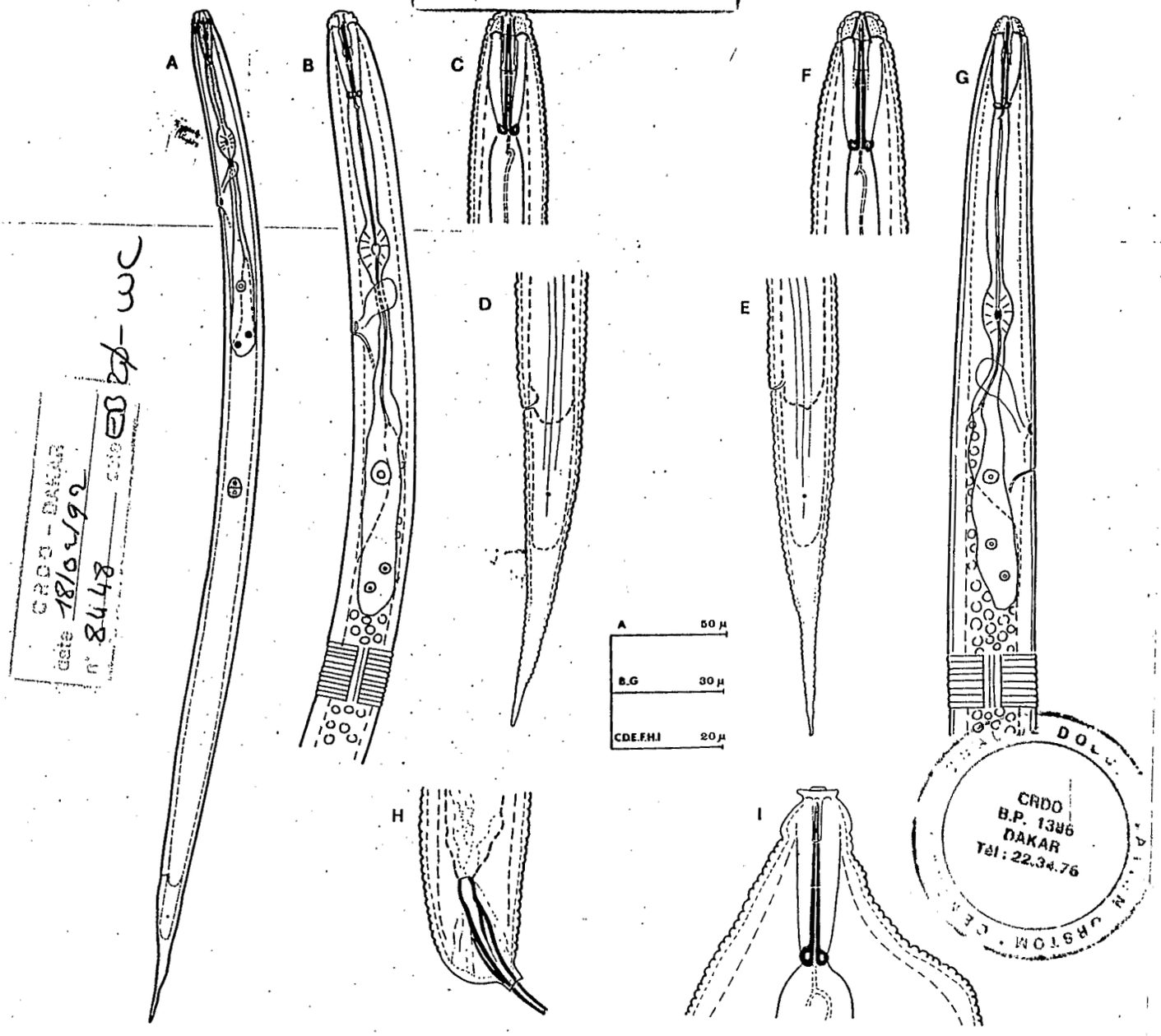

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***Heterodera oryzae* Luc & Berdon, 1961.**

MEASUREMENTS Original and topotype populations on rice, Ivory Coast (after Luc & Berdon, 1961, and original) 92 cysts: L = 0.31–0.81 (0.57) mm; breadth = 0.22–0.69 (0.46) mm; length/breadth = 0.85–1.72 (1.23).

20♂♂: L = 0.79–0.97 (0.90) mm; a = 33.0–37.6 (35.3); b = 7.1–7.5 (7.4); b′ = 4.9–5.5 (5.2); spear = 23–25 (24) µ; conus = 11–13 (12) µ; spicules = 32–36 µ; gubernaculum = 8–10 µ.

25 second-stage larvae: L (n = 100) = 373–507 (440) µ; a = 22.6–28.0 (24.7); b′ = 2.4–3.3 (2.7); c = 5.8–6.9 (6.5); c′ = 4.6–5.8 (5.3); breadth = 16–20 (18) µ; spear = 19.5–22.0 (20.8) µ; conus = 9–10 µ; tail length = 51–64 (58) µ; hyaline part of the tail = 31–45 (38) µ.

DESCRIPTION **Mature female:** White, lemon-shaped; lip region truncated with one retrorse annule and prominent labial disc; head sclerotization weak; spear 28–30 µ long, conus and posterior part of approximately the same length; knobs posteriorly rounded and anteriorly convex. Opening of the dorsal oesophageal gland situated 4–5 µ behind the spear; precorpus cylindrical; heavy median bulb. Cuticle annulated only on the fore part of the body; posteriorly an irregular lace-like pattern is present.

Cyst: Mature cysts dark brown to black, lemon-shaped with prominent vulval cone. Cuticle with a zig-zag pattern; punctations very refringent; **thick sub-crystalline layer. Cyst cone ambifenestrate;** combined length of fenestrae is 22–42 (27) µ, whereas fenestra width is greater: 26–43 (34) µ; **fenestral length/width = 0.60–1.05 (0.81).** Semifenestrae separated by a narrow vulval bridge with a vulval slit 43–51 (46) µ long. Underbridge parallel to vulval bridge and 12–32 (21) µ beneath it. **Underbridge long,** 80–120 (101) µ, with dendroid-like extremities adjoining the cyst wall but

without finger-like projections (Fig. 2D, E, F). There is an expanded hyaline area near the middle, 40–64 (50) μ long and (16–32) 25 μ wide (Fig. 2E, F). Generally the underbridge is not darkly coloured. Bullae present but their number, size, shape and location vary: usually they are small, rather spherical, and scattered inside the vulval cone (Fig. 2B, C). Frequently bullae are most abundant near the level of the underbridge; one bulla was observed attached to the underbridge. Distance of vulval slit to anus 42–64 (49) μ.

Male: Abundant. Body nearly straight or slightly ventrally curved when relaxed by heat, twisted in the posterior region, slightly tapering anteriorly, terminus rounded. Cuticle distinctly annulated: annules 1.2–1.3 μ wide in the middle of the body; lateral field marked by 4 longitudinal lines (=incisures), not crossed by transverse striae nor indented (the two central lines close to each other), occupying about 1/5 of the corresponding body diameter. Lip region dome-shaped, with 4 (rarely 3) annules, without longitudinal striations: cephalic framework heavily sclerotized, with outer margin conspicuous. Spear strong; knobs rounded posteriorly and with flat, backward sloping anterior surface. Dorsal oesophageal gland opening situated 3–5 (4) μ behind the spear. Median oesophageal bulb ovoid; oesophageal glands rather short and broad, filling nearly the entire body width; three nuclei present, the anterior one (of dorsal gland) bigger than the others. Excretory pore situated at 119–144 (135) μ from the anterior end. Hemizonid slightly curved, extending over two annules, situated at 104–128 (117) μ from the anterior end, or 11–21 (17) μ in front of the excretory pore. Hemizonion not seen. Testis single. Spicules curved, notched at tip; gubernaculum lamellate. Phasmids not observed.

Egg (n = 90): 90–120 (105) μ long, 40–57 (48) μ wide; L/W = 1.8–2.6 (2.2); many retained in the cyst, but as a rule very large egg masses are attached to the cysts; they are often more voluminous than the cysts themselves.

Second-stage larva: Body straight or very slightly ventrally curved when heat-relaxed, slightly tapering anteriorly, more attenuated at the posterior end. Cuticle annulated; annules 1 μ wide in the middle of body; lateral field marked by 3 longitudinal lines (=incisures), not crossed by transverse striae. Lip region dome-shaped, with 3 annules; cephalic framework heavily sclerotized. Spear strong, anterior part (conus) slightly shorter than the posterior. Dorsal oesophageal gland opening 5–6 μ behind the spear; median oesophageal bulb ovoid, with strong valvular apparatus; oesophageal glands elongate, covering the fore part of the intestine ventrally and ventro-laterally, together with the intestine filling nearly the entire body cavity; the anterior (dorsal gland) nucleus bigger than the two posterior ones (of subventral glands). Nerve ring situated immediately behind the median bulb. Excretory pore 80–98 μ from the anterior end. Hemizonid immediately in front of the excretory pore and extending over 2 annules. Tail conical, with elongated terminus and pointed extremity; hyaline terminal part unusually long, 31–45 (38) μ. Phasmids very small, pore-like, situated at level of first third of the tail.

Notes on identification: *Heterodera oryzae* falls in group 4 of *Heterodera* species, as defined by Mulvey (1972), in which the cysts are lemon-shaped, the vulval slit is over 30 μ long and there is generally a strong underbridge and bullae. In this group *H. oryzae* is characterized by the shape of the fenestrae (width greater than length), the shallow depth of the underbridge and its central expanded hyaline area, the second-stage larvae with 3 lines on the lateral field and a long tail with extensive hyaline part, and by the presence of big egg-masses attached to the cysts.

Mulvey (1972) described the underbridge of *H. oryzae* as having finger-like projections and others (see below) have accepted this description. Topotype material examined lacked such projections, nor were they mentioned in the original species description. Mulvey has subsequently examined cysts from cultures in Holland and from Ivory Coast. He agrees that *H. oryzae* lacks such finger-like projections and believes that the material he originally studied was a mixture also containing *H. sacchari* Luc & Merny, 1963 (Mulvey pers. comm.).

The species of *Heterodera* recorded in Japan on rice for the first time by Okada (1955) and then designated as *H. oryzae* by various Japanese nematologists (Hashioka, 1964; Ichinohe, 1968; Shimizu, 1971; Nishizawa *et al.*, 1972; Shimizu, 1972; 1973) was described later by Ohshima (1974) as a new species under the name of *H. elachista* Ohshima, 1974. The author differentiated *H. elachista* from *H. oryzae* mainly by the absence of finger-like projections on the underbridge, on the basis of Mulvey's work (1972). In fact the two species now appear to be rather close to each other, *H. elachista* differing from *H. oryzae* mainly by the shorter female and male stylets and spicules and in the structure of the underbridge, apparently without the central expanded hyaline area characteristic of *H. oryzae*. Anyway, comparative studies are needed to separate the two species more clearly.

TYPE HOST AND LOCALITY *Oryza sativa* L. (rice) cv. Morobérékan, at Bokakouamékro village, 40 km east of Bouaké, Ivory Coast.

SYSTEMATIC POSITION Tylenchida: Tylenchoidea: Heteroderidae: *Heterodera* Schmidt, 1871.

DISTRIBUTION AND HOSTS At the present time, the known distribution of *H. oryzae* is restricted to the inundated rice fields of the central area of Ivory Coast (Merny, 1970), and rice is the only known host.

BIOLOGY AND LIFE-HISTORY Monolarval infestations proved *H. oryzae* to be amphimictic (Merny, 1966; Netscher, 1969); the chromosome number is 18 (n=9); the processes of division of oocytes and fertilization conform to those of other members of the genus (Netscher, 1969). Genetic studies proved that sex is determined genetically (Cadet *et al.*, 1975) and that larval length is partly governed by genetic characters (Netscher & Pernès, 1971). The life-cycle takes about 1 month: the 1st moult, giving 2nd-stage larvae, occurs 9–11 days after the formation of eggs in the ovary; the 2nd moult takes place on the 3rd–4th day after penetration of the 2nd-stage larva into the rice root and the 3rd-stage larva is formed by the 5th–7th day; the 3rd moult, which lasts about 2 days, takes place on the 8th–9th day for male larvae and the 9th–10th day for females; 4th-stage larval males appear on the 10th day and females on the 11th day; the 4th moult takes place on the 13th–14th day for male larvae and the 16th day for female larvae (Berdon & Merny, 1964). In monoxenic conditions (Reversat, 1975a), on young rice plants grown in sterile agar tubes, the development of the nematodes is similar, but on excised rice roots grown in the same conditions development was incomplete, only some females being formed and no eggs produced. Eggs contained in cysts and in egg-masses appear to play different roles (Merny, 1966; 1972); the egg masses liberate large numbers of larvae quite rapidly, the maximum number being reached between 12 and 16 days (Reversat, 1975b). They can reinfest rice immediately and, due to the short duration of the life-cycle of the nematode (1 month), two or three generations can infest the same plant, but after 6 months, the egg masses do not produce any more larvae. In contrast, the larvae from cysts are liberated very slowly and the production is maximum between 40 and 80 weeks; these larvae are perfectly able to reinfest a new crop of rice. The cysts are resistant to desiccation in soil; after 9 months, larvae are liberated, but infectivity is retained better in humid soil (Merny, 1972). Hatching from cysts is positively influenced by rice root diffusate and various

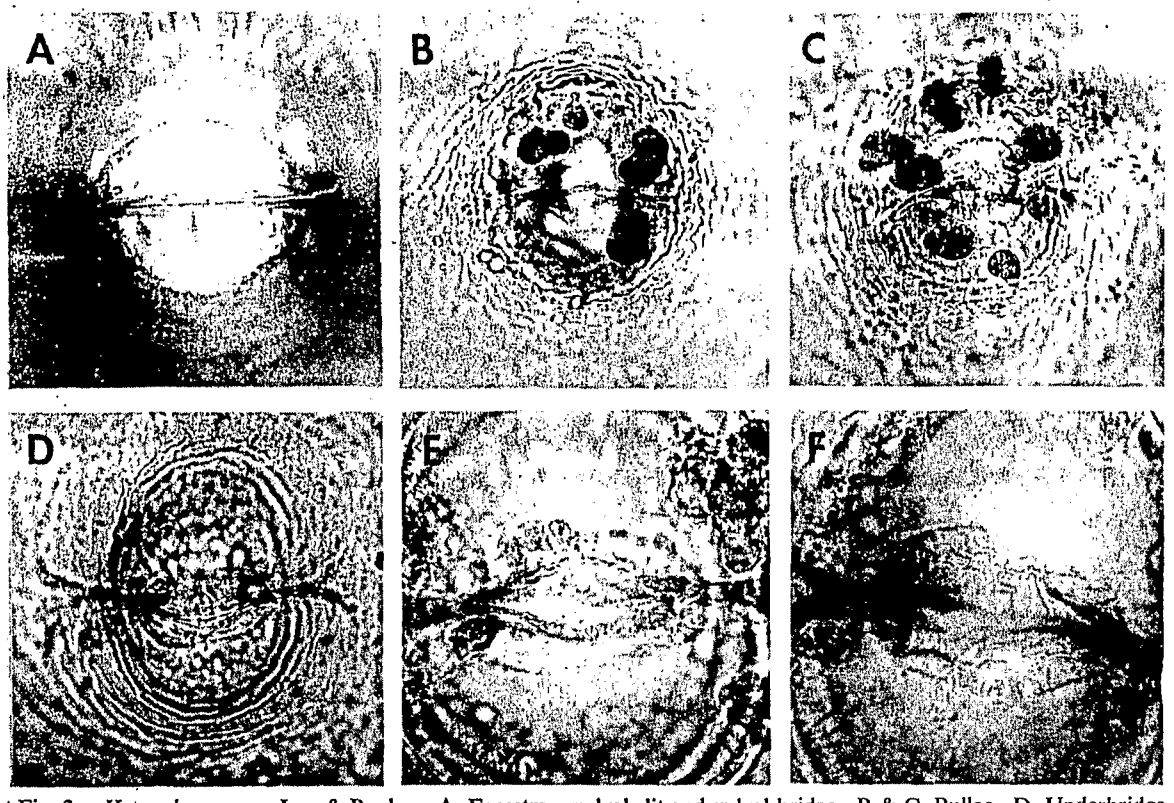

Fig. 2. *Heterodera oryzae* Luc & Berdon. A. Fenestrae, vulval slit and vulval bridge. B & C. Bullae. D. Underbridge. E & F. Expanded hyaline portion of underbridge showing absence of finger-like projections. (Original photomicrographs of topotype material.)

soil extracts (Merny, 1972). The larvae themselves have a short longevity in soil, about 20 days in normal conditions (Merny, 1966), but they can survive longer in anaerobic conditions: 90% survive after 4 weeks (Reversat, 1975c).

HOST–PARASITE RELATIONSHIPS The 2nd-stage larvae penetrate the roots obliquely without any site preference; they then follow a zigzag line into the parenchymatous tissue and the head penetrates the pericycle into the central cylinder. After development of females, large areas in the central cylinder appear to be transformed into syncytia whereas thyloses are produced inside the vessels (Berdon & Merny, 1964). Penetration is influenced by the granular structure of the substrate, the optimum being obtained, in artificial conditions, with particles of a diameter from 160 to 250 μ; the level of penetration varies too with the age of the plant (Reversat & Merny, 1973).

CONTROL No work has been recorded.

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