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# Ecology and pathogenicity of the Hoplolaimidae (Nemata) from the sahelian zone of West Africa. 5. *Aorolaimus macbethi* (Sher, 1964) Fortuner 1987

Pierre BAUJARD* and Bernard MARTINY

*ORSTOM, Laboratoire de Nématologie, B.P. 1386, Dakar, Sénégal.*

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**Summary** – *Aorolaimus macbethi* was found in low numbers in the soils of the semi-arid tropics of West Africa up to 80 cm deep. Soil temperature, soil moisture and host plants have a significant effect on its multiplication rate. The nematode is able to enter anhydrobiosis during the dry season and is characterized by a low multiplication rate. It was slightly pathogenic to millet at low inoculum levels.

**Résumé. *Écologie et nocuité des Hoplolaimidae (Nemata) de la zone sahélienne de l'Afrique de l'Ouest. 5.* Aorolaimus macbethi *(Sher, 1964) Fortuner, 1987*** – *Aorolaimus macbethi* a été trouvé en faibles nombres dans les sols de la zone sahélienne ouest africaine, jusqu'à 80 cm de profondeur. La température et l'humidité du sol, de même que la plainte-hôte affectent significativement les taux de multiplication. Cette espèce, capable d'entrer en anhydrobiose pendant la saison sèche, est caractérisée par de faibles taux de multiplication. Sa nocuité vis-à-vis du mil à de faibles niveaux d'inoculum a été démontrée.

**Key-words :** *Aorolaimus macbethi,* nematode, West Africa, population dynamics, geographical distribution, vertical distribution, soil temperature, soil moisture, host plant, multiplication rate, pathogenicity.

Thirty three species have been described in the genus *Aorolaimus* Sher, 1963 (Baujard *et al.*, 1994); compared to other genera of the Hoplolaimidae, nothing is known about biology and/or pathogenicity of these species. This fifth article on the ecology and pathogenicity of the Hoplolaimidae from the sahelian zone of West Africa (Baujard & Martiny, 1995 *c, d, e, f*) presents the result of field and laboratory studies on *Aorolaimus macbethi* (Sher, 1964) Fortuner, 1987 from the sahelian zone of West Africa (Baujard & Martiny, 1994, 1995 *a, b*).

## Material and methods

Studies on geographical distribution, field population dynamics and vertical distribution have been conducted as previously described (Baujard & Martiny, 1995 *c*). Unless otherwise stated, nematode extraction, nematodes cultures, technics, host plants and cultivars (peanut [*Arachis hypogea* L. cv. 55 437], millet [*Pennisetum typhoides* Rich. cv. Souna III], sorghum [*Sorghum vulgare* L. cv. 51 69], cowpea [*Vigna unguiculata* (L.)Walp. cv. N 58 57]) used for laboratory studies are those described by Baujard (1995).

### Origin of nematodes and stock cultures

Nematodes used for stock cultures and laboratory experiments originated from soil samples taken at the end of the rainy season in October 1984, in a field cropped with millet, at Dombe, km 5, Diourbel-Thies road, Senegal. One hundred-hand picked nematodes were reared on millet in the laboratory from November 1984 until January 1992 under three different culture conditions : first period (November 1984-October 1988) with constant soil temperature (35 °C); second period (November 1988-December 1989) with constant soil temperature (34 °C) and constant soil moisture (10 %); third period (January 1990-January 1992) with constant soil temperature (32 °C) and constant soil moisture (10 %). Culturing was for 2 months, sometimes 4 months.

### Soil temperature

Tubes were inoculated with 62 ± 4 nematodes (mixture of all stages) originating from laboratory stock cultures on millet, planted with millet, and maintained at four constant soil temperature levels (30, 32, 34 or 36 °C) with seven replications for each temperature level, at 10 % constant soil moisture, for 60 days in a growth chamber with artificial lighting (16-h photoperiod).

### Soil moisture

Tubes were inoculated with 100 hand-picked nematodes (mixture of all stages) originating from the previ-

(*) *Present address : Muséum National d'Histoire Naturelle, Laboratoire de Biologie Parasitaire, Protistologie, Helminthologie, 61, rue Buffon, 75005 Paris, France.*

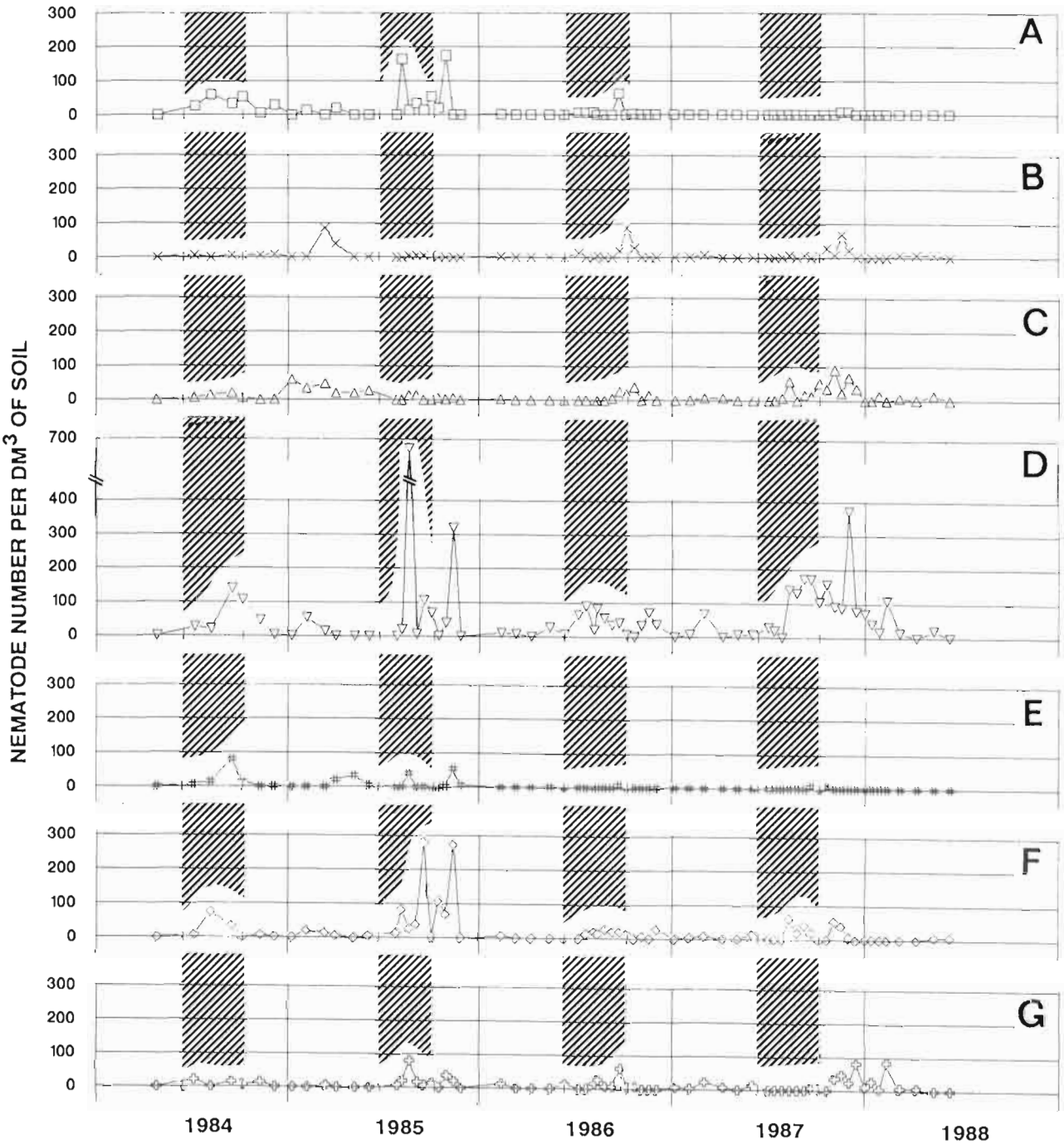


***Fig. 1.*** *Population dynamics of* Aorolaimus macbethi *according to the cultural practices. A : Peanut monoculture; B : Peanut-millet rotation without nematicidal treatment; C : Peanut-millet rotation with nematicidal treatment; D : Millet monoculture; E : Sorghum monoculture; F : Cowpea monoculture; G : Permanent fallow.* (Hatched areas : rainy seasons).

ous experiment (all treatments mixed), planted with millet, and maintained at four constant soil moisture levels (5, 7, 9 or 11 %) at 32 °C constant soil temperature for 60 days in a growth chamber. The four treatments were replicated seven times in a completely randomized design.

HOST PLANTS AND TEST FOR ANHYDROBIOTIC SURVIVAL

Tubes were inoculated with 69 ± 8 nematodes (mixtures of all stages) originating from laboratory stock cultures on millet, planted with one of the four host plants (cowpea, millet, peanut or sorghum), and maintained at 32 °C constant soil temperature and 10 % constant soil moisture in a greenhouse. The four treatments were replicated 20 times in a completely randomized design. After 60 days, nematodes were extracted from ten replications to obtain final population counts. At this time, watering was stopped for the ten remaining replications of each treatment. These tubes were kept at 34 °C constant soil temperature and weighed daily to follow the progress of soil desiccation. Sixty days later, nematodes were extracted by elutriation.

PATHOGENICITY ON MILLET

The multiplication rate and the effects on millet of 300 ± 15 or 600 ± 30 nematodes originating from laboratory stock cultures on millet were compared to control plants without nematodes at constant soil temperature (32 °C) and moisture (10 %) for 40 days in a greenhouse.

## Results

GEOGRAPHICAL DISTRIBUTION

*A. macbethi* appeared to be widely distributed from Mauritania to Niger although it appeared erratically and in low numbers in soil samples (0-500 nematodes per $dm^3$ of soil). In Mauritania, *A. macbethi* was found in the rhizosphere of *Pennisetum violaceum* L. (Baujard & Martiny, 1995 *b*). In Senegal, it was found during both the dry and rainy season in all the peanut cropping area (Baujard & Martiny, 1995 *a*) in the rhizosphere of crop plants (peanut, millet, sorghum, cowpea, rice, vegetables) and wild perennial plants (*Icacina senegaliensis* A. Juss., *Piliostigma reticulatum* (DC.) Hochst., *Andropogon guayanus* Hack., *Euphorbia balsamifera* Ait.). During the dry season, the nematode was recorded from samples of dry soil taken at 0-40 cm depth or from samples of wet soil taken below 60 cm in the rhizosphere of wild perennial plants. In the West of Mali (Baujard & Martiny, 1994) and in Niger, it was found in the rhizosphere of crop plants (peanut, millet, sorghum, cowpea) and in fields under fallow, always erratically and in low numbers.

FIELD STUDIES

*Population dynamics*

Population dynamics of *A. macbethi* are characterized by an increase of population levels during the second half of the rainy season followed by a regular decrease during the first months of the dry season (Fig. 1). Increases in population densities during the dry season occurred in 1984-1985 and 1987-1988 although the dry condition of the soil did not allow the multiplication of the nematode (Fig. 1). Millet appeared to be the best host for the nematode. Lower rates of multiplication were detected under cowpea and fallow (Fig. 1). Population densities in general remained below 100 nematodes per $dm^3$ of soil. The nematodes could not be recovered from the roots during the rainy season.

The multiplication rates of the nematode during the rainy seasons varied from 0 to 46 according to the year of observation and to the cultural practices, with a high degree of variability (Fig. 2). The survival rates of the nematode during the dry seasons varied from 0 to 100 % according to the year of observation and to the cultural practices, with a high degree of variability (Fig. 2).

*Vertical distribution*

*A. macbethi* was found only in a few microplots and only for three cultural practices in the experimental field at the sampling time during both the dry and rainy seasons. The vertical distribution of *A. macbethi* appeared to be relatively homogeneous, and the nematode was recovered up to 80 cm deep (Fig. 3).

LABORATORY STUDIES

*Observations made on stock cultures*

During the first period, multiplication rates varied from 0.54 to 3.6 ($\bar{x}$ = 1.48 ± 1; n = 9); during the second period, they varied from 1.57 to 5.40 ($\bar{x}$ = 3.25 ± 1.50; n = 5) and, during the third period, from 1.22 to 5.01 ($\bar{x}$ = 3.09 ± 1.25; n = 10). Increase of the duration of stock culture corresponded with an increase in the multiplication rate up to 10.

*Studies on the multiplication rate*

Soil temperature, soil moisture and host plants all had a significant effect on multiplication rate (Fig. 4 A-C). Optimal multiplication rate was observed at 32-34 °C soil temperature and 7-11 % soil moisture. Millet was the best host, whereas peanut was a non-host. Highest multiplication rate varied from 3 to 5 for a culture period of 60 days.

*Studies on survival rate after soil drying*

Soil moisture decreased to 0.2 % in 15 days after the cessation of watering. Adults and juveniles of the 3th and 4th stages were detected 140 days later. Mean survival rates varied from 20 to 60 % according to the host-plant (Figs 4 D, 5).

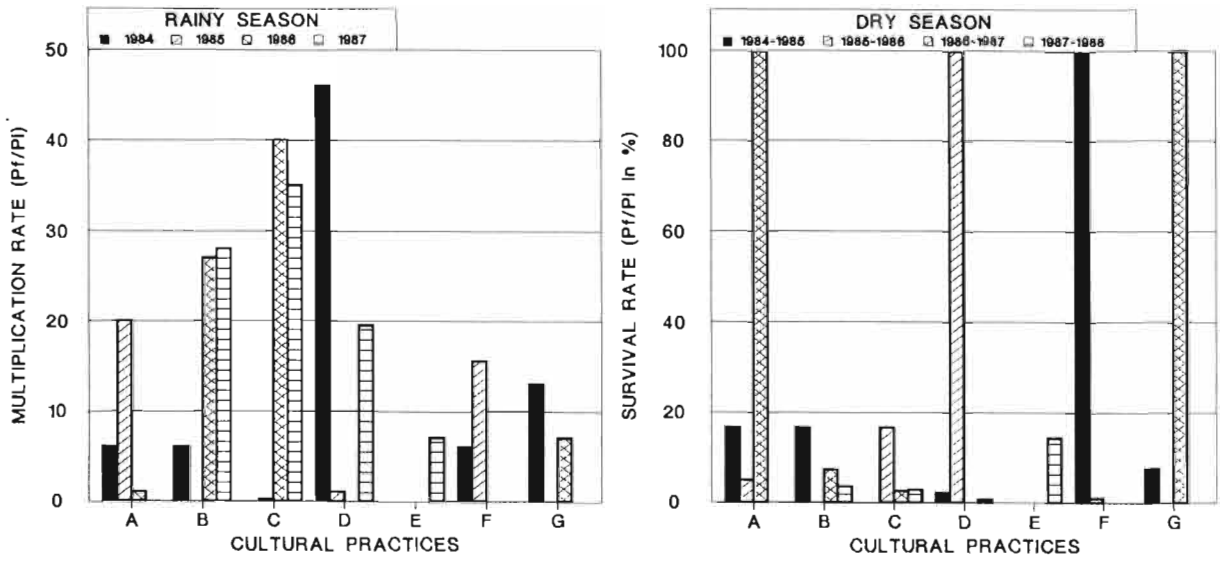


***Fig. 2.*** *Multiplication and survival rates of* Aorolaimus macbethi *during the rainy and dry seasons according to the cultural practice* (See Fig. 1 for the legend).

***Table 1.*** *Percentages of the population of* Aorolaimus macbethi *in the roots at the end of the different experiments.*

| Experiment and treatments | Root population as a % of the total tube population |
|---|---|
| Soil temperature | |
| 30 °C | 0 |
| 32 °C | 0.9 |
| 34 °C | 0.8 |
| 36 °C | 0.9 |
| Soil moisture | |
| 5 % | 0.4 |
| 7 % | 0.7 |
| 9 % | 0.6 |
| 11 % | 0.7 |
| Host plants | |
| peanut | 0 |
| millet | 0.5 |
| sorghum | 0.3 |
| cowpea | 1.2 |
| Pathogenicity | |
| millet | |
| * 300 nematodes | 0.2 |
| * 600 nematodes | 0.2 |

* Inoculum per tube.

*Pathogenicity against peanut and millet*

Significant reduction of fresh root weights of millet occurred with both inoculum levels of the nematode (Table 2) but no significant reduction occurred in shoot weights.

***Table 2.*** *Multiplication rate and effects of* Aorolaimus macbethi *on millet (Numbers followed by the same letter are not significantly different at* $P \leq 0.05$*).*

| Inoculum | Multiplication rate | Fresh weight (g) | | Dry weight (g) |
|---|---|---|---|---|
| | | Roots | Shoots | Shoots |
| 0 | – | 4.69 *a* | 5.31 *a* | 0.99 *a* |
| 300 | 0.76 | 2.34 *b* | 4.82 *a* | 0.84 *a* |
| 600 | 0.77 | 1.86 *b* | 4.74 *a* | 0.84 *a* |

## Discussion

The results showed that *A. macbethi* is well adapted to the climatic conditions of semi-arid tropics of West Africa. It is able to reproduce at high soil temperature and moderate soil moisture on several host plants. The nematode survived droughts. Nevertheless, its multiplication rate appeared to be low in comparison with other members of the Hoplolaimidae previously studied (Baujard & Martiny, 1995, *c, d, e, f*). Multiplication rates determined in the laboratory differed from those recorded in the fiels. This discrepancy might be related to :

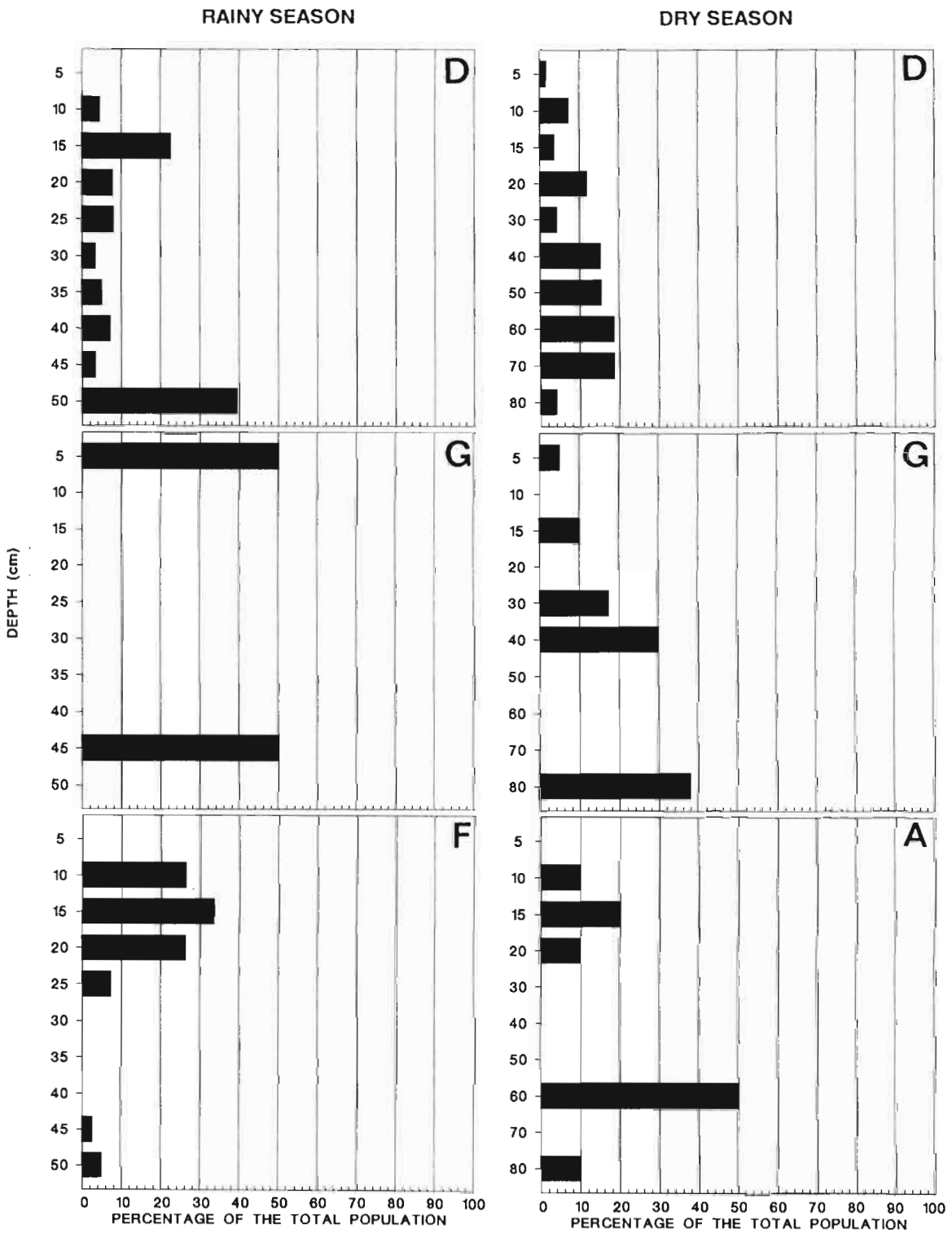


***Fig. 3.*** *Vertical distribution of* Aorolaimus macbethi *during the dry and rainy seasons under millet (D), fallow (G), cowpea (F) and peanut (A) monocultures.*

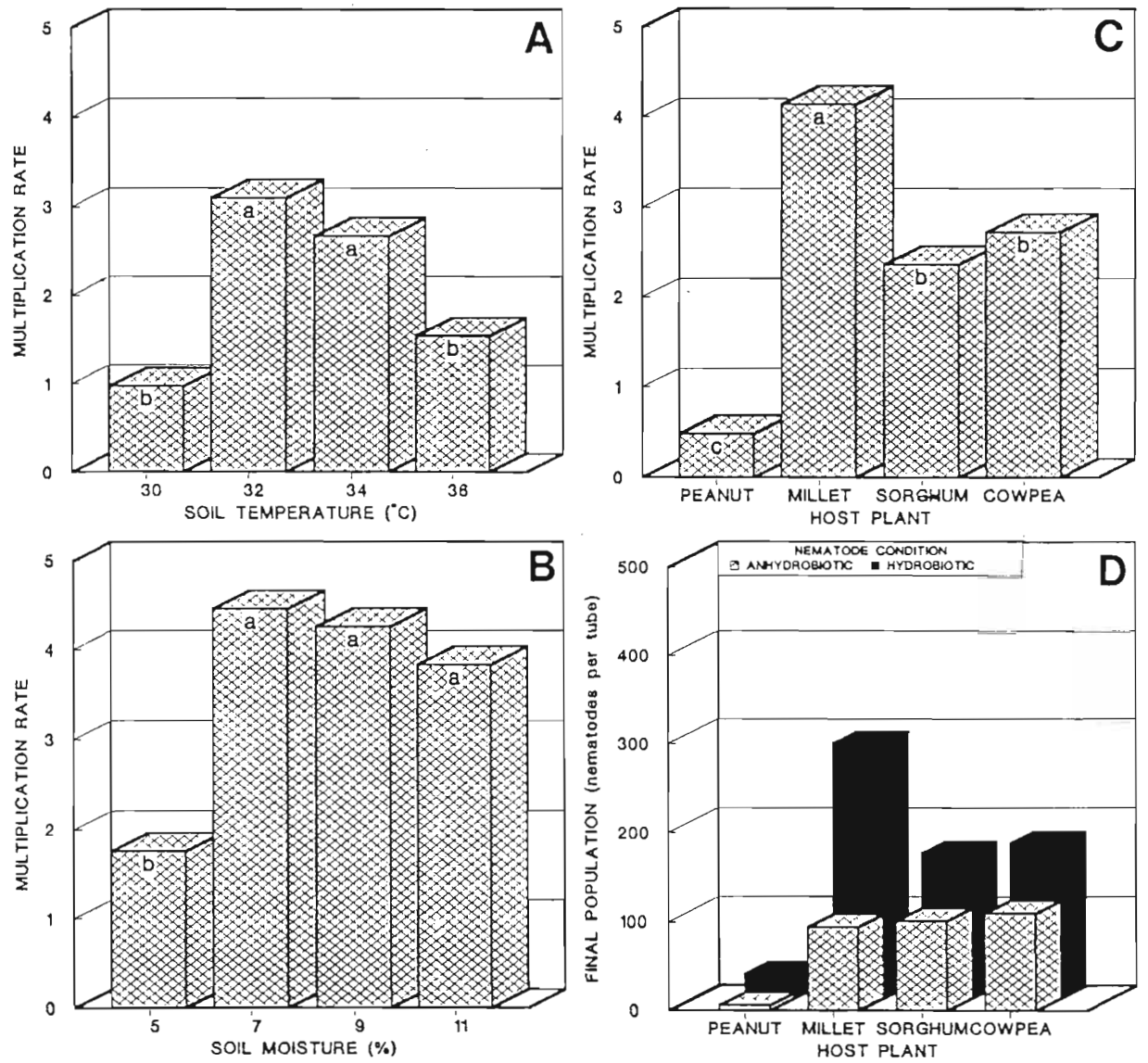


***Fig. 4.*** *Effects of soil temperature (A), soil moisture (B) and host plants (C) on the multiplication rate and effects of soil drying on population levels (D) of* Aorolaimus macbethi.

*i)* the culture duration; *ii)* the erratic distribution of the nematode in the soil; or *iii)* the effect of anhydrobiosis on multiplication rate as for species of the genus *Scutellonema* (Germani, 1981; Baujard & Martiny, 1995 *d*).

Increases in population levels during the dry season in the field cannot be explained by the multiplication of the nematode since moisture conditions do not allow reproduction. These increases might be explained by the effects of anhydrobiosis on nematode physiology as previously described for *Scutellonema cavenessi* (Baujard & Martiny, 1995 *d*). This hypothesis should be tested by other laboratory experiments.

The sole experiment on pathogenicity was conducted with low inoculum levels and showed that *A. macbethi* was pathogenic to millet by reducing root weight. The importance of this nematode on crop yield should not be overlooked in West Africa.

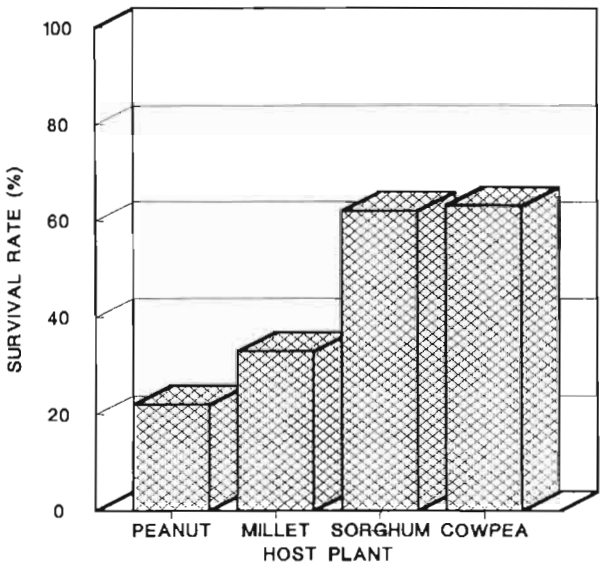


***Fig. 5.*** *Survival rate of* Aorolaimus macbethi *according to the host plant.*

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