Fundam. appl. Nematol., 1995, **18** (4), 335-345

Ecology and pathogenicity of the Hoplolaimidae (Nemata) from the sahelian zone of West Africa. 2. Laboratory studies on *Scutellonema cavenessi* Sher, 1964

Pierre BAUJARD* and Bernard MARTINY

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

Accepted for publication 2 August 1994.

Summary – The biology of *S. cavenessi* was affected by soil temperature, soil moisture, host plant, present and previous host plants, length of the active contact between nematode and host plant, age of the nematode, and the previous physiological state of the nematode (hydrobiotic *vs* anhydrobiotic) before inoculation. This species appeared to be well adapted to the ecological conditions of the semi-arid tropics of West Africa : it is polyphagous, reproducing at relatively high soil temperature (32-34 °C) and low soil moisture (> 5 %), with a life cycle of 100 days corresponding to the duration of the rainy season. Anhydrobiosis affected the physiology of the nematode in its reproductive activity. These biological characteristics might explain the geographical distribution according to the soil temperature and the variations of population densities according to the rainfall in the semi-arid tropics of West Africa. The study of the population dynamics showed that two periods occurred, the first corresponding to the reproductive activity of nematodes after anhydrobiosis at the end of the dry season, the second to that of nematodes produced from this first period. No pathogenic effects of the nematode to pluvial crops were recorded; this confirms previous field observations, showing that pathogenicity of *S. cavenessi* appeared doubtful.

Résumé – ***Écologie et nocuité des Hoplolaimidae (Nemata) de la zone sahélienne ouest africaine. 2. Études au laboratoire sur* Scutellonema cavenessi *Sher, 1964*** – La biologie du nématode apparaît être sous la dépendance de la température du sol, l'humidité du sol, la plante hôte, la plante sur laquelle le nématode a effectué son cycle précédent, la durée de la période de culture, l'âge du nématode et l'état physiologique du nématode (anhydrobiose ou hydrobiose) avant son inoculation. Cette espèce apparaît bien adaptée aux conditions écologiques de la zone sahélienne; elle est polyphage, se multipliant à de relativement hautes températures du sol (32-34°C) et faibles taux d'humidité du sol (> 5 %), avec un cycle biologique d'une durée de 100 jours qui correspond à celle de la saison des pluies. L'anhydrobiose affecte la physiologie du nématode, notamment dans sa capacité reproductrice. Ces caractéristiques biologiques expliquent sa répartition en relation avec les températures du sol et la variation des taux de population en relation avec la pluviosité dans la zone sahélienne ouest-africaine. L'étude de la dynamique des populations montre que la reproduction de l'espèce comprend deux phases successives, la première correspondant à l'activité des nématodes issus de la saison sèche précédente, la seconde à celle des nématodes issus de la première phase. Aucun effet pathogène du nématode n'a pu être enregistré vis-à-vis des cultures pluviales; ceci confirme les observations effectuées au champ et conduit à douter de la nocuité de cette espèce.

Key-words : *Scutellonema cavenessi,* nematode, West Africa, multiplication, survival, soil temperature, soil moisture, host plant, anhydrobiosis, population dynamics, pathogenicity, peanut, millet, sorghum, cowpea.

According to the results of numerous nematicide trials, the nematode *Scutellonema cavenessi* Sher, 1964 was considered as the most serious nematode parasite of pluvial crops in Senegal (Germani *et al.*, 1985). This fact was not confirmed by recent field studies on relationships between initial soil nematode densities and peanut yields (Baujard & Martiny, 1995 *c*) and additional nematicide trials have shown that peanut yield increases following nematicide injection cannot be explained only by nematode mortality (Duncan & Baujard, 1986; Baujard *et al.*, 1987, 1989), as nematicides used had a stimulant effect on leguminous plants (peanut, cowpea) cropped in this area (Sarr *et al.*, 1989; Baujard *et al.*, 1990).

The laboratory culture of *S. cavenessi* was considered as impossible (Demeure *et al.*, 1980; Germani, 1981 *a*), and only one experiment on its pathogenicity to peanut has been done, by inoculating a mixture of at least five different plant-parasitic species directly extracted from the field (Germani, 1981 *b*).

Studies on some other species originating from the same area have shown that soil temperature, soil moisture and host plants may have a significant effect on the multiplication rate of these organisms (Baujard & Marti-

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

ny, 1991, 1993, 1994, 1995 *a;* Baujard *et al.,* 1993). Recent field observations have shown that the reproduction of *S. cavenessi* was probably affected by the same factors (Baujard & Martiny, 1995 *c).* Attempts to culture this nematode species have been made in order to evaluate its pathogenicity using pure populations.

Material and methods

Nematodes extractions, culture methods and experiments have been conducted as previously described (Baujard, 1995).

Effects of soil temperature on multipplication rate

In four different experiments onto peanut (*Arachis hypogea* cv. 55 437), millet (*Pennisetum typhoides* Rich. cv. Souna III), sorghum (*Sorghum vulgare* L. cv. 51 69) and cowpea (*Vigna unguiculata* (L.) Walp. cv. N 58 57), tubes were inoculated with nematodes originating from the same host plant at the following inoculum levels : 85 ± 10 onto peanut, 657 ± 31 onto millet, 91 ± 13 onto sorghum, 292 ± 76 onto cowpea; and four constant soil temperatures : 30, 32, 34 and 36 °C. There were six replications per treatment and all experiments were done in a growth chamber for a 75-day period at 7 % constant soil moisture.

Effects of soil moisture on multiplication rate

In four different experiments in totally randomized designs with peanut, millet, sorghum and cowpea, tubes were inoculated with nematodes originating from the same host plant at the following inoculum levels : 137 ± 40 onto peanut, 500 onto millet, 64 ± 12 onto sorghum, 130 ± 9 onto cowpea; and four (5, 7, 9, 11 % for peanut and millet) or five (3, 5, 7, 9, 11 % for sorghum and cowpea) constant soil moistures. There were six replications per treatment and all experiments were done in a greenhouse for a 75-days period at 34 °C constant soil temperature.

Effects of host and previous host on multiplication rate

Nematodes originating respectively from laboratory mass cultures on peanut, millet, sorghum and cowpea are inoculated onto these four host plants in a completely randomized design at the following inoculum levels : 51 ± 8 from peanut, 224 ± 10 from millet, 180 ± 12 from sorghum, 192 ± 20 from cowpea. There were six replications per treatment and the experiment was done in a greenhouse for a 75-days period at 34 °C constant soil temperature and 7 % constant soil moisture.

Effects of sampling time on multiplication rate

One hundred hand-picked nematodes originating from soil samples collected in April 1987 (before the rainy season) and in November 1987 (after the rainy season) on fallow plots in the experiment field on population dynamics (experiment site 6 *in* Baujard & Martiny, 1995 *c*) were inoculated onto peanut, millet, sorghum and cowpea. There were six replications per plant and time of sampling in a completely randomized design and the experiment was done in a greenhouse for a 75-day period at 35 °C constant soil temperature and 7 % constant soil moisture.

Effects of continuous monocultures of 75 days on the multiplication rate

One hundred hand-picked nematodes were inoculated onto peanut, millet, sorghum or cowpea with ten replications in a greenhouse for a 75-days period at 34 °C constant soil temperature and 7 % constant soil moisture; after 75 days, nematodes from soil and root extraction were reinoculated four times in the same conditions onto the same host plant with ten replications per plant.

Effects of culture length on multiplication rate

One hundred hand-picked nematodes were inoculated onto millet for cultures of 75, 90, and 105 days with ten replications in a greenhouse at 34 °C constant soil temperature and 7 % constant soil moisture; after 75, 90 or 105 days, nematodes originating from soil and roots extractions were reinoculated three times (75 and 90 days) and twice (105 days) in the same conditions onto the same host plant with ten replications per culture length.

Effects of soil drying and of anhydrobiosis duration on survival rate and multiplication rate

A total of 367 ± 13 nematodes were inoculated onto millet in 100 tubes at 34 °C constant soil temperature and 7 % constant soil moisture. Ten tubes were extracted at 75, 90, 120, 150, 180, 210, 240, 270, 300 and 330 days respectively after inoculation. Watering was stopped 90 days after inoculation. After each extraction, nematodes from soil and roots were reinoculated onto millet (ten replications) and maintained in the same conditions for 75 days in the greenhouse.

Survival rate under anhydrobiosis and physiological effects

Nematodes were collected in the field at Nebe (site 6 *in* Baujard & Martiny, 1995 *c*) on microplots with monocultures of peanut, millet, sorghum, cowpea and fallow 34 days after the last rain of the rainy season. After extraction by elutriation 30 days later, 1000 nematodes originating from each cultural practice were inoculated (ten replications) in glass containers (75 cm^3) filled with washed and sterilized sand (65 cm^3). The soil was saturated with water and two sorghum seeds are sown in each glass container. The soil was left to des-

Table 1. *Characteristics of the experiments on the pathogenicity of* Scutellonema cavenessi.

Plant/experiment	Origin and characteristics of the inoculum	Inoculum level	Soil temperature-soil moisture-duration-number of replication
Peanut 1°	Laboratory cultures on peanut, millet, sorghum, cowpea; anhydrobiotic condition from 24 months previously	0-400-1200	34 °C-10 %-40 days-10
2°	Laboratory cultures on peanut, millet, sorghum, cowpea; hydrobiotic or anhydrobiotic condition from 7 months previously	0-1000-2000	34 °C-10 %-56 days-10
3°	Laboratory cultures on millet; hydrobiotic condition	0-900-4500-9000	34 °C-10 %-100 days-10
4°	Laboratory cultures on peanut; hydrobiotic condition	0-2000-4000	34 °C-10 %-40 days-10
Millet 1°	Laboratory cultures on millet and cowpea; hydrobiotic condition	0-300-600	34 °C-10 %-40 days-10
2°	Laboratory cultures on peanut; hydrobiotic condition	0-1800-5400	34 °C-10 %-40 days-10
3°	Laboratory cultures on millet; hydrobiotic conditions	0-600-1200-1800-3600	34 °C-7 %-40 days-10
Sorghum 1°	Laboratory cultures on millet and sorghum; hydrobiotic condition	0-1000-2000	34 °C-7 %-75 days-7
2°	Laboratory cultures on peanut; hydrobiotic condition	0-1800-5400	34 °C-10 %-40 days-10
Cowpea 1°	Laboratory cultures on peanut; hydrobiotic condition	0-2000-4000	34 °C-10 %-40 days-10

iccate and kept at 30 °C constant temperature. 120 days after inoculation, nematodes were extracted by flotation-sedimentation and counted directly without sieving. After counting, nematode suspension were put on Baermann trays and counted after 7, 14, 21, 28 and 35 days.

Population dynamics

20 000 nematodes originating from laboratory stock cultures were inoculated on millet in a pot filled with sandy soil (2.7 dm^3) at 34 °C constant soil temperature; the soil moisture was not monitored. Ninety days after inoculation, watering was stopped and the soil left to dry. After a further 258 days, the dry soil was thoroughly mixed and equally distributed in 162 tubes and ten millet seeds were sown in the dry soil of each tube. The initial populations per tube (62 ± 16 nematodes : 9 ± 4 males, 14 ± 3 females, 38 ± 12 juveniles of third-fourth stages) were evaluated by counting nematodes from 10 tubes. Tubes were moistened in a mist chamber and then kept at constant soil temperature (34 °C) and moisture (7 %) in the greenhouse. Every 5 days over the 95 days, nematodes were extracted from the soil of 8 tubes selected at random by centrifugation (Caveness & Jensen, 1955); root systems were fixed with lactophenol and nematodes stained by fuschin acid for counting and identification of stages under the microscope.

Pathogenicity to peanut, millet, sorghum and cowpea

Several experiments were conducted in order to evaluate the pathogenicity of the nematode on the four main pluvial crops and the possible influence of the previous host and of the hydrobiotic or anhydrobiotic conditions of the nematode on its pathogenicity for these crops (Table 1).

Results

Effects of soil temperature, soil moisture and previous and present host plant on multiplication rates

Soil temperature significantly affected ($P < 0.05$) the multiplication rate; the optimal temperatures were relatively high and varied according to the host plant : 34 °C for peanut, 30-34 °C for millet and sorghum, 34-36 °C for cowpea (Fig. 1 A). Soil moisture significantly affected ($P < 0.05$) the multiplication rate except for peanut (Fig. 1 C). The host plant and the previous host plant significantly affected ($P < 0.05$) alone or together the multiplication rate (Fig. 1 E); cowpea induced, as previ-

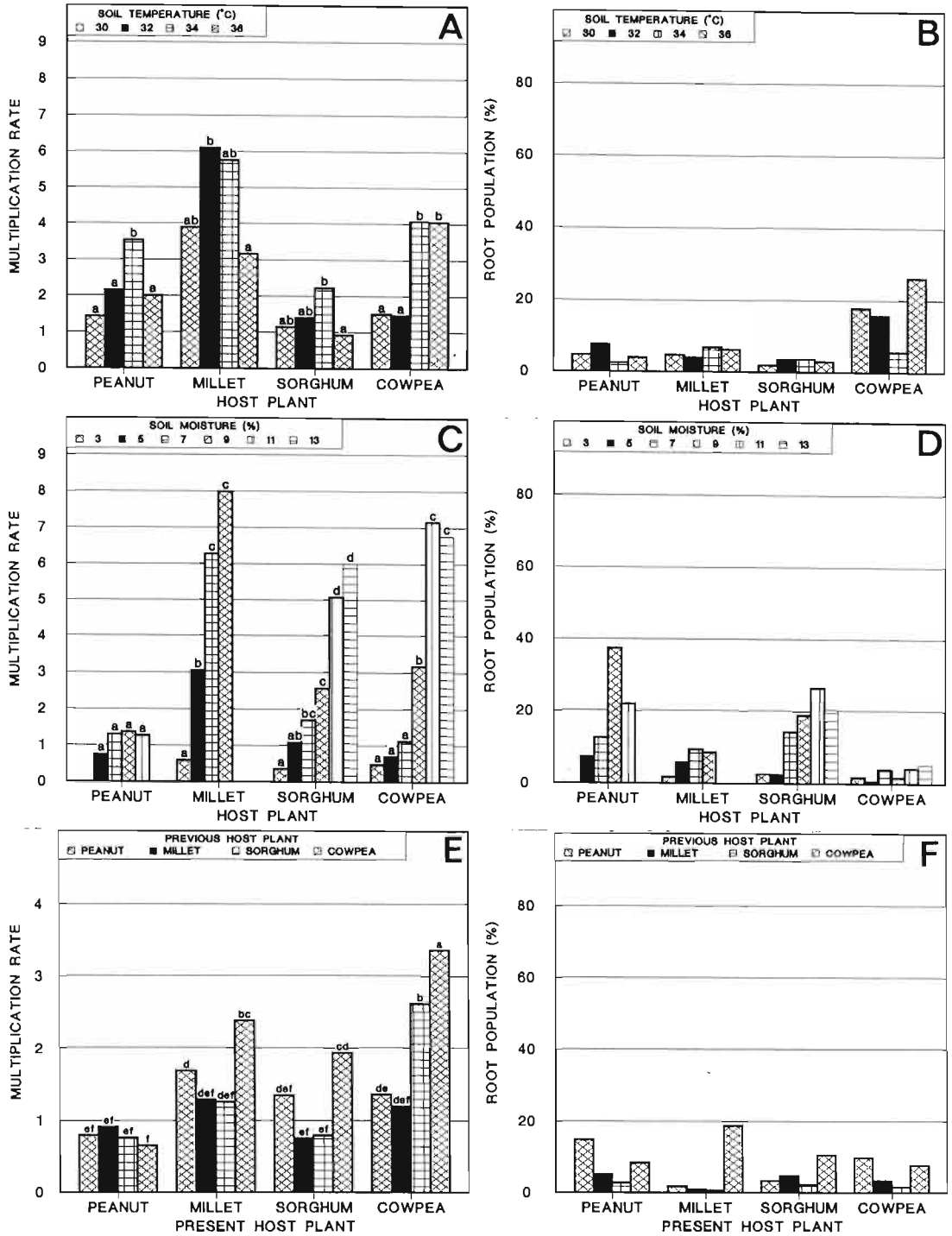

Fig. 1 : *Effects of soil temperature (A-B), soil moisture (C-D), actual and previous host plant (E-F) on multiplication rate (left column) and root population densities as a percentage of total population (right column) of* Scutellonema cavenessi [A, C : for each host plant, results followed by the same letter are not significantly different ($P < 0.05$); E : results followed by the same letter are not significantly different ($P < 0.05$)].

Table 2. *Field and laboratory survival rates of* Scutellonema cavenessi *and ability to move through the Baermann tray.*

Origin of nematodes	Survival rate		Percentage of recover after				
	Field	Laboratory*	7 days	14 days	21 days	28 days	35 days
Peanut	63	65.43 *a*	34	39	40	41	41
Millet	49	44.56 *c*	57	62	63	63	64
Sorghum	33	47.98 *bc*	41	45	47	48	49
Cowpea	61	55.38 *ab*	35	38	38	39	39
Fallow	51	57.58 *ab*	49	53	54	55	56

* Numbers followed by the same letters are not significantly different at $P < 0.05$.

ous host, significantly ($P < 0.05$) higher multiplication rates ($\bar{x} = 2.13$) than sorghum ($\bar{x} = 1.38$), peanut ($\bar{x} = 1.34$) and millet ($\bar{x} = 1.05$); cowpea induced also, as host plant, significantly ($P < 0.05$) higher multiplication rates ($\bar{x} = 2.21$), followed by millet ($\bar{x} = 1.68$), sorghum ($\bar{x} = 1.20$) and peanut ($\bar{x} = 0.79$). Root population densities varied from 2 to 26 %, 1-37 %, and 1-19 % of the total population respectively in these three different experiments on soil temperature, soil moisture and host plants, without any apparent relations with the factors tested (Fig. 1 B, D, F).

Effects of the date of sampling on the multiplication rate

The date of sampling affected significantly ($P < 0.05$) the multiplication rate for millet, sorghum and cowpea and not for peanut. For the nematodes collected before the rainy season, millet, sorghum and cowpea are better hosts than peanut; for those collected after the rainy season, the host plant did not have any significant effect ($P < 0.05$) on the multiplication rate (Fig. 2 A). Root populations varied from 3 to 38 % according to host plant and date of sampling, and was always highest for nematodes collected before the rainy season (Fig. 2 B).

Effects of the monoculture and culture length on the multiplication rate

Regular alternation of cultures with high and low multiplication rates were recorded with millet, sorghum and cowpea; with peanut, a regular increase of the multiplication rates was recorded for the first four cultures followed by a decrease for the fifth (Fig. C). Increase of the culture length from 75 to 90 and 105 days induced an increase of the multiplication rates, but multiplication rates decreased during the following two cultures of 90 days. Multiplication rates in the cultures of 105 days were stable and twice as high as those in the cultures of 75 days (Fig. 2 E).

Effects of soil drying and length of the anhydrobiotic phase on the multiplication rate

Soil drying induced a significant ($P < 0.05$) decrease of population densities up to the sixth month; afterwards, population densities were of the same value as those before soil drying (Fig. 2 D). Inoculation of nematodes extracted each month in the previous experiment showed a significant ($P < 0.05$) variation of the multiplication rates according to the " age " of the nematodes and to their physiological state (hydrobiotic or anhydrobiotic) before inoculation : multiplication rates of the nematodes that were under anhydrobiosis for 90-180 days were higher than those *i)* which did not enter anhydrobiosis, and *ii)* were under anhydrobiosis for 30-60 or for 210-240 days (Fig. 2 F).

Effects of host plant on anhydrobiosis and physiological effects of anhydrobiosis

After the induction of anhydrobiosis in the laboratory by soil drying, survival rates of nematodes differed significantly ($P < 0.05$) according to the host plant. Values recorded in the laboratory corresponded to thoses evaluated in the field; 40-60 % of the nematodes were able to actively migrate through the tissues on the Baermann trays after anhydrobiosis, this ability appearing inversely related to their survival rate (Table 2).

Population dynamics

Soil nematode densities decreased during the first 30 days after soil moistening and increased slowly up to 50th day and rapidly from the 50th up to the 70th day; afterwards, they remained constant. Nematodes entered in the root systems from the 15th day and root densities increased regularly up to the 75-85th day and then decreased abruptly (Fig. 3 A). Root densities as a percentage of the total population increased rapidly up to 60 %

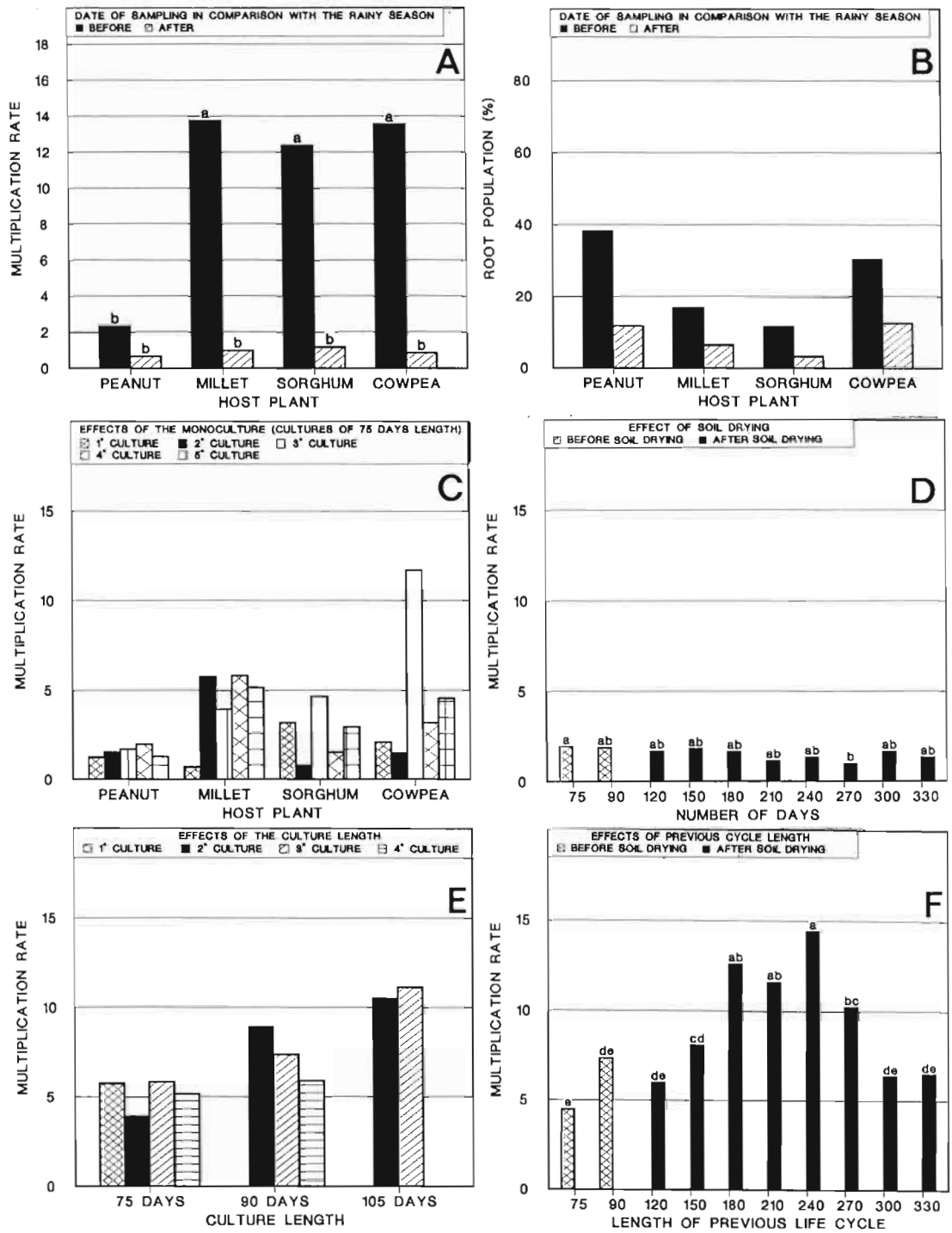

Fig. 2 : *Effect of date of sampling (A-B), culture length (C, E), soil drying (D), age and physiological state of the nematode (D, F) on multiplication rate and root population densities of* Scutellonema cavenessi *as a percentage of total populations.* [Results followed by the same letter are not significantly different ($P < 0.05$).]

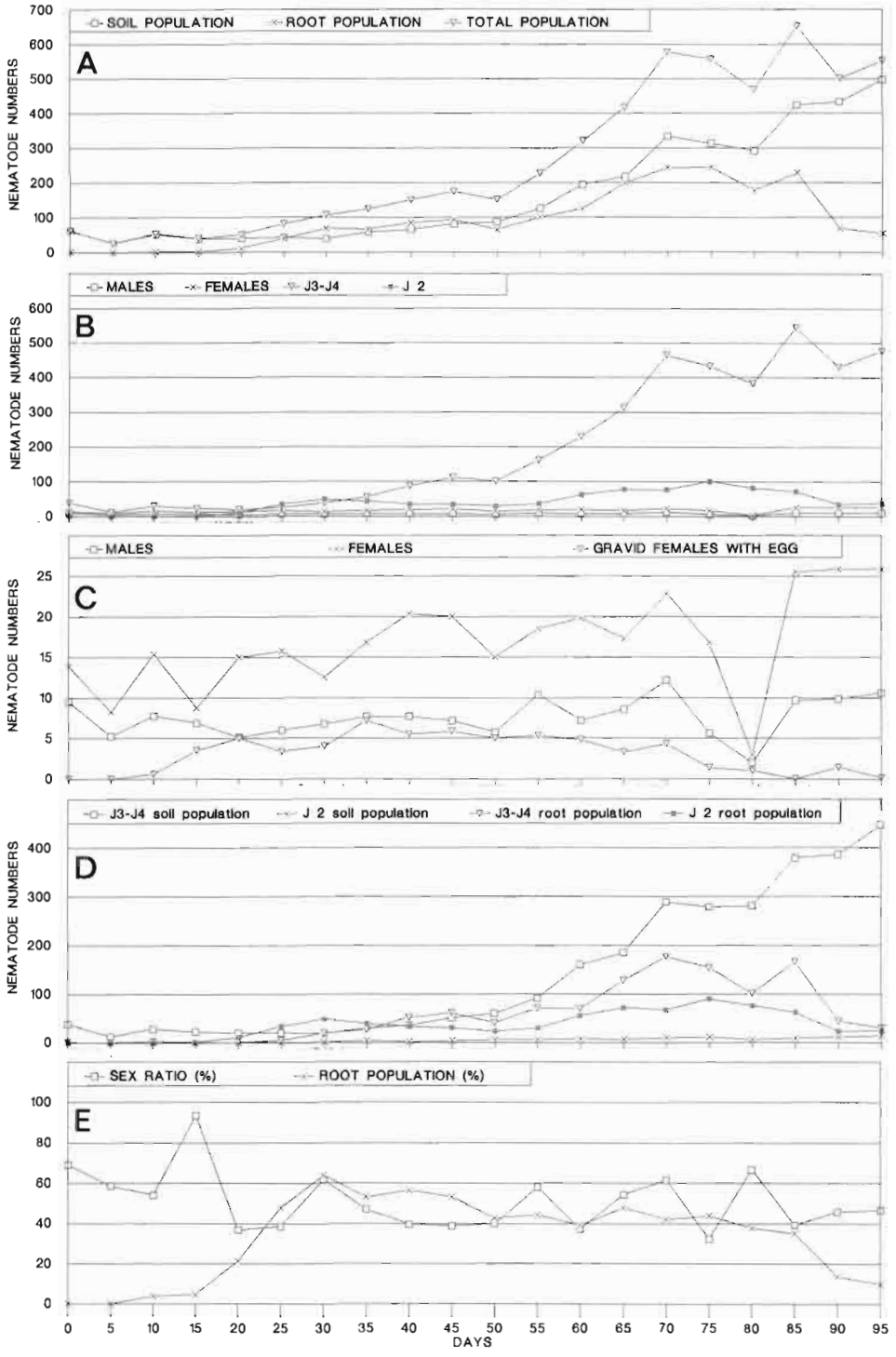

Fig. 3 : *Characteristics of the population dynamics of* Scutellonema cavenessi *on millet. A : Evolution of soil, root and total populations; B : Evolution of total soil and roots numbers of males, females and juveniles; C : Evolution of soil populations of males, females and gravid females with egg in uterus; D : Evolution of soil and root numbers of juveniles; E : Evolution of sex ratio and percentage of root population.*

Table 3. *Multiplication rate and effects of* Scutellonema cavenessi *on peanut.*

Experiment	Inoculum level and origin	Multiplication rate	Fresh weight		Dry weight
			Roots	Shoots	Shoots
1°	0	–	2.34 *a*	7.64 *a*	1.41 *a*
	400 (anh.)	2.54	1.90 *a*	7.47 *a*	1.28 *a*
	1200 (anh.)	1.91	2.27 *a*	6.87 *a*	1.23 *a*
2°	0	–	2.86 *a*	8.19 *a*	1.81 *a*
	1000 (peanut)	4.19	2.63 *a*	8.47 *a*	1.81 *a*
	1000 (millet	4.32	2.79 *a*	8.37 *a*	1.91 *a*
	1000 (sorghum)	5.01	2.94 *a*	9.15 *a*	1.92 *a*
	1000 (cowpea)	4.2	2.87 *a*	7.85 *a*	1.79 *a*
	1000 (anh.)	3.7	2.96 *a*	8.31 *a*	1.84 *a*
	2000 (anh.)	3.12	3.15 *a*	8.19 *a*	1.81 *a*
3°	0	–	2.35 *a*	4.62 *a*	1.25 *a*
	900 (millet)	7.02	2.39 *a*	5.03 *a*	1.30 *a*
	4500 (millet)	2.47	2.20 *a*	5.04 *a*	1.44 *a*
	9000 (millet)	1.76	2.12 *a*	5.21 *a*	1.17 *a*
4°	0	–	3.41 *a*	6.95 *a*	1.25 *a*
	2000 (peanut)	0.96	3.73 *a*	6.36 *a*	1.15 *a*
	4000 (peanut)	0.88	3.36 *a*	6.81 *a*	1.20 *a*

In each experiment, numbers followed by the same letters are not significantly different at $P < 0.05$.

from the 5th to the 30th day, decreasing slowly to 40 % up to the 85th day and abruptly thereafter (Fig. 3 E).

Adult numbers remained stable up to the 30th (females) or 50th (males) day, increased up to the 70th day, decreased abruptly up to the 80th day and increased again abruptly at the 85th day reaching a density slightly superior to that of the beginning of the experiment (Fig. 3 C); gravid females with eggs in the reproductive system appeared between the 5th and the 10th day, their number increasing up to the 20th day, remaining stable up to the 70th day and then decreasing up to the end of the cycle (Fig. 3 C); the sex ratio remained constant, 50 % on average, during the whole experiment (Fig. 3 E).

Juveniles of the second stage (J2) were observed in low numbers in the soil during the whole experiment; they penetrated into the roots from the 15th day, root numbers of J2 increasing in two periods, up to the 30th day and from the 50th up to 75th day; this evolution of the J2 root densities followed that of gravid females with eggs (Fig. 3 D, E).

Soil numbers of juveniles of the third-fourth stages (J3-4) remained stable up to the 30th day and then increased regularly up to the end of the experiment; J3-4 appeared in the roots since the 20-25th day, their numbers increasing slowly up to the 60th day, then rapidly up to the 70th day and decreasing thereafter (Fig. 3 D).

Study of the evolution of cumulated numbers of J2 in the roots indicated that two periods probably occurred in the development of the nematode : the first characterized by a relatively low prolificity up to the 55-60th day *($y = 5.46\,x - 53.73$; $r^2 = 0.94^{**}$)*, the second by a higher prolificity after the 55-60th day *($y = 12.69\,x - 659.78$; $r^2 = 0.98^{**}$)*.

Pathogenicity to peanut, millet, sorghum and cowpea

No pathogenic effects of the nematode were recorded on the different plants at the inoculum levels tested and with the different origins of the specimens (Tables 3-6).

Discussion

These experiments showed the complexity of the biology of *S. cavenessi* since its reproduction was affected by seven factors at least : *i)* soil temperature, *ii)* soil moisture, *iii)* host plant, *iv)* host plant on which previous life cycle was completed, *v)* length of the active contact between the nematode and its host plant, *vi)* the " age " of the nematode, *vii)* the previous physiological state of the nematode (hydrobiotic *vs* anhydrobiotic).

At 34°C soil temperature and 100 days of activity in the rhizosphere of plants, the nematodes did not show a break in their reproductive activity which characterized specimens collected at the end of the rainy season and studied at 30°C (Germani, 1981 *a*). The soil drying

Table 4. *Multiplication rate and effects of* Scutellonema cavenessi *on millet.*

Experiment	Inoculum level and origin	Multiplication rate	Fresh weight		Dry weight
			Roots	Shoots	Shoots
1°	0	–	8.36 *a*	5.96 *a*	1.62 *a*
	300 (millet)	31.65	6.56 *a*	5.09 *a*	1.26 *a*
	600 (millet)	29.37	7.08 *a*	5.67 *a*	1.52 *a*
2°	0	–	2.46 *a*	3.23 *a*	0.60 *a*
	1800 (peanut)	3.98	2.02 *a*	3.09 *a*	0.54 *a*
	5400 (peanut)	2.98	2.88 *a*	3.41 *a*	0.57 *a*
3°	0	–	2.58 *a*	3.23 *a*	0.92 *a*
	600 (millet)	6.95	2.40 *a*	3.71 *a*	0.94 *a*
	1200 (millet)	5.90	2.79 *a*	4.10 *a*	1.06 *a*
	1800 (millet)	6.92	2.54 *a*	3.81 *a*	0.98 *a*
	3600 (millet)	5.09	2.70 *a*	4.14 *a*	1.03 *a*

In each experiment, numbers followed by the same letters are not significantly different at $P < 0.05$.

Table 5. *Multiplication rate and effects of* Scutellonema cavenessi *on sorghum.*

Experiment	Inoculum level and origin	Multiplication rate	Fresh weight		Dry weight
			Roots	Shoots	Shoots
1°	0	–	2.29 *a*	4.57 *a*	0.55 *a*
	1000 (millet)	4.54	1.88 *a*	4.17 *a*	0.47 *a*
	1000 (sorghum)	2.81	2.79 *a*	4.92 *a*	0.66 *a*
	3000 (sorghum)	1.89	2.64 *a*	4.40 *a*	0.56 *a*
2°	0	–	2.79 *a*	4.86 *a*	0.81 *a*
	1800 (peanut)	3.61	2.75 *a*	5.14 *a*	0.90 *a*
	5400 (peanut	3.30	2.87 *a*	4.81 *a*	0.84 *a*

In each experiment, numbers followed by the same letters are not significantly different at $P < 0.05$.

Table 6. *Multiplication rate and effects of* Scutellonema cavenessi *on cowpea.*

Experiment	Inoculum level and origin	Multiplication rate	Fresh weight		Dry weight
			Roots	Shoots	Shoots
1°	0	–	3.05 *a*	5.65 *a*	0.96 *a*
	2000 (peanut)	4.02	2.82 *a*	5.48 *a*	0.91 *a*
	4000 (peanut)	3.76	2.73 *a*	5.52 *a*	0.90 *a*

In each experiment, numbers followed by the same letters are not significantly different at $P < 0.05$.

during the dry season induces only a quiescence by anhydrobiosis. In the climatic conditions of the sahelian zone of West Africa, the development cycle of *S. cavenessi* endures a hundred days, a longer period than previously determined under different thermic conditions (Demeure *et al.*, 1980); it is characterized by the continuous production of juveniles of the second stage in constant numbers, as previously described (Germani, 1981 *a*); study of the evolution of the production of juvenile of second stage revealed two periods, the first one corresponding probably to reproductive activity of " old " adults (present in the soil before the beginning of the rainy season), the second one to reproductive activity of " young " adults (developed from juveniles of the third and/or fourth stages present in the soil before the beginning of the rainy season); it seems probable that these two periods more or less each other overlap, since " old " adults probably survived up to the 70th day (Fig. 3 C). Comparison between these results and previous data (Germani, 1981 *a*) on reproductive activity of the nematode showed the same values for the regression coefficient of the curve, keeping in mind that data were calculated on at least two nematode stages (eggs and juveniles of second stage present in soil and roots) in the previous study : 23.7/2 = 11.85 *vs* 12.69 for " old " parents and 8.7/2 = 4.35 *vs* 5.46 for " young " parents); the differences between these values might be related to host plant (soybean *vs* millet) and/or soil temperature (30 *vs* 34°C).

The result of these laboratory studies support the field data collected in the sahelian zone of West Africa. The optimal soil temperatures for the reproduction corresponded with those recorded in the field (Baujard & Martiny, 1995 *a*). The significant effect of soil temperature on the multiplication rate showed that this factor affected strongly the biology of this species; it might explain the nematode's absence in *i)* the vegetable crops of the peanut cropping area under irrigation during the dry season where soil temperatures are lower (Baujard & Martiny, 1995 *a*), and in *ii)* the centre and east of the sahelian zone of West Africa where soil temperatures are higher than those recorded in Senegal (Sharma *et al.*, 1992). Presence of this species more to the south of this area in Nigeria, Cameroun, Congo (Sher, 1964, Elmiligy, 1970, Sakwe & Geraert, 1991), where soil temperatures are below 30°C indicates that the nematodes' development cycle was achieved at relatively low soil temperatures, probably over a longer period related to the absence of a dry season and/or soil drying.

The significant effect of soil moisture on the multiplication rate confirmed the results of surveys conducted in the peanut cropping area of Senegal and might explain the increase of population densities from the North to the South, an increase correlated with amount of rainfall (Baujard & Martiny, 1995 *c*). The rainfall might affect the reproduction of the nematode, on one hand directly by the soil moisture level, on the other hand indirectly by the duration of nematode activity in the rhizosphere : the duration of the rainy season increases with amount of rainfall from the north to the south (Leroux, 1980). The near disappearance of *S. cavenessi* in Mauritania, at the northern edge of the peanut cropping area of Senegal, might therefore be related to low soil moisture and a very short rainy season (Baujard & Martiny, 1995 *b*).

The host plant significantly affected the multiplication rate of the nematode, as previously observed in the field for the different pluvial crops (Duncan, 1985; Baujard & Martiny, 1995 *c*) : peanut is a moderate host for the nematode. The plant on which the nematode achieved its previous cycle also significantly affected the multiplication rate, a phenomenon previously known for *Criconemella ornata* (Barker, 1974).

Experiments showed that anhydrobiosis and duration of the anhydrobiotic state affected the reproductive capacity and the motility of *S. cavenessi.* Physiological effects of anhydrobiosis until now have been little studied : Glazer and Orion (1983) showed that anhydrobiosis significantly affected the penetration of *Pratylenchus thornei* into roots of *Vicia sativa.* These effects should be taken into consideration for population dynamics studies during the dry season and evaluation of survival rates; they might explain the evolution of field population densities of *S. cavenessi* (Baujard & Martiny, 1995 *c*).

Studies on the pathogenicity of *S. cavenessi* to the four main pluvial crops of the sahelian zone showed that this species did not induce any effect at the inoculum levels tested although a pathogenic effect has been previously recorded on peanut (Germani, 1981 *b*); three experimental factors differed between these two studies : *i)* a lower inoculum level : 300-9000 *vs* 10 000 nematodes per plant, *ii)* non-infection *vs* infection of roots with *Rhizobium, iii)* inoculation of a pure population of *S. cavenessi vs* a plurispecific population of *S. cavenessi, Hoplolaimus* sp., *Helicotylenchus* sp., and *Aorolaimus* sp. The pathogenicity of *S. cavenessi* to pluvial crops, especially to peanut, thus appeared doubtful since : *i)* field observations showed that high initial densities of *S. cavenessi* were associated with high yields of peanut (Baujard & Martiny, 1995 *c*), *ii)* field studies have shown that nematicides used in this area have a stimulant effect on leguminous crops (Duncan & Baujard, 1986, Baujard *et al.*, 1987, 1989, 1990; Sarr *et al.*, 1989) *iii)* other plant-parasitic nematodes frequently present in these soils have pathogenic effects on these crops (Baujard & Martiny, 1991, 1993, 1994; Baujard *et al.*, 1993).

References

BARKER, K. R. (1974). Influence of geographic area and previous crop on occurrence and density of plant-parasitic nematodes in North Carolina. *Pl. Dis. Reptr,* 11 : 991-995.

BAUJARD, P. (1995). Laboratory methods used for the study of the ecology and pathogenicity of Tylenchida, Longidoridae and Trichodoridae from rainy and semi-arid tropics of West Africa. *Fundam. appl. Nematol.,* 18 : 63-66.

BAUJARD, P., CHABRIER, C., MARTINY, B., MEUNIER, L., PARISELLE, A. & SARR, E. (1989). Comparaison de sept nématicides et étude du profil d'utilisation du dibromochloropropane pour la culture de l'arachide dans la zone Sahélienne du Sénégal. *Revue Nématol.,* 12 : 293-299.

BAUJARD, P., DUNCAN, L. W., PARISELLE, A. & SARR, E. (1987). Étude des effets de quatre nématicides fumigants sur les nématodes et l'arachide au Sénégal. *Revue Nématol.,* 10 : 355-360.

BAUJARD, P. & MARTINY, B. (1991). Données nouvelles sur le nématode *Tylenchorhynchus germanii* (Germani & Luc, 1984) Fortuner & Luc, 19987 (Nemata : Belonolaimidae). II. Études au laboratoire. *Afro-Asian J. Nematol.,* 1 : 135-142.

BAUJARD, P. & MARTINY, B. (1993). Ecology and pathogenicity of *Paralongidorus duncani* (nemata : Longidoridae) from Senegal, West Africa. *Afro-Asian J. Nematol.,* 3 : 177-181.

BAUJARD, P. & MARTINY, B. (1994). Ecology and pathogenicity of *Paratylenchus pernoxius* (Nemata : Tylenchulidae) from Senegal West Africa. *Afro-Asian J. Nematol.,* 4 : 7-10.

BAUJARD, P. & MARTINY, B. (1995 *a*). Characteristics of the soil nematode populations from the peanut cropping area of Senegal, West Africa. *J. afr. Zool.,* 109 : 51-69.

BAUJARD, P. & MARTINY, B. (1995 *b*). Nematodes associated with *Pennisetum glaucum* in arid regions of Mauritania and Niger, West Africa. *J. afr. Zool.,* 109 (in press).

BAUJARD, P. & MARTINY, B. (1995 *c*). Ecology and pathogenicity of the Hoplolaimidae from the sahelian zone of West Africa. 1. Field studies on *Scutellonema cavenessi* Sher, 1964. *Fundam. appl. Nematol.,* 18 : 261-269.

BAUJARD, P., MARTINY, B., JACOB, Y. & FERRET, R. (1990). Phytostimulation de l'arachide par un nématicide fumigant, le dibromochloropropane (DBCP). *C.2. 2e Réun. rég. ICRISAT Arachide Afr. Ouest, 10-Niamey, Niger, 10-14 sept.* 1990:46 [Abstr.].

BAUJARD, P., MARTINY, B. & TRAORE, A. (1993). Ecology and pathogenicity of the nematode *Paralongidorus bullatus* (Nemata : Longidoridae) in semi-arid tropics of West Africa. *Nematropica,* 23 : 149-157.

CAVENESS, F. E. & JENSEN, H. J. (1955). Modification of the centrifugal-flotation technique for the isolation and concentration of nematodes and their eggs from soil and plant tissue. *Proc. helminth. Soc. Wash.,* 22 : 87-89.

DEMEURE, Y., NETSCHER, C. & QUÉNÉHERVÉ, P. (1980). Biology of the plant-parasitic nematode *Scutellonema cavenessi* Sher, 1964 : reproduction, development and life cycle. *Revue Nématol.,* 3 : 213-225.

DUNCAN, L. W. (1985). Quantitative host-parasite relationships in a dry land farming region of Senegal. *J. Nematol.,* 17 : 519 [Abstr].

DUNCAN, L. W. & BAUJARD, P. (1986). Influence of nematicide placement depth and time of application on treatment efficacy in the Sahelian zone of Senegal. *Revue Nématol.,* 9 : 135-139.

ELMILIGY, I. A. (1970). On some Hoplolaiminae from Congo and Egypt. *Meded. Rijksuniv. Gent,* 35 : 1141-1153.

GERMANI, G. (1981 *a*). Evolution annuelle de l'aptitude à la reproduction chez le nématode *Scutellonema cavenessi. Revue Nématol.,* 4 : 183-189.

GERMANI, G. (1981 *b*). Pathogenicity of the nematode *Scutellonema cavenessi* on peanut and soybean. *Revue Nématol.,* 4 : 203-208.

GERMANI, G., BAUJARD, P. & LUC, M. (1985). *Control of phytoparasitic nematodes in the Bassin Arachidier of Senegal.* ORSTOM, Dakar, 16 p.

GLAZER, I. & ORION, D. (1983). Studies on anhydrobiosis of *Pratylenchus thornei. J. Nematol.,* 15 : 333-338.

LEROUX, M. (1980). Climat. *In : Atlas du Sénégal.* Paris, Éditions jeune Afrique ; 12-17.

SAKWE, P. N. & GERAERT, E. (1991). Some plant parasitic nematodes from Cameroon with a description of *Criconemella pelerentsi* sp. n. (Tylenchida : Criconematidae). *Nematologica,* 37 : 263-274.

SARR, E., BAUJARD, P. & MARTINY, B. (1989). Études sur les nématodes, les nématicides et le niébé *(Vigna unguiculata)* dans la zone sahélienne du Sénégal. 2. Résultats des expérimentations au laboratoire. *Revue Nématol.,* 12 : 365-268.

SHARMA, S. B., WALIYAR, F., SUBRAHMANYAM, P. & NDUNGURU, B. J. (1992). Role of *Scutellonema clathricaudatum* in etiology of groundnut growth variability in Niger. *Pl. & Soil,* 143 : 133-139.

SHER, S. A. (1964). Revision of the Hoplolaiminae (Nematoda). III. *Scutellonema* Andrássy, 1958. *Nematologica,* 9 (1963) : 421-443.