Fundam. appl. Nematol., 1994, **17** (6), 543-550

Transport of nematodes by wind in the peanut cropping area of Senegal, West Africa

Pierre BAUJARD * and Bernard MARTINY

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

Accepted for publication 27 January 1994.

Summary – Studies were conducted on the transport of nematodes by the wind in the peanut cropping area of Senegal by trapping sand and dust in pots pushed into the soil. Amounts of sand and dust recovered were not related to either the geographical locality of the traps or to the crop grown during the previous rainy season; they increased from the beginning to the end of the dry season, probably in relation to the disruption of surface vegetation by cattle. Nematodes recovered were dominated by mycetophagous and bacteriophagous forms; dorylaims and plant parasitic tylenchs were always low in number. Numbers of nematodes recovered appeared to be related to the abundance of the soil nematode population around individual traps. Laboratory tests showed that nematodes transported by the wind maintained their reproduction potential despite mechanical, moisture and thermal stresses.

Résumé – ***Transport des nématodes par le vent dans le bassin arachidier du Sénégal, Afrique de l'Ouest*** – Des études ont été menées sur la dissémination éolienne des nématodes dans le bassin arachidier du Sénégal en piégeant le sable et les poussières dans des pots affleurant la surface du sol. Les quantités de sable et de poussières récupérées ne dépendent pas de la localisation géographique des sites d'étude ni de la culture en place pendant la saison des pluies précédente; elles augmentent régulièrement au cours de la saison sèche, probablement en relation avec la destruction du couvert végétal sec par le bétail. Les populations de nématodes sont caractérisées par l'abondance des nématodes mycophages et bactériophages. Les Dorylaimida et les nématodes phytoparasites de l'ordre des Tylenchida sont peu nombreux. L'abondance des nématodes piégés semble en relation avec les niveaux de population de nématodes dans le sol autour des pièges. Des tests de laboratoire montrent que ces nématodes transportés par le vent conservent leurs facultés biologiques de reproduction malgré les stress subis.

Key-words : Nemata, wind dissemination, reproductive ability, Senegal, West Africa.

Field observations (Krnjaic' & Krnjaic', 1973; Viglierchio & Schmitt, 1981) and experimental studies (Tobar & Gallardo, 1974) have demonstrated that nematodes are transported by wind. In semi-arid tropics of West Africa, the climate is characterized by the alternation of a short rainy season of three to five months with a long dry season of seven to nine months. Throughout the dry season, hot, dry winds originating from the Sahara desert blow, carrying fine sands and dusts (Leroux, 1980).

Field and laboratory studies were conducted in Senegal in order to evaluate *i)* the possibility of the dissemination of nematodes by wind and the recontamination of fields treated with DBCP for nematode control (Germani *et al.*, 1985), *ii)* the biological capacities of nematodes after this transport.

Material and methods

Two surveys were conducted in the peanut cropping area (Fig. 1) of Senegal : the first during the dry season 1984-1985 at six sites located from north to south of the area; the second during the dry season 1986-1987 on a field at Nebe, in the centre of the cropping area of Senegal (site 6 in Fig. 1) which was also used in a study of nematode population dynamics (Baujard & Martiny, in press).

PVC tubes were put vertically in the soil so that the top of pots pushed into the tube was at level with the soil surface. Black PVC pots (2000 cm^3 in the first survey and of 1000 cm^3 in the second survey) were used to collect dust and sand transported by the wind. Sand and dust were collected every 15 days commencing 15 days after the last rain of the rainy season.

In the first survey, one pot was used at each locality. Pots were placed in fields previously cropped with cowpea (*Vigna unguiculata* (L.) Walp. at Keur Boumi, peanut (*Arachis hypogea* L.) at Sagatta, Darou Mousty and Touba Gueye and millet (*Pennisetum typhoides* Rich.) at Thiamene and Nebe. In these last two sites, as the millet stalks were not removed at harvest, wind erosion was very low, and pots were moved in fields previously cropped with peanut at the fourth month of the survey.

* *Present address : Muséum National d'Histoire Naturelle, Laboratoire de Biologie Parasitaire, Protistologie, Helminthologie, 61, rue Buffon, 75231 Paris Cedex 05, France.*

ISSN 1164-5571/94/06 $ 4.00 /

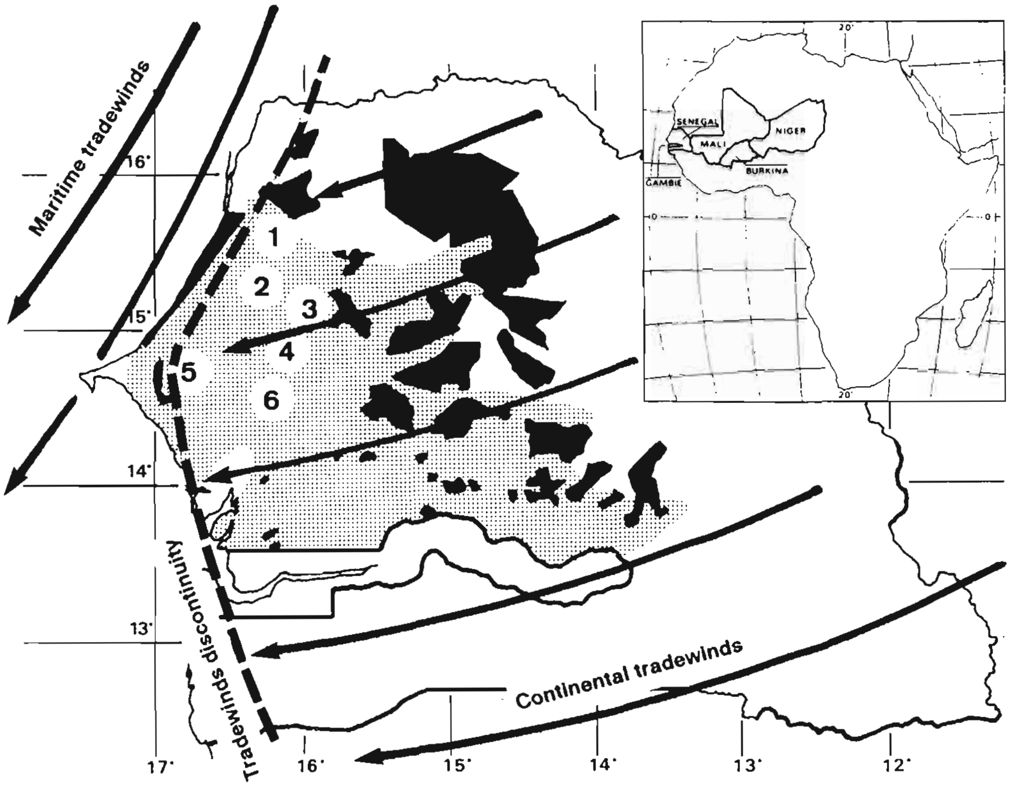

Fig. 1. *Study areas (black area = woodland; dotted area = peanut cropping area; arrows = wind direction; 1 – 6 = observation sites; 1 : Keur Boumi; 2 : Sagatta; 3 : Darou Mousty; 4 : Thiamene; 5 : Touba Gueye; 6 : Nebe).*

In the second survey, one pot was used in each of the six microplots used for five experimental cultural practices : peanut, millet, sorghum (*Sorghum vulgare* L.) and cowpea monocultures and permanent fallow (Baujard & Martiny, in press). Two periods of rainfall occured at the end of this second survey : the first of 17.5 mm between the 210th and the 225th day and the second of 2 mm between the 225th and the 255th day of the survey.

The volume of sand and dust were measured. Nematodes were extracted by elutriation (Seinhorst, 1962). In the second survey, after nematode counting, all the samples were mixed and nematodes inoculated into a pot planted with millet and subsequently kept at constant soil temperature (34 °C) and moisture (7 %) for 75 days in a growth chamber. At this time, nematodes were extracted and counted to evaluate the final population and their reproductive activity (Pf/Pi).

Wind transported sand and dust were directly observed under a microscope to recover nematodes for scanning electron microscopy; nematodes were hand-picked, mounted on the stub and coated with gold before observation.

Results

Volumes of sand and dust recovered increased regularly from the beginning to the end of the dry season during the first survey (Fig. 2); no variation occurred according to the geographical locality of the sites (Table 1). During the second survey, volumes remained low and increased sharply at the end of the survey (Fig. 4). During the first survey it was observed that the presence of crop residues (essentially stalks) constituted an obstacle to sand transport by the wind; the same effect occurred during the second survey with the microplots under fallow having mean sand volume less than half that in other microplots without plant residues (Table 1).

Total numbers of nematodes recovered varied erratically during the dry season (Figs 2, 3). No relation with the geographical location of the sites can be noted (Table 1). Mean nematode numbers recovered in the pots were higher on microplots under fallow and millet than in others (Table 1); these numbers varied according to the size of the total soil nematodes population for the different cultural practices (Baujard & Martiny, in press). Eleven nematode species belonging to the Ty-

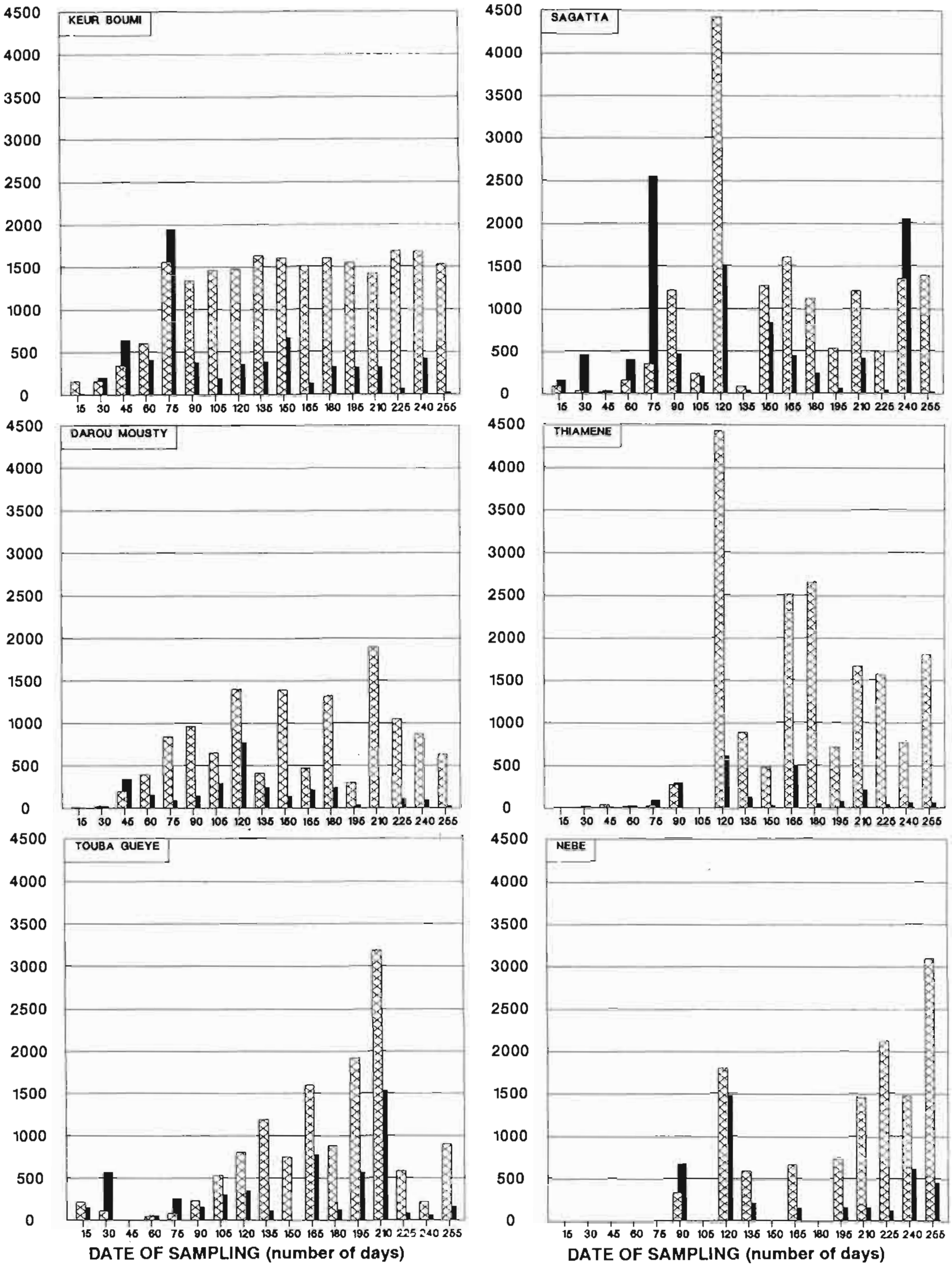

Fig. 2. *Amounts of sand and dust collected and total nematode numbers recovered at six different locations in the peanut cropping area of Senegal (for each date of collection : volumes, in cm³, of sand and dust recovered [crossed column] and numbers of nematodes recovered [black column]).*

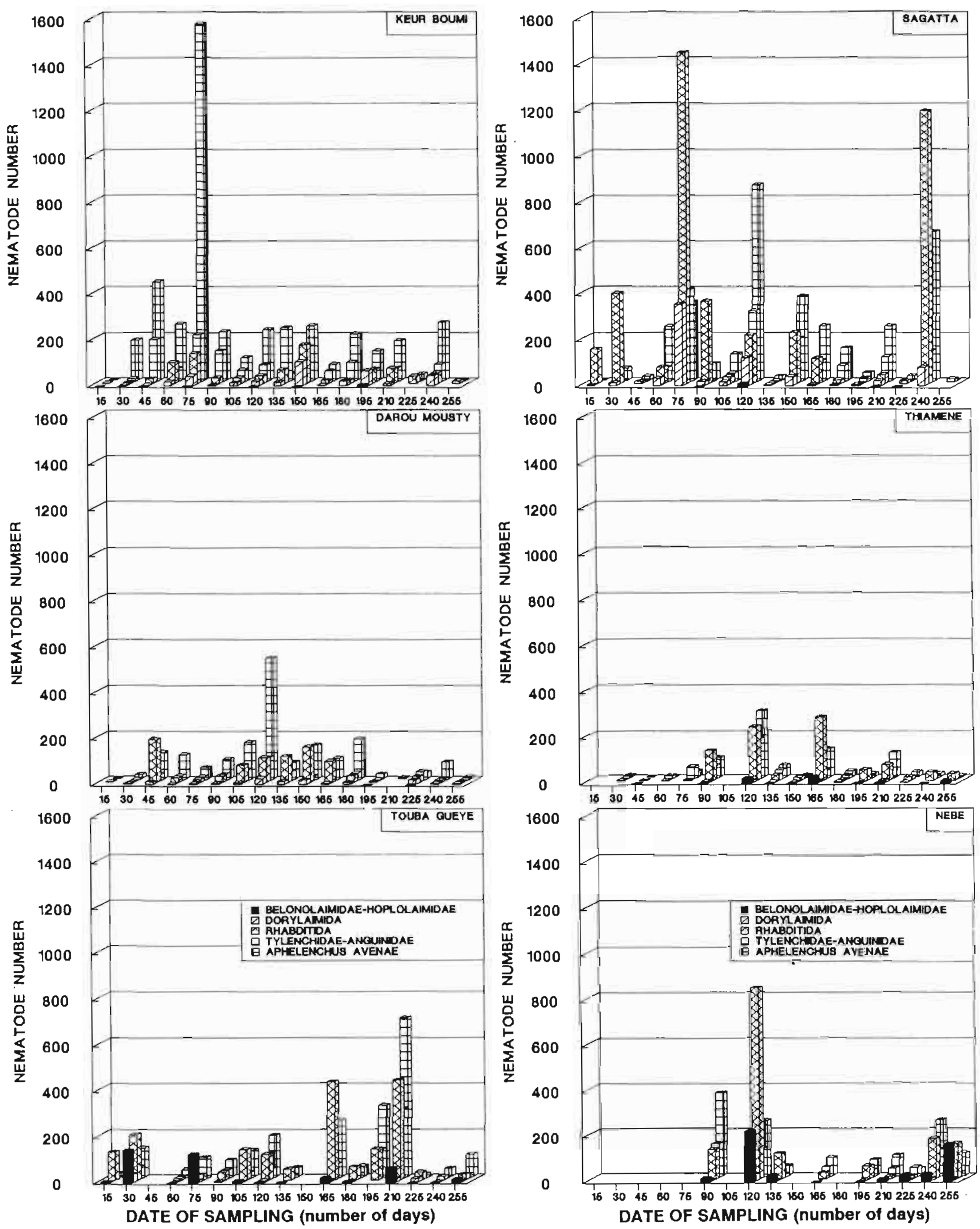

Fig. 3. *Composition and evolution of nematode populations at six differents locations in the peanut cropping area of Senegal.*

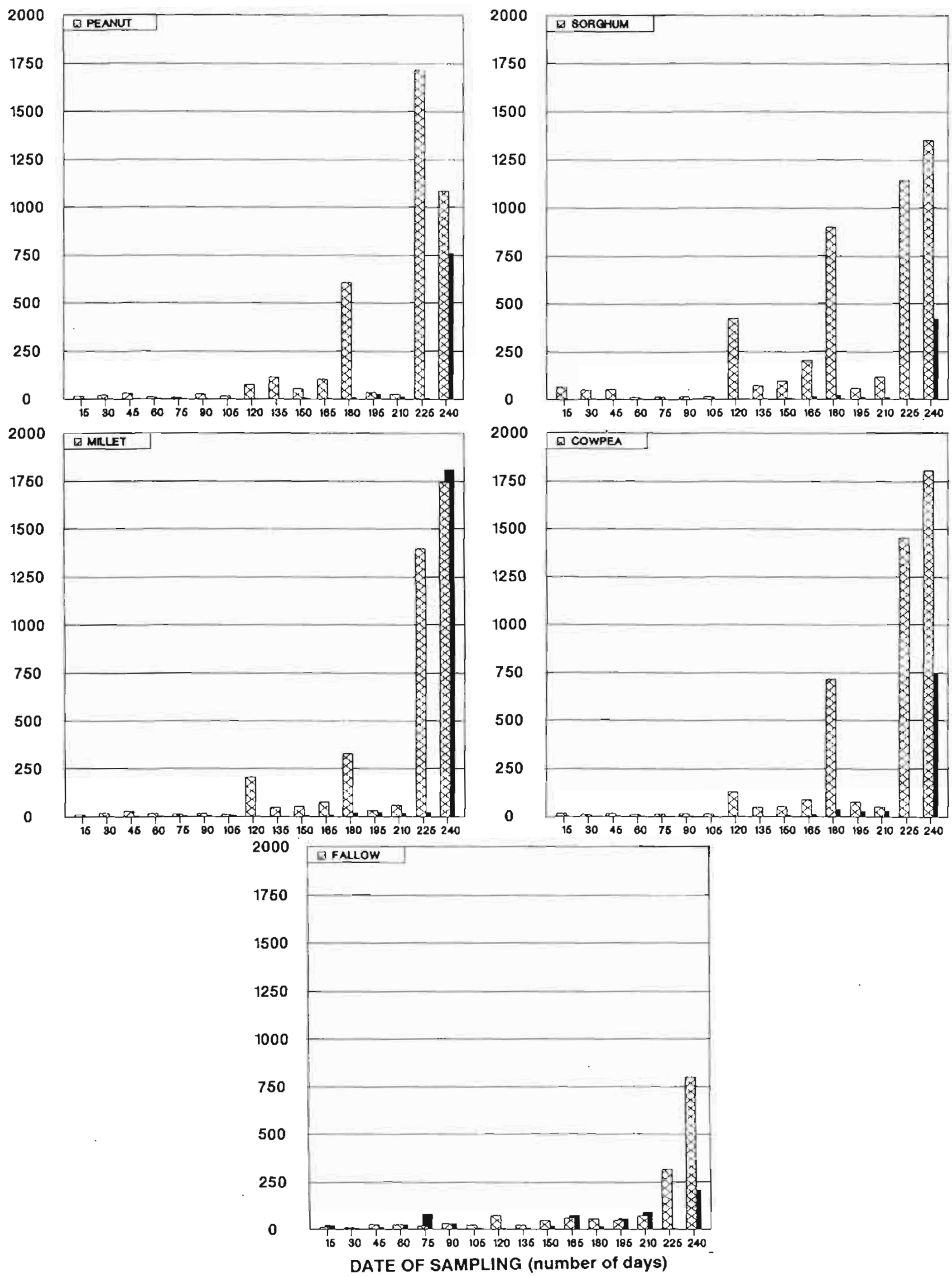

Fig. 4. Amounts of sand and dust collected and total nematode numbers recovered according to the cultural practices (for each date of collection : volumes, in cm³, of sand and dust recovered [crossed column] and numbers of nematodes recovered [black column]).

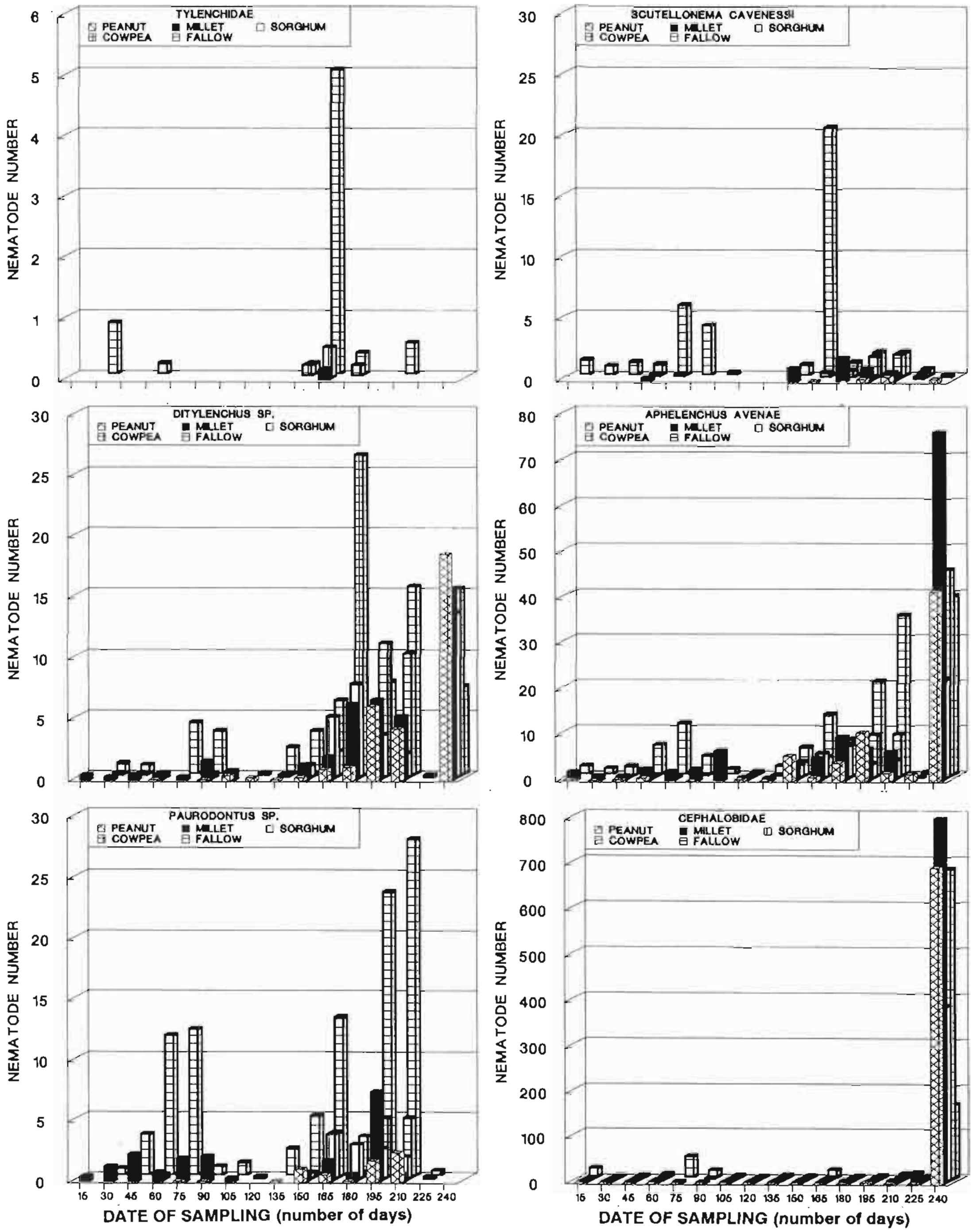

Fig. 5. Composition and evolution of nematode populations according to the cultural practices.

Table 1. *Mean volumes of sand and dust and mean number of nematodes collected over 15 days periods at different locations during the two surveys (mean of 17 yields).*

Location and crops	Mean number recovered	
	Sand and dust (cm^3)	Nematodes per dm^3
FIRST SURVEY		
Keur Boumi	1254	399
Sagatta	915	584
Darou Mousty	754	174
Thiamene	1115	138
Touba Gueye	827	330
Nebe	1364	444
SECOND SURVEY		
Peanut	246	211
Millet	253	481
Sorghum	285	108
Cowpea	282	193
Fallow	100	400

lenchida were recovered : *Filenchus* sp., *Neothada cancellata, Ditylenchus* sp., *Paurodontus* sp., *Tylenchorhynchus germanii, Tylenchorhynchus gladiolatus, Tylenchorhynchus ventralis, Scutellonema cavenessi, Hoplolaimus pararobustus, Helicotylenchus dihystera, Paratylenchus pernoxius. Aphelenchus avenae* and several species of Rhabditida (Cephalobidae only) and of Dorylaimida were also detected in the samples. The most abundant taxa in the samples were species of Tylenchidae and Anguinidae and *A. avenae* (Figs 3, 5). The high numbers of Cephalobidae in the last sample series of the second survey is probably related to the two rains which moistened the sand; the cephalobids are assumed to have found suitable conditions for reproduction. Direct observation of sand and dust showed that nematodes under anhydrobiotic condition may be either free in the sediments or fixed to the sand particles (Fig. 6).

Inoculation into pots of nematodes recovered at each sample date during the second survey revealed four reactions which generally relate to the feeding habits of the nematodes (Table 2) : *i)* mycetophagous species of the genera *Filenchus, Ditylenchus, Paurodontus* and *Aphelenchus* did not reproduce under growth chamber conditions; *ii)* bacteriophagous species of the cephalobids reproduced in 92 % of cases, reproductive rates varying from 1.8 to 50.6 ($\bar{x} = 17.8 \pm 17.1$); *iii) S. cavenessi* did not reproduce in the two first or the two last inoculation tests; for the nine others, multiplication factors varied from 1.37 to 6 ($\bar{x} = 3.63 \pm 1.5$); *iv)* two species, *Pratylenchus* sp. and *H. dihystera,* rarely or never occurred in the elutriates, but were found after 75 days of culture under millet; they may have been at the egg stage in the inoculum.

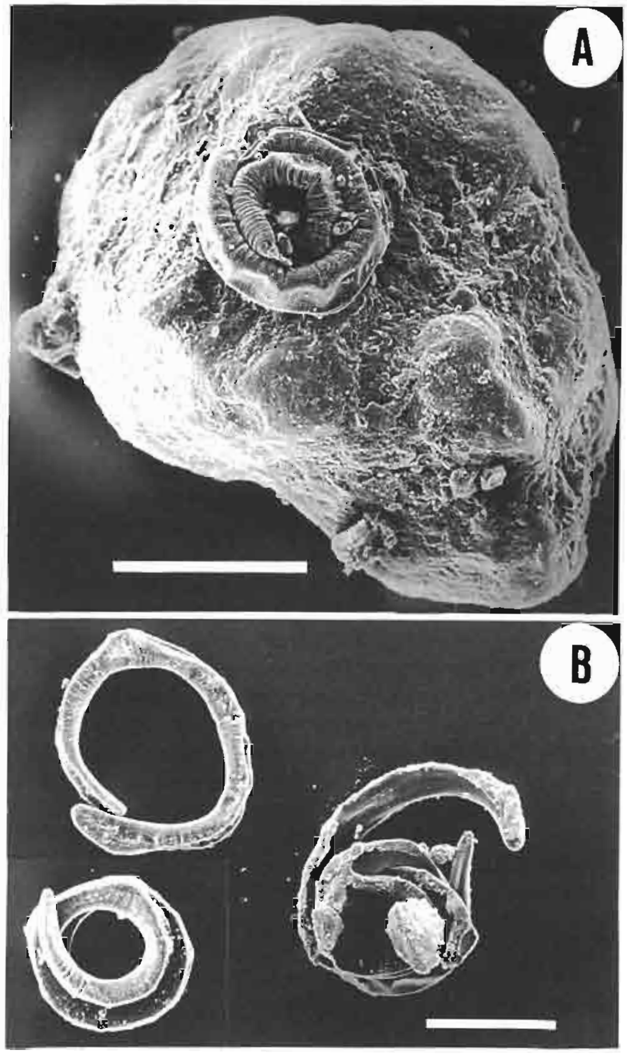

Fig. 6. Scutellonema cavenessi *under anhydrobiotic condition (A : Fixed on sand particle; B : Free).*

Discussion

Wind-transported nematode populations identified in Senegal are similar to those identified by Viglierchio and Schmitt (1981) in California, U.S.A. They are characterized by large proportions of mycetophagous forms belonging to the Aphelenchida and to the Tylenchidae, medium to large numbers of Rhabditida and smaller numbers of Dorylaimida and plant parasitic Tylenchida. In Senegal, this composition reflected the composition of the soil nematofauna in the soil surface and the evolution of this composition during the dry season (Baujard & Martiny, in press). The relation observed during the second survey between the number of nematodes recovered in the pots and the numerical abundance of the

Table 2. *Reproductive capacity of nematodes transported by the wind at different dates of collection* (Pi : *initial population;* Pf : *final population; for the dates 135, 225 and 240, data non determined*).

Nematode species	Date of collection 15		30		45		60		75		90		105		120		150		165		180		195		210	
	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf
Filenchus sp.																	4	0	36	0	4	0	4	0	4	0
Ditylenchus sp.	2	0	7	0	7	1	5	0	26	0	33	1	7	1	48	3	36	0	95	27	262	0	207	0	221	0
Paurodontus sp.	2	0	10	0	36	0	75	0	84	0	17	0	1	0	76	0	44	0	136	0	42	0	239	0	224	0
T. germanii																							1	0		
T. gladiolatus																		2	0							
T. ventralis																		3	0							
Pratylenchus sp.			0	4	0	8			0	1																
S. cavenessi	7	4	4	0	6	26	7	41	35	129	24	60	1	6	4	9	11	35	125	473	19	26	30	30	31	16
H. dihystera									0	26													0	166	4	421
A. avenae	21	6	14	0	28	2	59	5	80	1	39	0	43	3	154	17	125	0	170	0	210	0	306	0	333	0
Cephalobidae	123	225	14	708	31	657	50	345	275	3276	99	2543	27	1424	40	377	21	145	80	882	65	113	112	1226	123	60
Dorylaimida	1	0							2	0	2	0			1	0	1	0	3	1	4	4122	12	0	7	0

soil population around the pots may indicate that nematodes are probably not transported over long distances. However, after their deposition on soil they may again be displaced by wind.

The increase in amount of sand and dust during the dry season is probably correlated to the destruction by cattle which move in this area troughout the dry season of the surface vegetation arising from the previous rainy season. Such destruction of the plant cover allowed an increase in wind erosion.

Observations and experiments conducted in the peanut cropping area of Senegal demonstrated that nematodes are transported under anhydrobiotic conditions at egg or juvenile/adult stages by the wind and that this transport did not change their biological capacities in spite of the stresses following the shocks against sand particles and high temperatures at soil surface, this last point confirming an earlier report by Demeure (1978).

References

BAUJARD, P. & MARTINY, B. (in press). Characteristics of the soil nematode populations from the peanut cropping area of Senegal. *Afr. J. Zool.*

DEMEURE, Y. (1978). Influences des températures élevées sur les états actifs et anhydrobiotiques du nématode *Scutellonema cavenessi. Revue Nématol.,* 1 : 13-19.

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

KRNJAIC', D. & KRNJAIC', S. (1973). Dispersion of nematodes by wind. *Boll. Lab. Entomol. agr. " Filippo Silvestri ", Portici,* 30 : 66-70.

LEROUX, M. (1980). Climat. *In : Atlas du Sénégal,* Paris, Editions Jeune Afrique : 12-17.

SEINHORST, J. W. (1962). Modifications of the elutriation method for extracting nematodes from soil. *Nematologica,* 8 : 117-128.

TOBAR, A. & GALLARDO, M. (1974). An experimental study on the role of wind in the dispersal of some non cyst-forming nematodes. *Simp. intn. (XII) Nematologia, Soc. Europ. Nematologos, 1-7 Sept. 1974, Granada, Spain :* 102-103 [Abstr.].

VIGLIERCHIO, D. R. & SCHMITT, R. V. (1981). Background atmospheric burden of nematodes in California's Sacramento Valley. *Nematol. medit.,* 9 : 111-116.