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Ecology and pathogenicity of the Hoplolaimidae (Nemata) from the sahelian zone of West Africa. 3. *Scutellonema clathricaudatum* Whitehead, 1959

Pierre BAUJARD* and Bernard MARTINY

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

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Summary – The distribution of *Scutellonema clathricaudatum* in West Africa, the biotic and abiotic factors affecting its multiplication rate and its pathogenicity to peanut and millet are studied. This species appeared to be adapted to the climatic conditions of both semi-arid and rainy tropics of West Africa. No pathogenic effects of the nematode were recorded on peanut and millet. Since males have occurred during the laboratory experiments and " vaginal glands " (in fact the constrictor muscle of the vagina) are present in this species, the taxonomic relationships between three closely related species, *Scutellonema bradys, S. cavenessi* and *S. clathricaudatum,* need to be re-examined.

Résumé – ***Écologie et nocuité des Hoplolaimidae (Nemata) de la zone sahélienne d'Afrique de l'Ouest. 3.* Scutellonema clathricaudatum *Whitehead, 1959*** – La répartition géographique, les facteurs biotiques et abiotiques affectant le taux de multiplication et la nocuité de *Scutellonema clathricaudatum* sont étudiés. Cette espèce apparaît bien adaptée aux conditions écologiques tant des zones semi-arides que des zones humides d'Afrique de l'Ouest. Aucun effet pathogène du nématode sur l'arachide et le mil n'a été mis en évidence. Des mâles étant apparus au cours des expérimentations de laboratoire et les « glandes vaginales » (en réalité le muscle constricteur du vagin) étant présentes chez cette espèce, les relations taxonomiques entre trois espèces très proches, *Scutellonema bradys, S. cavenessi* et *S. clathricaudatum,* devraient être réexaminées.

Key-words : *Scutellonema clathricaudatum,* West Africa, distribution, multiplication rate, soil temperature, soil moisture, host-plants, pathogenicity, taxonomic relationships.

Two species of the genus *Scutellonema, S. cavenessi* Sher, 1964 and *S. clathricaudatum* Whitehead, 1959, considered as serious pests of peanut in Senegal (Germani *et al.*, 1985) and Niger (Sharma *et al.,* 1992) respectively, have been identified during the course of studies on ecology of soil nematodes from the sahelian zone of West Africa (Baujard & Martiny, 1994 *a, b;* 1995 *a, c*). *S. clathricaudatum* is widely distributed in Africa, Tanzania (Whitehead, 1959), Congo and Central African Republic (Luc *et al.,* 1964), Zaire (Ali *et al.,* 1973), South Africa (Van den Berg & Heyns, 1973 = *S. aberrans*) and especially in West Africa : Mali (Baujard & Martiny, 1994 *b*), Burkina Faso (Sharma, 1990), Niger (Sharma *et al.,* 1988, 1990, 1992; Sharma, 1990), Sierra Leone (Vovlas *et al.,* 1991), Ivory Coast (Malcevschi, 1978), Nigeria (Sher, 1964), Benin (Sharma, 1990) and Cameroon (Sakwe & Geraert, 1991, 1992). Data originating from surveys conducted by the first author in Mali, from slides deposited in the collection of the Muséum National d'Histoire Naturelle, Paris, France and from literature showed that *S. clathricaudatum* is widely distributed below the latitude 15 ° N from South-East of Mali up to the centre of Niger; it is absent from Senegal and the West of Mali (Fig. 1).

Previous work has shown the complicated biology of *S. cavenessi* (Baujard & Martiny, 1995 *c, d*), and the geographical distribution, ecology and pathogenicity of *S. clathricaudatum* have been studied.

MATERIAL AND METHODS

Unless otherwise stated, nematode extractions, nematode cultures and laboratory experiments were conducted as previously indicated; the same 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] and cowpea [*Vigna unguiculata* (L.) Walp. cv. N58 57]) were used in all experiments (Baujard, 1995).

ORIGIN OF NEMATODES AND STOCK CULTURES

Nematodes used for stock cultures and laboratory experiments were collected from peanut fields, Souroun-touna, Mali in October 1986 (Baujard & Martiny, 1994 *b*). Nematodes were cultured in the laboratory on millet at constant soil temperature (34 °C) and soil

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

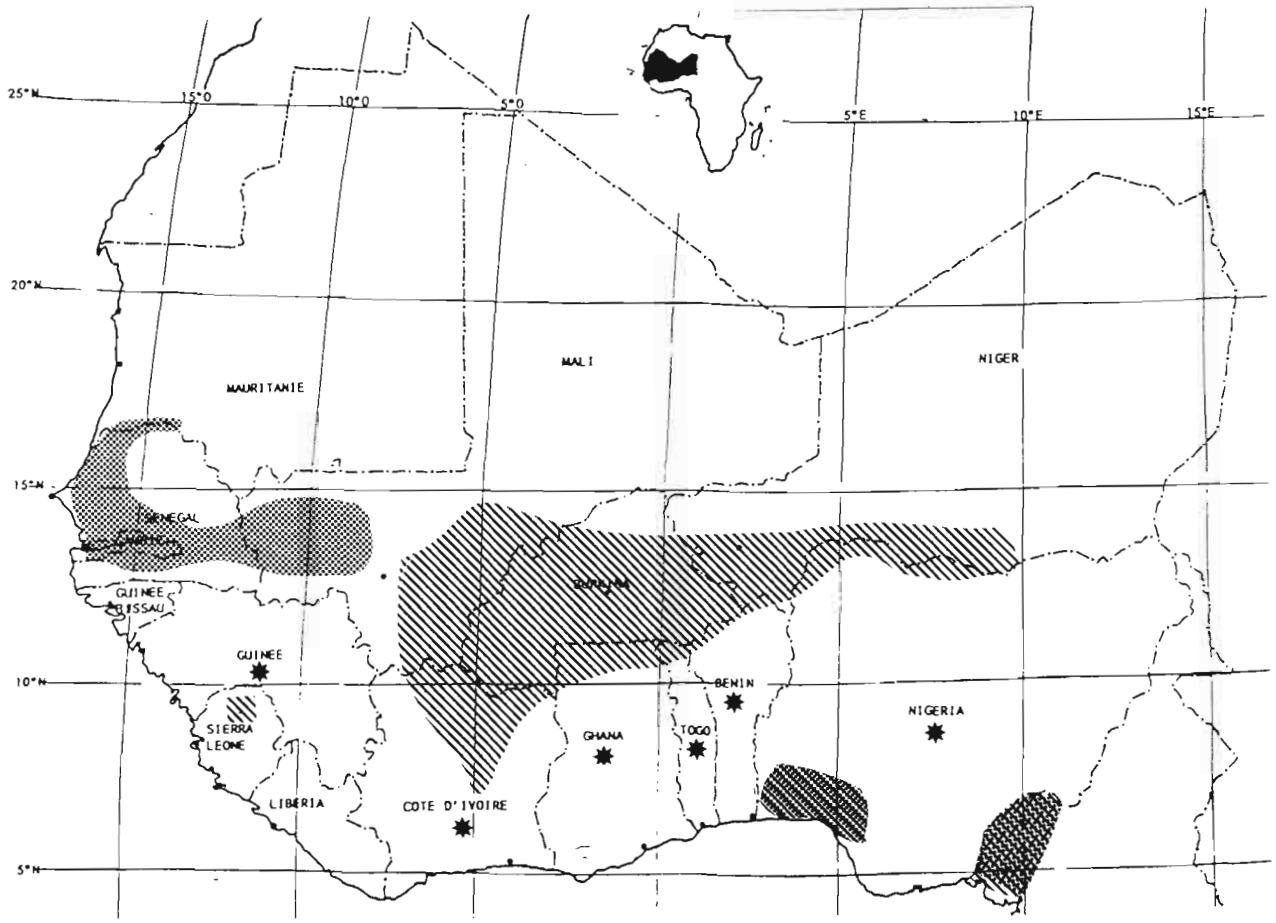

Fig. 1. *Known geographical distribution of* Scutellonema bradys, S. cavenessi *and* S. clathricaudatum *in West Africa (*S. cavenessi : *stipped area;* S. clathricaudatum : *hatched area; stars = countries where* S. bradys *was recorded in association with yams).*

moisture (10 %) in a growth chamber from October 1986 until January 1990; after this date, they were cultured under constant soil temperature (36 °C) and soil moisture (7 %) on millet.

Another population collected in September 1990 from the ICRISAT station at Bengou, Niger, in fields under fallow, peanut and sorghum was cultured at the laboratory under constant soil temperature (36 °C) and soil moisture (7%) on millet.

Soil temperature

Seventeen hand-picked nematodes (mixture of all stages) originating from a 100-day-old stock culture on millet were inoculated onto millet under constant soil moisture (10 %) and exposed to four constant soil temperature levels (30, 32, 34 or 36 °C) with seven replications per treatment for 75 days in a growth chamber.

Soil moisture

Ten hand-picked nematodes (mixture of all stages) originating from a 100 day-old stock culture on millet were inoculated onto millet under constant soil temperature (36 °C) and exposed to four constant soil moisture levels (5, 7, 9 or 11 %) with seven replications per treatment for 60 days in a growth chamber.

Host plant and soil drying

87 ± 10 nematodes (mixture of all stages) originating from a 100-day-old stock culture on millet were inoculated onto peanut, millet, sorghum or cowpea under constant soil temperature (36 °C) and soil moisture (10 %) with twenty replications per treatment in a greenhouse. After 60 days, ten replications were extracted for nematode counting and watering was stopped for the other ten replications. After an additionnal 60 days, these ten replications were extracted for evaluation of the survival rate.

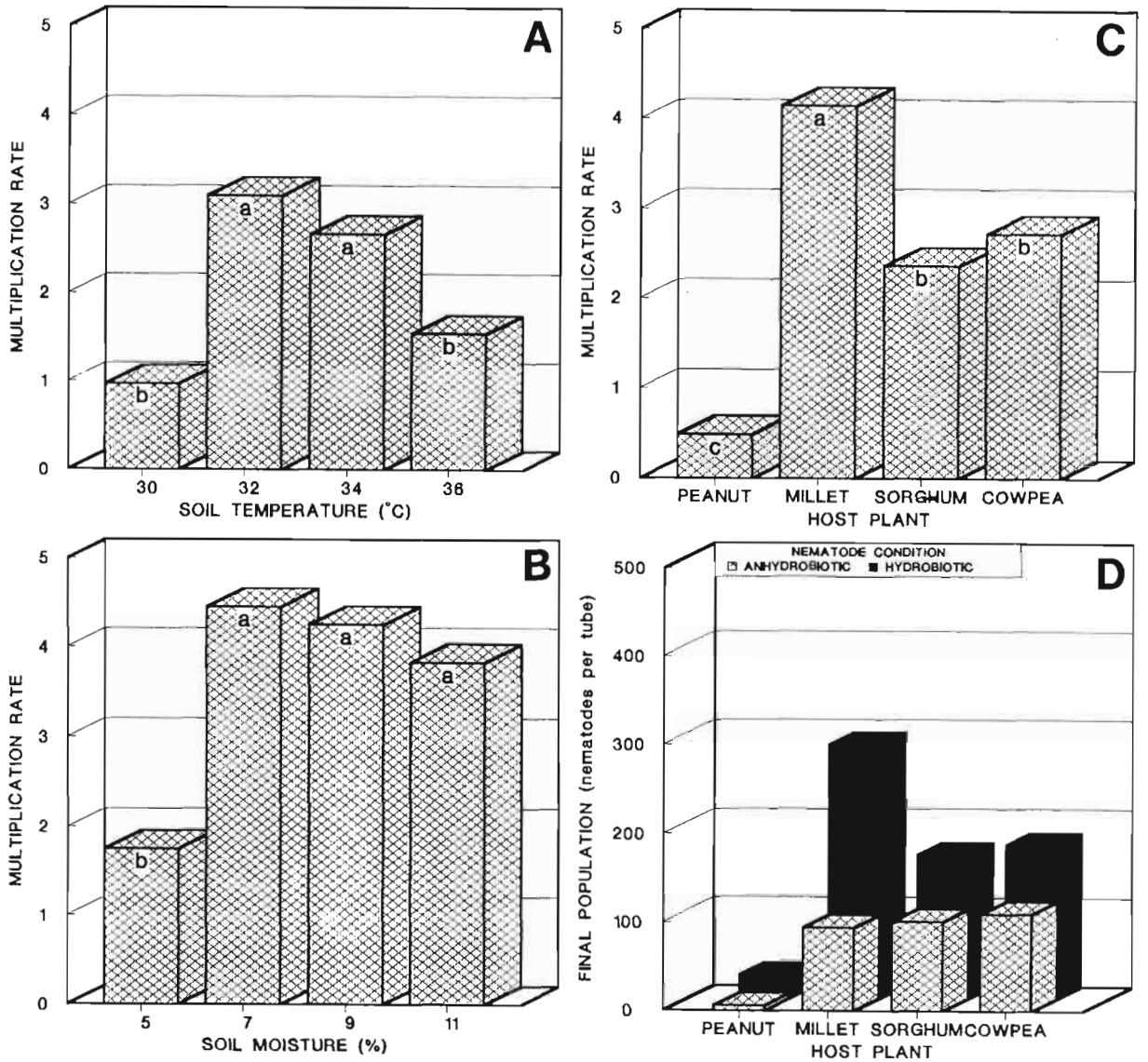

Fig. 2. *Effects of soil temperature (A), soil moisture (B) and host-plants (C, D) on multiplication rate of* Scutellonema clathricaudatum *and survival of the nematode after soil drying in relation to host-plant.* (Data followed by the same letter are not significantly different at $P < 0.05$).

CULTURE DURATION

Thirty hand-picked nematodes (mixture of all stages) originating from a 90-day-old stock culture on millet at constant soil temperature (36 °C) and soil moisture (10 %) were inoculated onto millet at constant soil temperature (36 °C) and soil moisture (7 %) for three different periods (60, 75 or 100 days) with seven replications per treatment in a growth chamber. At the end of each culture period, nematodes were extracted, counted, and maintained on the same plants under the same conditions (inoculum level, host-plant, soil temperature and moisture, periods). This was done three times for the treatment " 60 days " and twice for the treatments " 75 " and " 100 days ". In addition, nematodes originating from the " 75 days " treatment were reinoculated and maintained under the same experimental conditions for a culture period of 60 days; those originating from the " 100 days " treatment were reinoculated for a period of 60 or 75 days in order to evaluate the effect of the duration of the previous culture on the multiplication rate.

PATHOGENECITY ON PEANUT

The multiplication rate and the effects on peanut of 420 ± 50 or 840 ± 100 nematodes originating from a

120-day-old stock culture on millet at constant soil temperature (36 °C) and moisture (7 %) were compared to control plants without nematodes at constant soil temperature (36 °C) and moisture (7 %) for 40 days in a greenhouse.

Pathogenicity on millet

The multiplication rate and the effects on millet of 550 ± 40 nematodes originating from a 100-day-old stock culture on millet at constant soil temperature (36 °C) and moisture (7 %) were compared to control plants without nematodes at constant soil temperature (36 °C) and moisture (7 %) for 100 days in a growth chamber.

Results

Observations made on stock cultures

From October 1986 to January 1990, multiplication rates varied from 0.11 to 11 ($\bar{x}$ = 2.85 ± 3; n = 29); no males were observed. After January 1990, multiplication rates varied from 1 to 28 ($\bar{x}$ = 7.5 ± 5.7; n = 35); males began progressively to occur, up to 30 % of the cultures, representing 0.01-0.07 % of the total population. For the population originating from Niger, multiplication rates varied from 1 to 10; males occurred erratically, and in low numbers.

Multiplication rate

Soil temperature and soil moisture did not significantly affect ($P < 0.05$) multiplication rates (Fig. 2 A). The rate of multiplication observed during the experiment on soil temperature was higher than that observed during the experiment on soil moisture (Fig. 2 B). This observation could be related to the length of the two experiments (75 *vs* 60 days). Host-plant significantly affected the multiplication rate on all the plants tested that allowed reproduction (Fig. 2 C). Increases in culture duration from 60 to 100 days caused an increase in the multiplication from 2.33 to 4.41 for the treatments 100 days (Fig. 4 A), the daily multiplication rate for the treatments 60, 75 and 100 days being stable : 0.038, 0.027 and 0.044 respectively. The length of the previous culture had no effect on the multiplication rates of the nematode under the following culture (Fig. 4 B).

Densities of *S. clathricaudatum* in the roots varied from 9 to 44 % of the total population and were not directly affected by the differents treatments (Table 1).

Observations on the occurrence of males in the experiments showed a tendency toward an increase in the abundance of males from 0 to 61 % of the total population, and in their frequency of occurrence from 0 up to 100 % (Tables 2, 3).

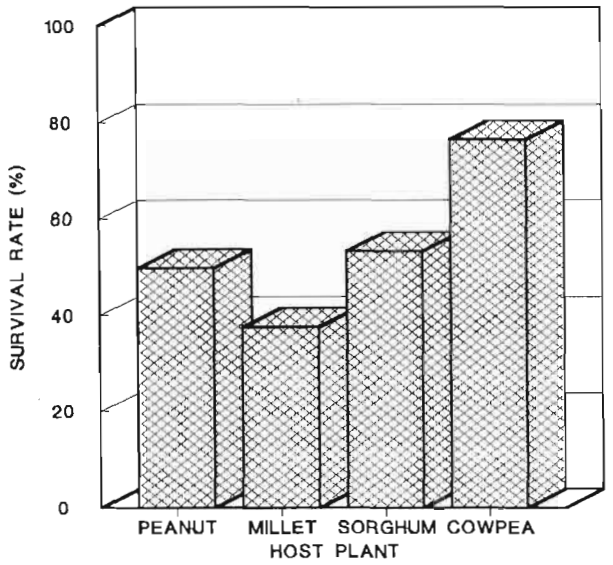

Fig. 3. *Survival rates of* Scutellonema clathricaudatum *after soil drying in relation to host-plant.*

Survival rate after soil drying

The cessation of watering caused a decrease in soil moisture down to 0.2 % in 15 days. Nematode extraction 45 days later revealed the presence of adults and 3rd and 4th stage juveniles. The mean survival rate was about 50 %, varying with host plants (Figs 2 D, 3).

Pathogenicity on peanut and millet

The nematode did not have a significant effect on the growth of peanut or millet (Table 4).

Discussion

S. clathricaudatum appeared to be adapted to climatic conditions of both semi-arid and rainy tropics. It is a polyphagous species able to reproduce at medium to high soil temperature (30-36 °C) levels. Soil moisture did not appear to have a significant effect on multiplication rate. The nematode was able to enter a state of anhydrobiosis during drought periods. Pathogenicity to peanut and millet appeared doubtful since the inoculum levels tested corresponded with soil populations of 200-1200 nematodes per dm^3 of soil in Niger (Sharma, 1990; Sharma *et al.*, 1988, 1990).

When compared with *S. cavenessi* (Baujard & Martiny, 1995 *c, d*), some differences and resemblances in their characteristics appear. *S. cavenessi* is localized in the West of the sahelian zone of West Africa whereas *S. clathricaudatum* is localized in the centre and the East of this area; further South, the two species appeared in the same areas (Fig. 1). Soil temperature and soil moisture have a significant effect on the multiplication rate of *S. cavenessi* which was higher than that of *S. clathricauda-*

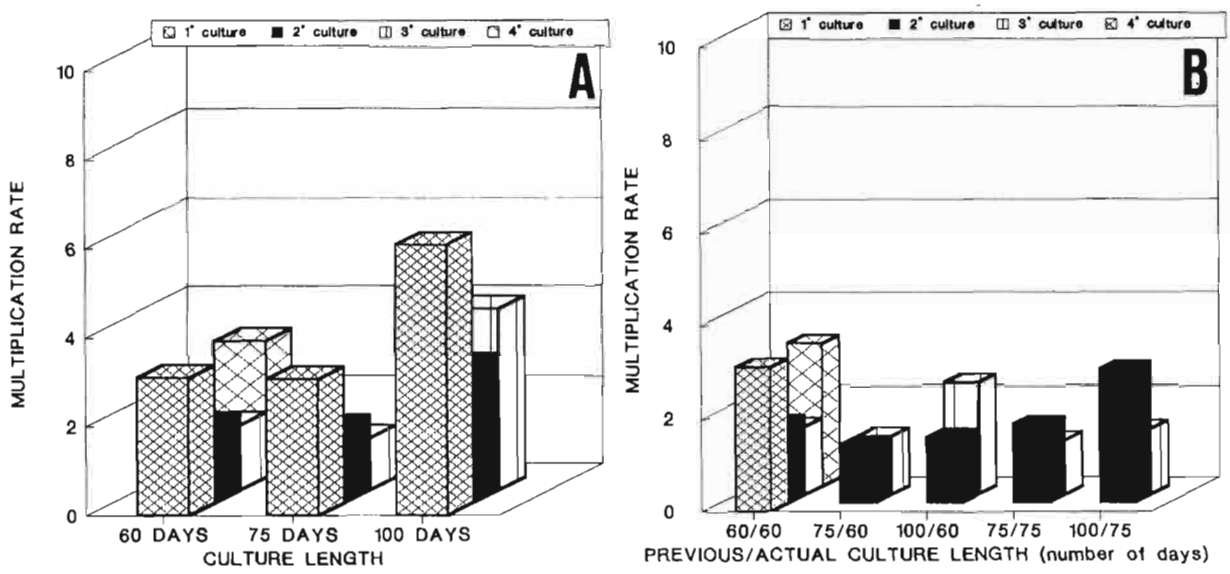

Fig. 4. *Effect of culture duration (A) and of previous culture duration (B) on multiplication rate of* Scutellonema clathricaudatum.

Table 1. *Percentages of the populations of* Scutellonema clathricaudatum *in the roots at the end of the different experimentations.*

Experiment and treatments	Root population as a % of total tube population
Soil temperature	
30 °C	29
32 °C	12
34 °C	9
36 °C	12
Soil moisture	
5 %	15
7 %	27
9 %	22
11 %	18
Host plants	
peanut	44
millet	25
sorghum	9
cowpea	39
Culture duration	
60/60 days	28
75/75 days	13
100/100 days	12
Pathogenicity	
peanut	
*420 nematodes	24
*840 nematodes	11
millet	
*550 nematodes	19

* inoculum per tube.

Table 2. *Abundance (in % of the total population per treatment) and frequency (in % of replication of each treatment) of occurrence of males of* Scutellonema clathricaudatum *in the soil temperature and soil moisture experiments.*

Experiment and treatments	Abundance-Frequency of males
Soil temperature	
30 °C	0
32 °C	0
34 °C	0
36 °C	0
Soil moisture	
5 %	6-43
7 %	6-14
9 %	0
11 %	17-43
Host plants	ND

* inoculum per tube.

tum (1-15 *vs* 1-5 respectively) under laboratory conditions. Both species exhibited the same host range, the same mean survival rate of 50 % after soil desiccation and the same reaction to culture duration.

S. cavenessi and *S. clathricaudatum* are morphologically closely related species differing only by two characters : presence/absence of males and presence/absence of spermatheca (Germani *et al.*, 1986). A third species, *S. bradys* (Steiner & LeHew, 1933) Andrássy, 1958 belongs to this group and is characterized by *i)* presence of males, *ii)* presence of spermatheca, *iii)* presence of vagi-

Table 3. *Abundance (in % of the total population per treatment) and frequency (in % of replication of each treatment) of occurrence of males of* Scutellonema clathricaudatum *in the culture duration experiment (ND : non determined).*

Treatments	Abundance-Frequency of males			
	1st cycle	2nd cycle	3rd cycle	4th cycle
60/60 days	0	8-14	45-100	13-43
75/60 days	–	8-43	ND	–
100/60 days	–	12-29	51-86	–
75/75 days	3-43	6-43	ND	–
100/75 days	–	10-57	10-57	–
100/100 days	5-43	45-57	61-86	–

* inoculum per tube.

Table 4. *Multiplication rate and effects of* Scutellonema clathricaudatum *on peanut and millet (numbers followed by the same letter are not significantly different at* $P < 0.05$*).*

Plant	Inoculum	Multiplication rate	Fresh weight (g)		Dry weight (g)
			Roots	Shoots	Shoots
Peanut	0	–	1.68 *a*	5.06 *a*	0.97 *a*
	420	0.88	1.77 *a*	5.66 *a*	1.08 *a*
	840	0.81	1.77 *a*	5.36 *a*	0.99 *a*
Millet	0	–	1.03 *a*	1.03 *a*	0.26 *a*
	550	5.78	1.34 *a*	1.48 *a*	0.36 *a*

Table 5. *Characters distinguishing* Scutellonema bradys, S. cavenessi *and* S. clathricaudatum *(+ = presence; – = absence; in brackets : previous situation).*

Characters	*S. bradys*	*S. cavenessi*	*S. clathricaudatum*
Spermatheca	(+) +	(+) +	(–) –/+
Males	(+) +	(+) +	(–) –/+
" Vaginal glandes " (constrictor muscles)	(+) +	(–) +	(–) +

nal glands around vagina (Germani *et al.*, 1986); this species showed the same geographical distribution in the south of West Africa (Fig. 1). No other morphological or biometrical differences were reported between the three species (Germani *et al.*, 1986). Vaginal glands are reported by Whitehead, 1959 *b* in *S. aberrans* (now *S. clathricaudatum*, see Germani *et al.*, 1986) by Van den Berg and Heyns (1973); Mounport *et al.* (1991) showed that vaginal glands are in fact constrictor muscles present in the three species (TEM studies conducted on the same populations of *S. cavenessi* and *S. clathricaudatum* as in the present work). It has been noted (Whitehead, 1959 *a*; Sher, 1964; Van den Berg & Heyns, 1973; Vovlas *et al.*, 1991) that no spermatheca occurred in *S. clathricaudatum* whereas Sakwe and Geraert (1992) observed the presence of a " spermatheca empty and collapsed ". Study of a population originating from the rhizosphere of *Vigna sinensis* in the Ondo Province of Nigeria identified by Sher (1964) as *S. aberrans* revealed the presence of an empty spermatheca in all the females (n = 5). Occurrence of males during the culture process of *S. clathricaudatum* in the laboratory makes the taxonomical situation more confused (Table 4).

Study of *i)* the biology of *S. bradys* under the same conditions as for the two other species, *ii)* the sexual behaviour of the three species, *iii)* the biochemical and molecular characteristics of the three species might give new information on the relationships between what we call the "*S. bradys* complex ".

References

Ali, S. S., Geraert, E. & Coomans, A. (1973). Some spiral nematodes from Africa. *Biol. Jaarb., Dodonaea,* 41 : 53-70.

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. & Martiny, B. (1994 *a*). Études nématologiques au Mali, Afrique de l'Ouest. I. Prospections de deux zones arachidières sur l'arachide et le mil. *J. afr. Zool.,* 108 : 217-226.

Baujard, P. & Martiny, B. (1994 *b*). Études nématologiques au Mali, Afrique de l'Ouest. II. Effets des traitements nématicides sur l'arachide et le mil. *J. afr. Zool.,* 108 : 329-334.

Baujard, P. & Martiny, B. (1995 *a*). Études nématologiques en Mauritanie et au Niger, Afrique de l'Ouest : nématodes associés au mil sauvage *(Pennisetum violaceum). J. afr. Zool.,* 109 : (in press).

Baujard, P. & Martiny, B. (1995 *b*). 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 *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. (1995 *d*). Ecology and pathogenicity of the Hoplolaimidae from the sahelian zone of West Africa. 2. Laboratory studies on *Scutellonema cavenessi* Sher, 1964. *Fundam. appl. Nematol.,* 18 : 335-345.

Germani, G., Baujard, P. & Luc, M. (1985). *Control of phytoparasitic nematodes in the Bassin Arachidier of Senegal.* Dakar, Sénégal, ORSTOM, 16 p.

Germani, G., Baldwin, J. G., Bell, A. H. & Wu, X. Y. (1986). Revision of the genus *Scutellonema* Andrássy, 1958 (Nematoda : Tylenchida). *Revue Nématol.,* 8 (1985) : 289-320.

LUC, M., MERNY, G. & NETSCHER, C. (1964). Enquête sur les nématodes parasites des cultures de la République Centre-Africaine et du Congo-Brazzaville. *Agron. trop., Nogent,* 19 : 723-746.

MALCEVSCHI, S. (1978). Considérations quantitatives sur la nématofaune d'une savane herbeuse à Andropogonées de Lamto (Côte d'Ivoire). *Revue Ecol. Biol. Sol,* 15 : 487-496.

MOUNPORT, D., BAUJARD, P. & MARTINY, B. (1991). Ultrastructure de la cuticule et de la région vaginale de *Scutellonema bradys, S. cavenessi* et *S. clathricaudatum* (Nemata : Hoplolaimidae). *Revue Nématol.,* 14 : 261-275.

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.

SAKWE, P. N. & GERAERT, E. (1992). Plant parasitic nematodes from Cameroon : Belonolaimidae, Criconematidae and Hoplolaimidae (Nematoda : Tylenchida). *Meded. Fac. Landbouww. Univ. Gent,* 57 : 857-877.

SHARMA, S. B. (1990). Further investigations on the role of plant parasitic nematodes in crop growth variability of groundnut in Niger. *Legumes Pathol. Progr. Rep., ICRISAT, India,* 8 : 61 p.

SHARMA, S. B., SUBRAHMANYAM, P. & SARR, E. (1990). Plant parasitic nematodes associated with groundnut in Niger. *Trop. Pest Manag.,* 36 : 71-72.

SHARMA, S. B., SUBRAHMANYAM, P., SARR, E. & VAN RIEL, H. (1988). Plant parasitic nematodes associated with groundnut at Sadoré in Niger. *Int. Arachis Newsl.,* 4 : 10-11.

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.

VAN DEN BERG, E. & HEYNS, J. (1973). South African Hoplolaiminae. 2. The genus *Scutellonema* Andrássy, 1958. *Phytophylactica,* 5 : 23-39.

VOVLAS, N., TROCCOLI, A. & LAMBERTI, F. (1991). Morpho-anatomical observations on *Aphasmatylenchus nigeriensis* and *Scutellonema clathricaudatum* from West-Africa. *Nematol. medit. :* 19 : 259-264.

WHITEHEAD, A. G. (1959 *a*). *Scutellonema clathricaudatum* n. sp. (Hoplolaiminae : Tylenchida), a suspected ectoparasite of the roots of the cotton plant (*Gossypium hirsutum* L. var. UK 51). *Nematologica,* 4 : 56-59.

WHITEHEAD, A. G. (1959 *b*). *Hoplolaimus aberrans* n. sp. (Hoplolaiminae : Tylenchida). *Nematologica,* 4 : 268-271.