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IN MEMORIAM

JEAN-JULES PASTEELS

(1906-1991)

Jean-Jules **Pasteels** fut un éminent Professeur, un embryologiste de renommée internationale et un grand entomologiste.

Dès son adolescence, il s'intéresse aux choses de la nature et guidé par son Professeur de Sciences, il sera rapidement un bon entomologiste amateur.

Il devint membre étudiant de notre Société dès 1926 et il en sera membre effectif en 1934. Il assista régulièrement aux séances présentant les résultats de ses diverses recherches et les publiera dans notre revue. Pendant plus de vingt ans, il présida efficacement aux destinées de la Société Royale Zoologique de Belgique, se dépensant largement à son administration et à la publication de nos Annales. Occupant successivement les postes de Secrétaire adjoint (1946), Secrétaire général (1957-67), Secrétaire du Comité de Rédaction des Annales de 1961 à 1968, il assura la Présidence de nos séances de 1962 à 1964 et fut Vice-Président de 1965 à 1969.

Nous lui sommes grandement reconnaissants de l'aide active et compétente qu'il nous apporta en dépit de ses charges importantes à l'Université de Bruxelles et dont nous donnerons ici un aspect panoramique.

En 1924, J.-J. Pasteels entre en 1re candidature en médecine à l'Université Libre de Bruxelles. En 1re année, il appréciera tout particulièrement le cours de Zoologie donné par un célèbre entomologiste, le Professeur Auguste Lameere. Par la suite, il s'intéressera plus particulièrement à l'embryologie et il devint l'élève-assistant du Professeur A. Brachet. Sous sa direction, il commence un travail de recherches sur le développement d'un mollusque *Barnea candida,* travail destiné à être présenté au Concours des Bourses de Voyage du Gouvernement. Il sera lauréat de ce concours en 1930, moment où il acquiert son diplôme de Docteur en Médecine.

La même année, disparaît son Maître vénéré auquel succède le Professeur Albert Dalcq. Dans le service de ce Maître, il poursuit sa carrière universitaire successivement nommé Assistant, Chef de travaux et en 1937 il défend brillamment sa thèse d'agrégation de l'enseignement supérieur en présentant un travail sur la gastrulation des Vertébrés méroblastiques, travail qui lui vaut d'emblée une renommée internationale.

Il sera Chargé de cours en 1941, et Professeur ordinaire en 1946. Lors de l'éméritat du Professeur A. Dalcq il prendra la Direction du Service d'Anatomie et d'Embryologie.

Au cours de cette longue carrière, il partagera son temps entre l'enseignement de l'embryologie et de l'anatomie et ses recherches en laboratoire. Avec conscience et dévouement, il consacra aux étudiants de longues heures dans l'amphithéâtre et les salles de travaux pratiques, il s'avéra ainsi un professeur hautement qualifié.

Il accueillit dans son laboratoire de nombreux chercheurs belges et étrangers qui lui doivent leur formation.

En 1976, il sera élevé à son tour à l'éméritat, mais il continuera à participer à la vie du laboratoire jusqu'à la fin de sa vie.

Résumer brièvement la carrière scientifique de J.-J. Pasteels n'est pas chose aisée tant elle comporte de multiples facettes.

Pendant trente ans, ses recherches seront intimement associées à celles du Professeur A. Dalcq. Ensemble, ils vont unir leurs efforts et leur talent pour continuer la tâche d'A. Brachet, fondateur de l'Embryologie causale, chacun de leur côté sur des matériaux différents. Ils vont rechercher quels sont les facteurs responsables du développement du jeune embryon et notamment ceux qui coordonnent les mécanismes de la gastrulation et la mise en place des ébauches des organes.

De nombreuses expériences souvent délicates sont entreprises chez les amphibiens par A. Dalcq, chez les poissons, les reptiles et les oiseaux par J.-J. Pasteels et de l'ensemble de ces travaux, naîtra une théorie nouvelle, celle du potentiel morphogénétique, basée sur l'existence d'un principe actif unique qui sera appelé organisine. Cette découverte fut discutée, puis adoptée par les plus grands embryologistes mondiaux marquant ainsi un tournant important de l'embryologie causale.

Entre-temps J.-J. Pasteels n'a cessé de fréquenter les laboratoires maritimes où il étudiait la physiologie du développement de divers invertébrés marins en leur appliquant les techniques les plus raffinées et les plus modernes.

Il avait aussi conservé au fond de son cœur son attirance pour l'Entomologie et il consacra tous ses loisirs à l'étude d'un groupe d'Hyménoptères, les Symphytes.

Cette passion lui permettra de parcourir la nature et notamment les Hautes Fagnes à la recherche de nombreuses espèces nouvelles. Il deviendra collaborateur de l'Institut Royal des Sciences Naturelles de Bruxelles. Il put ainsi consulter d'importantes collections de ce Musée et notamment celles de Tenthrédinides, insectes ravageurs des forêts du Congo.

Il fit aussi de remarquables mises au point sur la systématique des Gasteruptions d'Éthiopie, de Malaisie et d'Australie. Il consacra la fin de sa carrière à l'étude des abeilles Mégachilides d'Afrique.

Ces études furent l'occasion de nombreuses missions et de visites dans les plus célèbres musées d'Histoire Naturelle. L'ensemble des travaux de J.-J. Pasteels dans tous ces domaines lui valut de très nombreuses distinctions en Belgique et à l'étranger. Il serait trop long de les citer toutes, il ne l'aurait d'ailleurs pas apprécié. Je citerai simplement qu'il était membre des Académies Royales de Médecine et des Sciences de Belgique, Docteur Honoris Causa de l'Université de Nancy, Correspondant du Museum d'Histoire Naturelle de Paris, Membre d'honneur de la Société Zoologique de France.

La personnalité de cet homme si brillant est difficile à cerner. Très discret, il ne recherchait pas les honneurs et aux mondanités, il préférait le bonheur tranquille de la vie familiale auprès de son épouse dévouée et compréhensive, dont je salue la mémoire, et de ses enfants, dont il était très fier et auxquels il a veillé à inculquer ses propres qualités.

Nous garderons de lui le souvenir d'un homme aimable et érudit, d'un collègue sympathique et d'un collaborateur toujours prêt à rendre service.

La Société Royale Zoologique de Belgique, reconnaissante, salue avec émotion cet homme de bien et adresse à sa famille ses condoléances émues.

Henriette HERLANT MEEWIS,
Président d'Honneur
de la Société Royale Zoologique
de Belgique.

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STEGELLETINA LATICOLLARIS N.SP., A SECOND NEW SPECIES OF THE GENUS FROM SENEGAL (NEMATODA : CEPHALOBIDAE)

by

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SUMMARY

Stegelletina laticollaris n.sp. from marginal soil at Cambérène, Senegal was studied with light microscope and SEM. It is small (L = 0.3 mm) and differs from known species of the genus in the expanded pharyngeal collar, in the cephalic probolae with six or seven digitate tines, and in the shape of the labial probolae, which carry a basal ridge and are bifurcate at two levels, with two platelets implanted at the primary bifurcation. The presence of the basal ridge is reminescent of the genus *Nothacrobeles*.

Key words : Stegelletina, Nothacrobeles, Nematoda, taxonomy, morphology, Senegal.

INTRODUCTION

Recently, DE LEY *et al.* (1990) reported a new species of the genus *Stegelletina* ANDRÁSSY, 1984 from Senegal, described as *Stegelletina capraeola* DE LEY *et al.*, 1990. While scanning the original samples for more material of *S. capraeola,* seven females and one juvenile of another new species were picked out. This second new species is described here as *Stegelletina laticollaris* n.sp. The status of the genus *Stegelletina* is questionable because its diagnosis overlaps with *Cervidellus* THORNE, 1937 on the one hand, and comes very close to *Acrobeles* VON LINSTOW, 1877 on the other (BOSTRÖM, 1985 and 1991 ; DE CLERCK and DE LEY, 1990 ; DE LEY *et al.*, 1990). The new species adds further to these difficulties because it shows affinities with *Nothacrobeles* ALLEN and NOFFSINGER, 1971. Details on the samples and on fixation methods can be found in DE LEY *et al.* (1990). Three females were submitted to critical point drying and sputter-coating for study with SEM after measuring ; one female was lost during this procedure.

RESULTS

Stegelletina laticollaris n. sp.

(Figs 1, 2)

Measurements : Table 1

TABLE 1

Measurements of Stegelletina laticollaris *n.sp.*

	Holotype ♀	Holotype and paratypes (7 ♀♀)		
		mean	SD	range
L (µm)	310	295	7	286-310
pharynx (µm)	88	87	3	84-92
tail (µm)	33	32	2	29-34
body width (µm)	20	20	1	19-21
anal width (µm)	11	11	1	11-12
a	14.1	14.4	0.4	13.9-15.0
b	3.5	3.4	0.1	3.3-3.6
c	9.3	9.2	0.7	8.6-10.4
c'	3.0	2.8	0.3	2.6-3.2
stoma (µm)	7	8	1	7-9
corpus (µm)	36	36	4	31-43
isthmus (µm)	26	26	1	23-28
bulbus (µm)	17	17	1	17-18
excret. pore (µm)	57	52	6	49-59
e.p. (% pharynx)	65	61	7	58-69
nerve ring (µm)	56	54	4	52-62
n.r. (% pharynx)	64	63	4	61-71
deirid (µm)	74	65	7	60-74
dei. (% pharynx)	84	75	8	70-84
V (%)	65	65	1	63-67
G (%)	26	26	2	22-30
vagina (µm)	5	4	1	3-6
rectum (µm)	14	13	1	11-15

Description

Small, compact animals with body straight to weakly ventrally arcuate upon fixation. Cuticle 1 µm thick or less, annulated. Annules 1.8-2.2 µm wide at midbody and 2.2-2.5 µm wide in neck region, carrying longitudinal striations which are only rarely continuous from annule to annule. Lateral field with three lines extending from about level of excretory pore to tail tip.

Lip region confluent with neck or weakly offset, 11-12 µm wide, with four cephalic and six labial papillae. Amphidial apertures inconspicuous, leaf-shaped slits (1.3 µm wide in female of Fig. 2B). Primary axils deeper and narrower than secondary axils, resulting in grouping of the lips in one dorsal and two ventrosublateral pairs. Lips asymmetrically triangular with slender, digitate tip, each also with four or five digitate tines in the secondary axils and one digitate tine or guard process in the primary axils. Tines only very faintly visible with light microscope. SEM reveals a pattern of incisures on the lips, with an incisure running transversely over each lip pair in such manner that it touches the amphid and the cephalic papilla(e), and offsets the guard processes in the primary axils from the lip tips and the tines in the secondary axils. In addition, one longitudinal incisure extends between each pair of guard processes from the primary axil down to the first body annule, and another longitudinal incisure partly divides the lips in each lip pair, running over a pair of incompletely fused tines in the middle of each secondary axil down to the transverse labial incisure (Fig. 1G, 2A,B). Labial probolae 5-6 µm high, bifurcating at two levels : once at mid-height, and again at the tips of each of the primary branches. Secondary bifurcations approximately at straight angles to the plane of the primary bifurcation. Base of each labial probola relatively broad, carrying a concave central abaxial ridge or scale a little below the primary bifurcation, as well as two angular platelets tangentially at the level of this same bifurcation. Tangential ridges present perradially, alternating with the labial probolae. No radial ridges seen.

Cheilorhabdia refractive and round, other rhabdia not sclerotized, apparently very flexible instead : buccal lumen locally strongly expanded in some specimens (Fig. 1D,E). Pharyngeal collar not simply cylindrical as in most Cephalobidae, but expanding rapidly at its anterior end to a width approaching that of the pharyngeal corpus, then narrowing gradually to a constriction lying slightly anterior to the base of the buccal cavity, and then widening again and joining the walls of the corpus without a clear demarcation (Fig. 1B-E). Buccal cavity itself sometimes also difficult to delineate from pharyngeal lumen.

Corpus cylindrical, only 1.1-1.8 times as long as isthmus. Anterior end of isthmus offset from corpus by a shallow constriction, also slightly wider and with more distinct muscular fibres than remainder of isthmus. One coelomocyte lying ventrally of bulbus. Excretory pore about level with middle of isthmus, at 22-25 annules from lip region. Nerve ring slightly more anterior and deirid a little more posterior to excretory pore, at 28-32 annules from lip region. Cardia small, 3-5 µm long. Intestinal wall thin, anteriorly with prominent cellular ridges extending transversely into the lumen. Four females with posterior end of intestine offset as a 23-28 µm long « prerectum ».

Vulva at two-thirds of body, a short slit with finely wrinkled lips. Female reproductive system compact, monodelphic, prodelphic. Spermatheca empty in all females, 7 ± 3 (4-12) µm long. Postvulval uterine branch rudimentary, 5 ± 2 (3-

8) µm long, consisting of about six minute cells which merge with the ventral chord. Ovary with nine to ten oocytes, of which four or six in double file near the straight ovary tip. One female with a single egg measuring 45 by 17 µm. Up to three coelomocytes visible around gonad. Tail conical, with sharp to very sharp tip and about 10-14 ventral annules (annulation fading towards tip). Phasmids in anterior third of tail, at 9 ± 3 (6-11) µm from anus.

No males found.

Type locality and habitat

A plot of very nutrient-poor soil lacking natural vegetation at the « Centre pour le Développement de l'Horticulture » at Cambérène, Senegal (sample n° 1014 ; see De Ley *et al.*, 1990 and De Ley, 1992).

Type specimens

Holotype female with one paratype female on slide n° 3645 and two paratype females on SEM-mount in the collection of the Instituut voor Dierkunde, Universiteit Gent, Belgium. Two paratype females deposited in the USDA nematode collection, Beltsville, Maryland, USA.

Etymology

The specific epithet is a contraction of the latin adjective *latus* (for « wide ») and the latin noun *collaris* (for « collar »), referring to the peculiar shape of the pharyngeal collar.

Diagnosis

Very small Cephalobidae with longitudinally striated annules ; three lateral lines ; labial probolae each bifurcating at two levels, carrying a central abaxial ridge as well as two basal tines ; lips asymmetrically triangular, each with four or five digitate tines in its secondary axil ; primary axils each with two digitate guard processes ; pharyngeal collar anteriorly expanded ; corpus less than twice as long as isthmus, cylindrical ; postvulval uterine branch rudimentary, less than half a body width long ; tail conical, acute.

Differential diagnosis and relationships

To our knowledge, no cephalobid has hitherto been described with a pharyngeal collar shaped like that of the new species. While the pharyngeal collar is swollen in *Acromoldavicus skrjabini* (Nesterov and Lisetskaya, 1965) Nesterov, 1970, there is no clear constriction at the base of the collar as in our new species (cf. Fig. 1a in Nesterov, 1970). *A. skrjabini* is quite different from *S. laticollaris* in

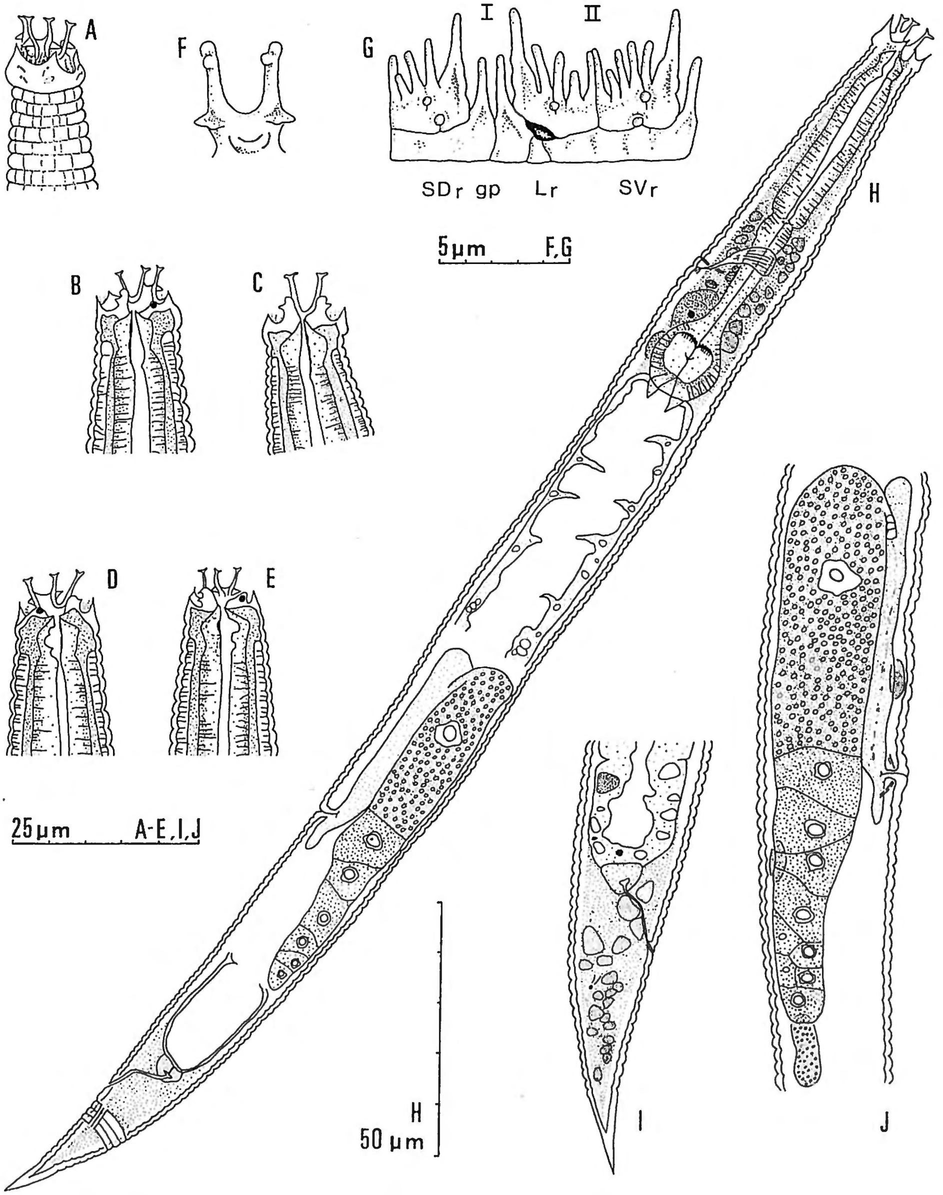

Fig. 1. — *Stegelletina laticollaris* n.sp. female morphology : A. Surface view of lip region. B-E. Lip regions in optical section. F. Right-subventral labial probola as seen with SEM. G. Diagram of lips on right side of lip region as seen with SEM. H. Entire female. I. Tail. J. Reproductive system. Abbreviations in G : I = primary axil, II = secondary axil, gp = guard processes, L_r = right-lateral lip, SD_r = right-subdorsal lip, SV_r = right-subventral lip.

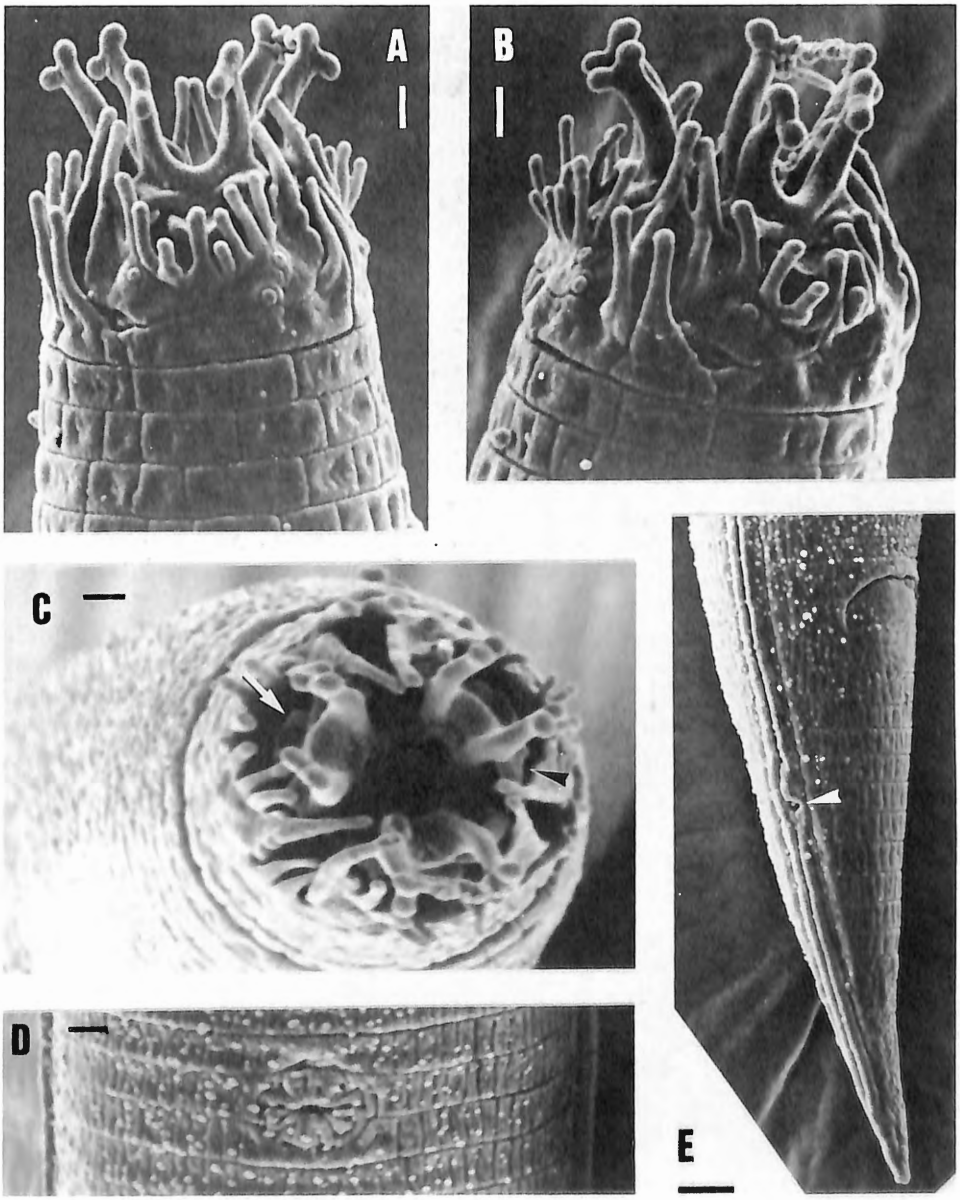

Fig. 2. — *Stegelletina laticollaris* n.sp. female morphology : A. Lip region in ventrosublateral view. B. Lip region in lateral view. C. Lip region *en face* (arrow points at a basal ridge, arrowhead at tangential platelet). D. Vulva. E. Tail (arrowhead points at phasmid). Scale bar is 1 μm in A-D and 2 μm in E ; dorsal side is on left in A,B and in top right corner in C.

several other respects, with e.g. very large, flap-like lips overhanging small labial probolae that are acute and not bifurcate.

S. laticollaris appears to be closest to *Stegelletina rara* (NESTEROV, 1969) ANDRÁSSY, 1984, but can be distinguished from this species by the shape of the labial probolae, which lack platelets at the primary bifurcation and have longer secondary branches in *S. rara*. Tines on the cephalic probolae were not described in *S. rara* by NESTEROV (1969), but these may well have been present, as suggested by their inconspicuousness under light microscope in the new species.

Apart from *S. rara* and *S. capraeola* DE LEY *et al.*, 1990, no other species of *Stegelletina* is known to have an abaxial thickening on the base of each labial probola. *S. capraeola* has an abaxial knob instead of a ridge, and differs further from the new species in its non-expanded pharyngeal collar, in the labial probolae branching at three levels, in the cephalic probolae with four rounded and five digitate tines instead of six or seven digitate ones, and in a pharyngeal metacorpus with double swelling when fixed in expanded state. *S. laticollaris* can also be distinguished from *S. capraeola,* even at lower magnification, by the transverse extensions of the anterior intestinal cells into the intestinal lumen.

Together with *S. rara* and *S. capraeola,* the new species is of relevance to the diagnosis of *Stegelletina* because of the basal ridge on the labial probolae. This feature is reminescent of the genus *Nothacrobeles,* because in species of this genus the labial probolae always have a well-developed basal ridge continuous with the primary branches. Furthermore, the presence in each primary axil of two guarding pieces offset from the lips by a circumferential incisure is also a feature shared by *Nothacrobeles* and our new species (cf. Fig. 7,9 in SAUER *et al.,* 1979). Finally, *Nothacrobeles* species have tines along the rims of ridge and primary branches of the labial probolae, and the presence of tine-like platelets on the labial probolae of *S. laticollaris* therefore suggests close affinity, too.

ACKNOWLEDGEMENTS

We are grateful to Prof. Dr. A. Coomans and Dr. S. Boström for comments, and to Ms. R. Van Driessche and Mrs. R.-M. Servaes for the SEM-photographs. The first author is research assistant with the National Fund for Scientific Research (Belgium).

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LES NÉMATODES PHYTOPARASITES DU GENRE *XIPHINEMA* (LONGIDORIDAE) EN GUYANE ET EN MARTINIQUE

par

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RÉSUMÉ

Dans ce qui constitue la première étude du genre *Xiphinema* en Martinique et Guyane, treize espèces (*X. brasiliense, X. brevicolle, X. elongatum, X. ensiculiferum, X. filicaudatum labratum* subsp. n., *X. ifacolum, X. krugi, X. macrostylum, X. oryzae, X. paritaliae, X. riocaquetae, X. setariae, X. surinamense*) sont brièvement décrites et illustrées de façon à en permettre une reconnaissance aisée. *X. filicaudatum labratum* subsp. n. diffère de *X. f. filicaudatum* par la présence d'un bourrelet périoral, caractère unique dans le genre. Un mâle de *X. krugi* et plusieurs de *X. macrostylum* sont décrits : ils étaient considérés comme rares chez l'une et l'autre espèces. Des données sont également fournies sur la répartition des différentes espèces.

Mots clés : Nématodes, *Xiphinema,* Martinique, Guyane.

Plant-parasitic nematodes of the genus *Xiphinema* (Longidoridae) in Guiana and Martinique

SUMMARY

This is the first study of the genus *Xiphinema* in Martinique and Guiana. Thirteen species (*X. brasiliense, X. brevicolle, X. elongatum, X. ensiculiferum, X. filicaudatum labratum* subsp. n., *X. ifacolum, X. krugi, X. macrostylum, X. oryzae, X. paritaliae, X. riocaquetae, X. setariae, X. surinamense*) are briefly described and illustrated so as to facilitate easy identification. *X. filicaudatum labratum* subsp. n. differs from *X. f. filicaudatum* in the presence of a perioral elevation, a unique character in the genus. A male of *X. krugi* and several males of *X. macrostylum* are described. They were considered as rare in both species. Information on the ditribution of the different species is also presented.

Key words : Nematodes, *Xiphinema,* Martinique, Guiana.

INTRODUCTION

Les données sur les nématodes phytoparasites appartenant au genre *Xiphinema* Cobb, 1913 (Longidoridae) de la Guyane et de la Martinique étaient inexistantes pour le premier territoire et limitées pour le second à une seule référence (Scotto la Massèse, 1969) signalant *Xiphinema* sp. associé à la patate douce et *X. setariae* (sous le nom de *X. vulgare*) au cocotier.

L'examen de spécimens provenant de prélèvements effectués par deux nématologistes de l'ORSTOM, G. Germani en Guyane et P. Cadet à la Martinique, a révélé la présence des espèces suivantes :

X. brasiliense Lordello, 1951
X. brevicolle Lordello et Da Costa, 1961
X. elongatum Schuurmans Stekhoven et Teunissen, 1938
X. ensiculiferum (Cobb, 1893) Thorne, 1937
X. filicaudatum labratum n. subsp.
X. ifacolum Luc, 1961
X. krugi Lordello, 1955
X. macrostylum Esser, 1966
X. oryzae Bos et Loof, 1985
X. paritaliae Loof et Sharma, 1979 (= *X. dolosum* Bos et Loof, 1985)
X. riocaquetae Hunt, 1982
X. setariae Luc, 1958 (= *X. vulgare* Tarjan, 1964)
X. surinamense Loof et Maas, 1972

Ces espèces sont décrites ci-dessous, plus ou moins en détail suivant les nouvelles informations que les observations ont pu apporter. Pour chacune d'entre elles, sont données une brève description, les mensurations essentielles et une illustration, permettant ainsi une reconnaissance relativement aisée par tout nématologiste quelque peu familier de la détermination.

Des spécimens appartenant au « groupe *Xiphinema americanum* » représentant vraisemblablement plusieurs espèces ont été également observés. Seul *X. brevicolle,* relativement bien caractérisé, sera étudié ici, l'identification des espèces de ce groupe demeurant difficile et souvent aléatoire.

MATÉRIEL ET MÉTHODES

Les nématodes ont été extraits du sol par élutriation (Seinhorst, 1956), tués par chauffage progressif jusqu'à 60°C, fixés au formol neutre (2 %), puis montés dans la glycérine anhydre suivant la méthode rapide de Seinhorst (1959).

La localisation des prélèvements est la suivante :

— Guyane :

1. Riz pluvial, Iracoubo, 142 km, route de Cayenne à St Laurent,
2. Canne à sucre, St Laurent, plantation des Malgaches,

3. Fougères et Maranthacées, Cayenne, 15 km de la piste du Bagne des Annamites,
4. Ananas, Cayenne, plantation Poujet,
5. Ananas, Javouhey, plantation Nmong,
6. Forêt, route entre Javouhey et Mana,
7. Riz de plateau, Station IRAT de Cayenne.

— Martinique :

8. Tomate, carbet, lieu-dit Le Fromager,
9. Catalpa (*Thespesia populnea* (L.) SOLANDER ex CORREA) et tamarinier (*Tamarindus indica* L.), Ste Anne, plage de l'Anse Meunier,
10. *Alpinia* sp., Morne Rouge, Plantation Yang Ting,
11. *Anthurium* sp., Champ Flore,
12. *Anthurium* sp., Gros Morne,
13. Jachère, Morne Rouge, lieu-dit Savane Petit,
14. Aubergine, Le Lamentin,
15. Canne à sucre, St Pierre, Plantation Depaz,
16. Tomate, St Pierre, route de Fond St Denis,
17. Forêt, Cap St Martin (alt. 250 m, N.O. de la Montagne Pelée),
18. Savane d'altitude (600-700 m), Montagne Pelée,
19. Forêt, Ravine Caverne, Sud du Morne Bigot,
20. Résinier (*Coccoloba uvifera* (L.) JACQ.), Ste Anne, plage de l'Anse Trabaud, Baie des Anglais,
21. Igname (*Dioscorea* sp.), Le François, Centre de Formation Professionnelle des Adultes, Parcelle 1,
22. *Alpinia* sp., St Joseph, Plantation Leclerc,
23. *Croton* sp., St Joseph, Jardin de la Lézarde,
24. Canne à sucre, Le Lamentin, Plantation de Lareinty,
25. Chou caraïbe (*Xanthosoma sagittifolium* SCHOTT), La Trinité, lieu-dit Bonneville,
26. Canne à sucre, La Trinité, Plantation du Gallion, parcelle Abricot.

Les spécimens étudiés ont été déposés dans la Collection Nationale des Nématodes Parasites des Plantes et du Sol, Muséum National d'Histoire Naturelle, Paris.

DESCRIPTIONS ET REMARQUES

Xiphinema brasiliense LORDELLO, 1951
(Fig. 1)

Dimensions. Femelles. (localité 2 ; n = 15). L = 1,61-2,25 (1,94 ± 0,20) mm ; a = 30,4-39,6 (34,1 ± 2,43) ; b = 4,2-7,2 (5,5 ± 0,82) ; queue = 34-49 (42 ± 5,80) µm ; c = 34,2-62,3 (46,3 ± 8,60) ; c′ = 1,1-1,5 (1,3 ± 0,14) ; V = 26,6-34,3 (29,3 ± 1,93) ; odontostyle = 109-131 (121,5 ± 7,69) µm ; odontophore = 66-77 (70,5 ± 2,62) µm; stylet = 177-207 (192 ± 9,34) µm.

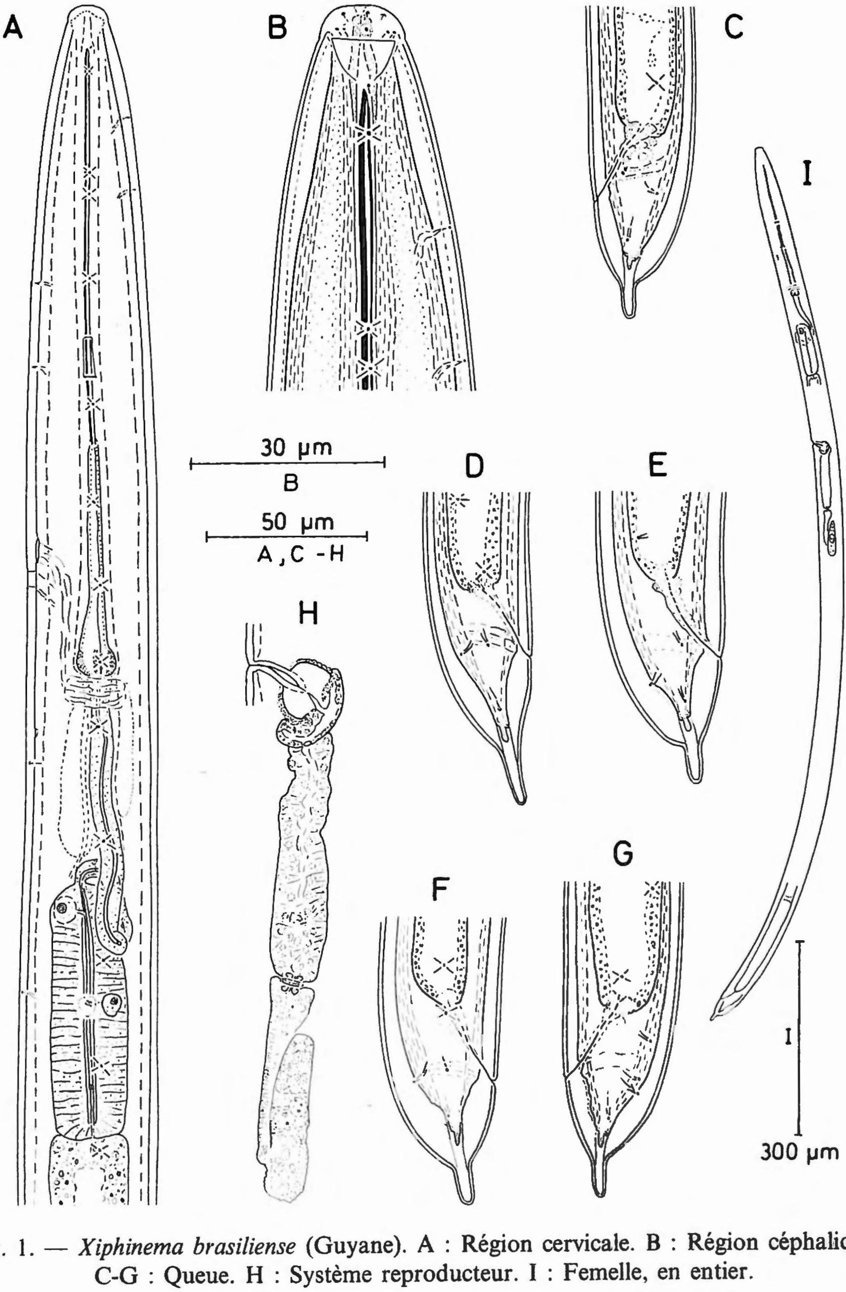

Fig. 1. — *Xiphinema brasiliense* (Guyane). A : Région cervicale. B : Région céphalique. C-G : Queue. H : Système reproducteur. I : Femelle, en entier.

(localité 3 ; n = 10). L = 1,40-1,97 (1,60 ± 0,17) mm ; a = 32,4-41,0 (35,7 ± 2,41) ; b = 3,9-5,4 (4,6 ± 0,44) ; queue = 36-40 (37,5 ± 1,28) μm ;

c = 36,8-51,8 (42,6 ± 4,31); c' = 1,1-1,3 (1,2 ± 0,09) ; V = 30,4-33,8 (31,6 ± 1,25) ; odontostyle = 124-142,5 (133,5 ± 7,45) µm ; odontophore = 73-82 (76,5 ± 2,99) µm ; stylet = 197-227 (210 ± 10,13) µm.

(localité 4 ; n = 7). L = 1,70-2,00 (1,90 ± 0,10) mm ; a = 44,7-52,4 (48,9 ± 2,47) ; b = 4,7-6,1 (5,4 ± 0,42) ; queue = 34-44 (41 ± 3,36) µm ; c = 44,3-51,3 (47,0 ± 3,08) ; c' = 1,3-1,6 (1,4 ± 0,11) ; V = 27,0-28,7 (28,0 ± 0,53) ; odontostyle = 108-124 (116,5 ± 5,62) µm; odontophore = 52-71 (67 ± 6,44) µm ; stylet = 168-195 (184,5 ± 10,60) µm.

Description. Femelle. Corps relativement court, massif, peu aminci à l'avant et à l'arrière, légèrement courbé ventralement, cette courbure étant plus prononcée à la partie postérieure. Région labiale arrondie, de largeur moyenne, la séparation d'avec le reste du corps n'étant que faiblement marquée. Ouverture des amphides en fente large, au niveau de cette séparation. Pores cervicaux (n = 3) : 2 dorsaux, 6-8 ventraux, 13-14 latéraux. Vulve située antérieurement (au premier tiers du corps environ) ; vagin oblique, dirigé vers l'arrière ; ovéjecteur asymétrique, à partie antérieure réduite ; aucune trace de la branche génitale antérieure ; branche postérieure courte, sans différenciation utérienne. Queue hémisphérique à conique, pourvue d'une digitation terminale axiale ou sub-axiale, cylindrique, légèrement renflée et arrondie à son extrémité ; cuticule de la queue épaisse.

Localités. Guyane (1,2,3,4).

Remarques. Cette espèce se reconnait aisément par la forme particulière de la queue, la position antérieure de la vulve et le vagin oblique, ceci lié à l'absence totale de branche génitale antérieure, cette réduction affectant également l'ovéjecteur. C'est l'espèce chez laquelle cette réduction est la plus prononcée.

Aucun mâle n'a été observé ; un seul mâle a été décrit, provenant de sol de forêt primaire de Côte d'Ivoire (Luc, 1981).

X. brasiliense est une espèce pan-tropicale, signalée à de nombreuses reprises sur toute l'étendue du Brésil (Lordello, 1951 ; Carvalho, 1962 [*X. itanhaense*] ; Ferraz, 1977, 1980 ; Loof et Sharma, 1979 ; Lamberti *et al.*, 1987c ; Ferraz *et al.*, 1989 ; Germani, 1989), au Pérou (Lamberti *et al.*, 1987b ; Alkemade et Loof, 1990) ainsi qu'en Côte d'Ivoire (Luc, 1981 ; Fortuner et Couturier, 1983), au Nigeria (Afolami et Caveness, 1983) et en Inde (Phukan et Sanwal, 1980 ; Khan, 1982 [*X. mammillocaudatum*]).

Xiphinema brevicolle Lordello et Da Costa, 1961

(Fig. 2)

Dimensions. Femelles. (n = 10) : L = 1,71-1,90 (1,84 ± 0,30) mm ; a = 41,1-47,4 (44,6 ± 1,43) ; b = 5,3-6,1 (5,8 ± 0,39) ; queue = 19-23 (21 ± 0,20) µm ; c = 81,4-99,5 (88,8 ± 7,02) ; c' = 0,7-0,8 (0,75 ± 0,13) ; V = 50,3-54,0 (52,2 ± 2,25) ; odontostyle = 88-99 (94 ± 3,51) µm ; odontophore = 53-56 (54 ± 1,94) µm ; stylet 143-153 (148 ± 2,30) µm.

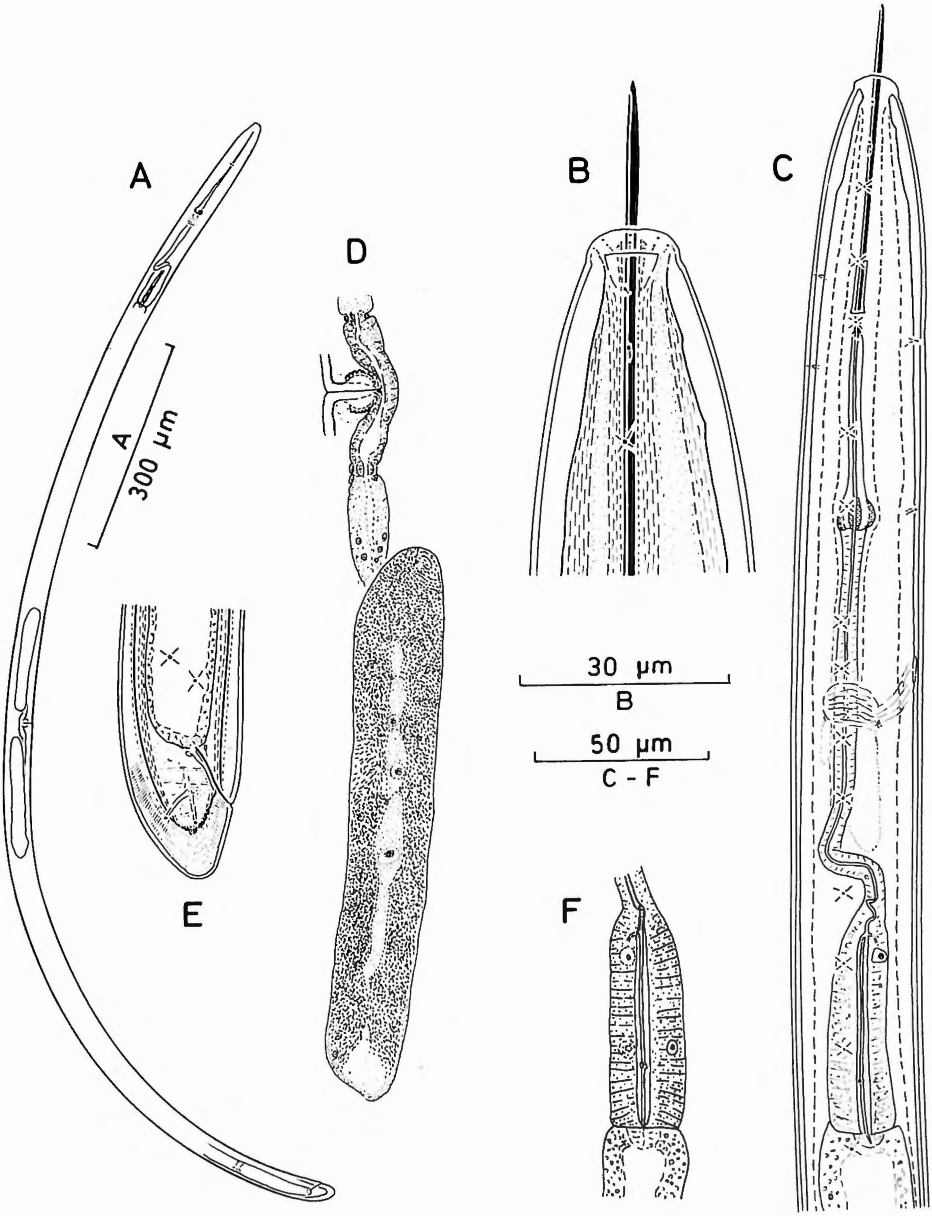

Fig. 2. — *Xiphinema brevicolle* (Martinique). A : Femelle, en entier. B : Région céphalique. C : Région cervicale. D : Système reproducteur (branche antérieure). E: Queue. F : Bulbe du pharynx.

Description. Femelle. Corps de longueur moyenne, robuste, très progressivement aminci vers l'avant et vers l'arrière, sauf dans la région caudale, en forme de C plus ou moins fermé. Région labiale basse, à profil général arrondi mais plus ou moins aplati vers l'avant, séparée du reste du corps par une constriction moyennement marquée. Ouverture des amphides en fente de longueur équivalant à environ 60 % du diamètre correspondant, située très peu en avant de la constriction. Vulve à mi-longueur du corps ou postérieure. Deux branches génitales semblables comportant — caractéristique du groupe *americanum* — un utérus très court, voir absent, un sphincter faiblement développé, un oviducte tubulaire, mince, presque indifférencié, et un ovaire très développé où les ovocytes sont remplis de bactéries allongées. Queue courte, grossièrement conique, à extrémité arrondie et à courbure essentiellement dorsale; canal aveugle présent.

Localité. Martinique (9).

Remarques. L'appartenance de ces spécimens au groupe *americanum* se décèle immédiatement par la taille du corps, petite à moyenne, la robustesse du stylet et celle de la cuticule bordant la lumière du bulbe pharyngien, la queue courte et conique-arrondie, mais surtout par la structure très particulière du tractus génital : utérus réduit, voire absent, oviducte fin et presque indifférencié et ovocytes remplis de bactéries. *X. brevicolle* se sépare des autres espèces du groupe par sa queue arrondie, massive et surtout par le fait que le corps n'est pas toujours spiralé mais aussi en forme de C après fixation.

Aucun mâle n'a été observé dans l'échantillon étudié. Quelques rares mâles ont été décrits d' Israël (COHN, 1969), d' Afrique du Sud (HEYNS, 1974), d'Inde (BAJAJ et JAIRAJPURI, 1978) et du Brésil (LOOF et SHARMA, 1979).

Nous rapportons les spécimens observés à *X. brevicolle,* encore que la récente description par LAMBERTI *et al.* (1992) de trois nouvelles espèces (*X. parvum, X. taylori, X. pseudoguirani*), très proches de *X. brevicolle* — de même que *X. diffusum,* étudié dans ce même article — puisse créer une certaine interrogation. Sans prendre position sur ce qui apparait comme un « sous-groupe *X. brevicolle* » au sein du « groupe *X. americanum* », nous estimons préférable de retenir dans le cas présent le nom de *X. brevicolle,* ce qui rejoint d'ailleurs le concept apparemment géographique mis en avant par ces auteurs pour la différenciation des espèces en cause. Rappelons que *X. brevicolle* a été en effet décrit du Brésil.

X. brevicolle, espèce pan-tropicale (Afrique, Asie, Amérique du Sud), est également rencontré en Amérique du Nord et en Europe (cf. LAMBERTI *et al.,* 1992).

Xiphinema elongatum SCHUURMANS STEKHOVEN et TEUNISSEN, 1938
(Fig. 3)

Dimensions. Femelles. (localité 6 ; n = 22). L = 2,08-2,45 (2,19 ± 0,10) mm ; a = 48,6-68,8 (60,1 ± 5,8) ; b = 5,7-8,9 (6,6 ± 1,02) ; queue = 56-65 (60 ± 2,79) µm ; c = 33,3-39,8 (36,8 ± 1,93) ; c' = 2,4-2,9 (2,6 ± 0,14) ; V = 38,4-40,6 (39,6 ± 0,76); odontostyle = 92-98 (95 ± 1,76) µm ; odontophore = 57-62 (58 ± 1,40) µm ; stylet = 149-157 (153 ± 2,61) µm.

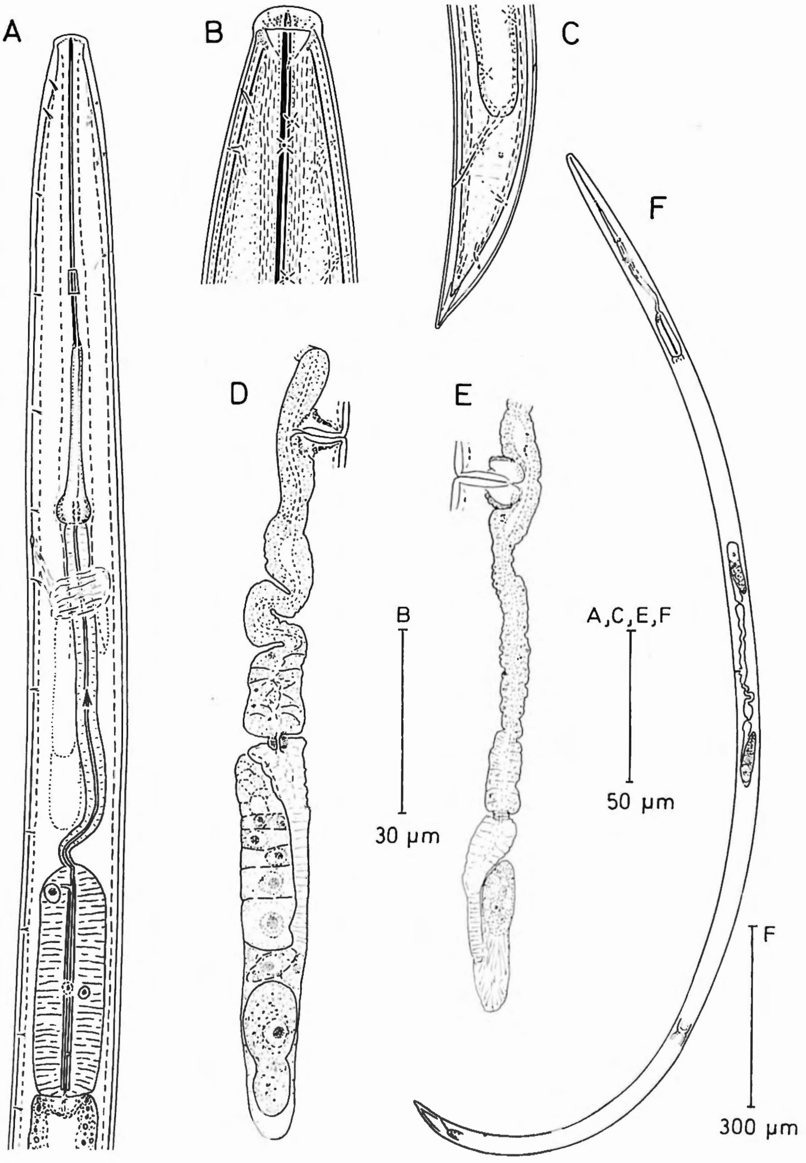

Fig. 3. — *Xiphinema elongatum* (Martinique). A : Région cervicale. B : Région céphalique. C : Queue. D : Branche génitale postérieure d'une femelle mature. E : Branche génitale antérieure d'une jeune femelle. F : Femelle, en entier.

(localité 16 ; n = 7). L = 2,1-2,5 (2,2 ± 0,18) mm ; a = 47,4-61,1 (57,5 ± 4,29) ; b = 6,1-6,9 (6,5 ± 0,26) ; queue = 44-64 (58 ± 6,13) µm ; c = 32,2-37,1

(34,9 ± 1,71) ; c′ = 2,5-2,8 (2,7 ± 0,15) ; V = 37,7-40,2 (39,2 ± 0,72) ; odontostyle = 90-96 (92,5 ± 2,42) µm ; odontophore = 53-56 (54,5 ± 0,96) µm ; stylet = 144-151 (147 ± 2,67) µm.

Description. Femelle. Corps de longueur moyenne, peu effilé vers l'avant et vers l'arrière, courbé ventralement, beaucoup plus fortement à la partie postérieure (aspect en J ou même en C fermé). Région labiale arrondie, aplatie à l'avant, séparée du reste du corps par un épaulement assez marqué. Ouverture des amphides en fente de longueur supérieure à 50 % du diamètre correspondant, située un peu en avant de l'épaulement. Pores cervicaux (n = 2) : 3 dorsaux, 10 ventraux, 13, 17 latéraux. Vulve située quelque peu antérieurement à la moitié du corps ; vagin perpendiculaire au grand axe du corps ; ovéjecteur peu défini ; branches génitales de longueur sensiblement égale, dépourvues de différenciation Z. Queue de longueur moyenne, régulièrement conique, légèrement courbée ventralement, grand axe continu avec celui du reste du corps ; canal aveugle présent, sans caractère particulier.

Localités. Guyane (2, 6) ; Martinique (14, 15, 16).

Remarques. Cette espèce, par son absence de caractères particuliers et son assez grande variabilité, n'est pas des plus aisées à reconnaître. On peut toutefois tabler sur la forme de la queue, la longueur moyenne du corps et celle du stylet, la position de la vulve. Elle peut être confondue avec *X. setariae,* espèce tropicale également très courante, mais la queue de cette dernière est plus courte et nettement subdigitée.

Aucun mâle n'a été rencontré dans les échantillons étudiés. Quelques mâles seulement ont été observés provenant d' Afrique du Sud (Heyns, 1974), d'Inde, sous le nom de *X. nagarjunense* Khan, 1982 synonyme mineur de *X. elongatum* (Khan, 1982), et du Burundi (Coomans *et al.,* 1990).

X. elongatum, présent sur tous les continents, est l'une des espèces pan-tropicales les plus fréquentes et les plus répandues (cf. Luc et Southey, 1980).

Xiphinema ensiculiferum (Cobb, 1893) Thorne, 1937
(Fig. 4)

Dimensions. Femelles. (localité 3 ; n = 5). L = 1,68-1,79 (1,74 ± 0,04) mm ; a = 37,3-43,2 (39,3 ± 2,29) ; b = 3,8-5,3 (4,5 ± 0,62) ; queue = 19-20 (20 ± 0,83) µm ; c = 88,4-96,1 (92,7 ± 3,60) ; c′ = 0,6 (0,6) ; V = 29,2-30,5 (29,9 ± 0,54) ; odontostyle = 140-143 (141 ± 1,29) µm ; odontophore = 73-78 (76,5 ± 2,41) µm ; stylet = 215-222 (217,5 ± 2,94) µm.

(localité 6 ; n = 10). L = 1,78-2,07 (1,89 ± 0,32) mm ; a = 31,0-41,3 (34,5 ± 3,54) ; b = 4,3-5,7 (4,9 ± 0,45) ; queue = 19-29 (23 ± 3,35) µm ; c = 65,9-100,0 (84,8 ± 11,22) ; c′ = 0,6-0,8 (0,7 ± 0,08); V = 27,9-29,2 (28,5 ± 0,39) ; odontostyle = 132-142 (137,5 ± 2,29) µm ; odontophore = 74-80 (77 ± 1,90) µm ; stylet = 209-218 (214,5 ± 3,09) µm.

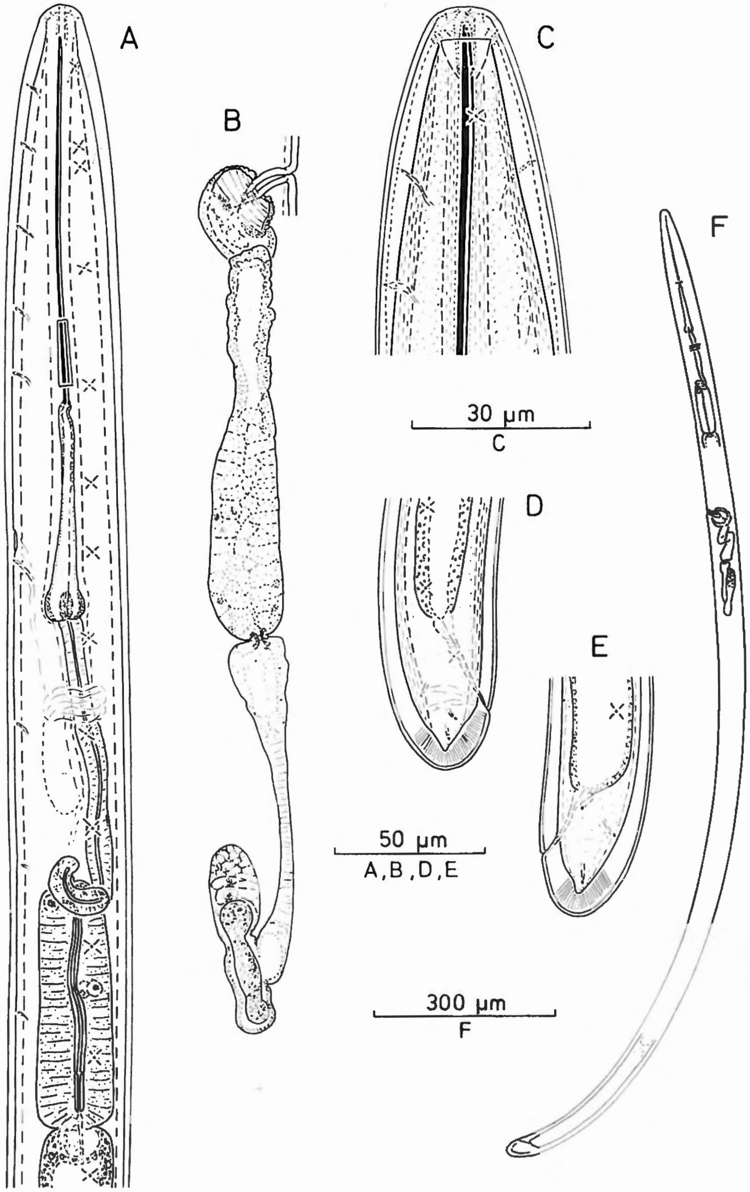

Fig. 4. — *Xiphinema ensiculiferum* (Guyane). A : Région cervicale. B : Système reproducteur. C : Région céphalique. D,E : Queue.F : Femelle, en entier.

Description. Femelle. Corps court, massif, très peu aminci vers l'avant et vers l'arrière, courbé ventralement en forme de parenthèse, la courbure étant un peu plus nette au tiers postérieur. Région labiale de forme générale arrondie, large, un peu aplatie à l'avant ; séparation d'avec le reste du corps très peu marquée, voire absente. Ouverture des amphides en fente large, à la base de la région labiale. Pores cervicaux (n = 5) : 2-5 dorsaux, 9-13 ventraux, 12-16 latéraux. Vulve située antérieurement (au niveau du tiers antérieur) ; vagin légèrement oblique et dirigé vers l'arrière ; aucune trace de la branche génitale antérieure et ovéjecteur asymétrique ; branche postérieure courte ; utérus court, sans différenciation. Queue hémisphérique ou en ogive faiblement marquée, symétrique ; cuticule très épaisse, surtout à l'extrémité ; pas de canal aveugle terminal.

Localités. Guyane (3, 6).

Remarques. Cette espèce se reconnaît aisément étant la seule à combiner les deux caractères « absence totale de branche génitale femelle antérieure » et « queue hémisphérique ».

Les échantillons étudiés ne contenaient aucun mâle. Deux seulement sont connus, de Malaisie (SAUER et WINOTO, 1975) et des îles Salomon (HEYNS et COOMANS, 1983).

Cette espèce a été originellement décrite des îles Fidji (COBB, 1893 ; SOUTHEY et LUC, 1973) où ORTON WILLIAMS (1980) la considère comme peu fréquente, alors que ce même auteur l'a couramment rencontrée dans les îles océaniennes de Niue, Samoa et Tonga. *X. ensiculiferum* a également été signalé dans les pays suivants : Hawaiis, Philippines (COHN et SHER, 1972), Nouvelles-Hébrides (YEATES, 1973), Malaisie (SAUER et WINOTO, 1975 ; AHMAD et BAQRI, 1987 [*X. ilyasi* (*)], Inde-Kerala (BAJAJ et JAIRAJPURI, 1979), îles Salomon (HEYNS et COOMANS, 1983).

En dehors de l'aire pacifique, *X. ensiculiferum* a été rapporté du Brésil (CARVALHO, 1955 ; SHARMA ET SHER, 1973a ; FERRAZ *et al.*, 1989) et de Floride (NORTON *et al.*, 1984). En fait, seule la signalisation de FERRAZ *et al.* (1989) est fiable. La population citée par CARVALHO (1955) correspond en réalité à *X. surinamense* (cf. FERRAZ, 1980) ; les deux autres signalisations ne comportent pas suffisamment d'éléments pour être assuré de l'identification.

Cette espèce existerait également au Pérou. JATALA (1975) signale en effet un *Xiphinema* sp. « closely related to *X. ensiculiferum* » dont l'illustration (pas de mesures) va à l'appui de cette identification. LAMBERTI *et al.* (1987b) citent ces mêmes individus comme « *X. spec.* », mais ALKEMADE et LOOF (1990) admettent qu'il s'agit très vraisemblablement de *X. ensiculiferum.*

Quoiqu'il en soit, nos observations confirment la présence de cette espèce dans la partie nord de l'Amérique du Sud.

(*) *X. ilyasi* AHMAD et BAQRI, 1987 a été synonymisé avec *X. ensiculiferum* par LOOF et LUC dans : « A revised polytomous key for the identification of species of the genus *Xiphinema* COBB, 1913 (Nematoda : Longidoridae) with exclusion of the *X. americanum*-group : Supplement I ». *Systematic Parasitology* (sous presse).

Xiphinema filicaudatum subsp. *labratum* subsp. n. (*)
(Figs 5 et 6)

Dimensions. Femelles. (n = 5 ; holotype et paratypes) : L = 3,27-3,76 (3,57 ± 0,20) mm ; a = 63,8-68,4 (65,5 ± 1,87) ; b = 5,0-6,8 (6,1 ± 0,49) ; queue = 345-447 (408 ± 38,95) µm; c = 7,6-10,2 (8,8 ± 0,96) ; c' = 10,4-13,9 (12,3 ± 1,27) ; V = 43,1-45,9 (44,7 ± 1,27) ; odontostyle = 185-191 (188 ± 2,83) µm ; odontophore = 105-123 (117,5 ± 7,16) µm ; stylet = 294-314 (305,5 ± 7,76) µm.

Holotype : L = 3,76 mm ; a = 68,4 ; b = 6,1 ; queue = 447 µm ; c = 8,4 ; c' = 12,8 ; V = 43,1 ; odontostyle = 190 µm ; odontophore = 121 µm ; stylet = 311 µm.

Description. Femelle. Corps long et fin, presque droit — seule l'extrémité de la queue est souvent courbée ventralement — longuement aminci vers l'avant et surtout vers l'arrière. Région labiale étroite, en ogive, comportant une sclérotisation hexaradiale et sans séparation d'avec le reste du corps, avec à l'avant — caractère unique dans le genre — un bourrelet très fin mais net entourant l'ouverture orale. Amphides à ouverture en fente étroite et courbée, occupant moins de 50 % du diamètre correspondant. Stylet très long (300 µm et plus). Pores cervicaux (n = 3) : 3 dorsaux, 10 ventraux, 13-17 latéraux. Vulve située un peu en avant de la mi-longueur du corps. Vagin perpendiculaire au grand axe du corps. Ovéjecteur bien défini. Branche génitale postérieure présentant un utérus court, composé d'une partie distale (**) glandulaire et d' une partie proximale (**) fortement muscularisée. Branche antérieure réduite, utérus nettement plus long que celui de la branche postérieure, ceci surtout dû à la longueur de la partie musculaire ; sphincter bien visible, oviducte dégénéré, ovaire absent. Queue très longue, d'abord conique puis effilée, généralement courbée ventralement à sa partie postérieure, extrémité pointue.

Localité. Guyane (3).

Remarques. Aucun mâle n'a été observé ici. L'espèce est elle-même très facilement reconnaissable par son aspect effilé, sa longue queue, le très grand stylet (environ 300 µm) et la réduction de la branche génitale femelle antérieure. Le caractère discret mais net, unique dans le genre, qui permet une identification immédiate de la nouvelle sous-espèce est représenté par le bourrelet entourant l'ouverture orale.

Cette espèce, décrite sur deux importantes populations provenant de deux localités du Suriname (Loof et Maas, 1972), n'avait pas été signalée depuis. Les deux populations surinamiennes diffèrent entre elles par certains caractères tels la

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(*) Holotype et deux paratypes déposés dans la Collection Nationale des Nématodes Parasites des Plantes et du Sol, Muséum National d'Histoire Naturelle, Paris. Un paratype déposé dans chacune des collections de l'Instituut voor Dierkunde, Gand, Belgique et de l'Agricultural University, Wageningen, Pays-Bas.

(**) « Proximal » et « distal » se réfèrent à la position par rapport à la vulve.

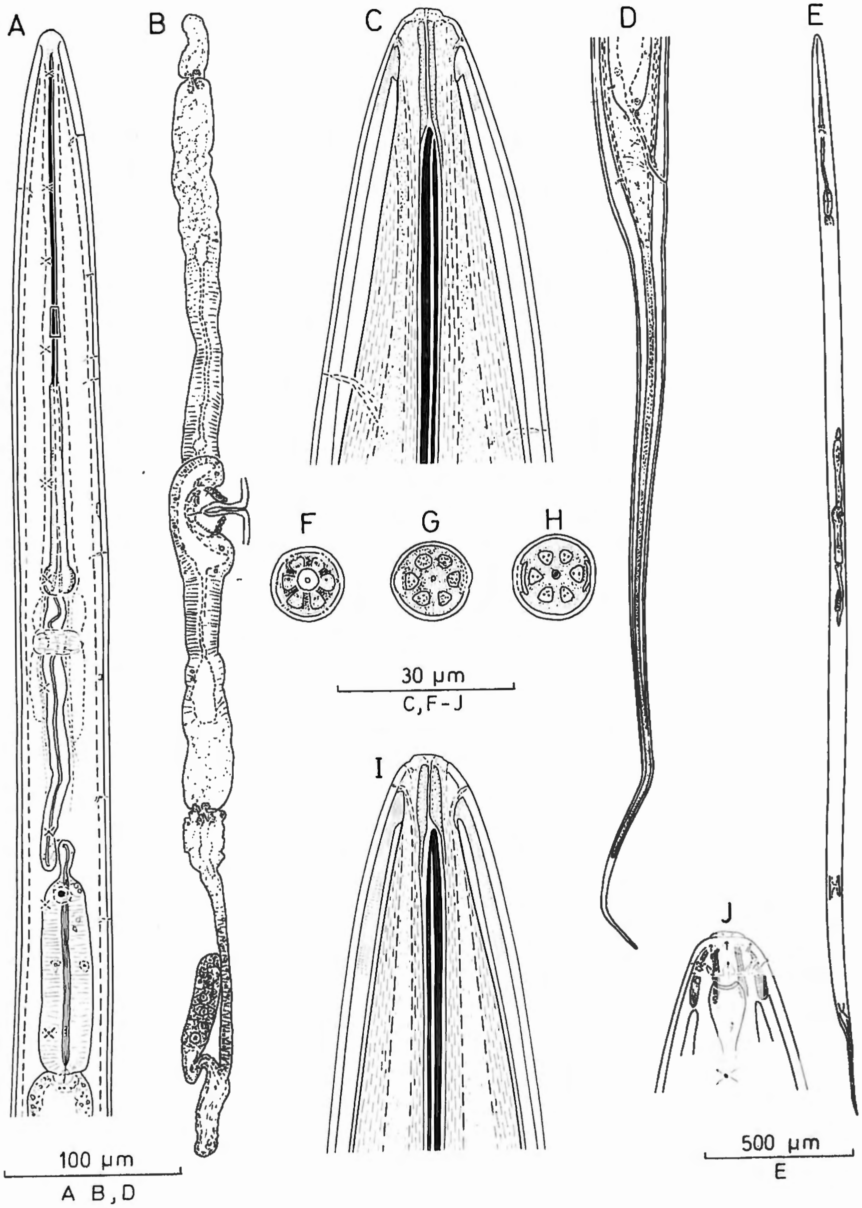

Fig. 5. — *Xiphinema filicaudatum labratum* n. subsp. (Guyane). A : Région cervicale. B : Système reproducteur. C, I : Région céphalique (vue médiane). D : Queue. E : Femelle, en entier. F-H : Sections consécutives de la région céphalique. J : Région céphalique en vue latérale superficielle.

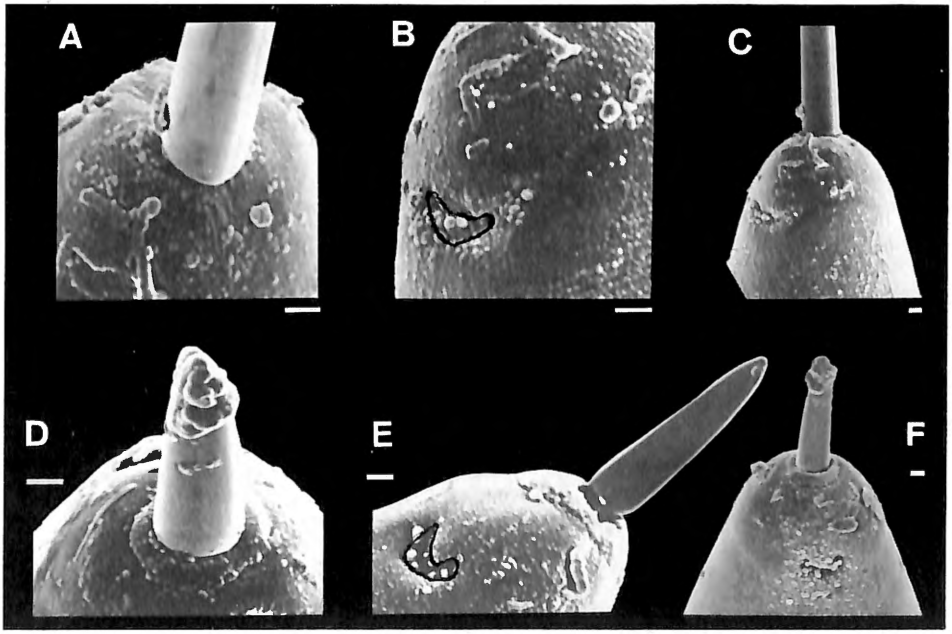

Fig. 6. — *Xiphinema filicaudatum*. A-C : *X. f. filicaudatum* (paratype). D-F : *X. f. labratum* n. subsp. (Gyane). A-D : Région labiale vue en face et légèrement oblique. B-E : Détail de l'extrémité antérieure avec ouverture amphidienne à gauche. C : Extrémité antérieure, en vue submédiane. F : Idem, en vue latérale (Barre = 1 µm).

valeur de L et V (pop. La Poule, type : L = 4.06-4.70 mm ; V = 40-43. Pop. Alasabaka : L = 3.70-4.11 mm ; V = 43-47). Les mâles n'ont été rencontrés que dans la population type. Les spécimens observés ici se rapprochent de la population Alasabaka par la valeur de L, encore plus faible, celle de V, l'absence de mâles, et la présence d'un bourrelet peri-oral, lequel n'a pu être observé chez la population La Poule, type.

Il nous parait donc justifié de considérer l'existence de deux sous-espèces, *X. filicaudatum filicaudatum* Loof et Maas, 1972 et *X. filicaudatum labratum* n. subsp. ; à cette dernière nous rapportons les spécimens décrits ici et la population surinamienne d'Alasabaka (Loof et Maas, 1972). Comme cité plus haut, ces deux sous-espèces diffèrent par les valeurs de L et V, et surtout par la présence d'un bourrelet péri-oral et, dans une moindre mesure, par l'absence de mâles chez *X. filicaudatum labratum* n. subsp.

Xiphinema ifacolum Luc, 1961
(Fig. 7)

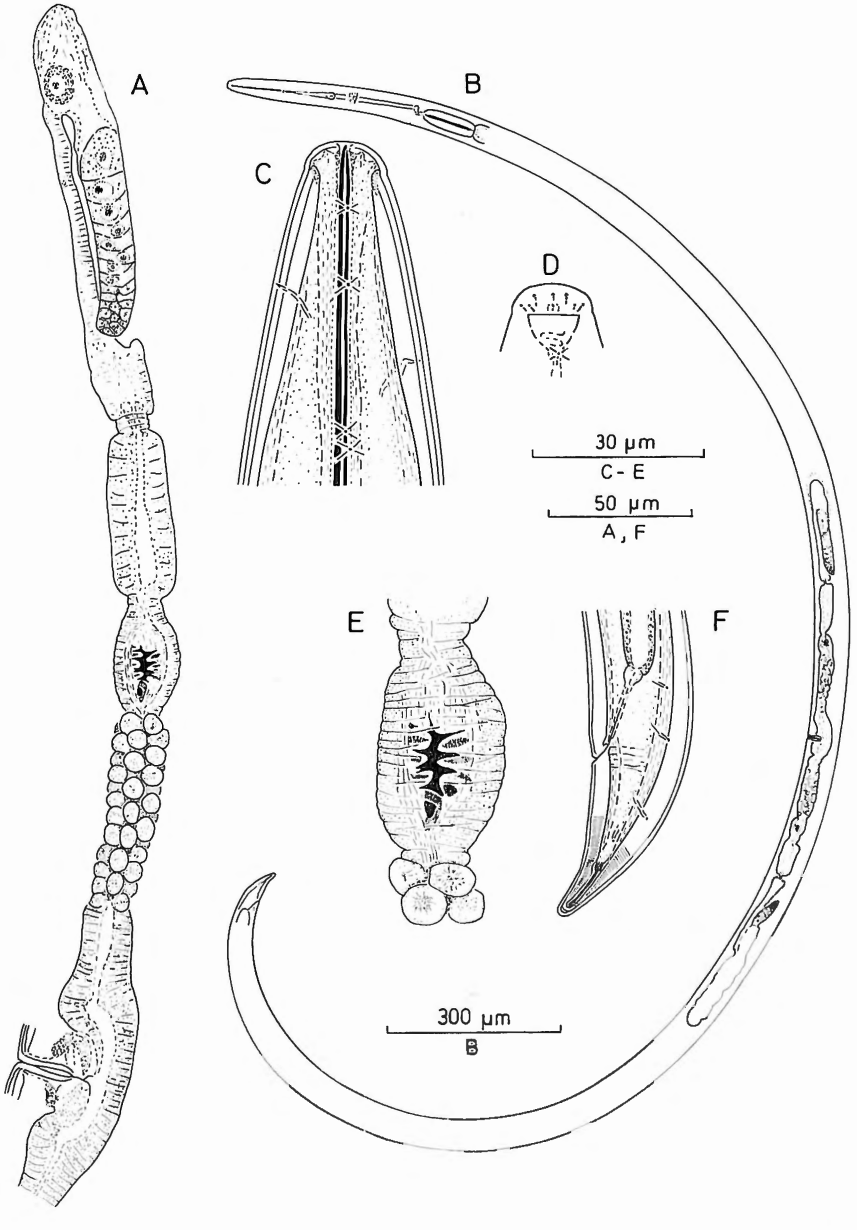

Fig. 7. — *Xiphinema ifacolum* (Guyane). A : Système reproducteur, branche antérieure. B : Femelle, en entier. C : Région céphalique. D : Région céphalique en vue latérale superficielle. E : Différenciation Z. F : Queue.

Dimensions. Femelles. (n = 5). L = 3,16-3,48 (3,29 ± 0,12) mm ; a = 58,0-68,7 (62,1 ± 4,50) ; b = 7,0-7,7 (7,3 ± 0,30) ; queue = 54-65 (60 ± 4,03) µm ; c = 50,8-60,9 (55,5 ± 4,69) ; c′ = 1,6-2,0 (1,8 ± 0,16) ; V = 48,4-52,8 (51,3 ± 1,34) ; odontostyle = 112-128 (121 ± 6,42) µm ; odontophore = 68-71 (69 ± 1,30) µm ; stylet = 180-197 (190 ± 6,88) µm.

Description. Femelle. Corps de longueur moyenne, peu aminci vers l'avant et vers l'arrière, en C parfois assez refermé, partie postérieure pouvant amorcer une spirale. Région labiale arrondie, de largeur moyenne. Ouverture des amphides en fente large située au niveau de l'épaulement. Pores cervicaux (n = 4) : 4 dorsaux, 10-12 ventraux, 18-23 latéraux. Vulve située à mi-corps. Branches génitales de mêmes longueur et structure. Vagin perpendiculaire au grand axe du corps ; ovéjecteur moyennement développé ; pas de muscularisation au niveau de la jonction entre ovéjecteur et utérus ; utérus long, comportant un organe Z puissant, allongé, très muscularisé et contenant des apophyses internes assez développées. Queue conique, de longueur moyenne, légèrement courbée ventralement (courbure dorsale plus importante), subdigitée, extrémité arrondie ; le canal aveugle est très particulier : très fin, il est légèrement dilaté à son extrémité et parait entouré d'un manchon à sa partie antérieure.

Localité. Guyane (7).

Remarques. Cette espèce est facilement caractérisée par la présence d'un organe Z bien développé et la structure particulière du canal aveugle de la queue.

Aucun mâle n'est connu.

X. ifacolum, observé en Afrique de l'Ouest et notamment de Guinée (LUC, 1961), de Côte d'Ivoire (ADIKO, 1988) et du Liberia (LAMBERTI *et al.*, 1987 a), a été également signalé au Brésil (LOOF et SHARMA, 1979).

Xiphinema krugi LORDELLO, 1955
(Figs 8, 9)

Dimensions. Femelle. (n = 1). L = 2,01 mm ; a = 43,7 ; b = 4,8; queue = 28 µm ; c = 71,8 ; c′ = 0,8 ; V = 35,3 ; odontostyle = 125 µm; odontophore = 71 µm ; stylet = 196 µm.

Mâle (n = 1). L = 2,10 mm ; a = 47,3 ; b = 4,7 ; queue = 37 µm ; c = 56,8 ; c′ = 1,0; odontostyle = 120 µm ; odontophore = 73 µm ; stylet = 193 µm ; spicules = 69 µm ; pièces accessoires = 11 µm.

Description. Femelle. Corps assez massif, peu effilé vers l'avant, encore moins vers l'arrière, courbé ventralement, surtout dans la partie postérieure ceci conférant une forme de J. Région labiale arrondie, séparée du reste du corps par une constriction faible mais nette. Ouverture des amphides en fente large, au niveau de la constriction. Pores cervicaux (n = 2) ; 3 dorsaux, 7, 10 ventraux, 14, 15 latéraux. Vulve située antérieurement ; vagin perpendiculaire au grand axe du corps. Branche génitale postérieure normale, relativement courte, utérus sans différenciation par-

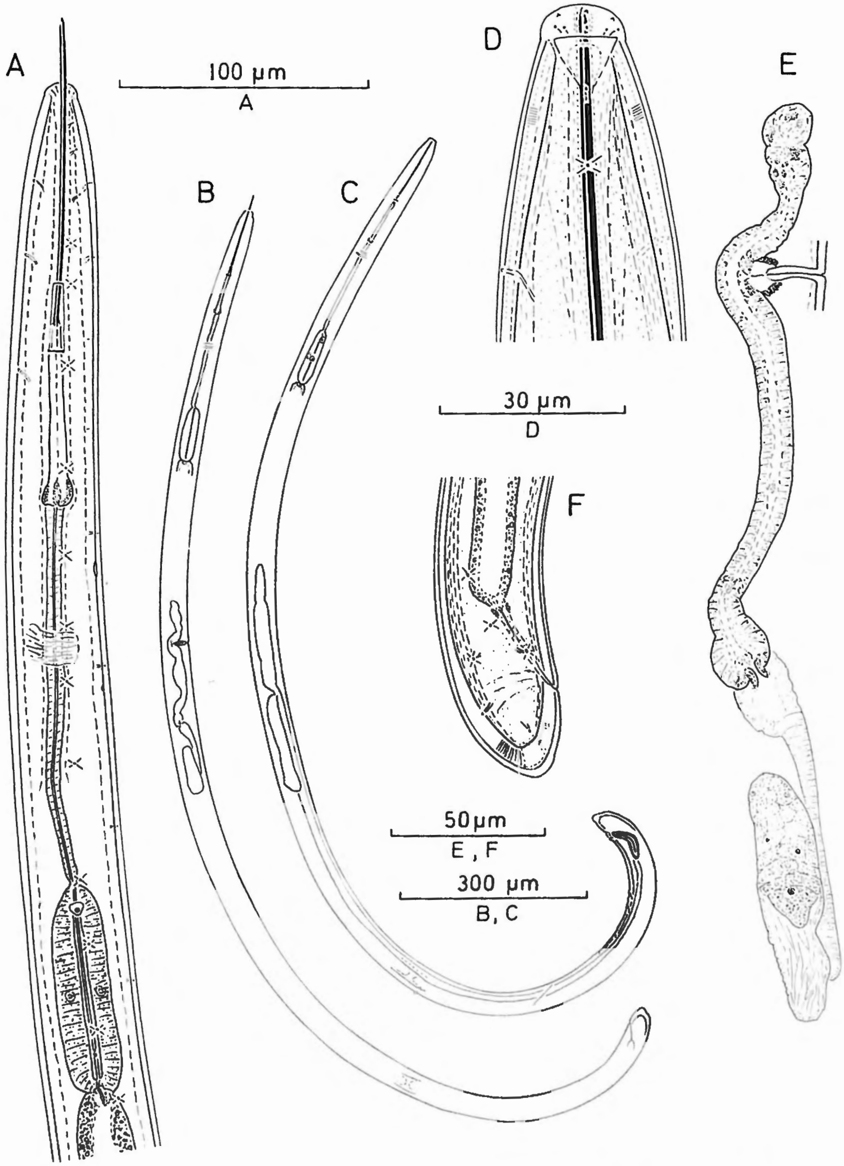

Fig. 8. — *Xiphinema krugi* (Martinique). A : Région cervicale de la femelle. B : Femelle, en entier. C : Mâle, en entier. D : Région céphalique du mâle. E : Système reproducteur de la femelle. F : Queue de la femelle.

ticulière. Branche antérieure réduite : utérus plus court que le postérieur et mal différencié ; sphincter joignant utérus et oviducte dégénéré, difficilement discernable ; oviducte réduit à une très courte masse indifférenciée ; ovaire absent. Queue arron-

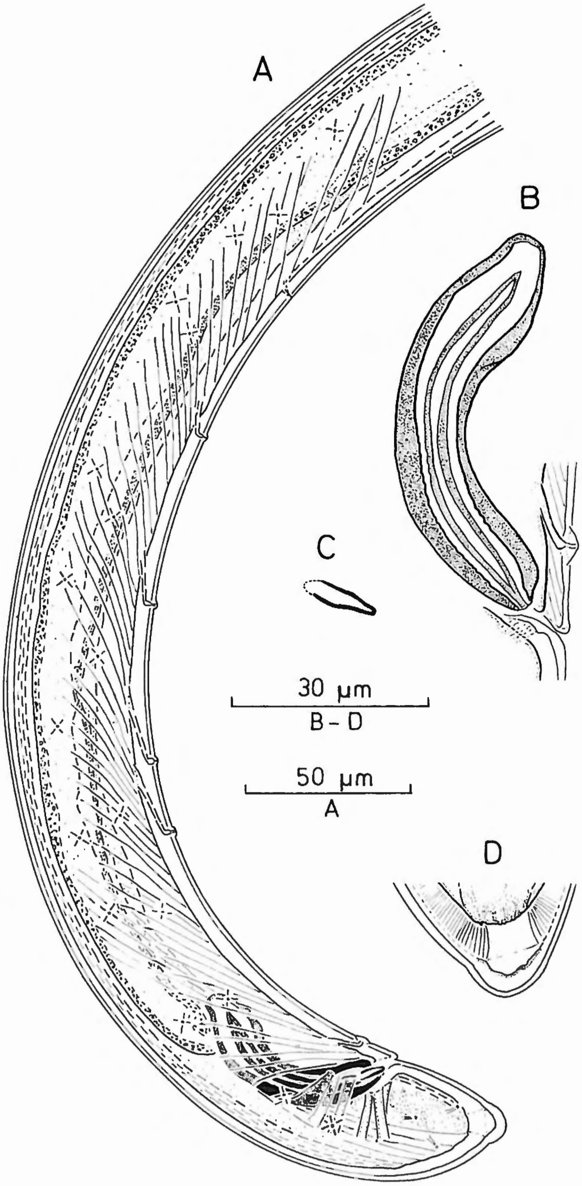

Fig. 9. — *Xiphinema krugi* (Martinique). A : Région postérieure du mâle. B : Spicule. C : Pièce accessoire du gubernaculum. D : Portion terminale de la queue du mâle.

die, ogivale, à courbure dorsale plus prononcée que la courbure ventrale, comportant à l'extrémité une bosse, ici en relief ; cette bosse est sous-tendue par un apparent « décollement » (zone optiquement vide) des couches cuticulaires, assez caractéristique.

Mâle. Aspect général identique à celui de la femelle, mais corps beaucoup plus courbé ventralement à sa partie postérieure en crochet ; queue un peu plus longue. Spicules courbés ; pièces accessoires du gubernaculum courtes, triangulaires. Papille ventrale double située 12 µm en avant de l'ouverture cloacale ; quatre suppléments ventraux situés 91, 113, 162 et 215 µm en avant de l'ouverture cloacale.

Localité. Martinique (17).

Remarques. Cette espèce est assez facilement reconnaissable par le type de réduction de la branche génitale femelle antérieure, l'attitude en J du corps lorsque fixé, et la forme et la structure particulière de la queue. Cette forme est toutefois variable suivant les populations et les individus : la bosse terminale peut ainsi être pratiquement absente, seul le « décollement » cuticulaire étant visible, ou au contraire assez développée pour former un mucron de plusieurs microns de long. Le diagnostic ne devra donc pas s'appuyer sur les seuls caractères liés à la forme de la queue.

Les mâles de cette espèce sont fort rares et, en dehors de celui décrit ici, deux autres seulement ont été observés, l'un au Sri-Lanka (LOOS, 1949), l'autre au Brésil (FERRAZ, 1980).

X. krugi est une espèce pan-tropicale, rencontrée au Brésil, Paraguay, Suriname, USA (Floride et Alabama), Sénégal, Ile Maurice, Sri-Lanka (cf. LUC et HUNT, 1970). Elle a été également signalée en Afrique du Sud (HEYNS, 1977), à la Réunion (LAMBERTI *et al.*, 1986), à Trinidad (BALA, 1984), aux îles Fidji (ORTON WILLIAMS, 1980) et en Inde (SHARMA et EDWARD, 1986).

Xiphinema macrostylum ESSER, 1966
(Figs 10 et 11)

Dimensions. Femelles. (localité 18 ; n = 14). L = 1,83-2,40 (2,19 ± 0,17) mm ; a = 26,6-42,1 (31,4 ± 3,44) ; b = 4,2-5,3 (4,8 ± 0,31) ; queue = 28-42 (35,5 ± 3,68) µm ; c = 52,6-85,7 (62,6 ± 7,68) ; c' = 0,6-0,8 (0,7) ; V = 41,3-47,6 (45,5 ± 1,92) ; odontostyle = 141-168 (153,5 ± 8,23) µm ; odontophore = 80-97 (90 ± 4,77) µm ; stylet = 224-264 (243 ± 10,60) µm.

Mâles. (localité 18 ; n = 10). L = 1,88-2,32 (2,16 ± 0,16) mm ; a = 30,7-42,7 (35,1 ± 3,30) ; b = 3,9-5,5 (4,5 ± 0,51) ; queue = 37-46 (40,9 ± 3,30) µm; c = 47,5-60,5 (53,0 ± 3,72) ; c' = 0,8-0,9 (0,8 ± 0,05) ; odontostyle = 141-156 (150,5 ± 5,14) µm ; odontophore = 83-94 (87,5 ± 3,50) µm ; stylet = 227-245 (238 ± 5,16) µm ; spicules = 79-91 (89,5 ± 4,36) µm ; pièces accessoires = 16-23 (19 ± 1,98) µm.

Description. Femelle. Corps épais, massif, très peu aminci vers l'avant et vers l'arrière, en C très ouvert ; moitié antérieure souvent rectiligne. Cuticule épaisse, surtout dans la région sous-labiale et sur la queue. Région labiale large, arrondie parfaitement continue avec le reste du corps. Ouverture des amphides en fente

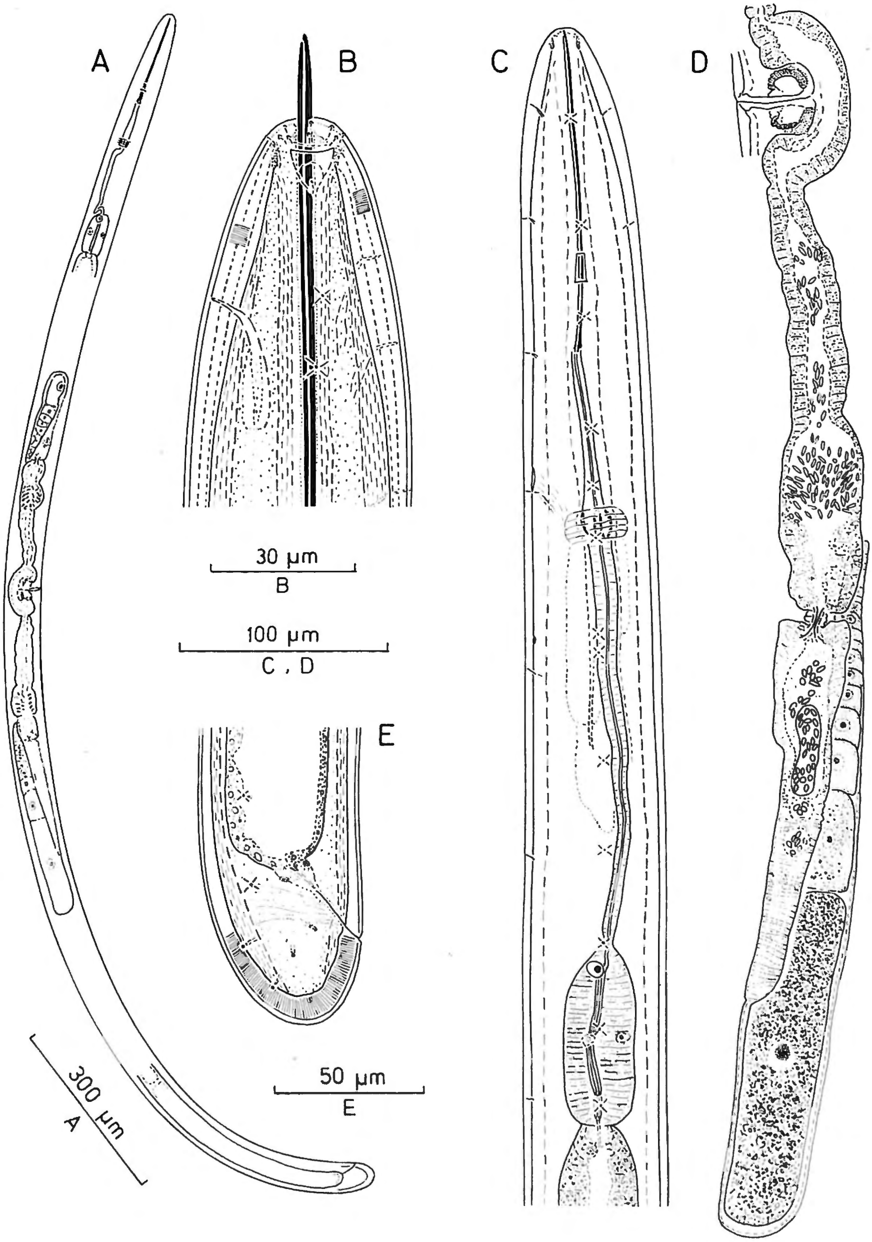

Fig. 10. — *Xiphinema macrostylum* (Martinique). A : Femelle, en entier. B : Région céphalique de la femelle. C : Région cervicale du mâle. D : Système reproducteur de la femelle (branche postérieure). E : Queue de la femelle.

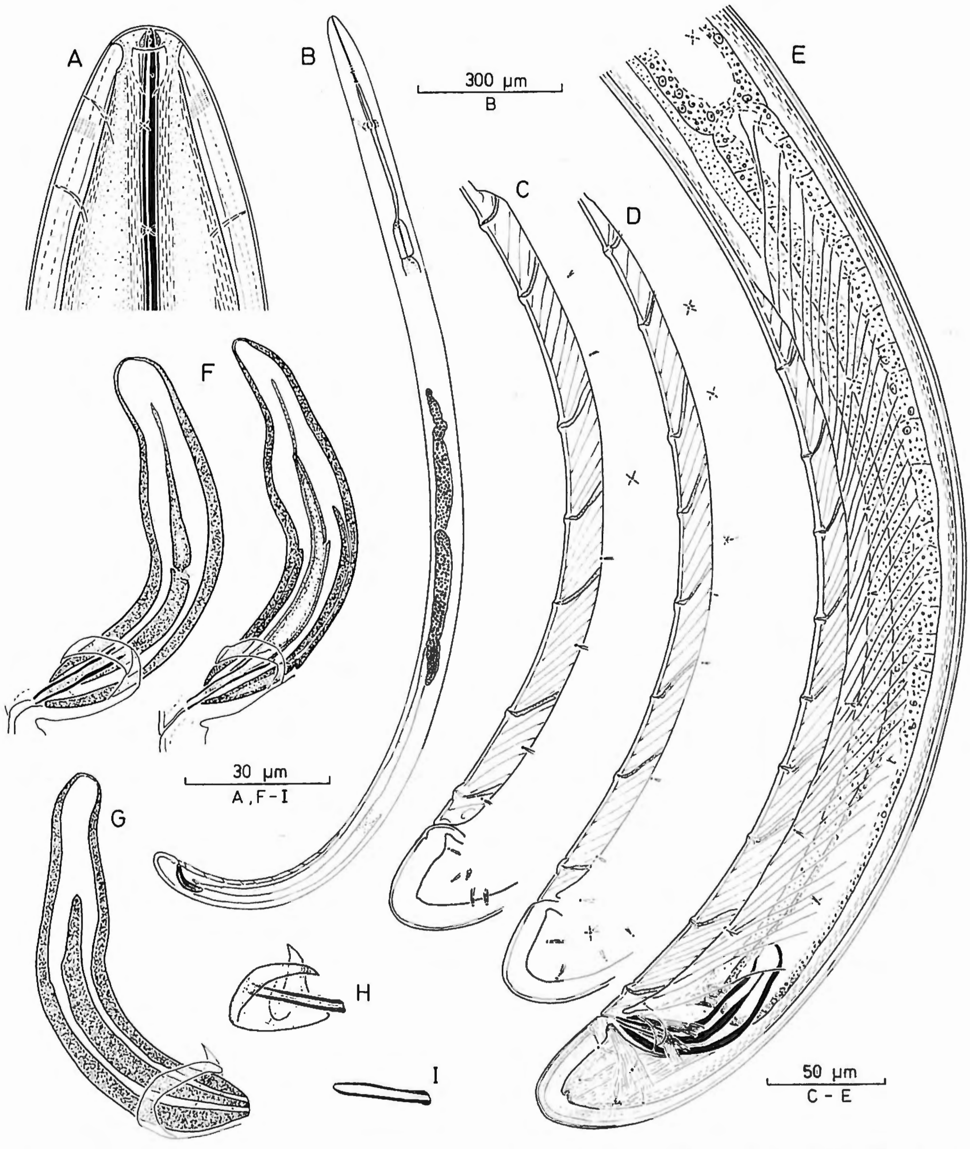

Fig. 11. — *Xiphinema macrostylum* (Martinique). A : Région céphalique du mâle. B : Mâle, en entier. C,D : Position des papilles génitales chez deux mâles. E : Région postérieure du mâle. F,G : Spicules. H : Gubernaculum. I : Pièce accessoire du gubernaculum.

courte (40 % du diamètre correspondant), parfois légèrement oblique ou courbée. Pores cervicaux (n = 6), 3 dorsaux, 7 ventraux (n = 1), 11-17 latéraux. Vulve située un peu en avant de la moitié du corps ; vagin perpendiculaire au grand axe du corps ; deux branches génitales de longueur à peu près égale, sans caractères particuliers, et notamment sans différenciation utérienne. Queue hémisphérique ou légèrement ogivale ; cuticule très épaisse à l'extrémité, sans canal aveugle.

Mâle. Aspect général identique à celui de la femelle, mais corps fortement courbé ventralement à la partie postérieure (aspect en poignée de canne). Fente amphidienne plus étroite que chez la femelle (environ 30 % du diamètre correspondant). Spicule long, fin, courbé en faucille ; pièces accessoires du gubernaculum linéaires ; queue de même forme que celle de la femelle, toutefois légèrement plus longue. Papille ventrale double située 15-20 µm en avant de l'ouverture cloacale. Les suppléments ventraux sont remarquables par leur nombre (généralement 7 ou 8, plus rarement 6) et surtout par le fait que le premier supplément est placé à une courte distance de la papille ventrale, l'espace entre cette papille et celui entre les différents suppléments étant de valeur voisine. Ces suppléments s'étagent comme suit (distance à partir de l'ouverture cloacale : S1 = 48-96 µm ; S2 = 78-111 µm ; S3 = 102-143 µm ; S4 = 133-206 µm ; S5 = 183-269µm ; S6 = 214-304 µm ; S7 (n = 8) = 251-303 µm ; S8 (n = 5) = 265-301 µm. Un nombre aussi élevé et une telle disposition de ces suppléments est exceptionnelle dans le genre en dehors du « groupe *Xiphinema americanum* ».

Localités : Martinique (17, 18).

Remarques. Dans le groupe des espèces possédant deux branches génitales femelles également développées et sans différenciation utérienne, cette espèce est assez facilement reconnaissable par sa queue hémisphérique dépourvue de canal aveugle, la très grande longueur de son stylet, la région labiale continue avec le reste du corps et les fentes amphidiennes étroites.

Les mâles étaient considérés jusqu'ici comme rares, un seul ayant été décrit, de la Dominique (Hunt, 1976). Ils sont au contraire relativement abondants dans les populations étudiées ; le tractus génital de la plupart des femelles contient d'ailleurs des spermatozoïdes.

Cette espèce n'avait jusque là été signalée que de l'Equateur (Esser, 1966) et de la Dominique (Hunt, 1976), dans les deux cas au voisinage de racines de bananiers.

Xiphinema oryzae Bos et Loof, 1985
(Fig. 12)

Dimensions. Femelle. (n = 1). L = 3,42 mm ; a = 65,8 ; b = ? ; c = 8,2 ; c' = 13,0 ; V = 35,1 ; odontostyle = 149 µm : odontophore = 71 µm ; stylet = 220 µm ; queue = 417µm.

Description. Femelle. Corps mince, élancé, moyennement effilé vers l'avant, longuement vers l'arrière, légèrement courbé ventralement, cette courbure étant plus prononcée à la partie postérieure. Région labiale arrondie, de largeur moyenne, séparée du reste du corps par une dépression peu marquée. Ouverture des amphides en fente large (environ 60 % du diamètre correspondant), située au niveau de la dépression. Vulve située un peu en arrière du tiers antérieur du corps; vagin per-

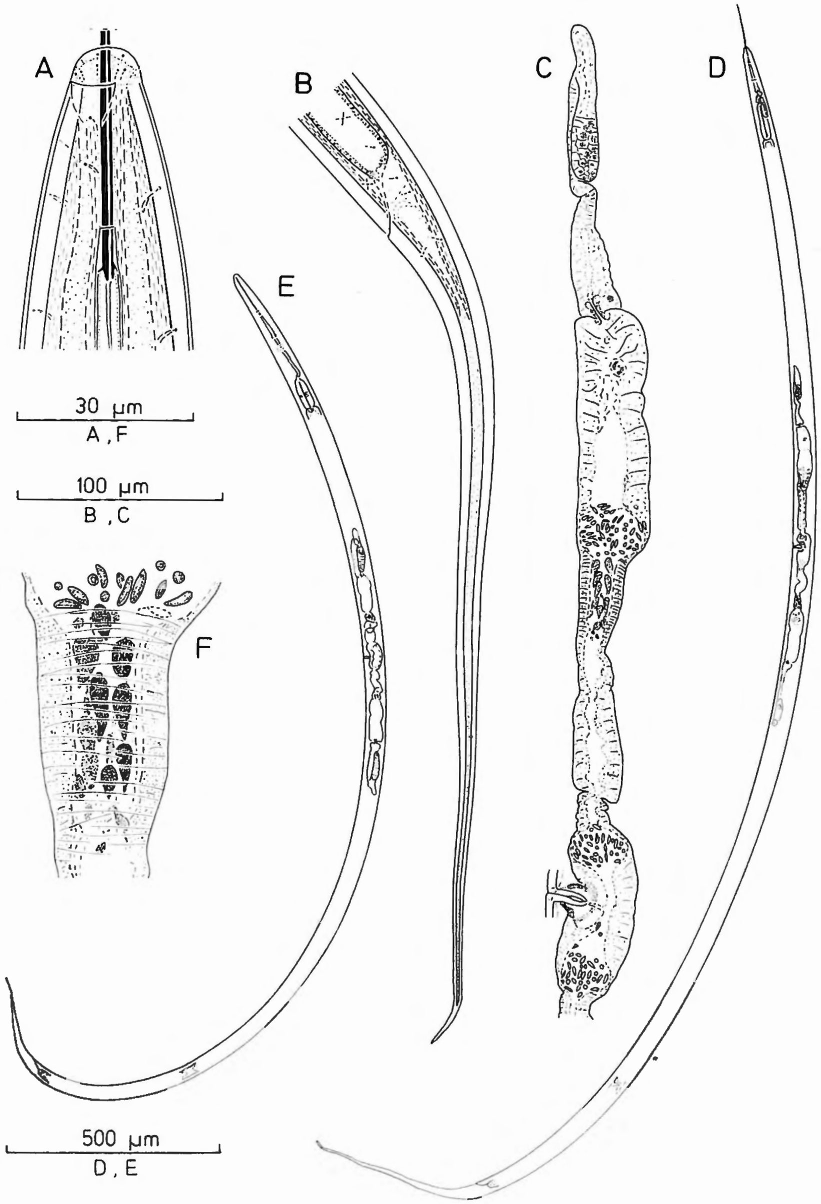

Fig. 12. — *Xiphinema oryzae (Guyane)*. A : Région céphalique. B : Queue. C : Système reproducteur de la femelle (branche antérieure). D : Femelle, en entier. E: Paratype (Nigéria). F : Différenciation Z.

pendiculaire au grand axe du corps; ovéjecteur très développé; deux branches génitales de longueur voisine et de structure identique; utérus composé d'une partie distale principalement glandulaire et comportant dans sa partie proximale une zone « spermathèque » et une différenciation Z assez particulière (apophyses pointues dirigées vers la vulve), et une partie plus ou moins tubulaire avec muscularisation bien développée. Queue très longue, régulièrement effilée, courbée ventralement, à cuticule épaisse; partie hyaline terminale courte (60 µm ou 14 % de la longueur totale de la queue), extrémité pointue.

Localité. Guyane (3).

Remarques. Cet unique spécimen est rapporté à *X. oryzae*, espèce dont il est le plus proche par l'aspect général, la forme de la queue, celle de la région labiale, la position relativement antérieure de la vulve, la structure des branches génitales dont la présence d'une différenciation Z. Il diffère toutefois de la population type — et unique — par la plus grande longueur du corps et de la queue (3,42 *vs* 2,6-3,07 mm et 417 *vs* 182-251 µm, respectivement), par un stylet également plus long (220 *vs* 167-184 µm) et, quelque peu, par la structure de la différenciation Z. La variabilité de ces caractères, observée chez d'autres espèces, et la concordance des principaux caractères, conduit toutefois à identifier provisoirement ce spécimen à *X. oryzae*.

Aucun mâle n'a été observé. Un seul est connu, dans la population type.

Cette espèce, décrite sur riz au Nigéria (Bos et Loof, 1985) n'avait pas été signalée depuis. Parmi les espèces présentant une différenciation Z, elle est aisément reconnaissable par la combinaison d'une queue longuement effilée et la position relativement antérieure de la vulve.

Xiphinema paritaliae Loof et Sharma, 1979
= *X. dolosum* Bos et Loof, 1985
(Fig. 13)

Dimensions. Femelles. (localité 2 ; n = 25). L = 2,65-3,77 (3,17 ± 0,24) mm; a = 45,7-87,4 (58,3 ± 11,43) ; b = 6,3-11,6 (9,0 ± 1,65) ; queue = 72-102 (91 ± 8,67) µm ; c = 27,9-52,4 (35,4 ± 5,71) ; c' = 2,4-3,1 (2,8 ± 0,21) ; V = 41,6-46,2 (43,9 ± 1,39) ; odontostyle = 120-132 (127,5 ± 2,91) µm ; odontophore = 59-78 (73 ± 4,24) µm ; stylet = 179-207 (200,5 ± 6,57) µm.

(localité 3 ; n = 12). L = 3,05-3,51 (3,27 ± 0,17) mm ; a = 56,7-74,7 (65,7 ± 4,91) ; b = 7,4-8,8 (8,2 ± 0,49) ; queue = 85-96 (89 ± 3,71)µm ; c = 34,3-41,3 (36,6 ± 2,21) ; c' = 2,7-2,9 (2,8 ± 0,07) ; V = 41,9-45,3 (43,4 ± 1,31) ; odontostyle = 130-146 (139,5 ± 4,48) µm ; odontophore = 67-78 (72,5 ± 3,40) µm ; stylet = 204-221 (212 ± 5,60) µm.

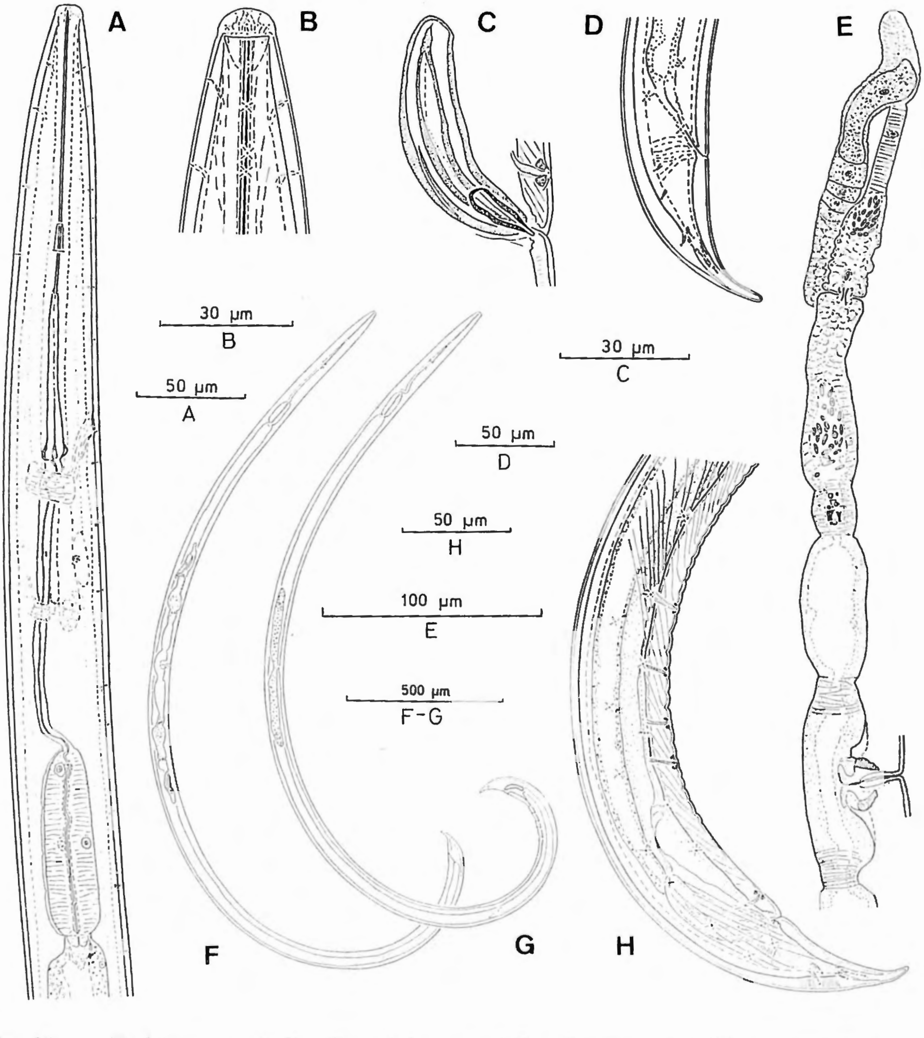

Fig. 13. — *Xiphinema paritaliae* (Martinique sauf E : Guyane). A : Région cervicale de la femelle. B : Région céphalique du mâle. C : Spicule et pièce accessoire du gubernaculum. D : Queue de la femelle. E : Système reproducteur de la femelle (branche antérieure). F : Femelle, en entier. G : Mâle, en entier. H : Région postérieure du mâle.

(localité 13 ; n = 8). L = 2,51-3,15 (2,90 ± 0,19) mm ; a = 56,9-72,2 (66,5 ± 4,33) ; b = 6,5-8,2 (7,2 ± 0,78) ; queue = 75-83 (79 ± 2,7) µm ; c = 32,6-40,4 (36,8 ± 2,36) ; c′ = 2,2-2,6 (2,4 ± 0,17) ; V = 39,1-42,2 (40,4 ± 1,07) ; odontostyle = 124-133 (127,5 ± 3,20) µm ; odontophore = 65-70 (68,5 ± 1,87) µm ; stylet = 190-200 (196 ± 3,73) µm.

Mâles. (localité 2 ; n = 10). L = 2,45-3,09 (2,80 ± 0,20) mm ; a = 50,4-75,4 (61,8 ± 8,95) ; b = 5,9-8,9 (6,9 ± 0,97) ; queue = 70-90 (80 ± 5,91) µm ; c = 30,5-38,0 (35,1 ± 1,92) ; c′ = 1,8-2,3 (2,2 ± 0,19) ; odontostyle = 125-132 (128 ± 2,17) µm ; odontophore = 63-72 (67 ± 2,82) µm ; stylet = 190-201 (195 ± 3,19) µm ; spicules = 54-62 (59 ± 2,68) µm ; pièces accessoires = 12-20 (15 ± 2,30) µm.

Description. Femelle. Corps fin, longuement aminci à l'avant et à l'arrière, courbé ventralement en forme de C ou de J. Région labiale arrondie séparée du reste du corps par un épaulement net. Ouverture des amphides en fente large (plus de 75 % du diamètre correspondant) au niveau de l'épaulement. Vulve située en avant de la moitié du corps ; une encoche ventrale (repli de la cuticule) ou des rides cuticulaires généralement présentes à une courte distance en arrière de la vulve (pop. Martinique, n = 9 : 8 avec encoche, 1 avec rides ; pop. Guyane, n = 15 : 2 avec encoche, 11 avec rides, 2 lisses) ; vagin perpendiculaire au grand axe du corps ; ovéjecteur puissant, comportant le plus souvent une zone muscularisée au contact avec l'utérus. Deux branches génitales identiques ; utérus relativement court composé d'une partie distale glandulaire faisant office de spermathèque et d'une partie proximale comportant une différenciation Z très variable, la musculature en étant plus ou moins longue et développée et les éléments sclérotisés, généralement anguleux, très variables en taille et en nombre. Queue régulièrement conique, de longueur moyenne, fortement courbée ventralement pour les deux cinquièmes postérieurs, extrémité arrondie.

Mâle. Aspect général identique à celui de la femelle ; corps plus courbé à sa partie postérieure et démarcation de la zone labiale moins nette. Spicules massifs, courbés ; pièces accessoires de forme générale triangulaire. Papille ventrale double située 12-17 µm en avant du cloaque. Quatre à cinq suppléments ventraux (exceptionnellement six).

Localités. Guyane (2, 3, 5) ; Martinique (8, 9, 10, 11, 12, 13).

Remarques. Cette espèce est assez facilement identifiable par la structure particulière de l'utérus, relativement court mais comportant une différenciation Z à musculature souvent puissante, et par la forme assez caractéristique de la queue, régulièrement conique et à courbure ventrale prononcée.

La synonymisation de *X. dolosum* et *X. paritaliae* est proposée et argumentée dans une autre publication (Coomans et Luc, sous presse) dans laquelle le mâle est décrit en détail, un seul ayant jusque là été signalé (Ferraz, 1980). Ces mâles paraissent en fait assez fréquents car présents dans toutes les populations abondantes examinées (pop. 3, 4, 12, 13).

Cette espèce est connue du Nigéria sous le nom de *X. dolosum* ; elle a été rencontrée, sous le nom de *X. paritaliae*, à plusieurs reprises au Brésil (Loof et

Sharma, 1979; Ferraz, 1980; Germani, 1989) et au Pérou (Lamberti *et al.*, 1987b ; Alkemade et Loof, 1990), associée à des plantes variées.

Xiphinema riocaquetae Hunt, 1982
(Fig. 14)

Dimensions. Femelle. (n = 1) : L = 2,91 mm ; a = 57,1 ; b = 4,3 ; c = 97,0 ; c′ = 0,8 ; V = 51,2 ; odontostyle = 182 µm ; odontophore = 98 µm ; stylet = 280 µm ; queue = 30 µm.

Description. Femelle. Corps long (parfois plus de 3 mm), peu effilé à l'avant, non effilé vers l'arrière, presque droit car seulement très légèrement et régulièrement courbé ventralement. Région labiale de largeur moyenne, arrondie ; séparation d'avec la partie postérieure du corps très peu marquée. Ouverture des amphides en fente longue d'environ 50 % du diamètre correspondant, à la base de la région labiale. Pores cervicaux (n = 1) : 3 dorsaux, 8 ventraux, 12 latéraux. Vulve située très peu en arrière de la mi-longueur du corps ; vagin perpendiculaire au grand axe du corps ; deux branches génitales de longueur comparable, complètes l'une et l'autre, sans différenciation utérienne. Queue hémisphérique, à cuticule épaisse, surtout à l'extrémité ; pas de canal terminal aveugle.

Localité. Guyane (3).

Remarques. Parmi les espèces présentant deux branches génitales femelles également développées sans différenciation utérienne et une queue hémisphérique sans canal aveugle, *X. riocaquetae* se distingue par son très long stylet, la séparation labiale faible mais néanmoins marquée, et surtout par son corps presque rectiligne après fixation.

Cette espèce, originellement décrite sur un faible nombre de spécimens (8) provenant de forêt primaire en Colombie (Hunt, 1982), n'avait pas été signalée depuis. Le mâle est inconnu.

Xiphinema setariae Luc, 1958
(= ***X. vulgare*** Tarjan, 1964)
(Fig. 15)

Dimensions. Femelles. (localité 20; n = 15). L = 2,76-3,55 (3,17 ± 0,22) mm; a = 61,2-74,3 (67,5 ± 3,40) ; b = 7,1-10,4 (8,0 ± 0,94) ; queue = 37-54 (46 ± 35) µm ; c = 60,2-88,4 (69,2 ± 7,72) ; c′ = 1,3-1,8 (1,7 ± 0,13) ; V = 36,8-40,3 (38,5 ± 0,96) ; odontostyle = 116-127 (122,5 ± 2,44) µm ; odontophore = 61-68 (64,5 ± 2,09) µm ; stylet = 177-191 (187 ± 3,41) µm.

(localité 22 ; n = 8). L = 2,38-3,30 (2,80 ± 0,39) mm ; a = 54,7-75,2 (63,1 ± 7,02) ; b = 6,4-8,7 (7,4 ± 0,87) ; queue = 47-50 (48 ± 1,27) µm ; c = 50,6-70,2 (58,3 ± 8,18) ; c′ = 1,5-1,8 (1,7 ± 0,12) ; V = 37,4-39,0 (38,3 ± 0,53) ; odontostyle = 108-123 (114 ± 5,60) µm ; odontophore = 64-70 (67 ± 2,47) µm ; stylet = 172-187 (181 ± 4,70) µm.

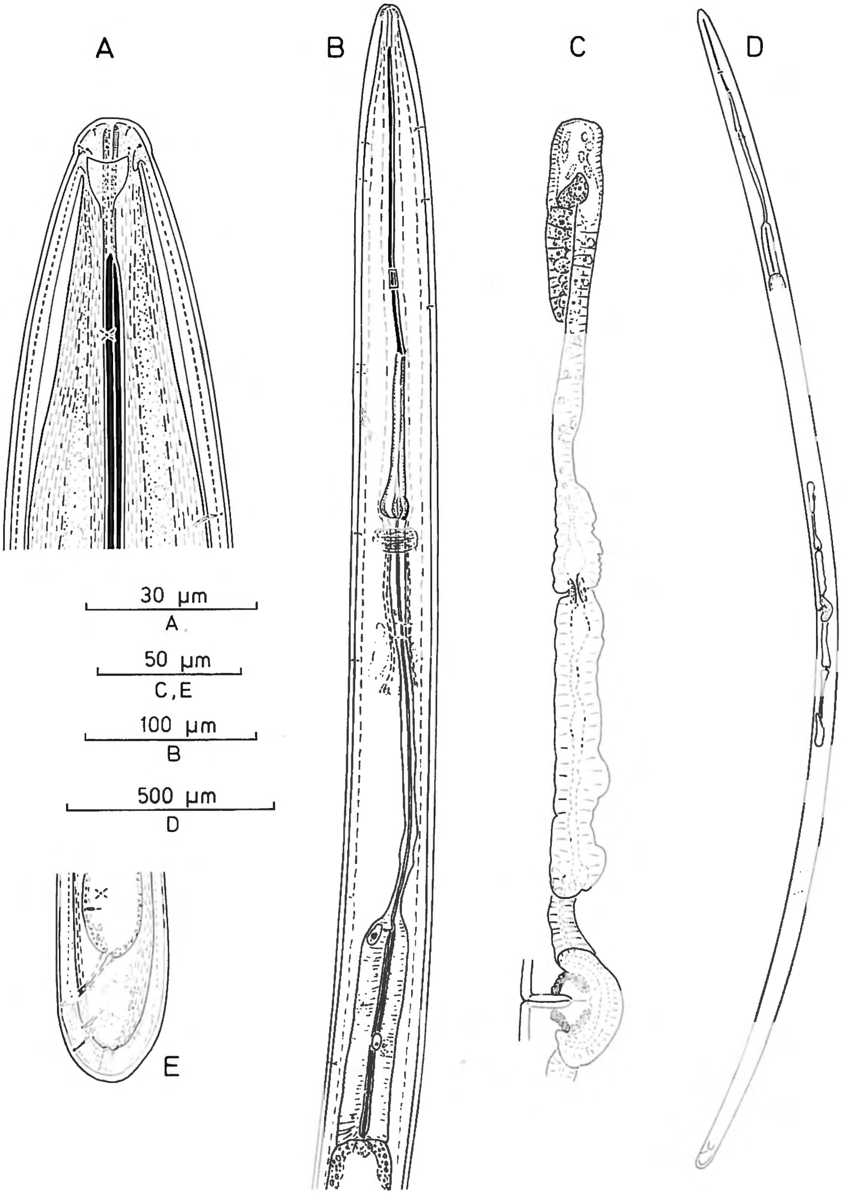

Fig. 14. — *Xiphinema riocaquetae* (Guyane). A : Région céphalique. B : Région cervicale. C : Système reproducteur de la femelle (branche antérieure). D : Femelle, en entier. E : Queue.

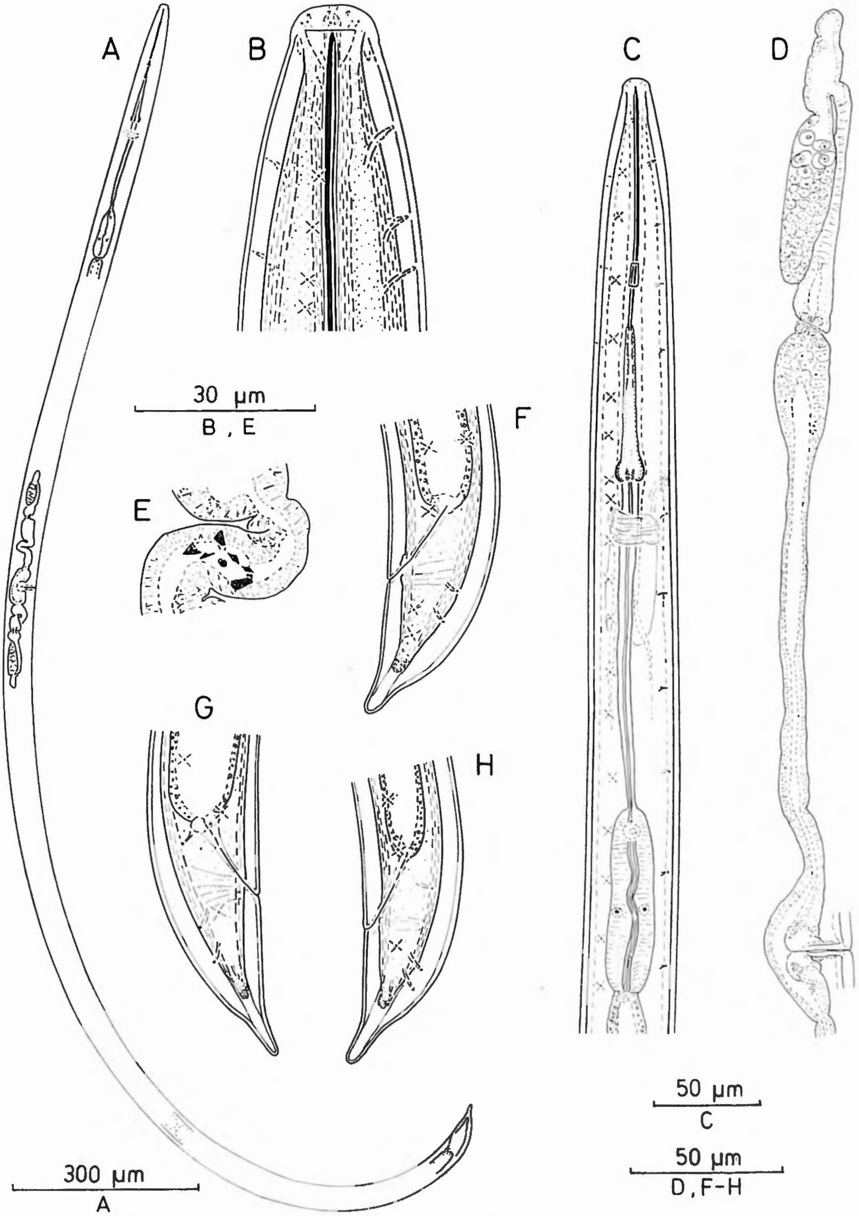

Fig. 15. — *Xiphinema setariae* (Martinique). A : Femelle, en entier. B : Région céphalique. C : Région cervicale. D : Système reproducteur de la femelle (branche antérieure). E : Différenciation Z. F-H : Queue.

(localité 23 ; n = 9). L = 2,31-2,64 (2,51 ± 0,12) mm ; a = 50,0-60,7 (54,8 ± 3,81) ; b = 6,2-7,4 (6,9 ± 0,39) ; queue = 43-51 (48 ± 2,57) µm ; c = 47,1-

57,2 (52,8 ± 3,20) ; c′ = 1,7-1,9 (1,8 ± 0,73) ; V = 38,2-40,5 (39,8 ± 0,73) ; odontostyle = 106-115 (111,5 ± 2,54) µm ; odontophore = 66-70 (68,5 ± 1,41) µm ; stylet = 174-184 (180 ± 3,20) µm.

Description. Femelle. Corps de longueur moyenne, relativement épais, peu aminci vers l'avant et vers l'arrière, en forme de C, la partie postérieure pouvant parfois être nettement plus courbée, conférant l'aspect d'un J ouvert. Région labiale arrondie, de largeur moyenne, séparée du reste du corps par une constriction peu marquée. Ouverture des amphides en fente longue de 60 % du diamètre correspondant, située nettement en avant de la constriction. Pores cervicaux (n = 4): 3-5 dorsaux, 11-12 ventraux, 16-21 latéraux. Vulve nettement antérieure à la mi-longueur du corps (V au plus 40). Deux branches génitales également développées, comportant parfois une faible différenciation utérienne. Queue de longueur moyenne, conique, à courbure dorsale plus prononcée que la ventrale ; partie terminale digitée, extrémité arrondie ; canal aveugle présent.

Localités. Guyane (2) ; Martinique (9, 15, 20, 21, 23, 24, 25, 26).

Remarques. Manquant de caractères vraiment particuliers, cette espèce n'est pas des plus faciles à identifier. Il est cependant possible de s'appuyer sur la longueur et la forme conique -subdigitée de la queue, la position de la vulve, rarement située à plus de 40 % de la longueur du corps et le stylet, de longueur moyenne.

Aucun mâle n'est connu.

X. setariae est une espèce pan-tropicale, signalée en Côte d'Ivoire (Luc, 1958), au Togo (Luc et Hoestra, 1960), au Botswana (Heyns et Coomans, 1991), au Brésil (Sharma et Sher, 1973b ; Sharma, 1975 ; Ferraz, 1980 ; Rashid *et al.*, 1987 ; Lamberti *et al.*, 1987c ; Ferraz *et al.*, 1989), au Suriname (Loof et Maas, 1972), au Pérou (Lamberti *et al.*, 1987b ; Alkemade et Loof, 1990), aux USA-Floride (Tarjan, 1974 ; MacGowan, 1987), en Inde-Assam (Phukan et Sanwal, 1980) en Indonésie-Java (Brown *et al.*, 1981), à l'Ile Maurice (Williams et Luc, 1977).

Dans les îles caraïbes, cette espèce avait déjà été signalée à la Martinique (Scotto la Massèse, 1969), à la Guadeloupe et à Marie-Galante (Kermarrec et Scotto la Messèse, 1972), ainsi qu'à Sainte Lucie (Hunt et Towle, 1979).

Xiphinema surinamense Loof et Maas, 1972
(Fig. 16)

Dimensions. Femelle. (n = 1). L = 2,29 mm ; a = 45,8 ; b = 6,2 ; queue = 22 µm; c = 104,1 ; c′ = 0,7 ; V = 40,6 ; odontostyle = 144 µm ; odontophore = 79 µm ; stylet = 223 µm.

Mâle. (n = 1). L = 2,36 mm ; a = 52,4 ; b = 6,7 ; queue = 26 µm ; c = 90,8 ; c′ = 0,8 ; odontostyle = 142 µm ; odontophore = 80 µm ; stylet = 222 µm ; spicules = 53 µm ; pièces accessoires = 14 µm.

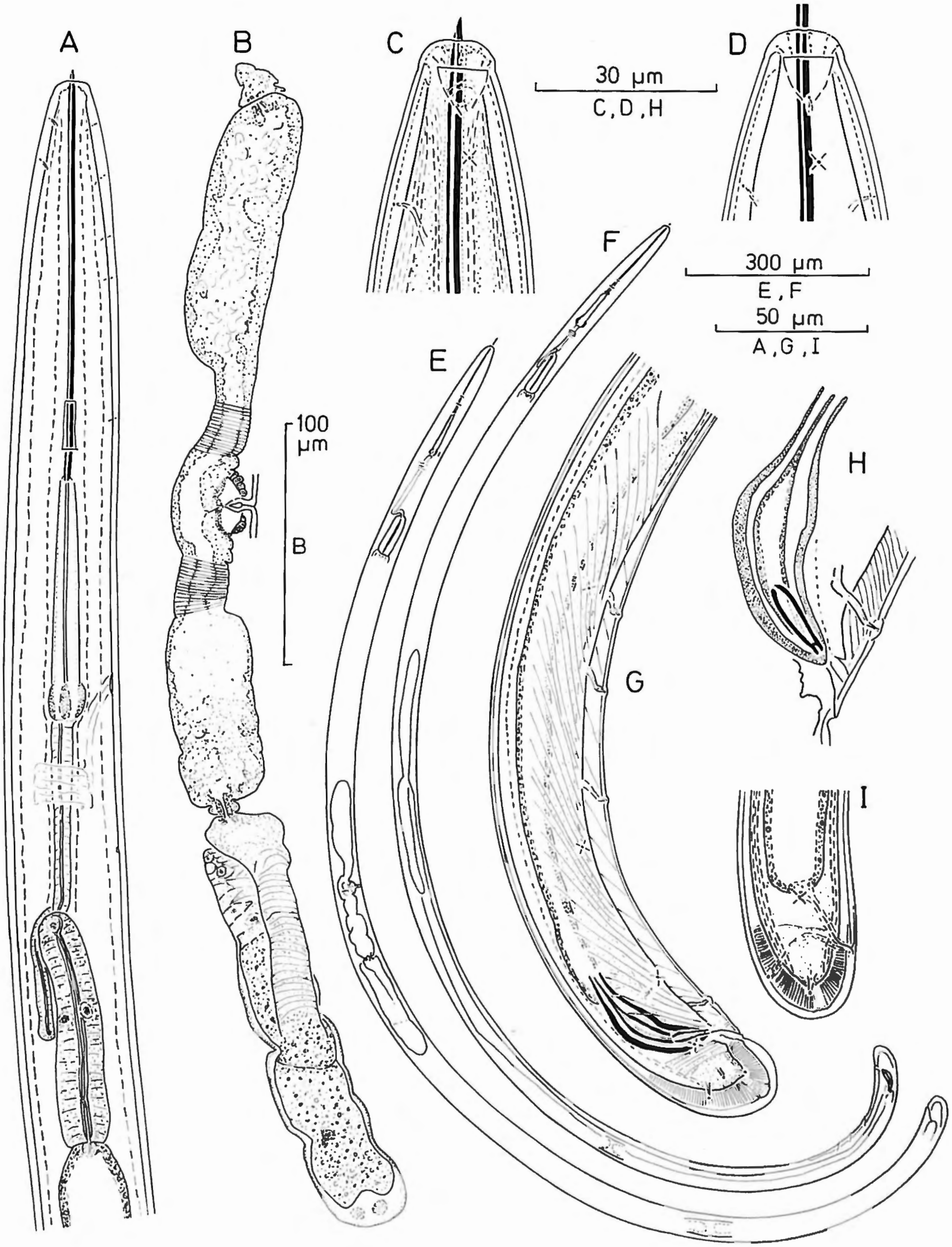

Fig. 16. — *Xiphinema surinamense* (Guyane). A : Région cervicale du mâle. B : Système reproducteur de la femelle. C : Région céphalique du mâle. D : Idem en vue superficielle. E : Femelle, en entier. F : Mâle, en entier. G : Région postérieure du mâle. H : Spicule et pièce accessoire du gubernaculum. I : Queue de la femelle.

Description. Femelle. Corps de dimension moyenne, massif, peu aminci à l'avant, pas du tout à l'arrière, courbé en forme de C avec courbure plus prononcée à la partie arrière. Région labiale arrondie, large, séparation bien marquée par un épaulement. Ouverture des amphides en fente de longueur moyenne (plus de 60 % du diamètre correspondant), au niveau de l'épaulement. Pores cervicaux (n = 1) : 3 dorsaux, 7 ventraux, 12 latéraux. Vulve située en avant de la partie médiane du corps (40 %). Vagin perpendiculaire au grand axe du corps, sphincter puissant. Branche génitale postérieure complète : utérus très court composé d'une partie distale glandulaire, non dilatée, de longueur normale et d'une partie proximale courte et fortement muscularisée ; branche antérieure incomplète : utérus plus long que celui de la branche postérieure, sphincter visible, oviducte réduit à une petite masse inorganisée, ovaire absent. Queue sub-hémisphérique, symétrique, cuticule très épaisse ; canal aveugle absent ou très faiblement marqué.

Mâle. Aspect générale identique à celui de la femelle, mais corps plus courbé ventralement à sa partie postérieure. Spicules peu courbés, et peu épais. Pièces accessoires du gubernaculum triangulaires. Papille ventrale double située 13 µm en avant de l'ouverture cloacale. Trois suppléments ventraux situés 91, 125 et 153 µm en avant de l'ouverture cloacale.

Localité. Guyane (3).

Remarques. X. surinamense se distingue des autres espèces à branche génitale antérieure réduite et incomplète (pas d'ovaire), sauf *X. costaricense* LAMBERTI et TARJAN, 1974, par la forme hémisphérique de la queue. *X. surinamense* se différencie essentiellement de *X. costaricense* par le fait que chez la première espèce l'utérus antérieur est aussi long (voire plus long) et de même structure que le postérieur, tandis que chez *X. costaricense* l'utérus antérieur est fortement réduit et désorganisé.

X. surinamense, décrit du Suriname, a été signalé également au Brésil (LOOF et SHARMA, 1979 ; FERRAZ, 1980 ; FERRAZ *et al.,* 1989). Cette espèce avait été antérieurement désignée, toujours au Brésil, comme *X. ensiculiferum* par CARVALHO (1955). L'examen du spécimen en cause par FERRAZ (1980) a permis de l'attribuer à *X. surinamense.*

La femelle rencontrée ici est de taille faible en comparaison des deux populations originellement décrites du Suriname où L = 2,42 - 2,71 et 3,21 - 3,74 mm. Notre spécimen se rapprocherait plus de la population brésilienne décrite par FERRAZ (1980) où L = 2,0 - 2,5 mm et de l'importante population (n = 30) décrite, également au Brésil, par LOOF et SHARMA (1979) où L = 1,94 - 3,11 mm et le stylet = 167 -203 µm. La longueur du stylet, 223 µm, est ici plus proche de celle de la « petite » population du Suriname (201-215 µm). LOOF et SHARMA (1979) admettent d'ailleurs pour cette espèce une grande variabilité dans les données métriques, ce que nous ne pouvons que confirmer.

Les mâles semblent assez fréquents chez cette espèce.

DISCUSSION

En dépit du faible nombre de prélèvements et pour certaines espèces de celui des spécimens, la présente étude permet de donner une première image des *Xiphinema* présents dans les deux territoires concernés.

On retrouve d'abord un certain nombre d'espèces pan-tropicales bien connues: *X. brasiliense, X. brevicolle, X. elongatum, X. krugi, X. setariae.*

Un deuxième groupe comprend *X. filicaudatum* et *X. surinamense* signalés jusqu'ici uniquement au Brésil ou au Suriname et qu'il est assez logique d'observer dans des biotopes naturels de Guyane. On peut rattacher à ce groupe *X. riocaquetae,* connu seulement de Colombie, et *X. macrostylum* décrit de l'Equateur et retrouvé à la Dominique. Il s'agit là — jusqu'à ce que de nouvelles observations viennent infirmer cette opinion — d'espèces apparemment typiques de la zone comprenant le nord de l'Amérique du Sud et les îles Caraïbes.

Un troisième groupe comprend *X. ifacolum, X. oryzae* — rencontré dans un biotope naturel — et *X. paritaliae* (= *X. dolosum*), espèces connues jusqu'à présent uniquement d' Afrique de l'Ouest et de la zone Caraïbe -Nord de l'Amérique du Sud. Ceci confirme la communauté, observée dans d'autres groupes de nématodes phytoparasites, entre les deux aires intertropicales situées de l'un et l'autre côtés de l'océan atlantique. Les causes éventuelles d'une telle communauté peuvent être recherchées dans les échanges fréquents au cours des siècles passés de matériel enraciné entre l'Afrique et l'Amérique du Sud, le transport par le vent (typhons) ou la dérive des continents, mais aucun début de preuve ne vient étayer ces différentes hypothèses, qui ne s'excluent pas l'une l'autre d'ailleurs.

Le cas de *X. ensiculiferum* est quelque peu différent ; cette espèce déjà signalée au Brésil et au Pérou, et ici dans des biotopes naturels de Guyane, est surtout répandue dans l'aire pacifique où elle est parfois très abondante. Il faudrait donc supposer son « arrivée » en Amérique du Sud par le Pacifique.

Est à noter également la richesse des échantillons provenant de la rhizosphère de fougères et de Maranthacées de la forêt de Guyane (localité 3) où sept espèces étaient présentes. Cette observation donne une idée de la diversité de ce groupe de nématodes dans les milieux non perturbés de la forêt équatoriale sud-américaine.

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STRUCTURAL ANALYSIS OF THE MEIOBENTHOS COMMUNITIES OF THE SHELF BREAK AREA IN TWO STATIONS OF THE GULF OF BISCAY (N.E. ATLANTIC)

by

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SUMMARY

In a first attempt to obtain information in order to characterize the shelf break zone, the meiobenthos communities of two fine sandy stations of 190 m and 325 m depth in the Gulf of Biscay off the Spanish coast were investigated in relation to some environmental characteristics (sediment composition, chlorophyll a content, redox values). The nematodes, which are the dominant taxon, were studied in detail. Their communities are relatively poor in densities (840 and 779 individuals per 10 cm^2) and biomass (0.137 and 0.334 mg dwt/10 cm^2) compared to those of shallow coastal areas. The dominance of small species (mean individual biomass : 0.169 and 0.423 µg dwt) and a low total biomass can be related to the low chlorophyll a content (maximum of 1.14 µg/g). However, the number of nematode genera is much higher (46 and 62 genera per station) than on the continental shelves (often less than 40 species per 10 cm^2). *Sabatieria*, *Daptonema*, *Minolaimus*, *Richtersia* and *Halalaimus* are the dominant genera in the two stations. These are also characteristic genera for the abyssal zone. The composition of the nematode communities is more similar to deep-sea communities than to those from subtidal zones. The low food supply is considered as an important structuring factor.

Key words : Meiobenthos, nematodes, shelf break

INTRODUCTION

When compared to the continental shelves, the meiobenthos from the deep-sea is poorly investigated. However, the shallow parts of the continental slopes are often less known than the deeper areas. Only a few studies deal with the 200 to 500 m depth zone (WIGLEY and MCINTYRE, 1964 ; THIEL, 1971, 1972 ; VITIELLO, 1976 ; COULL *et al.*, 1977 ; VIVIER, 1978 ; PFANNKUCHE *et al.*, 1983 ; PKANNKUCHE and THIEL, 1987 ; ALONGI and PICHON, 1988 ; SOETAERT *et al.*, 1991). This paper is the first of a series of studies on the meiobenthos of the shelf break zone in the

Gulf of Biscay. For this area only three meiobenthic studies, two on the bathyal (2000-5000m ; DINET and VIVIER, 1977, 1979) and one on the intertidal zone (after the oil spill in La Coruna ; GIERE, 1979) are known to us.

The present study investigates the densities of the meiobenthos taxa, and the biomass and composition of the nematode communities of two stations in the shelf break area off the Spanish coast (Fig. 1). Also some environmental parameters (sediment composition, chlorophyll a content and redox profiles) are determined. The results are compared with those from shallow waters and from the deep-sea. A detailed vertical sampling approach provides information on chemical and biological characteristics within the sediment.

MATERIALS AND METHODS

During a cruise of the Belgian R/V « BELGICA » in September 1989, sediment samples were obtained from two stations along the Spanish coast, respectively 190 m (station 10) and 325 m (station 9) deep. The coordinates are N 43° 59.92 and W 008° 30.31 for station 9 and N 43° 45.02 and W 008° 30.14 for station 10. Each of the sediment samples, taken with a box-corer (0.07 m^2 sampling surface), was subsampled by cores of 10 cm^2. All cores were vertically subdivided in slices of one cm, to 10 cm in the sediment.

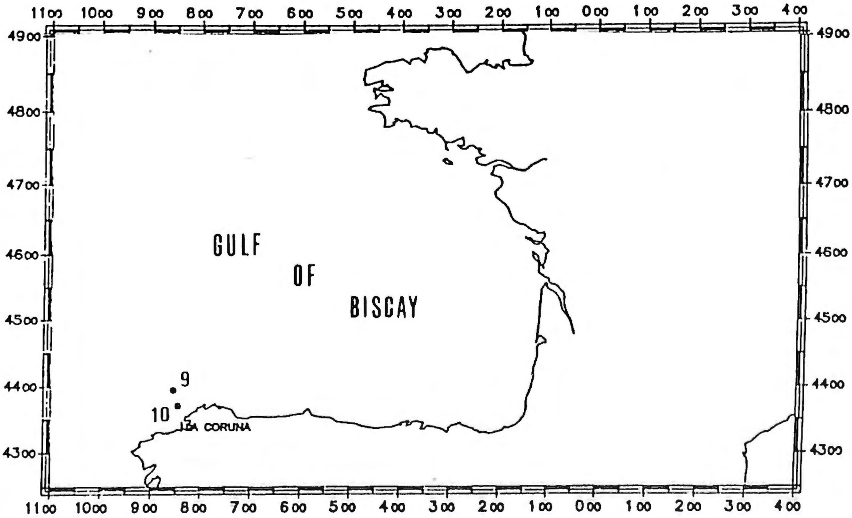

Fig. 1. — The Gulf of Biscay with indication of the two stations.

For two cores, all meiobenthic animals were counted and classified per taxon. From each sediment slice all or minimally 100 nematodes were randomly picked out and determined to the genus level (for a detailed description of the extraction procedure of the nematodes see HEIP *et al.*, 1985). The mean individual biomass of

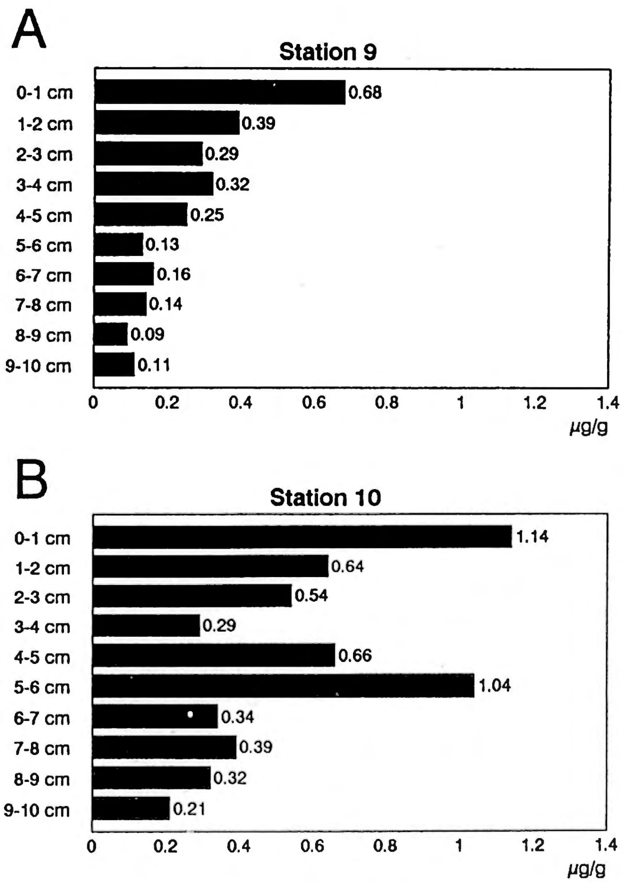

Fig. 2. — Vertical profile in the sediment of the chlorophyll a content in (A) station 9 and (B) station 10.

the nematodes of the upper five cm per station was determined according to the procedure of ANDRASSY (1956). Dry weight was calculated by taking 25 % of the wet weight (HEIP *et al.*, 1985). From a third core a sedimentological analysis (median grain size (mm), silt fraction (%), gravel fraction (%) and sorting (Φ)) was carried out. The chlorophyll a content was determined fluorimetrically on extractions of dry sediments of a fourth core with 90 % acetone (STRICKLAND and PARSONS, 1972), and calculated by the equation of HOLM-HANSEN *et al.* (1965) and LORENZEN (1966). The relative redox values were measured in millivolts by means of a micro-electrode on a fifth core.

RESULTS

The environmental factors

Both stations are characterized by a well sorted (sorting = 0.44 Φ in station 9 and 0.65 Φ in station 10), fine sandy sediment (the median grain size of the sand fraction is 0.140 mm at station 9 and 0.178 mm at station 10). The silt fraction is 8.5-13 % at station 10 , and 12.5-19 % at station 9. There is no gravel fraction.

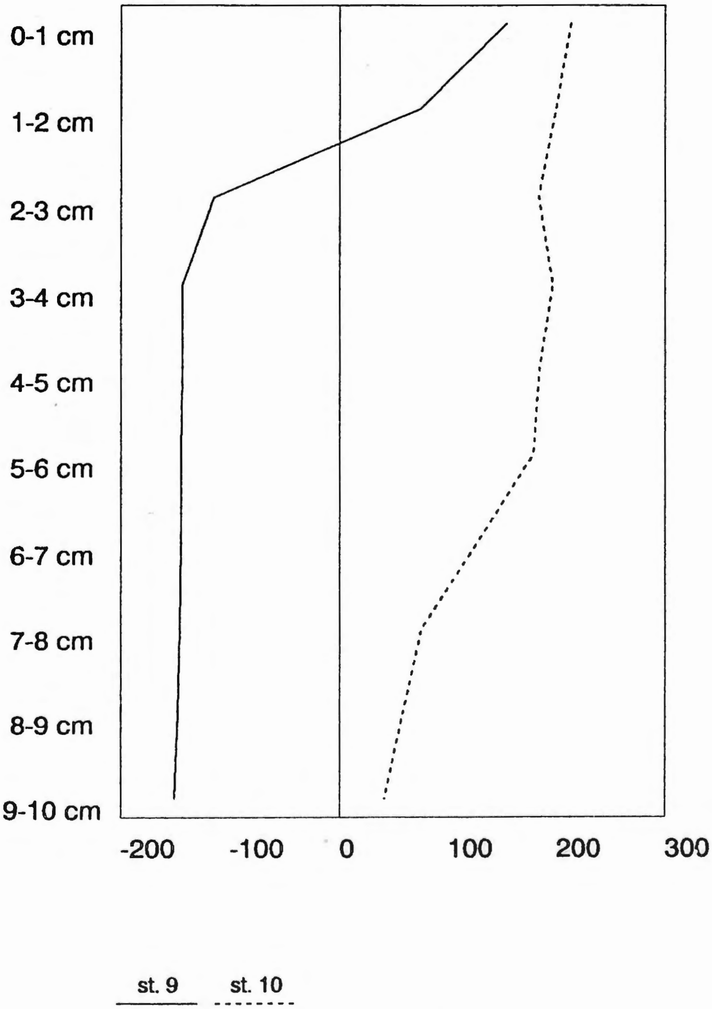

Fig. 3. — Vertical profile in the sediment of the redox potential in station 9 and station 10.

TABLE 1A

Vertical profile of the densities (per 10 cm^2) of the meiofauna taxa for two cores per station (a and b) and the mean of station 9.

		0-1 cm	1-2 cm	2-3 cm	3-4 cm	4-5 cm	5-6 cm	6-7 cm	7-8 cm	8-9 cm	9-10 cm	Sum
Nematodes	a	461	292	100	17	3	1	2	3	1	1	881
	b	337	216	131	56	26	4	5	11	8	5	799
	mean	399.5	254.0	115.5	36.5	14.5	2.5	3.5	7.0	4.5	3.0	840.5
Harpacticoids	a	47	4									51
	b	36										36
	mean	41.5	2.0									43.5
Turbellarians	a	7	2									9
	b	6	2			1		2				11
	mean	6.5	2.0			0.5		1				10.0
Polychaetes	a	11										11
	b	9	3	2	1	3						18
	mean	10.0	1.5	1.0	0.5	1.5						14.5
Oligochaetes	a	3	2	1								6
	b	1				1						2
	mean	2.0	1.0	0.5		0.5						4.0
Kinorhynchs	a											
	b	1										1
	mean	0.5										0.5
Gastrotrichs	a	1										1
	b	1										1
	mean	1										1.0
Ostracods	a	2										2
	b	1										1
	mean	1.5										1.5
Sum	a	532	300	101	17	3	1	2	3	1	1	961
	b	392	22	33	57	31	4	7	11	8	5	869
	mean	462.0	260.5	117.0	37.0	17.0	2.5	4.5	7.0	4.5	3.0	915.0

TABLE 1B

Vertical profile of the densities (per 10 cm^2) of the meiofauna taxa for two cores per station (a and b) and the mean of station 10.

		0-1 cm	1-2 cm	2-3 cm	3-4 cm	4-5 cm	5-6 cm	6-7 cm	7-8 cm	8-9 cm	9-10 cm	Sum
Nematodes	a	376	65	12	18	5	4	4	2	1		487
	b	532	261	129	64	36	19	16	11	3	1	1072
	mean	454.0	163	70.5	41	20.5	11.5	10	6.5	2	0.5	779.5
Harpacticoids	a	33	2									35
	b	48	1									49
	mean	40.5	1.5									42.0
Turbellarians	a	7		3								10
	b	1										1
	mean	4.0		1.5								5.5
Polychaetes	a	31	1	3	1							36
	b	22	6		2					3		33
	mean	26.5	3.5	1.5	1.5					1.5		34.5
Oligochaetes	a		1	2	1							4
	b	3										3
	mean	1.5	0.5	1.0	0.5							3.5
Kinorhynchs	a	8										8
	b	9		1		1		1				12
	mean	8.5		0.5		0.5		0.5				10.0
Gastrotrichs	a			2								2
	b											
	mean			1.0								1.0
Ostracods	a	3			1							4
	b											
	mean	1.5			0.5							2.0
Sum	a	430	69	22	21	5	4	4	2	1		558
	b	615	268	130	66	37	19	17	11	6	1	1170
	mean	522.5	168.5	76.0	43.5	21.0	11.5	10.5	6.5	3.5	0.5	864.0

Chlorophyll a (chl a) is highest in the upper sediment layer at station 9 (0.68 µg/g) (Fig. 2A). In the second cm the chl a content is almost halved (0.39 µg/g). The same reduction is observed at station 10 (1.14->0.64 µg/g), but a second peak (1.04 µg/g) is present between 4 and 6 cm in the sediment (Fig. 2B).

The redox potential layer is situated between 2 and 3 cm depth into the sediment at station 9, and between 6 and 8 cm depth at station 10 (Fig. 3). At station 9 the redox values are negative from the third cm in the sediment. At station 10 the redox potential is positive over the 10 centimeters.

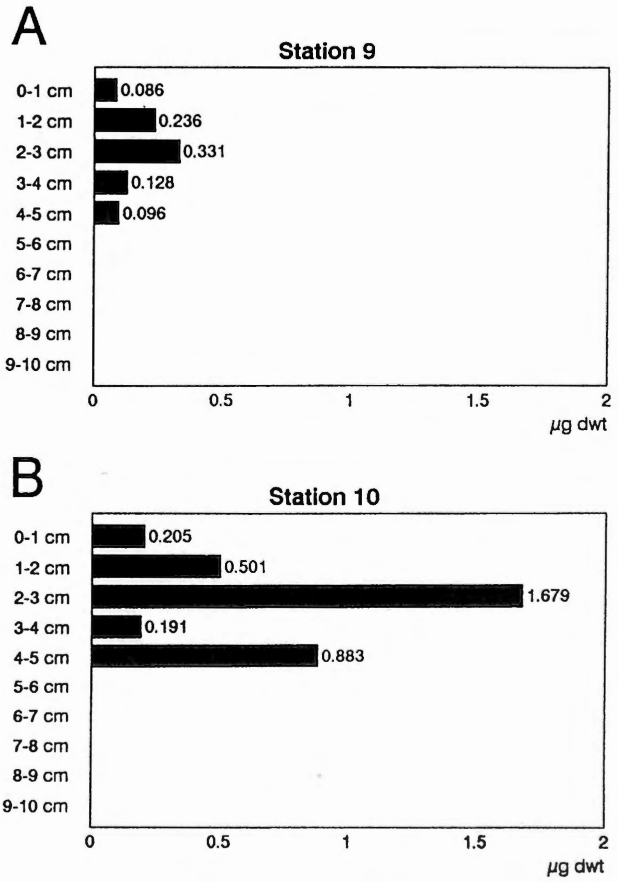

Fig. 4. — Vertical profile in the sediment of the mean individual biomass of the nematodes in (A) station 9 and (B) station 10.

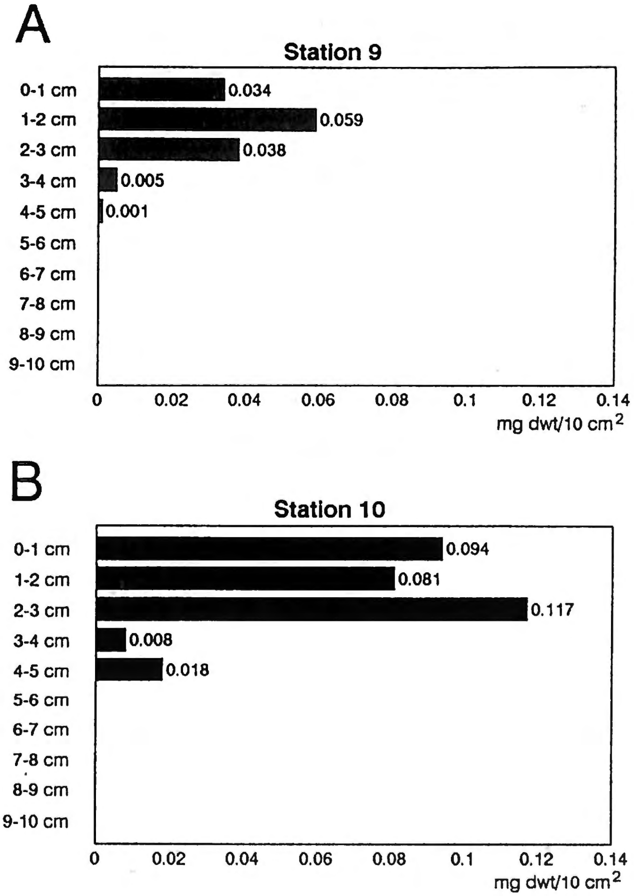

Fig. 5. — Vertical profile in the sediment of the total biomass of the nematodes in (A) station 9 and (B) station 10.

The meiobenthos

The composition of the meiofauna is similar for both stations (Table 1A and B) : nematodes are dominant, harpacticoids are subdominant, turbellarians, polychaetes and kinorhynchs are found sporadically. Oligochaetes, gastrotrichs and ostracods are present with fewer than 10 individuals per 10 cm^2. At station 9, the total meiofauna is represented by 915 individuals per 10 cm^2. At station 10, the mean number of individuals is 864 per 10 cm^2.

All taxa have their highest abundance in the upper layer of the sediment (Table 1). In both stations, nematodes are dominant in all the sediment layers (up to 10 cm depth). Harpacticoids, always the second most abundant taxon in the first

TABLE 2

Relative abundances of the nematode genera at station 9 for each sediment layer (per cm) and over the first five centimeters.

Genera	0-1 cm	1-2 cm	2-3 cm	3-4 cm	4-5 cm	0-5 cm
Sabatieria	1.43	30.88	55.88			17.54
Daptonema	13.57	10.29				10.61
Minolaimus	1.43	10.29	5.88			4.90
Richtersia	2.14	5.88	11.76			4.45
Halalaimus	5.71	2.94				4.00
Prochromadorella	7.14					3.75
Metadesmolaimus	5.71					3.00
Setosabatieria	1.43	2.94	2.94	30.00		2.66
Diplopeltula	2.86	2.94				2.50
Viscosia	2.14	2.94	2.94			2.45
Pselionema	4.29					2.25
Actinonema	2.86	1.47				2.00
Paracyatholaimus	3.57					1.88
Desmoscolecidae gen.	3.57					1.88
Microlaimus	2.86			10.00		1.69
Filitonchus		1.47	2.94	30.00	66.67	1.64
Oxystomina	2.14	1.47				1.62
Acantholaimus	2.86					1.50
Desmodora	2.86					1.50
Southerniella	2.86					1.50
Marylinnia		4.41				1.49
Paralongicyatholaimus		4.41				1.49
Pierrickia		4.41				1.49
Synonchiella		1.47	5.88	10.00		1.36
Odontophora	0.71	1.47	2.94			1.21
Bathylaimus	2.14					1.13
Ceramonema	2.14					1.13
Cyatholaimidae gen.		2.94				0.99
Desmolaimus		1.47	2.94			0.83
Bolbolaimus	1.43					0.75
Calomicrolaimus	1.43					0.75
Chromadora	1.43					0.75
Chromadorella	1.43					0.75
Rhips	1.43					0.75
Spilophorella	1.43					0.75
Cheironchus	1.43					0.75
Paramesonchium	0.71			10.00		0.57
Trefusia	0.71			10.00		0.57
Leptolaimus		1.47				0.50
Metachromadora		1.47				0.50
Desmodoridae gen.		1.47				0.50
Xyalidae gen.		1.47				0.50
Ammotheristus	0.71					0.38
Amphimonhystrella	0.71					0.38
Choanolaimus	0.71					0.38
Chromadorita	0.71					0.38

Genera	0-1 cm	1-2 cm	2-3 cm	3-4 cm	4-5 cm	0-5 cm
Dichromadora	0.71					0.38
Disconema	0.71					0.38
Gomphionema	0.71					0.38
Linhomoeus	0.71					0.38
Linhystera	0.71					0.38
Metacyatholaimus	0.71					0.38
Metalinhomoeus	0.71					0.38
Nemanema	0.71					0.38
Neochromadora	0.71					0.38
Neotonchus	0.71					0.38
Pomponema	0.71					0.38
Rhabdocoma	0.71					0.38
Microlaimidae gen.	0.71					0.38
Megadesmolaimus			2.94			0.33
Mesacanthion			2.94			0.33
Eubostrichus					33.33	0.11

centimeter, are no longer present from the third centimeter downward in the sediment. Turbellarians, polychaetes and oligochaetes disappear from the fifth to seventh cm down at station 9 (Table 1A) and from the third to fourth cm down at station 10 (Table 1B). Kinorhynchs are present at station 10 up to the seventh cm in the sediment. At station 9 they are limited to the upper sediment layer with one specimen.

The nematodes

Biomass

The mean individual biomass amounts to 0.169 µg dwt at station 9 and 0.423 µg dwt at station 10. Both stations are characterized by an increase of the individual biomass with depth into the sediment in the upper three cm (Fig. 4). At station 10, however, the maximal biomass per individual is five times higher (1.679 µg dwt : Fig. 4B) than at station 9 (0.331 µg dwt : Fig. 4A). In this station also the fifth cm of the sediment is characterized by a higher value for the individual biomass (0.883 µg dwt : Fig. 4B). As a result, the total biomass is more than twice as high at station 10 (0.334 mg dwt/ 10 cm^2) than at station 9 (0.137 mg dwt/10 cm^2). Due to the highest nematode densities in the first two centimeters and the highest individual biomass in the third cm, the upper three sediment layers of both stations are characterized by the highest total biomass values (Fig. 5A and B).

Faunal composition

Tables 2 and 3 show the relative abundances of the genera per cm and for the first 5 cm at stations 9 and 10 respectively. Station 9 is dominated by *Sabatieria*, which is most abundant in the deeper sediment layers. *Daptonema* is the dominant

TABLE 3

Relative abundances of the nematode genera at station 10 for each sediment layer (per cm) and over the first five centimeters.

Genera	0-1 cm	1-2 cm	2-3 cm	3-4 cm	4-5 cm	0-5 cm
Richtersia	6.29	18.42				7.51
Sabatieria	1.40	18.42	33.33	41.67	100.00	7.05
Trichotheristus	6.99	5.26	11.11			6.52
Desmodora	7.69	2.63				6.44
Daptonema	6.99	5.26				6.25
Halalaimus	6.99	5.26				6.25
Actinonema	6.29	2.63				5.33
Desmoscolecidae gen.	6.29	2.63				5.33
Pselionema	5.59					4.42
Prochromadorella	4.90					3.87
Setosabatieria	2.10	2.63	22.22	25.00		3.50
Calomicrolaimus	4.20					3.31
Bolbolaimus	2.80	5.26				2.94
Diplopeltula	3.50					2.76
Ptycholaimellus	2.80					2.21
Enoploides	2.10	2.63				2.02
Viscosia	2.10			8.33		1.97
Diplopeltoides	2.10					1.66
Minolaimus	2.10					1.66
Rhips	2.10					1.66
Paralongicyatholaimus	0.70			25.00		1.48
Chromadora	1.40					1.10
Leptolaimus	1.40					1.10
Marylinnia	1.40					1.10
Pomponema	1.40					1.10
Synonchiella		7.89				1.09
Chromadorita	0.70	2.63				0.92
Sphaerolaimus	0.70		11.11			0.83
Odontophora		2.63	11.11			0.64
Aponema	0.70					0.55
Ceramonema	0.70					0.55
Cheironchus	0.70					0.55
Mesacanthion	0.70					0.55
Neochromadora	0.70					0.55
Pandolaimus	0.70					0.55
Polygastrophora	0.70					0.55
Southerniella	0.70					0.55
Chromadoridae gen.	0.70					0.55
Cyatholaimidae gen.	0.70					0.55
Aegialoalaimus		2.63				0.36
Axonolaimus		2.63				0.36
Bathylaimus		2.63				0.36
Dorylaimopsis		2.63				0.36
Halichoanolaimus		2.63				0.36
Spirinia		2.63				0.36
Odontanticoma			11.11			0.27

TABLE 4

Relative abundances of the nematode families at the stations 9 and 10.

Families		*Families*	
Comesomatidae	22.26	Chromadoridae	16.19
Xyalidae	15.25	Xyalidae	12.77
Chromadoridae	11.89	Comesomatidae	10.91
Cyatholaimidae	11.51	Selachinematidae	9.51
Selachinematidae	6.94	Microlaimidae	6.80
Oxystominidae	6.00	Desmodoridae	6.80
Diplopeltidae	4.00	Oxystominidae	6.25
Microlaimidae	3.57	Cyatholaimidae	5.89
Ceramonematidae	3.38	Desmoscolecidae	5.33
Oncholaimidae	2.45	Ceramonematidae	4.97
Linhomoeidae	2.30	Diplopeltidae	3.31
Desmodoridae	2.11	Thoracostomopsidae	2.57
Desmoscolecidae	1.88	Aegialoalaimidae	2.02
Ethmolaimidae	1.64	Oncholaimidae	1.97
Axonolaimidae	1.21	Leptolaimidae	1.10
Tripyloididae	1.13	Axonolaimidae	1.05
Trefusiidae	0.95	Sphaerolaimidae	0.83
Neotonchidae	0.70	Pandolaimidae	0.55
Leptolaimidae	0.50	Encheliidae	0.55
Thoracostomopsidae	0.33	Tripyloididae	0.36
		Anticomidae	0.27

genus in the surface layers. Subdominant genera in station 9 are *Minolaimus*, *Richtersia*, *Halalaimus* and *Prochromadorella*. At station 10 several genera are present with the same abundance : *Richtersia*, *Sabatieria*, *Trichotheristus*, *Desmodora*, *Daptonema*, *Halalaimus* and *Actinonema*. Table 4 shows the dominant families at both stations. These are the Comesomatidae, and to a lesser extent the Xyalidae, the Chromadoridae and the Cyatholaimidae at station 9. The Chromadoridae are dominant at station 10, with the Xyalidae, the Comesomatidae and the Selachinematidae as subdominant families.

Diversity

In total, 79 genera are found of which 29 are present at both stations. Station 9 contains 62 genera, and at station 10, 46 genera are found. With the exception of two, all genera are represented by less than 5 % dominance at station 9. The two dominant genera have a relative abundance of respectively 10.61 % and 17.54 %. In station 10 all genera have a relative abundance of less than 10 % (Tables 2 and 3).

DISCUSSION

The environmental factors

The chl a content of both stations off the Spanish coast is very low when compared to other, even deeper areas. For instance, a slope transect of 300 to 900 meter depth in the deep Western Coral Sea (Australia) is characterized by chl a values of 9 µg/g ; and even on the abyssal plain (900-1000 m) the chl a amounts to 3.9 µg/g (ALONGI and PICHON, 1988). In coastal areas the chl a content is even more high : 1.50-22.06 µg/g along the coast of Brittany (RIAUX-GOBIN *et al.*, 1989), and 10-20 µg/g along the Belgian coast (unpublished own results).

Low values of the redox potential (Eh) are often explained by a larger input of organic matter, related to a greater number of aerobic bacteria which degrade the organic matter, using oxygen. The negative Eh values in station 9 on the other hand can not be explained by a high organic input. In this case the sediment composition might influence the oxygen supply to the deeper sediment layers. The oxygenation into the sediment can be hampered because of the finer and more silty sediment at station 9, compared to station 10. However, the differences in sediment composition are small.

The meiobenthos

The nematode densities in both stations along the Spanish coast are higher than the values found in some other areas with a comparable depth (ALONGI and PICHON, 1988 ; COULL *et al.*, 1977 ; SOETAERT *et al.*, 1991 ; VIVIER, 1978 ; WIGLEY and MCINTYRE, 1964 : Table 5). Some areas, which are characterized by an high detritus input (see their chloroplastic pigment equivalents or CPE in Table 5), have higher meiofauna densities (PFANNKUCHE and THIEL, 1987 ; PFANNKUCHE *et al.*, 1983 ; SOETAERT *et al.*, 1991 : Table 5). Whereas in subtidal areas, the sediment composition determines the nematode densities, the food supply is an important factor controlling densities in deeper areas (COULL *et al.*, 1977 ; DINET, 1979 ; RENAUD-MORNAND and GOURBAULT, 1990 ; THIEL, 1979 ; TIETJEN *et al.*, 1989 ; SOETAERT *et al.*, 1991).

The dominance of the nematodes (70-95 %) and the increase in their dominance with increasing water depth are also in accordance with the results in other areas (DINET, 1973 ; DINET and VIVIER, 1977 ; RUTGERS VANDERLOEFF and LAVALEYE, 1986 ; SOETAERT *et al.*, 1991).

Besides harpacticoids, also polychaetes, kinorhynchs, gastrotrichs and tardigrades are frequently found in deeper areas. With the exception of the tardigrades, these taxa are also present in the two stations off the Spanish coast. The higher abundance of the kinorhynchs and the polychaetes at station 10 might be due to the higher redox values, compared to station 9. HIGGINGS and KRISTENSEN (1988) found that kinorhynchs are present with higher densities in the upper oxygenated sediment layers, while they are missing in anoxic sediments.

TABLE 5

Mean nematode densities per 10 cm² recorded for several areas and depths, with indication of the available values of Chloroplastic pigments equivalents (CPE).

Author	Area	depth (m)	ind/10cm²	CPE (µg/cm²)
ALONGI and PICHON, 1988	Western Coral sea	300-645	55-279	
WIGLEY and MCINTYRE, 1964	West Atlantic	40-567	50-924	
COULL *et al.*, 1977	West Atlantic	400	51-353	
VIVIER, 1978	Mediterranean	168-580	72-441	
SOETAERT *et al.*, 1991	Mediterranean	160-530	447-724	0.5-1.5
PFANNKUCHE *et al.*, 1983	N.E. Atlantic	130-400	1778-2656	17-24
PFANNKUCHE and THIEL, 1987	N. Greenland sea	200-400	545-3400	7-23
SOETAERT *et al.*, 1991	Mediterranean	155-370	1426-2157	4-8

The decrease of the meiofaunal densities with depth in the sediment is typical for all marine, fine sandy and silty sediments of a large depth. Most authors associate this with the accumulation of food in the surface layers of the sediment (DINET, 1973 ; DINET and VIVIER, 1977 ; SOETAERT *et al.*, 1991 ; THIEL, 1983 ; TIETJEN *et al.*, 1989). But also the sediment composition and the oxygen supply can change with the depth in the sediment and may have their impact on the vertical distribution of the taxa. A compact sediment in the deeper layers, for example, prevents larger nematodes from moving in the small interstitial spaces, while many species or even members of higher taxa (like the kinorhynchs and the harpacticoids) are bound to the oxic layers. In both stations along the Spanish coast the highest chl a values are found in the upper cm, while the RPD layer is situated at respectively 2 to 3 cm and 6 to 8 cm depth into the sediment. Although the oxygen supply to the deeper layers is better in station 10, there is no difference among both stations in the vertical distribution of the harpacticoids. The kinorhynchs, however, are present, although not abundant, in the deeper layers of station 10, while they are no longer found deeper than one cm in station 9.

The nematodes

The horizontal distribution of the mean individual biomass per station is often related to the sediment composition (MCINTYRE and MURISON, 1973 ; WARWICK, 1971 and WIESER, 1960) and the food supply (THIEL, 1979). According to WARWICK (1971) the mean nematode length is positively correlated with the median grain size within sandy sediments. The individual biomass of station 10 (0.191-1.679 µg dwt) lies within the range found in subtidal sediments (e.g. 0.085-2.46 µg dwt in the Voordelta (VANREUSEL, 1990)). In station 9, which is situated in a deeper area, the smaller biomass values (< 0.350 µg dwt) are more in accordance with the biomass values found in other areas of a similar depth (0.07-0.82 µg dwt on 40 to 580 m : in VIVIER, 1978 and WIGLEY and MCINTYRE, 1964), and even at larger depths (f.i. 0.48-0.94 µg dwt : in TIETJEN, 1984).

The vertical distribution of the individual biomass in both stations shows that especially the deeper sediment layers are characterized by higher biomass values. Based upon findings that nematodes are on the average three times smaller in the upper cm of a sandy bottom than in the next eight centimeters, JENSEN (1987) already suggested that the length/width ratio of thiobiotic species (= species associated with anoxic habitats) is significantly larger than those of oxybiotic species ; this would be a functional adaptation of the thiobiotic species to the epidermal uptake of dissolved organic matter as an extra food source, and in relation to the minimal required oxygen uptake in such oxygen-poor habitats.

The total biomass in both stations along the Spanish coast (0.137-0.334 mg dwt/10 cm^2) is low in comparison to the biomass from most shallow subtidal areas (0.1-3.8 mg dwt/10 cm^2 : from HEIP *et al.*, 1985). Even compared to other deep-sea communities these values are not very high (0.01-0.32 mg dwt/10 cm^2 : from HEIP *et al.*, 1985). The low total biomass values are mainly due to the presence of small species, but also the densities are rather low in both stations.

Several of the dominant genera of the transition zone from the continental shelves to the deep-sea are also characteristic for the abyssal zone of the Gulf of Biscay (DINET and VIVIER, 1979). Here the genera *Minolaimus*, *Theristus*, *Halalaimus* and *Spiliphera* are dominant. SOETAERT (1983: in HEIP *et al.*, 1985) found that *Sabatieria*, *Halalaimus* and *Richtersia* are dominant genera in deeper areas of the Mediterranean. Other characteristic genera for the deep-sea such as *Acantholaimus*, *Leptolaimus* and *Sphaerolaimus* (DINET and VIVIER, 1979 ; TIETJEN, 1989) are present although not abundant along the Spanish coast.

In general the diversity in the deep-sea is significantly higher than the diversity in shallow waters. In most of the deeper areas (300 to 8000 m) 50 to 130 species are found per 10 cm^2 (DINET and VIVIER, 1979 ; TIETJEN, 1984, 1989 ; RUTGERS VANDERLOEFF and LAVALEYE, 1986 ; SOETAERT and HEIP, 1990). Diversity even seems to increase with depth (DINET and VIVIER, 1979). Thus the high diversity at the genus level along the Spanish coast is more in agreement with deep-sea situations than with the values found on the continental shelf. In shallow waters the species richness is rarely higher than 50 species per station (HEIP *et al.*, 1985).

Deep-sea nematode species also tend to be evenly distributed and only occasionally is a species dominant with more than 10 %. For the Spanish coast, and especially for station 10, the same tendency is observed already on the genus level, and can therefore be expected to be even more obvious on the species level.

CONCLUSIONS

A preliminary investigation of two stations in the shelf break area along the Spanish coast shows that the composition of the meiobenthos and especially the genus composition of the nematode communities is more similar to communities which are characteristic of the abyssal zones than to those from shallow areas. The low food supply is suggested as an important structuring factor, which discerns this area from the continental shelf.

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AQUATIC OLIGOCHAETES OF LAKE VIRELLES : FOUR NEW SPECIES FOR THE BELGIAN FAUN

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SUMMARY

Nais christinae, Nais simplex, Vejdovskyella intermedia and *Ilyodrilus templetoni,* four species of freshwater oligochaetes, are recorded for the first time from Belgium. The genera *Vejdovskyella* and *Ilyodrilus* are also new for the Belgian fauna. Identification criteria based on external characters are proposed as well as ways to avoid possible confusion with closely related species. Some notes on the ecology of these four species are given.

Key words : aquatic oligochaetes, *Nais, Vejdovskyella, Ilyodrilus.*

INTRODUCTION

Lake Virelles is the largest natural lake of Belgium (Philippart, 1990). A few years ago, its management was entrusted to three associations for Nature preservation : AVES, the « Réserves Naturelles et Ornithologiques de Belgique » (RNOB) and the World Wildlife Fund (WWF). In the framework of the lake management, it was drained during the winter of 1986-1987, which resulted in a spectacular recovery of the water transparancy and of the flora (Scohy *et al.*, 1987) during the following months. A broad survey of the invertebrate fauna of the lake was then conducted, and material was collected in 1987 and 1988 (Moureau *et al.*, 1992).

Specimens of different kinds of plants and algae present were collected from the lake and preserved in bottles with 4 % formalin. The bottom sediment was sampled with a tube corer (diameter 4.4 cm, surface 15.2 cm^2) and fixed with 4 % formalin. Samples were sorted out in the laboratory. The complete procedure of sampling is described in Moureau *et al.* (1992). Oligochaetes were mounted in polyvinyl lactophenol, and were examined with an interferential microscope (Reichert, Austria). All figures were drawn by means of a camera lucida.

I identified twelve species of oligochaetes in this material (Table 1 ; Moureau *et al.*, in press). Four species, three Naididae and one Tubificidae, are new for the Belgian fauna : *Nais christinae* Kasprzak (1973), *Nais simplex* Piguet (1906), *Vejdovskyella intermedia* (Bretscher, 1896) and *Ilyodrilus templetoni* (Southern, 1909). The genera *Vejdovskyella* Michaelsen (1903) and *Ilyodrilus* Eisen 1879 are also found for the first time in Belgium.

These new records are not surprising because the oligochaete fauna of Belgium is still ill-known (Martens, 1989). A good example of this situation is given by the recent description of three species of the genus *Potamothrix,* mentioned for the first time in Belgium despite their holarctic distribution (Martin, 1991). This brings the total number of species of Belgian aquatic oligochaetes to 55. The four newly found species are kept in the collections of the Royal Belgian Institute of Natural Sciences (No I.G. 27.854).

IDENTIFICATION CHARACTERS AND ECOLOGICAL INFORMATION

Nais christinae (Kasprzak, 1973)

This species is one of the most interesting new records because of its very recent description by Kasprzak (1973). Actually, this species was already recognized

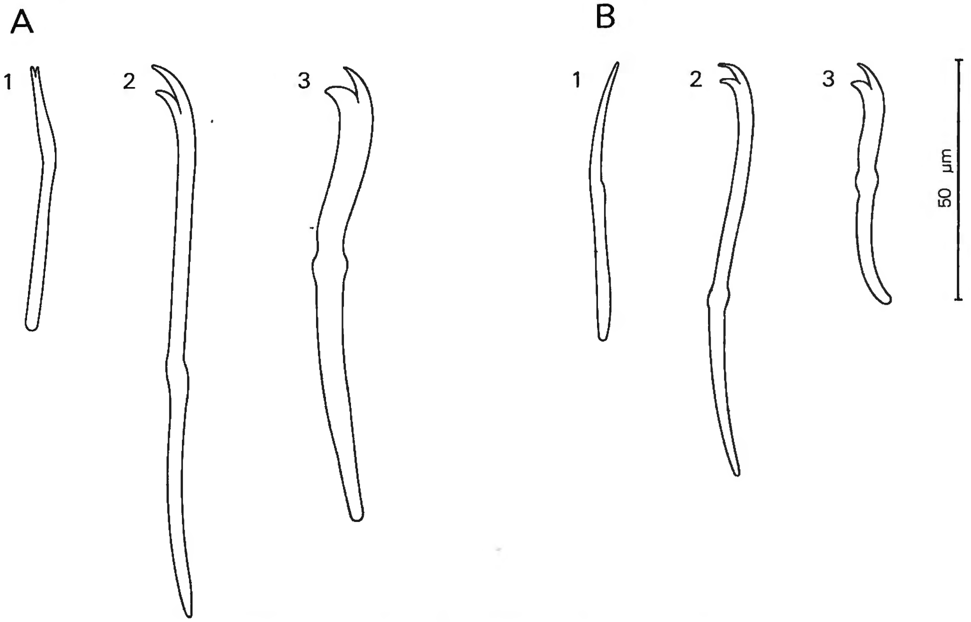

Fig. 1. — (A) *Nais christinae :* bifid dorsal crotchet (1) and ventral chaetae of segment II (2) and of segment VI (3). (B) *Nais simplex :* blunt dorsal crotchet (1) and ventral chaetae of segment II (2) and of segment VI (3).

without any doubt by PIGUET in 1906, but was considered as a variant of *Nais variabilis* PIGUET (1906), i.e. *N. variabilis* var. « des grands lacs ».

Within the genus *Nais,* the species is easily identifiable externally by its dorsal bifid crotchets and ventral chaetae (KASPRZAK, 1973 ; HRABĚ, 1979 ; Fig. 1A). On segments II to V, the latter are very characteristic, with a proximal tooth nearly twice as long as the distal one, and forming a very acute angle with it. Behind segment V, the ventral chaetae are very stout and have nearly equally-long teeth. These characters allow distinction from *N. variabilis* and *Nais pardalis* PIGUET (1906), respectively.

Nais christinae was found exclusively in the surroundings of various macrophytes, as its swimming mode of life would suggest : *Potamogeton pectinatus* L., *Utricularia australis* R. BR., *Alisma plantago* L., *Sparganium erectum* L. and *Myriophyllum* sp.

Due to its recent specific status, its distribution is ill known. HRABĚ (1979) mentioned it from Czechoslovakia, Switzerland, Sweden, Poland and USSR. It may seem strange that an apparently well-defined species was described only recently, whereas it was already mentioned as a variant by PIGUET in 1906. On the basis of the ventral chaetae, the author pointed out that there were numerous intermediate forms between *N. variabilis* and the variant « des grands lacs ». This could explain a possible confusion between both species. However, the recent examination of other characteristics by KASPRZAK (1973), such as structure, shape and size of parts of the genital organs, validated the specific status. Careful examination of material is therefore necessary, and it is quite probable that the species may be discovered in old collections.

Nais simplex PIGUET (1906)

Contrary to the situation of *N. christinae, N. simplex* has been known for a very long time (BRINKHURST and JAMIESON, 1971) and is well defined. Within the genus, it shares simple-pointed dorsal crotchets with *N. barbata, N. pseudobtusa* and *N. alpina (*BRINKHURST, 1971). However, the blunt tip of the dorsal crotchets (Fig. 1B) allows the distinction with the first two species (BRINKHURST, 1971 ; HRABĚ, 1979). *N. simplex* differs from *N. alpina* because the distal tooth on the ventral chaetae in segments II to V is perpendicular to the axis of the chaeta (HRABĚ, 1979) and the posterior ventral chaetae have equal teeth (unlike in *N. alpina,* where their proximal tooth is twice as long as the distal ; BRINKHURST, 1971).

Nais simplex is a swimming species as well as *N. christinae,* and was never found in the sediment but only periphytic on algae and on macrophytes : *Potamogeton lucens* L., *Potamogeton berchtoldii* FIEB., *Potamogeton natans* L. and *Rhizoclonium* sp. It was occasionally found in association with *N. christinae* on *Myriophyllum* sp.

Vejdovskyella intermedia (Bretscher, 1896)

Vejdovskyella is a very easy genus to identify because of its numerous thick hair chaetae, strongly serrated, giving a « hairy » look to the animal (Fig. 2A).

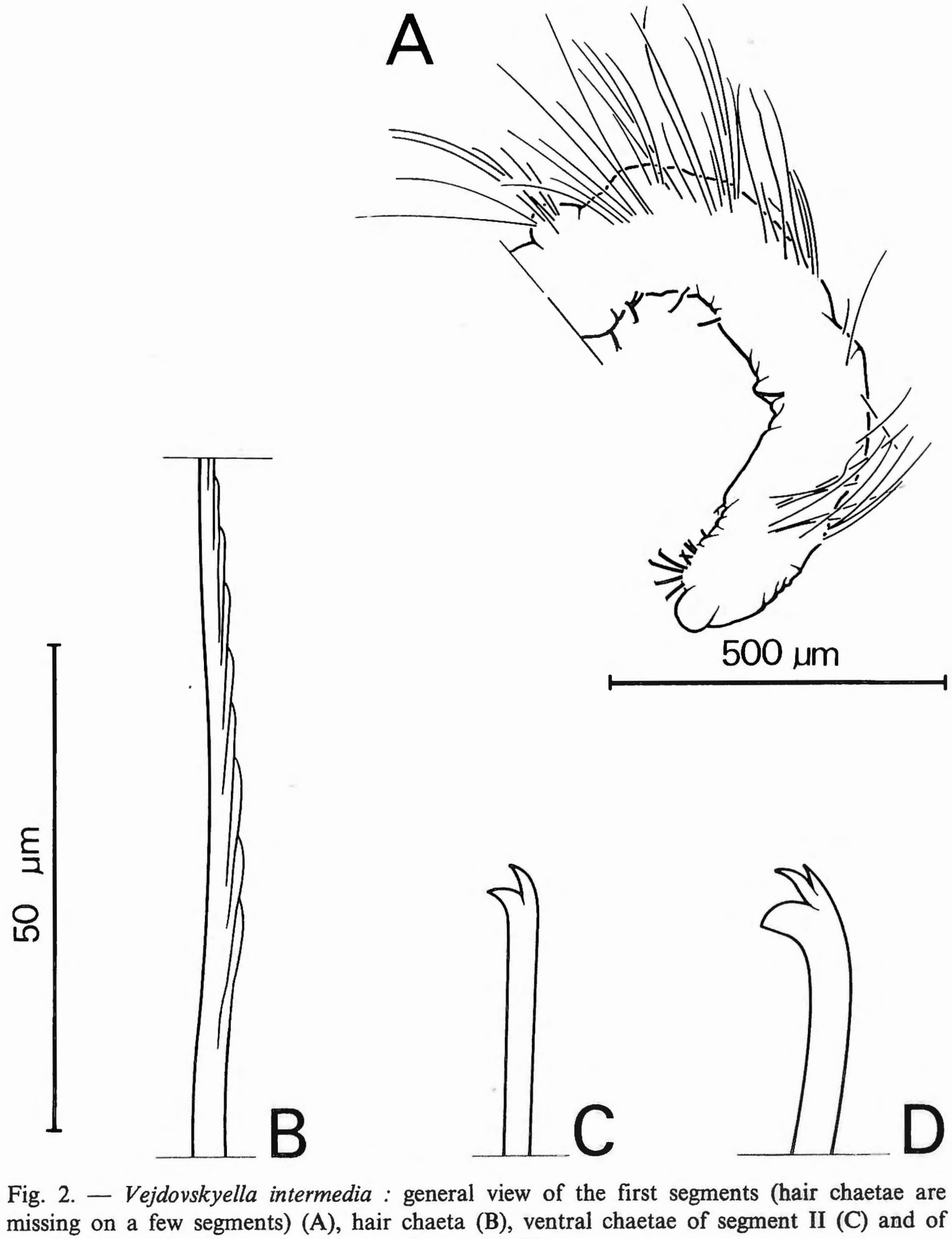

Fig. 2. — *Vejdovskyella intermedia* : general view of the first segments (hair chaetae are missing on a few segments) (A), hair chaeta (B), ventral chaetae of segment II (C) and of segment VI (D).

The genus includes two species, *V. comata* and *V. intermedia.* A third one, *V. hellei,* was transferred to the genus *Specaria* by BRINKHURST and KATHMAN (1983) but this transfer was later omitted (BRINKHURST and WETZEL, 1984) and the genus was suspected to require a careful revision. Actually, the situation of the genus has been thoroughly confused for a long time, which led BRINKHURST and JAMIESON (1971) to synonymize *V. comata* and *V. intermedia.* However, a recent examination of BRINKHURST and KATHMAN (1983) identified the source of confusion and both species are now again deemed valid.

Vejdovskyella intermedia differs from *V. comata* in the absence of eyes and the presence of a particularly large chaeta with a wide lower tooth and 2-3 thin upper teeth in ventral segment VI and often subsequent segments (SPERBER, 1950 ; HRABĚ, 1979 ; Fig. 2D). In *V. intermedia,* hair chaetae have large coarse lateral serrations, set close to shafts (Fig. 2B), but in *V. comata,* the serrations are often curled back over the main shaft (BRINKHURST and KATHMAN, 1983).

Vejdovskyella intermedia was found in the sediment of one station only. It is not a swimming animal (BRINKHURST and JAMIESON, 1971), and this can explain its absence in the surroundings of plants.

Ilyodrilus templetoni (SOUTHERN, 1909)

Ilyodrilus templetoni is a non-papillate tubificid with hair chaetae in dorsal bundles accompanied by pectinate chaetae, without modified genital chaetae but with a cuticular penis sheath (BRINKHURST, 1971). This penis sheath is longer than broad and often inconspicuous (Fig. 3A).

BRINKHURST (1986) points out that this species is often confused with *Tubifex tubifex* (MÜLLER, 1774) but that *I. templetoni* has the most anterior ventral chaetae with proximal teeth distinctly longer than the distal ones. As it can be seen in Fig. 3B, this difference is not always obvious. However, the short and typically granular penis sheath of *T. tubifex* allows an easy distinction between the two species.

The specimens sampled in Lake Virelles are often less than 10 mm long, which is in accordance with BRINKHURST and JAMIESON (1971) who mentioned a relatively small size for most specimens, and with HRABĚ (1979), who indicated a body length of 10 mm.

Most tubificids are burrowers (BRINKHURST, 1982), which probably explains the exclusively presence of *I. templetoni* in the sediments. It was found associated with other tubificids, such as *Limnodrilus claparedeianus, Limnodrilus hoffmeisteri, Branchiura sowerbyi,* and even with naidids like the non-swimming *Vejdovskyella intermedia* or *Dero digitata* which lives like tubificids in organic silts (BRINKHURST, 1982).

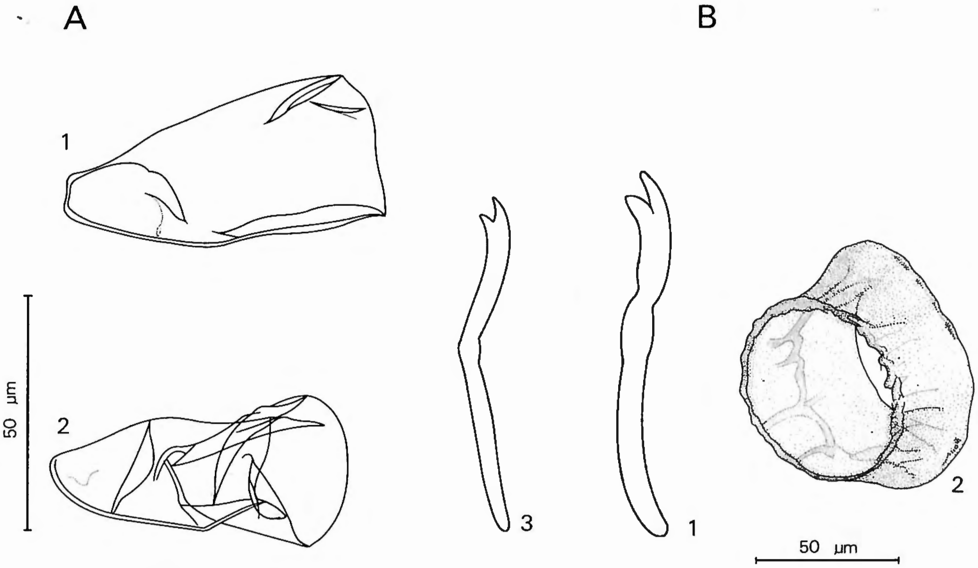

Fig. 3. — (A) *Ilyodrilus templetoni* : penis sheaths (1-2), ventral chaeta of segment II (3). (B) *Tubifex tubifex* : ventral chaeta of segment II (1) and penis sheath (2). The scale is the same for all drawings except for the penis sheath of *T. tubifex* (B2).

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TABLE I

Faunistic list of oligochaetes of Lake Virelles (Belgium)

Fam. Naididae

Dero digitata (Müller, 1773)
Nais christinae Kasprzak, 1973
Nais simplex Piguet, 1906
Ophidonais serpentina (Müller, 1773)
Stylaria lacustris (Linnaeus, 1767)
Vejdovskyella intermedia (Bretscher, 1896)

Fam. Tubificidae

Branchiura sowerbyi BEDDARD, 1892
Ilyodrilus templetoni (SOUTHERN, 1909)
Limnodrilus claparedeianus RATZEL, 1868
Limnodrilus hoffmeisteri CLAPARÈDE, 1862
Tubifex tubifex (MÜLLER, 1774)

Fam. Lumbriculidae

Stylodrilus heringianus CLAPARÈDE, 1862

Fam. Enchytraeidae

Spp. not identified.

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A REDESCRIPTION OF *HEMILAOPHONTE JANINAE* JAKUBISIAK (COPEPODA, HARPACTICOIDA), A LAOPHONTID LIVING IN THE GILL CHAMBERS OF THE COMMON SPIDER CRAB

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SUMMARY

Hemilaophonte janinae Jakubisiak, living in the gill chambers of the common spider crab *Maja squinado* (Herbst), is redescribed in detail. Specimens of this harpacticoid were found on crabs collected along the Atlantic coasts of France and the Spanish Sahara. *H. clysmae* Por and Marcus, the second species assigned to the genus, is allocated to the closely related genus *Coullia* Hamond. Whereas the common spider crab shows a wide distribution throughout the Mediterranean, *H. janinae* has only been found on crabs from the Atlantic Ocean. Spider crabs from the Mediterranean Sea mainly host laophontids of the genus *Paralaophonte* Lang.

Key words : Hemilaophonte janinae, decapod associate, *Coullia clysmae* comb. nov.

INTRODUCTION

In 1932, Jakubisiak described the highly advanced laophontid, *Hemilaophonte janinae* he encountered in washings of several specimens of the common spider crab, *Maja squinado* (Herbst, 1788) (Decapoda, Brachyura, Majidae). So far the species has never been reported again, although Petkovski (1964) and Raibaut (1968) studied the associated fauna of Mediterranean spider crabs to some extent.

In the course of a revision of the family Laophontidae, washings of common spider crabs from the western Atlantic Ocean led to the redescovery of this interesting species. As the type-specimens of *H. janinae* could not be localized, the detailed redescription given herein, is based on the newly recovered material only.

Por and Marcus (1972) assigned a second species, *Hemilaophonte clysmae* to the genus, found in sediment samples from the Gulf of Suez. In addition, they broadened the generic diagnosis of *Hemilaophonte* Jakubisiak to accommodate *H. clysmae* properly. As will be discussed below, the latter should not be maintained in *Hemilaophonte*. Instead, *H. clysmae* should be assigned to the closely related genus *Coullia* HAMOND.

MATERIAL AND METHODS

Common spider crabs preserved in the collections of the Invertebrates Section of the Koninklijk Belgisch Instituut voor Natuurwetenschappen were treated as described in FIERS (1990). Dissected specimens are mounted in glycerine while preserved ones are stored in 75 % neutralized ethyl alcohol.

Drawings were made with the aid of a camera lucida attached to a light microscope equipped with phase contrast. Terminology and abbreviations used herein are according to LANG (1948, 1965).

Specimens of *Hemilaophonte janinae* were found on common spider crabs from the following localities :

— France, Dinard. Leg. K.B.I.N., 20 September 1950, IG : 17639. One female common spider crab containing 7 females and 4 males. 1 female and 1 male dissected, slides labeled COP 3664a, b and 3665 respectively. Other specimens preserved in alcohol, COP 2339.

— Spanish Sahara (Rio de Oro) : Port Etienne (Nouadhibou), Bay de Repos. Leg. MERCATOR, 11th cruise, 7/8 November 1935. One male common spider crab containing 7 females, 1 male and 1 female copepodid CV, preserved in alcohol, COP 2337.

— Spanish Sahara (Rio de Oro) : Port Etienne (Nouadhibou). Leg. MERCATOR, 14th cruise, 3 January 1938, IG. 11553. One female common spider crab containing 1 female and 1 female CV copepodid. Female dissected, slides labeled 3666a, b. Juvenile preserved in alcohol, COP 2338.

All the harpacticoid specimens are deposited in the collections of the Recent Invertebrates Section of the Koninklijk Belgisch Instituut voor Natuurwetenschappen.

SYSTEMATICS

Genus ***Hemilaophonte*** JAKUBISIAK, 1932

Diagnosis. — Small translucent laophontids with a strongly depressed body shape and divergent cylindrical furcal rami; antennule six-segmented without thorns or processes on the proximal segments; antenna with a well-developed exopodite bearing four sub-equal setae; P1 with prolonged protopodite and two-segmented exopodite; exopodites P2 and P3 three-segmented; exopodite P4 two-segmented; three outer spines on ultimate exopodal segments of P2 and P3, two outer spines on second exopodal segment of P4; endopodites P2-P4 two-segmented; endopodite P2 smaller than endopodites of P3 and P4; baseoendopodite P5 with two apical and two lateral setae; exopodite P5 short, with six setae.

Sexual dimorphism : antennule sub-chirocer ; P3 endopodite two-segmented possessing a long curved apophysis on second segment ; P5 with two baseoendopodal and five exopodal setae ; P6 with two setae.

Type-species. — *Hemilaophonte janinae* JAKUBISIAK, 1932, by monotypy.

Discussion. — JAKUBISIAK (1932) considered *Hemilaophonte* to be closely related to *Harrietella* T. SCOTT, a monospecific genus commonly found in association with the woodboring gribble (*Limnoria*, HICKS, 1989 and references therein). Although LANG (1948, p. 1449, 1450) consented to JAKUBISIAK's (1932) view, he expressed clearly his reservations because of the concise and probably erroneous description of the male. Obviously, as male features are of basic significance in revealing the phylogenetic relationships within the Laophontidae, the ignorance of the sexual characteristics strongly questions possible statements about relationships between the genera.

Clearly, relying on female characteristics only, *Hemilaophonte* and *Harrietella* resemble each other because of their shared reduced segmentation of the P4 exopodite, their remarkable depressed body shape and, although to a lesser degree, the reduced chaetotaxy of the legs. Apparently, JAKUBISIAK (1932) and LANG (1948) also based their conclusion on the comparable way of life of the species in association with other invertebrates.

As illustrated herein, JAKUBISIAK (1932) overlooked the sexually dimorphic morphology of the third leg as well as one of the setae on the P5 exopodite of the male. Males of *H. janinae* possess a large curved apophysis on a two-segmented P3 endopodite and exhibit in the P5 five exopodal and two endopodal setae. Other legs show no sexually dimorphic features. Clearly, P3 and P5 of the males of *Hemilaophonte* differ significantly from those of *Harrietella*. In the latter, the male P5 bears at the most four exopodal setae and has only a single endopodal seta while the P3 endopodite possesses a rather short and blunt outer subdistal process. Moreover, the endopodal setae of the male P3 of *Harrietella* exhibit marked differences in comparison with those of the female. The inner lateral and inner distal setae are shorter and more rigid while the outer distal one is spiniform and only as long as the apophysis (HICKS, 1989). In contrast, the P3 endopodite of the males in *Hemilaophonte* with its long curved sharp apophysis bears a seta which is markedly shorter and more slender than in the female. Apparently, the sexually dimorphic characteristics of *Hemilaophonte* have a different origin than those of the *Pseudonychocamptus* — *Harrietella* branch.

Two more recently erected laophontid genera, namely *Coullia* HAMOND, 1973 and *Phycolaophonte* PALLARES, 1975, share a particular characteristic with *Hemilaophonte*. In general, the endopodal lengths in laophontids decrease from P2 towards P4. Whereas the P2 endopodite reaches beyond the middle of the second exopodal segment, the P4 endopodite is only as large as the first exopodal segment and often even smaller. The three above-mentioned genera do not share this arrangement. Here, the P2 endopodite is distinctly smaller than the P3 and P4 endopodites because of the reduced size and shape of the segments. In the genus *Coullia* the endopodite P2 can either be absent or be represented as a single seta.

This particular pattern, in addition to the P5 chaetotaxy and the shape of the male P3 endopodite, unifies these three genera in a separate branch within the family. This branch is probably not directly related with the *Pseudonychocamptus* — *Harrietella* lineage.

At present two species are assigned to the genus *Coullia*, namely *C. heteropus* Hamond, 1973 and *C. platychelipusioides* (Noodt, 1958) and only one, *P. insularis* Pallares, 1975, to the genus *Phycolaophonte*. Unfortunately, the male is known only for the latter but after observations were made of several other species of the genus *Coullia*, at present unknown and which will be described in a forthcoming contribution, the morphology of the sexual dimorphic P3 and the chaetotaxy of the male P5 in *Coullia* was found to be exactly the same in *Phycolaophonte* and *Hemilaophonte*.

Having justified the relationships of *Hemilaophonte* to *Coullia* and *Phycolaophonte*, the question still remains whether *H. clysmae* Por and Marcus, 1972 should be maintained in the genus. Firstly, it should be noted that the numerations in the illustrations given by Por and Marcus (1972) of the P2 (Fig. 40) and P3 (Fig. 39) are interchanged as is evidenced in accompanying descriptions of both legs.

Hemilaophonte clysmae differs significantly from *H. janinae* by the presence of a three-segmented P4 exopodite, a long ovate exopodite in the P5 and by the distinct ventrolateral extensions on the genital double-segment and the second abdominal somite. These specific features of *H. clysmae* exclude this species from the genus *Hemilaophonte* as they are typical for the closely related genus *Coullia*. Consequently, *H. clysmae* should be allocated to the latter genus and indicated as *Coullia clysmae* (Por and Marcus, 1972) comb. nov.

SYSTEMATICS

Hemilaophonte janinae Jakubisiak, 1932

Hemilaophonte Janinae nov. gen., nov. sp.- Jakubisiak, 1932 : p. 510-513, Fig. 2.
Hemilaophonte janinae Jakubisiak, 1932 - Willey, 1935 : p. 51 ; Jakubisiak, 1936 : p. 320 ; Nicholls, 1941 : p. 95 ; Lang, 1948 : p. 1427, fig. 584(1) ; Vervoort, 1964 : p. 371 ; Medioni and Soyer, 1966 : p. 1062 ; Por and Marcus, 1972 : p. 258 ; Wells, 1976 : p. 172, 189. ; Huys, 1988 : p. 1528.

Type-material. — Unknown.

Type-locality. — Jakubisiak (1932 : p. 506) examined several specimens of *Maja squinado* captured near Roscoff (France) and a single specimen of unknown origin bought at a market in Paris. Unfortunately he did not mention exactly from which specimens he collected *Hemilaophonte janinae*.

Redescription. — Female : body (Fig. 1a) strongly dorso-ventrally depressed ; cephalothorax with smoothly curved lateral margins ; largest width in the posterior half of the cephalothorax ; thorax and abdomen tapering towards the anal somite ; genital double somite about as long as wide, without posterolateral extensions of the edges (Fig. 1c) ; anal operculum rounded ; body length, measured from rostral tip to distal margin of the furcal rami, 565 - 605 µm.

Integumental structures : dorsal surfaces of the thoracic and abdominal somites naked ; pleural regions of the thoracic somites furnished with fragile hairs ; genital double somite and abdominal somites with some short rows of spinules along the lateral margins and on the ventral surfaces.

Rostrum (Fig. 1d) broad at base, strongly tapering anteriad and fused with the cephalothorax ; rostral tip not prominent.

Furcal rami two and a half times as long as wide, divergent ; inner margin with a small spinulose elevation near the implantation of the dorsal seta ; the latter implanted near the inner margin and articulating on two basal parts ; three lateral setae arising in the distal third of the outer margin ; inner apical seta small ; principal setae not fused ; outer principal one as long as the supporting ramus ; outer distal edge showing a large tubular pore.

Genital field (Fig. 1h) with two setae on both halves ; median field formed by a complex of internal structures, reaching almost towards the middle of the ventral surface of the segment.

Antennule (Fig. 2g) six-segmented ; first segment rather small ; surface of the segments smooth except for a short row of spinules on the distal anterior edge of the first segment ; setal ornamentation : 1-8-5-2+Aesth-1-12.

Antenna (Fig. 2c) with allobasis bearing an inner seta and a well developed exopodite ; exopodite with three sub-equal setae and one longer spinulose seta (Fig. 2b) ; endopodal segment with a few spinules in the proximal half and along the distal margin, ornamented laterally with two spines and a slender seta and apically with three spines, two geniculated setae and a slender seta.

Mandible (Fig. 1f) with four teeth and a seta on the gnathobasis ; palp cylindrical, twice as long as wide, bearing four smooth setae and a feathered one ; rami obsolete.

Arthrite of maxillule (Fig. 1e) slender, having five unarmed teeth and two setae ; coxal extension with two setae and basal extension with three setae ; exopodite distinct as a minute segment, bearing a single seta ; endopodite obsolete, represented as a single seta.

Maxilla (Fig. 1g) with three endites ; proximal one obsolete, represented as a seta ; median and apical endites cylindrical, nearly five times as long as wide and bearing each two slender setae and one armed strong spine ; basis furnished with teeth along the ultimate third of the extension and bearing one seta on the surface ; rami obsolete, represented as three setae.

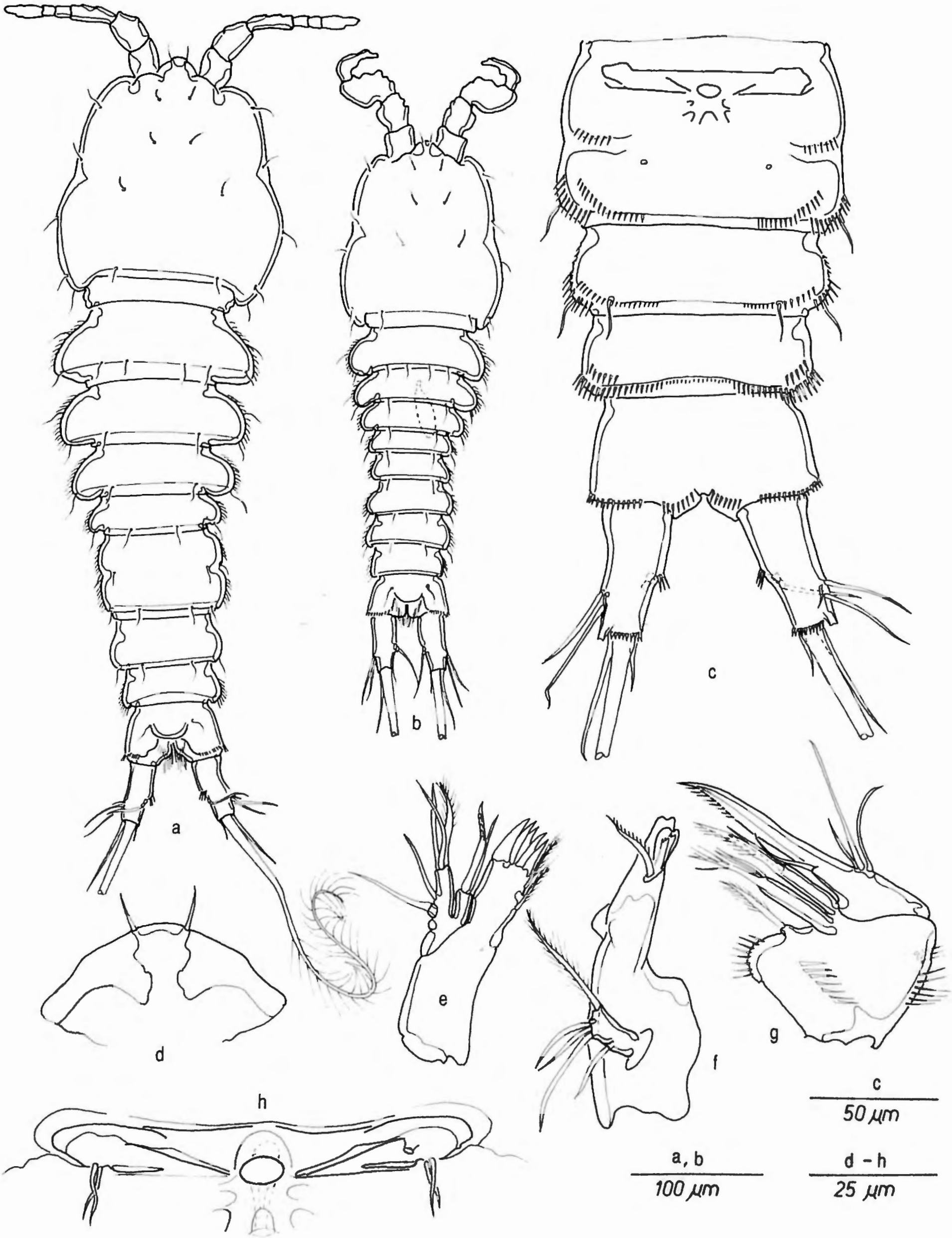

Fig. 1. — *Hemilaophonte janinae* : a, habitus of the female, dorsal view ; b, habitus of the male, dorsal view ; c, abdomen of the female, ventral view ; d, rostrum, dorsal view; e, maxillule ; f, mandible ; g, maxilla ; h, genital field.

Redescription. — Female : body (Fig. 1a) strongly dorso-ventrally depressed; cephalothorax with smoothly curved lateral margins ; largest width in the posterior half of the cephalothorax ; thorax and abdomen tapering towards the anal somite ; genital double somite about as long as wide, without posterolateral extensions of the edges (Fig. 1c) ; anal operculum rounded ; body length, measured from rostral tip to distal margin of the furcal rami, 565 - 605 µm.

Integumental structures : dorsal surfaces of the thoracic and abdominal somites naked ; pleural regions of the thoracic somites furnished with fragile hairs ; genital double somite and abdominal somites with some short rows of spinules along the lateral margins and on the ventral surfaces.

Rostrum (Fig. 1d) broad at base, strongly tapering anteriad and fused with the cephalothorax ; rostral tip not prominent.

Furcal rami two and a half times as long as wide, divergent ; inner margin with a small spinulose elevation near the implantation of the dorsal seta ; the latter implanted near the inner margin and articulating on two basal parts ; three lateral setae arising in the distal third of the outer margin ; inner apical seta small ; principal setae not fused ; outer principal one as long as the supporting ramus ; outer distal edge showing a large tubular pore.

Genital field (Fig. 1h) with two setae on both halves ; median field formed by a complex of internal structures, reaching almost towards the middle of the ventral surface of the segment.

Antennule (Fig. 2g) six-segmented ; first segment rather small ; surface of the segments smooth except for a short row of spinules on the distal anterior edge of the first segment ; setal ornamentation : 1-8-5-2+Aesth-1-12.

Antenna (Fig. 2c) with allobasis bearing an inner seta and a well developed exopodite ; exopodite with three sub-equal setae and one longer spinulose seta (Fig. 2b) ; endopodal segment with a few spinules in the proximal half and along the distal margin, ornamented laterally with two spines and a slender seta and apically with three spines, two geniculated setae and a slender seta.

Mandible (Fig. 1f) with four teeth and a seta on the gnathobasis ; palp cylindrical, twice as long as wide, bearing four smooth setae and a feathered one ; rami obsolete.

Arthrite of maxillule (Fig. 1e) slender, having five unarmed teeth and two setae ; coxal extension with two setae and basal extension with three setae ; exopodite distinct as a minute segment, bearing a single seta ; endopodite obsolete, represented as a single seta.

Maxilla (Fig. 1g) with three endites ; proximal one obsolete, represented as a seta ; median and apical endites cylindrical, nearly five times as long as wide and bearing each two slender setae and one armed strong spine ; basis furnished with teeth along the ultimate third of the extension and bearing one seta on the surface ; rami obsolete, represented as three setae.

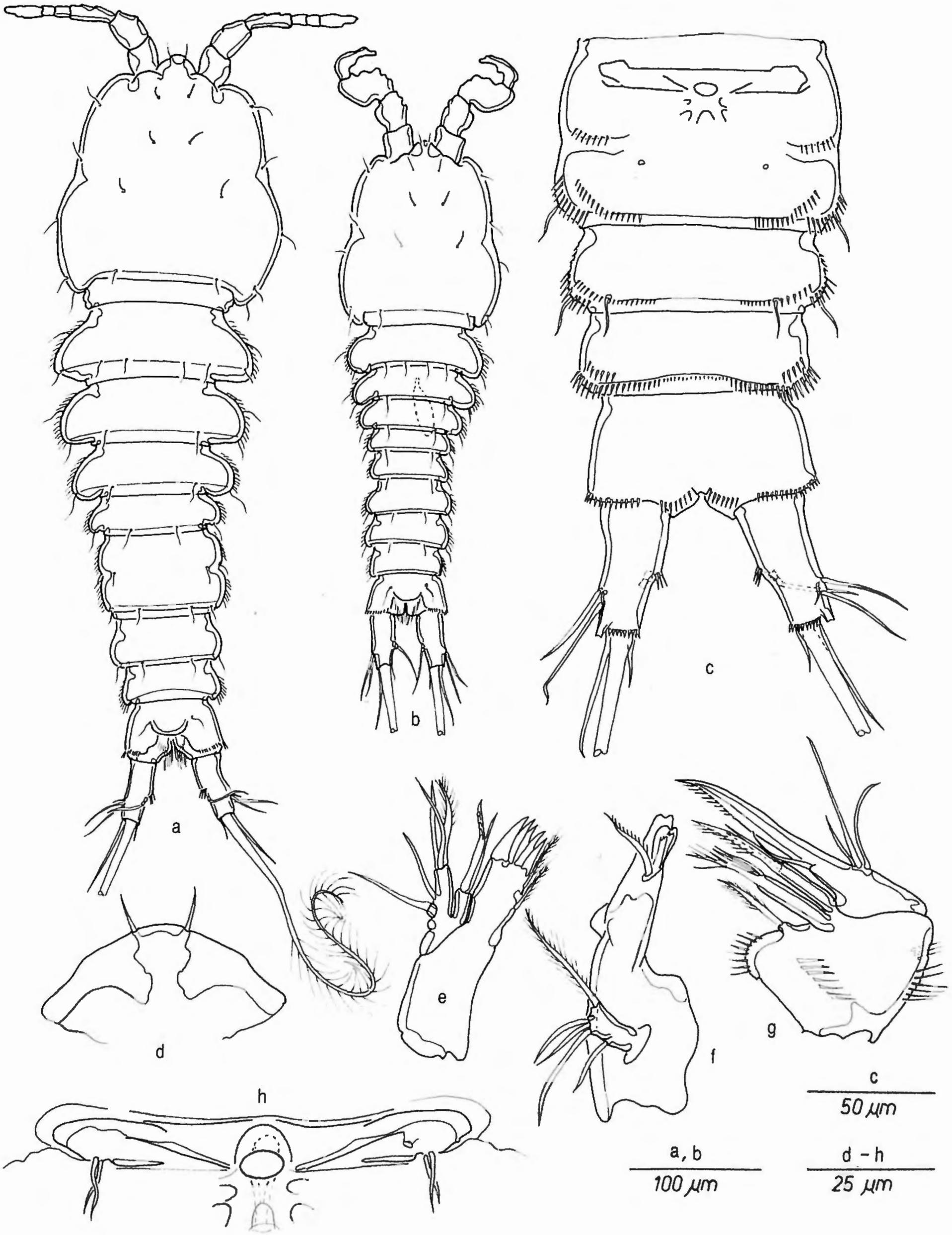

Fig. 1. — *Hemilaophonte janinae* : a, habitus of the female, dorsal view ; b, habitus of the male, dorsal view ; c, abdomen of the female, ventral view ; d, rostrum, dorsal view; e, maxillule ; f, mandible ; g, maxilla ; h, genital field.

Fig. 2. — *Hemilaophonte janinae* : a, male antennule ; b, exopodite of antenna ; c, antenna ; d, maxilliped ; e, male P5 ; f, female antennule ; g, male P6.

Maxilliped (Fig. 2d) with a short syncoxa, bearing two setae ; endopodal claw longer than basis furnished with strong teeth in the distal third ; tiny seta at basis of the claw.

P1 (Fig. 3a) : prae-coxa triangular and smooth ; coxa twice as long as wide, spinulose along the inner margin ; basis up to four times as long as wide with outer seta implanted proximally ; exopodite two-segmented ; second segment two and a half times as long as the first one and bearing two outer minute spines and two api-

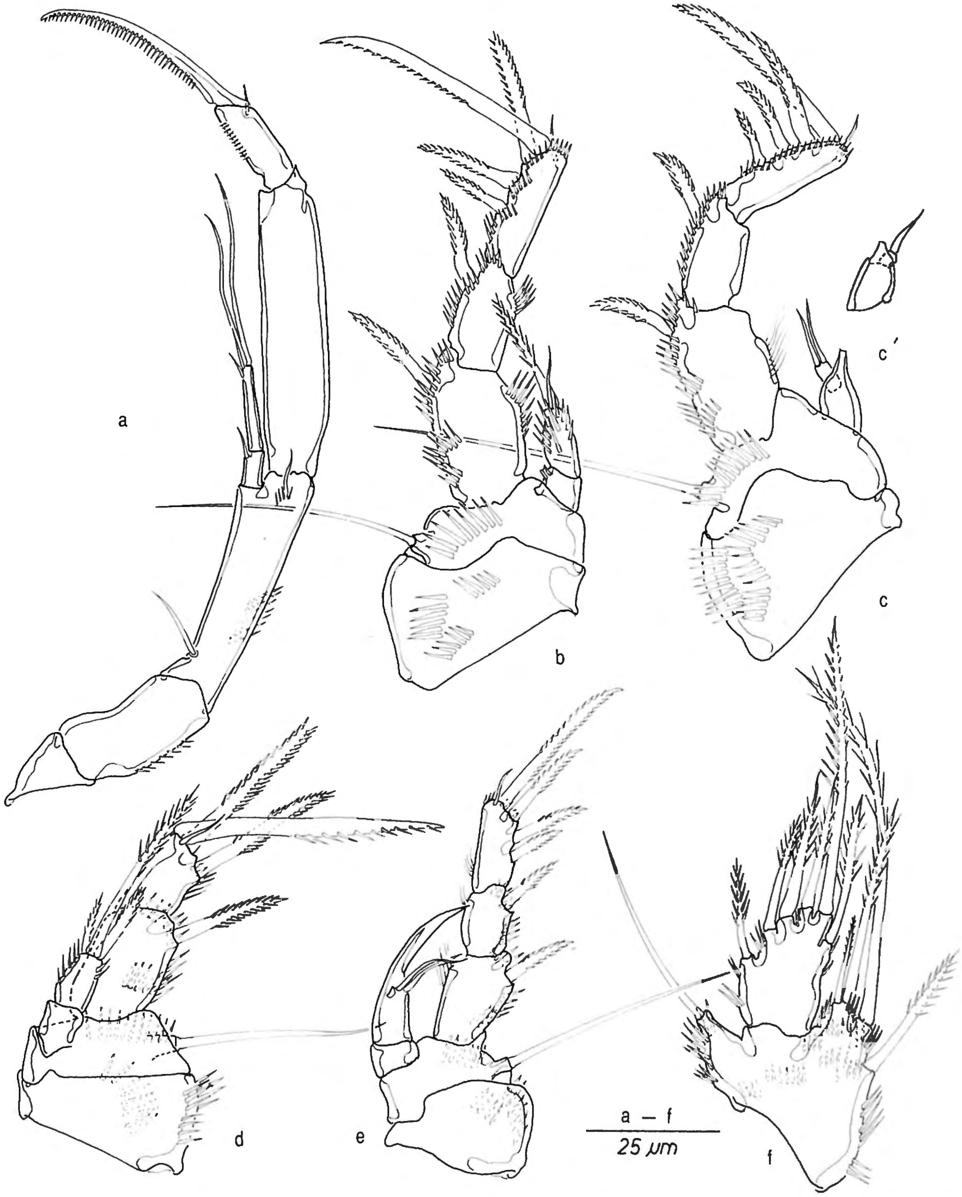

Fig. 3. — *Hemilaophonte janinae* : a, P1 ; b, P2 ; c, P3 ; c', endopodite P3 of another specimen ; d, P4 ; e, male P3 ; f, female P5.

cal smooth setae ; first endopodal segment four times as long as wide ; endopodal claw strongly armed.

P2-P4 (Fig. 3c, b and d, respectively) with large spinules on protopodal segments ; exopodites of P2 and P3 three-segmented, of P4 two-segmented ;

endopodites P2-P4 two-segmented; inner distal edge of proximal endopodal segment of P3 with a large hyaline tubular pore; chaetotaxy of the legs in table I.

TABLE I

Chaetotaxy of Hemilaophonte janinae

	P2	P3	P4
Exopodite	0-0-023	0-0-023	0-022
Endopodite	0-020	0-020	0-021

Baseoendopodite of P5 with a small endopodal lobe, bearing four spinulose setae (two apical and two lateral ones, Fig. 3f); exopodite one and a half times as long as wide, having six spinulose setae; integument ornamented with spinules on the surface of the baseoendopodite and along the margins of the exopodite.

Male : habitus (Fig. 1b) resembling closely that of the female but differing in length (390 - 435 µm) and in the more parallel-sided abdomen.

Antennule (Fig. 2a) six-segmented, sub-chirocer with aesthetasc on segment four; ultimate segment prolonged with a sharp distal edge.

Mouthparts, P1-P4 as in the female, except for the P3 endopodite; the latter (Fig. 3e) with a long and curved sharp apophysis arising from the inner distal edge of the second segment.

P5 (Fig. 2e) with a small but distinct baseoendopodite, showing an inner expansion with two setae; opposite legs not fused together; exopodite as long as wide, bearing four spinulose setae and one smooth seta.

Right P6 (Fig. 2f) somewhat larger than left one; both legs with two smooth setae.

Variability. — One specimen (France, Dinard) was found bearing a single seta on the second endopodal segment of P2 (Fig. 3c′).

Discussion. — The herein studied specimens agree in many respects with the original description of *H. janinae*. However, comparing the illustrations in JAKUBISIAK's (1932) description with the present ones, some differences in the chaetotaxy of the legs are worth stating.

The ultimate exopodal segments bear a short and slender inner seta on the inner distalmost edge. Those setae often hidden beyond the outer exopodal spine and the fringe of spinules arising along the apical margin are rather difficult to observe. Moreover, regarding the chaetotaxy of the endopodites, including the endopodal lobe of the female P5 and the exopodite of the male P5 in the original description, the situation is equivocal. In all these legs JAKUBISIAK (1932) illustrated and described one seta less than observed in the herein studied specimens. Although we encountered one specimen with a single endopodal seta in P2, it is noticeable that each leg in the original description lacks the shortest and slendermost seta. Obviously, these setae were overlooked because of their small dimensions.

Bionomics. — Superficial rinsing of the body and body parts of the common spider crabs never revealed the presence of *H. janinae*. The harpacticoid fauna obtained in this way shows a high diversity comprising representatives of several different families (JAKUBISIAK, 1932 ; see also INGLE, 1983 for a list of associates found on *Maja squinado*). *H. janinae*, as well as *Paralaophonte royi* JAKUBISIAK, 1932 n. comb., *P. majae* PETKOVSKI, 1964, *P. ormieresi* RAIBAUT, 1968 were only found in the residues when the gill chambers of the crabs were thoroughly rinsed using a strong water current (FIERS, 1990).

Apparently, *Hemilaophonte janinae* and *Paralaophonte royi* n. comb., the two species JAKUBISIAK (1932) found on *Maja squinado* are typical associates of this decapod, living exclusively on the gills of their host.

Distribution. — The distribution of the common spider crab is fairly well-documented. This large, regionally economically important decapod crustacean is known in the Atlantic Ocean from the west coast of Scotland towards the coasts of Guinea, including the Canary Islands. In the Mediterranean its range extends eastwards up to the Bosporus (ZARIQUIEY ALVAREZ, 1968 ; CHRISTIANSEN, 1969 ; ADEMA, 1991). A single male specimen in the collections of the Recent Invertebrate Section was trawled off Ghana, extending the known distribution somewhat more southwards along the west African coast.

Regarding the distribution area of *Maja squinado* one could expect to encounter *Hemilaophonte janinae* throughout its range. Surprisingly, this harpacticoid associate has only been found on spider crabs collected in the Atlantic Ocean. Several specimens of spider crabs from Mediterranean localities were rinsed in search of harpacticoid copepods but *H. janinae* was never found. Instead, the examined Mediterranean spider crabs hosted *Paralaophonte ormieresi* and some new species of the genera *Coullia* and *Laophonte*, amongst others which are not considered as typical associates (*Laophonte cornuta*, *L. elongata*, *Pseudonychocamptus proximus*, etc.).

Of particular interest is the presence of *Paralaophonte royi* n. comb., described from Roscoff by JAKUBISIAK (1932) and found on a specimen of *Maja squinado* collected off Ghana and as such extending the known range of this harpacticoid species far southwards.

There are several indications suggesting that the three *Paralaophonte*-species known as associates of the common spider crab, have a common origin within *Paralaophonte*. This particular lineage occurs in most of the host's range with the most plesiomorph representative (*P. majae*) in the eastern part of the Mediterranean. A comparable east-westwards distribution has been previously suggested for the genus *Laophontina* (FIERS, 1991) and for the *monodi*-species group of the genus *Afrolaophonte* (FIERS, 1990b).

In contrast, *Hemilaophonte janinae* seems to occur only in the eastern Atlantic while its sistergroup, the genus *Coullia*, shows a circum-tropical distribution pattern. As, however, the relationships within *Coullia* are not fully understood yet, it would be premature to state fargoing conclusions about the zoogeographical origin of *Hemilaophonte*. But, it seems possible that this genus branched off from a West-African stock as part of the eastern Pacific-western Atlantic track.

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KINEMATICS OF PREY CAPTURE IN IGUANID LIZARDS : COMPARISON BETWEEN *ANOLIS EQUESTRIS* (ANOLINAE) AND *OPLURUS CUVIERI* (OPLURINAE)

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SUMMARY

Prey capture in *Anolis equestris* MERREM, 1820 and *Oplurus cuvieri* (GRAY, 1831) involves tongue prehension. Prey capture is a complex motor pattern involving displacements of the body and the head toward the prey related to the gape-tongue cycle. At short distances between the lizard and the prey (≤15 cm), the gape cycle begins prior to or simultaneously with the lizard's displacement toward the prey. At long distances (≥15 cm), the jaws are always opened after displacement of the lizard toward the prey. The role of the tongue is (1) pressing the prey onto the substratum and (2) retracting the prey into the buccal cavity. Retraction of the tongue is short (about 0.03 s). The gape cycle is divided into four stages : slow opening I (SO I), slow opening II (SO II), fast opening (FO), and fast closing (FC) in both iguanids. In *O. cuvieri*, SO II is shorter for short prey-lizard distance, and often absent in *A. equestris*.

Key words : prey capture, kinematics, Iguanidae, Reptilia.

INTRODUCTION

In general, prey capture of lizards has been classified into lingual prehension for iguanians (Agamidae, Chameleontidae, Iguanidae) and jaw prehension for scleroglossans (other families). Kinematics of lingual prehension has been studied in agamids (SCHWENK and THROCKMORTON, 1989 ; KRAKLAU, 1991), chameleontids (BELS and BALTUS, 1987 ; BELL, 1990 ; WAINWRIGHT *et al.*, 1991) and a few iguanids (SCHWENK and THROCKMORTON, 1989 ; BELS, 1990). The iguanians share several plesiomorphic characters in the displacements of the jaws and the tongue (SCHWENK, 1988 ; SCHWENK and BELL, 1988 ; SCHWENK and THROCKMORTON, 1989 ; REILLY and LAUDER, 1990). For instance, the pattern of gape cycle is similar for terrestrial insectivorous and herbivorous species. It involves a slow opening stage divided into opening *per se* (SO I) and a stationary stage (SO II) prior to the fast opening stage (FO). FO corresponds to a sudden increase of the gape angle as soon as the tongue contacts the prey. This stage is followed by a fast closing (FC) of the jaws.

SCHWENK (1988) assumes that tongue morphology is phylogenetically related and states « Hence, phylogeny is better predictor of tongue morphology than is ecology ». In iguanians, SCHWENK and THROCKMORTON (1989) describe an interfamiliar difference between agamids and iguanids for the tongue shape within the buccal cavity prior to protrusion. If tongue prehension is plesiomorphic for iguanians, kinematics of its displacements and intrinsic deformations prior to prey contact may be functionally adapted. Body, head, jaw and tongue displacements may be related to the diet characteristics (size, volume, etc.) or the species-specific foraging strategies (*i.e.*, sit-and-wait, and active foraging).

Comparison of kinematics in prey capture provides a very useful example to test the major evolutionary adjustments to environmental contingencies of the feeding behaviour in iguanid lizards. In the present study, we examine body, head, jaw and tongue displacements toward large prey (relative to the size of the lizards), by using a high speed cinematographic analysis, in one terrestrial (*Oplurus cuvieri* (GRAY, 1831)) and one arboreal (*Anolis equestris* MERREM, 1820) iguanid. The prey items were placed at variable distances from *O. cuvieri* for analyzing the timing relationship between gape opening, tongue protrusion, and locomotor pattern.

MATERIALS AND METHODS

Four adult male *A. equestris* (133-164 mm snout-vent length) were filmed at 200 frames per second and eight adult male *O. cuvieri* (117 ± 23 mm snout-vent length) were filmed at 100 frames per second (*O. cuvieri*) with Eastman Ektachrome high speed 7250 Tungsten 16 mm film, using a Photosonic 1 PL camera. The lizards were filmed under three 1000-watt tungsten photoflood lights. Each lizard was isolated in a vivarium two or three weeks before filming. Anoline lizards were conditioned to feed while perched on a branch (100 mm diameter). Food consisted of live adult locusts *Locusta migratoria* (length : 49-65 mm) placed near the branch. *A. equestris* did not take prey at distances over 10 cm. *O. cuvieri* were conditioned to capture the food (live adult crickets *Acheta domesticus* of almost same size (24 ± 3 mm)) on the ground. The crickets were placed at different distances (range : 230-10 mm) for analyzing the relationship between gape opening and body displacements toward the prey.

A total of 14 capture cycles for *A. equestris,* and 14 for *O. cuvieri* were filmed. In seven capture cycles for *O. cuvieri* and 10 for *A. equestris,* the prey items were captured with almost no lateral head displacements (eye-snout distance did not change on the successive frames). These sequences were projected onto a graphic table (AGMEE, ULg) using a NAC motion analyzer connected to a Copam AT microcomputer. Each sequence of frames was analyzed by digitizing a combination of points on the body, the head, the tongue, and the prey for selected frames.

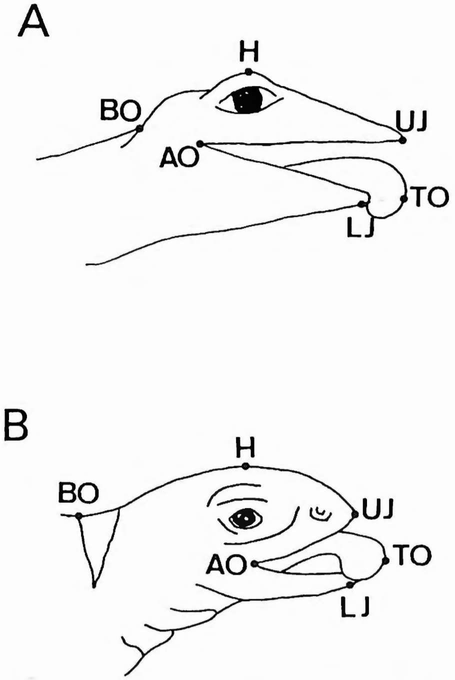


Fig. 1. — Points digitized from high speed films in *Anolis equestris* (A) and *Oplurus cuvieri* (B). AO, angulus oris; BO, body; H, head; LJ, lower jaw; TO, tongue; UJ, upper jaw.

Vertical (Y) and horizontal (X) coordinates were recorded for each digitized point (Fig. 1). The data were stored in data files as tables of bipolar (X and Y) coordinates. The files were then analyzed using a computer set of programs developed by P. Theate, and V. Bels. Frame 1 for each gape cycle was arbitrarily chosen to occur at the beginning of the slow opening (SO) stage. Kinematic graphs were plotted by using Lotus 123.

The kinematic profiles illustrate the displacements of the tongue, the jaws, and the head of the lizard. The X- and Y-coordinates of the points of the jaws (LJ and UJ), and the tongue (TO) were calculated relative to the X- and Y-coordinates of the body point (BO) for deleting the effects of its displacements (transformed coordinates). The following kinematic variables were measured : (1) the *gape angle* is the angle between the tip of the snout (UJ), the angulus oris (AO) and the most anterior point on the mandible (LJ) ; (2) *tongue protrusion* is the horizontal distance (X-coordinates) between the anterior-most points of the tongue (TO) and the mandible (LJ) : this distance is positive as soon as the tongue is protruded beyond the mandibular tip ; (3) *displacement of the lizard* is the horizontal distance (X-coordinates) between the tip of the snout (UJ) and the prey (P) ; (4) *displacements*

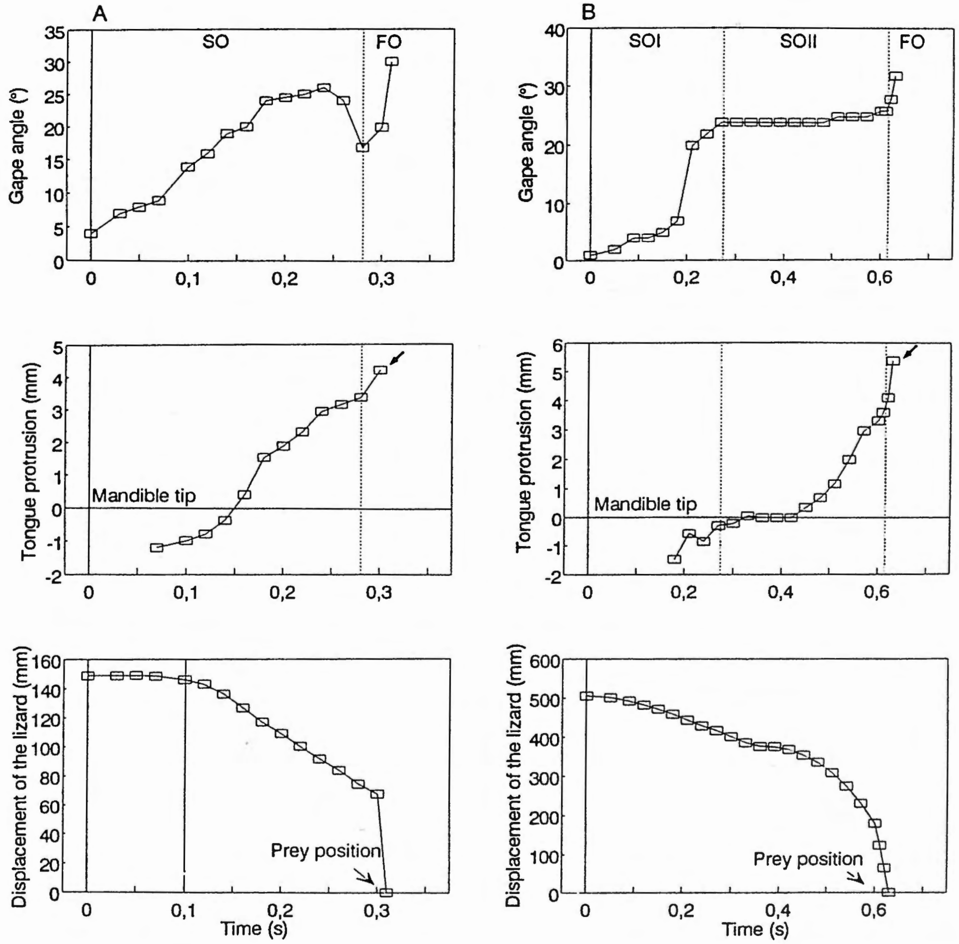


Fig. 2. — Representative kinematic profiles of prey capture by *Oplurus cuvieri*. A. The distance between the lizard and the prey is short (≤ 15 cm). The solid vertical line in the lower graphs indicates the beginning of lizard displacement. B. The distance between the lizard and the prey is long (≥ 15 cm). The arrow in the second graphs indicates tongue-prey contact. FO, fast opening stage ; SO I, slow opening I stage, and SO II, slow opening II stage.

of the prey : horizontal and vertical displacements (X- and Y-coordinates) of point P against time from the first frame of tongue-prey contact ; (5) *displacements of the tongue :* transformed X- and Y-coordinates of point TO against time ; (6) *displacements of the head :* horizontal and vertical displacements (X- and Y-coordinates) of point H against time. The displacements of the point H are appropriated to describe the displacements and the rotation of the head of the lizard toward the prey. The coordinates of this point used in the graphs were not transformed relative to point BO. Durations of the successive stages (slow opening, fast opening, fast closing), maximal gape angle, duration of the tongue retraction and time to tongue-prey contact were measured from 6-7 cycles in *O. cuvieri* (1-2 cycles/individual) and 10 cycles in *A. equestris* (1-2 cycles/individual). Time to tongue-prey contact was calculated as the time between the first frame in which the tongue touched the prey and the frame corresponding to maximal gape angle at the end of the fast opening stage.

The coefficient of variation (CV) was measured for some of the variables depicting the gape cycle : duration of slow opening (SO) and fast opening (FO) stages. The regression line between prey-lizard distance and the beginning of gape opening was calculated for *O. cuvieri.* The first frame involving horizontal displacement of the body of the lizard toward the prey refers to time 0. The timing difference between this frame and the first frame involving opening of the mouth was then computed. When the mouth opened prior to body displacement, this timing was thus considered negative.

RESULTS

Prey capture in *A. equestris* and *O. cuvieri* was effected by displacements of the body, jaws and tongue. This behaviour in both species can be divided into preparatory, lunge, and retraction phases. The preparatory phase mainly involved orientation of the head toward the prey when the lizard was not in line with the prey. The lunge phase involved locomotor behavioural patterns toward the prey and one gape cycle. *A. equestris* captured prey when the distance between the lizard and the prey did not exceed 10 cm. In *O. cuvieri,* lunge phases were observed even

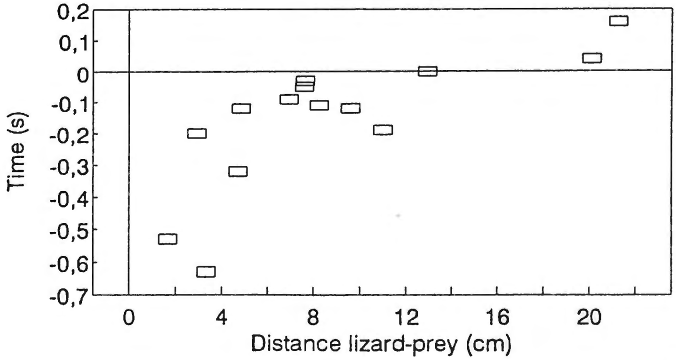


Fig. 3. — The time between beginning of the gape cycle and beginning of body displacement of *Oplurus cuvieri* is positively correlated to prey-lizard distance. Beginning of gape cycle refers to the first frame of increasing gape angle. The first frame involving body displacement is arbitrarily selected as time 0. When the gape cycle begins after body displacement, the time is positive. When the gape cycle begins prior to body displacement, the time is negative.

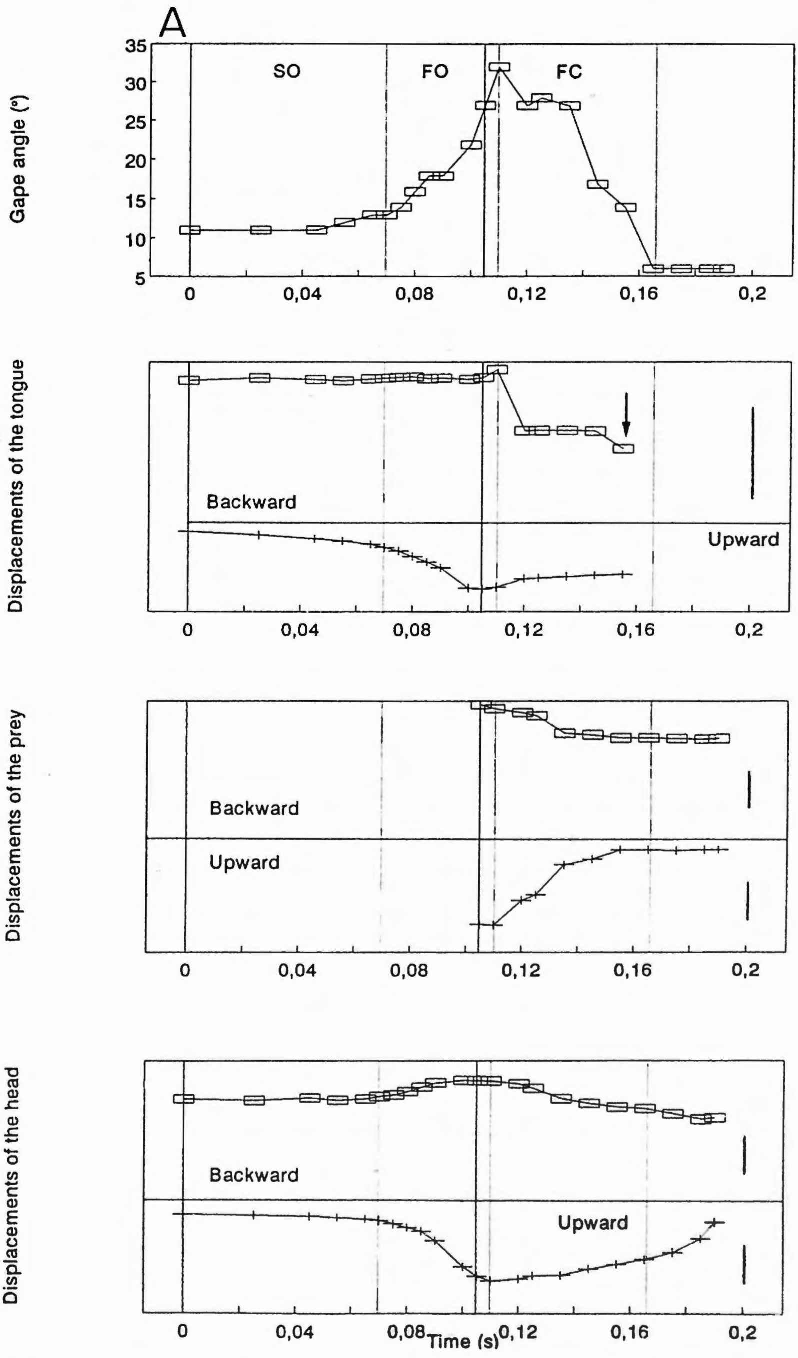
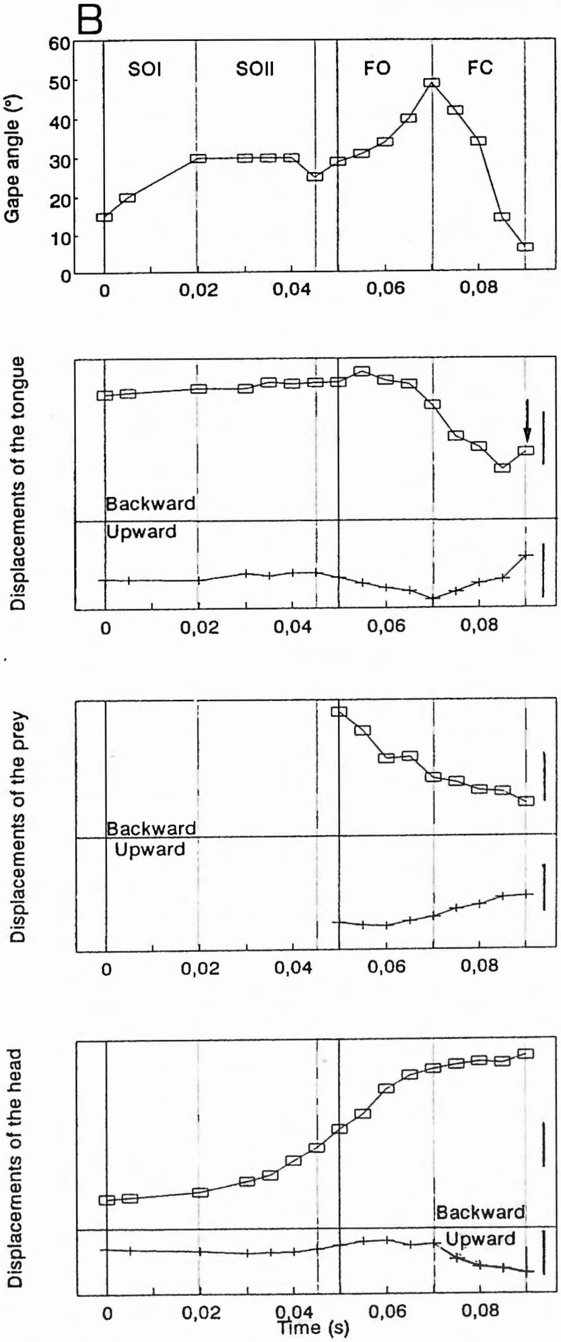


Fig. 4. — Representative kinematic profiles of prey capture by *Anolis equestris* (A) and *Oplurus cuvieri* (B) at short prey distances. The solid vertical line indicates tongue-prey contact. The vertical bars correspond to



10 mm. In the second graph (displacements of the tongue), the arrow indicates the last frame in which the tongue was visible for digitizing. (▭), horizontal displacement; (+), vertical displacement.

when distances between the lizard and the prey were about 50 cm. In *A. equestris,* the gape cycle began simultaneously or immediately prior to the rotation of the forebody onto the elbow. In *O. cuvieri,* at long distances ($\geq$15 cm), the locomotor behaviour began prior to or simultaneously with gape opening (Fig. 2). At short distances ($\leq$15 cm), the mouth opened prior to or simultaneously with locomotion toward the prey as in *A. equestris* (Fig. 3). The timing between beginning of gape opening (first frame of SO stage) and the beginning of body displacements was significantly related (Timing = $-0.39 + 0.027\,X$; r = 0.56) to the prey-lizard distance.

The gape cycle was divided into four successive stages : slow opening (SO) divided into slow opening I (SO I) and slow opening II (SO II), fast opening (FO), and closing (FC). The duration of the SO I stage was rather stereotyped (CV in *A. equestris :* 37.5 ; CV in *O. cuvieri :* 47.1). The duration of SO II stage in *O. cuvieri* was highly variable (CV : 84.0). The SO II stage was often absent (more than 80 % of gape cycles) in *A. equestris* feeding on prey at close distance, and ranged from 0 to 0.03 s in 20 % of the cycles. The duration of FO stage in both iguanids was rather similar (Table 1). In both lizards, the velocity of mouth closure (fast closing stage or FC) was also similar (Fig. 4), and this stage can not be divided into fast and slow steps. Gape amplitude was larger in *O. cuvieri* than in *A. equestris* (Table 1).

The tongue was protruded and deformed simultaneously as illustrated for *O. cuvieri* (Fig. 5). The anterior-most point of the tongue moved downward until it contacted the prey. Anteriorly, two lateral masses were separated by a central concavity as soon as the tongue was beyond the jaw margins (Fig. 5). When the tongue contacted the prey, it expanded and then retracted with the prey. At the same time, the jaws surrounded the prey.

During SO and early FO, the tongue was protruded beyond the mandibular symphysis (Figs 2 and 5). However, in both lizards the maximal extension of the tongue tip beyond the mandibular symphysis was slight : 7-9 mm (N = 14) in *O. cuvieri* and 6-7 mm (N = 10) in *A. equestris.* The tongue contacted the prey during FO (Fig. 4) and always before maximal gape. In both species, tongue-prey contact occured variably in the FO stage (0.04-0.02 s before maximal gape, see also BELS, 1990 and DELHEUSY and BELS, 1992). Retraction of the tongue with the adhering prey always began during the FO stage and continued until the end of the FC stage. Tongue retraction in *O. cuvieri* and *A. equestris* were rather similar for prey items of different weights, crickets and locusts respectively (Table 1).

After tongue-prey contact, the head of *O. cuvieri* continued to move forward and the widely opening jaws completely surrounded the prey (Figs 4 and 5), which started to be retracted into the mouth by the tongue. The prey was thus brought into the buccal cavity by tongue retraction, but also by forward shift of the lower and upper jaws around the prey item. Whereas the forward movement of the jaws (head, body) continued during FC in *O. cuvieri,* in *A. equestris* in contrast this movement was reversed at the transition between FO and FC (Fig. 4).

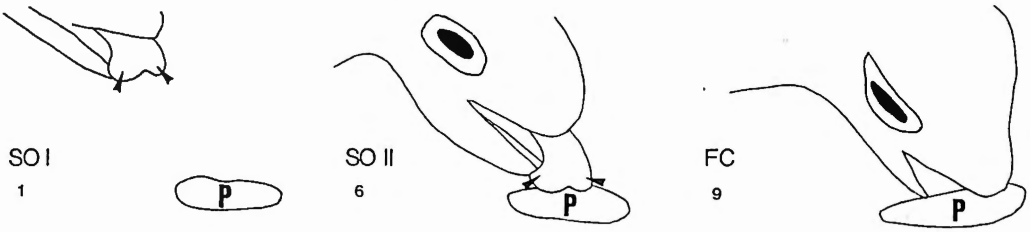


Fig. 5. — Tracings from three typical frames of *Oplurus cuvieri* capturing a cricket. The arrows indicate deformations of the foretongue. Time is indicated in frames, and time between two successive frames is 0.01 s. See figure 2 for abbreviations ; P, prey.

DISCUSSION

Kinematic profiles of jaw and tongue displacements during prey prehension in one terrestrial (*O. cuvieri*) and one arboreal (*A. equestris)* insectivorous lizard do not differ from the previously described capture kinematics in terrestrial iguanids (SCHWENK and THROCKMORTON, 1989) and agamids (SCHWENK and THROCKMORTON, 1989 ; KRAKLAU, 1991). However, high speed cinematographic data in *A. equestris* and *O. cuvieri* show that the duration of tongue retraction is lesser in these iguanids (range : 0.03-0.04 s, Table 1) than those data reported by SCHWENK and THROCKMORTON (1989) for iguanids (range : 0.049-0.180 s). Prey retraction in the buccal cavity in *A. equestris* and *O. cuvieri* is produced by simultaneous forward displacements of the jaws around the prey and tongue retraction (Fig. 5) as in the previously described agamids and iguanids (SCHWENK and THROCKMORTON, 1989). For calculating the duration of tongue retraction, we thus only measure the time of the X-displacement of the tongue tip relative to the tip of the mandible. The speed of filming and method of calculation may explain the discrepancy with the data of SCHWENK and THROCKMORTON (1989). Except in Chamaeleontidae which do not move the head toward the prey (WAINWRIGHT *et al.,* 1991), the jaws in iguanians play a major role for prey capturing. In two iguanids using different habitats, the jaw-tongue displacements toward the prey are similar (Fig. 4). The displacement of the jaws in *A. equestris* is mainly produced by a rotation of the body on the elbow (Fig. 1 in BELS, 1990) whereas the displacement of the jaws in *O. cuvieri* is a by-product of the running movement of the lizard toward the prey. Such a running movement should be unfavourable in *A. equestris* because this lizard moves on rather round substrates such as branches with variable diameters. The fixation of this lizard by the subdigital lamellae that contact strongly the surface of the substratum when the lizard is at about 10 cm of the prey (BELS, 1990) is highly favourable for approaching the head toward the prey and capturing it firmly.

Tongue shape in the buccal cavity resembles that described for other iguanids (SCHWENK and THROCKMORTON, 1989). The tongue may have two functional roles : (1) hold the prey onto the substratum, and (2) help to enter the prey into the buccal

TABLE 1

Summary statistics for eight kinematic variables describing the capture cycles in *Anolis equestris* and *Oplurus cuvieri.* FC, fast closing ; FO, fast opening ; SO I, slow opening I ; SO II, slow opening II. (*) refers to DELHEUSY and BELS (1992) and (**) to BELS (1990). N corresponds to the number of digitized cycles.

Variables	N	Anolis equestris	N	Oplurus cuvieri
Duration of SO I (s)	10	0.15 ± 0.10 **	7	0.17 ± 0.10 *
Duration of SO II (s)	10	0.02 ± 0.01 **	7	0.25 ± 0.21 *
Duration of FO (s)	10	0.04 ± 0.01 **	7	0.04 ± 0.01 *
Duration of FC (s)	10	0.04 ± 0.01 **	7	0.04 ± 0.02 *
Maximal gape angle (°)	10	30 ± 5 **	7	35 ± 17 *
Duration of tongue retraction (s)	10	0.03 ± 0.01 **	7	0.04 ± 0.01 *
Time to tongue-prey contact (s)	10	0.02 ± 0.01 **	6	0.02 ± 0.01 *

cavity. Except in chameleontids (BELL, 1990 ; WAINWRIGHT *et al.,* 1991 ; SO *et al.,* 1992) and perhaps some agamids such as *Phrynocephalus helioscopus* (SCHWENK and BELL, 1988 ; SCHWENK and THROCKMORTON, 1989), the main role of the tongue should be maintaining the prey in position when the jaws are moving forward around the prey. But, retraction of the prey off the substratum is necessary to allow the mandible to slide underneath the prey. In lizards which do not use tongue prehension, the head positioning is completely different (BELS and GOOSSE, 1990 ; GOOSSE and BELS, 1992). Kinematics of head displacement during retraction of the prey may thus depend on the mechanism used for prey prehension. It also seems to depend on the species-specific adaptation. In a terrestrial species such as *O. cuvieri,* that runs fast toward the prey (Fig. 2), the head elevation occurs after the complete capture cycle (DELHEUSY and BELS, 1992). *A. equestris* moves the head posteriorly during the mouth closure by a backward rotation on the elbow (BELS, 1990). Both displacements of the head may help to prevent the escape of the prey because the prey loses its contact with the substratum.

In *Agama agama* (KRAKLAU, 1991), the beginning of the lunge phase involving the locomotor behaviour is the « committed » step of the prey capture (= strike, in KRAKLAU, 1991) for two reasons ; (1) the tongue may retract at any time of the preparatory phase, and (2) the lunge phase is always completed and the lizard moves along the original trajectory without any modulation. Prey capture is thus a complex motor pattern that involves locomotor and jaw muscles (Fig. 4 ; see also BELS, 1990). In *O. cuvieri,* gape opening is initiated prior to or after the displacement of the lizard toward the prey depending on prey distance (Figs 2 and 3). At short distances (range : 1-15 cm), the gape cycle always begins prior or simultaneously to displacements of the body or the head toward the prey. This is also the case for *A. equestris*. At long distances (range : 16- 22 cm), the gape cycle in *O. cuvieri* often begins after the displacement of the lizard (Figs 2 and 3). The duration of the SO II stage is related to the distance between the lizard and the prey, whereas duration of SO I is more stereotyped. For prey captures recorded in this study, the SO II stage was short or absent at short distance, but increased at long distance (Fig. 2). BELS (1990) emphasized that the SO II stage may be completely absent in *A. equestris*. The duration of the SO II stage may be affected by different prey characteristics such as mobility, velocity and shape which are not considered in this study, but also by the distance between the lizard and the prey. When the prey is close to its snout ($\leq$15 cm for *O. cuvieri*), the lizard might « evaluate » the distance for opening the gape which is necessary for tongue protrusion. The predator thus reduces the duration of the SO II, and begins body displacement toward the prey after the beginning of gape opening. When the prey is at long distances, this « evaluation » might occur during displacements of the lizard toward the prey.

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ABSTRACTS

Meeting in the K.B.I.N./I.R.B.Sc.N.
Brussels, 24th October 1992

MODELLING PECTORAL FIN ADDUCTION OF GOBIES. *D. Adriaens, D. Decleyre* and *W. Verraes*. University of Ghent, Lab. Morfologie en Systematiek der Dieren, Ledeganckstraat 35, B-9000 Gent.

In general *Pomatoschistus lozanoi* cannot be regarded as a good swimmer. Swimming occurs by means of short swimming-darts where the propulsion is generated through tail-fin motion and pectoral fin adduction. The latter was analysed by means of a physical model, constructed on the basis of the morphological structure of the pectoral girdle and fin of *P. lozanoi*. Two springs were attached to the medial side of the shoulder- and fin-plate, simulating the contraction forces of the fin adductor muscles. The model-fin was operated in water. Two types of displacement were video-recorded : one where both the fin-plate and the shoulder-plate could rotate freely (type I) and another where the shoulder-plate was restricted in a forward rotation by Baudelot's ligament between the shoulder-plate and the neurocranium (type II). Using the coordinates of the model-parts, the pressure drag on the shoulder- and fin-plate was calculated. In both motions the shoulder-plate exerted a forward rotation, producing a negative pressure drag and so resulting in a braking effect during forward propulsion. In order to calculate the pressure drag on the fin-plate, an equation point had to be taken into account, *i.e.* the point on the fin-plate where the backward rotation speed of the fin-plate equals the forward rotation speed of the shoulder-plate-end. In type I displacement, the positive pressure drag produced by the backward rotation of the fin-plate is neutralised through a negative pressure drag generated by the forward rotation of the shoulder-plate. In type II displacement, the shoulder-plate is stopped in its forward rotation, so only a positive pressure drag is generated.

ECOTOXICOLOGICAL EVALUATION OF AN INDUSTRIAL EFFLUENT. *M. Baillieul, L. Bervoets* and *R. Blust*. University of Antwerp (RUCA), Dept. of Biology, Groenenborgerlaan 171, 2020 Antwerp.

An ecotoxicological evaluation of an industrial effluent was conducted to assess the current impact of the discharge on a freshwater river and to derive discharge levels that would allow for a partial recovery of the ecosystem. This was done by a combination of toxicity tests, field surveys and chemical analysis. Toxicity tests were performed on the effluent and water from different locations along the river course. Solutions of the main effluent component ($CaCl_2$) were tested to identify its contribution to the overall toxicity. Dilution water was collected from an uncontaminated location of the same river. Acute and chronic toxicity was tested using *Daphnia magna* ; acute toxicity was also tested on carp (*Cyprinus carpio*) and three resident species (*Gobio gobio, Asellus aquaticus, Hydropsyche angustipennis*). The field survey included the inventarisation of the aquatic communities and analyses of a set of physical and chemical variables. Using this strategy it was possible to : 1) detect stress that cannot be attributed to the chemical composition of the water (e.g. oxygen stress) ; 2) identify the most important chemicals responsible for the acute or chronic toxicity of the effluent ; 3) assess the evolution of the toxicity of the river along its course. The results indicate the importance of incorporating toxicity tests, field surveys and chemical analysis in environmental impact assessments of effluents.

THE EFFECT OF CADMIUM ON CULTURED INSECT CELLS : DEVELOPMENTAL AND ULTRASTRUCTURAL ASPECTS.

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We used the AEAL-cell culture (derived from the dipterous *Aedes albopictus*) to study the effect of $CdCl_2$ on invertebrate cells at sublethal Cd-concentrations. In order to define the sublethal region we first determined the lethal concentration by using a neutral red viability assay. The lethal Cd-concentrations after 24 hrs of treatment was found to be 4 ppm. The sublethal concentration range was tested in long term experiments : growth curves showed that between 1 and 4 ppm of $CdCl_2$, cell multiplication was almost completely halted. Between 0.25 and 1 ppm the cells were able to multiply but their multiplication was inhibited dose dependently. Based on these results cells were treated with 0, 0.3, 1 and 2 ppm $CdCl_2$ for 8, 16, 24 and 48 hrs respectively. The morphological effects were studied both at S.E.M. and at T.E.M. mode. Morphologically the cells are of the fibroblast type ; they resemble insect granulocytes (blood cells). Cd-treatment induced several alterations in relation to the control ultrastructure. At the S.E.M. mode cell blebbing and rounding were the most characteristic effects, they are probably indicative for the disturbance of the cytoskeleton. Fine sections showed blebbing, swelling of the mitochondria and condensation of the chromatin. We also found dilatation of the R.E.R.-cisternae and an increase in size and number of secondary lysosomes. The former effects are clearly pathological, the latter can probably be interpreted in terms of a defence system.

EFFECTS OF VARIOUS EXTERNAL CALCIUM LEVELS ON THE UPTAKE OF RADIOACTIVE COBALT BY A FRESHWATER FISH, *CYPRINUS CARPIO*.

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The effects of various external calcium levels on the uptake of radioactive cobalt by the carp were examined. Fish were acclimated to different external calcium levels during a 14 day period previous to the experiments. The uptake of cobalt and calcium was measured after a 3 hour incubation period of the fish in water with different calcium concentrations and activities of 1480 Bq ^{45}Ca/l and 740 Bq ^{57}Co/l. Apparently the concentrations of calcium in the water during the experiment was of greater importance on the uptake of both elements than the concentrations of calcium of the water during the acclimation period. Both cobalt and calcium uptake were high at low external calcium concentrations, and a significant correlation between the uptake of the elements was observed. By adding calcium channel antagonists (i.e. lanthanum and cadmium) to the water we measured a decrease of both ^{45}Ca and ^{57}Co uptake with concentrations of cadmium exceeding 10^{-6} M. The size of decrease however was not the same for both elements. Adding lanthanum to the water had no effect on the uptake of cobalt nor calcium. These results suggest that although calcium and cobalt uptake are correlated, the uptake of both elements does not appear to involve the same uptake mechanism.

FUNCTIONAL MORPHOLOGICAL STUDY OF THE FEEDING APPARATUS IN *CROCODILUS NILOTICUS* (REPTILIA).

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The morphology and function of the craniocervical complex and its associated musculature were studied in *Crocodilus niloticus* by anatomical and experimental techniques. Movements of jaws and neck were recorded by a magnetoresistive gape-transducer and a tri-axial accelerometer. The kinematic output was correlated with the activity pattern of all jaw muscles and one cervical muscle. Feeding in *Crocodilus niloticus* can be divided into six sequential stages : acquisition, holding, killing, reduction, transport and swallowing. The intraoral transport of the prey is an inertial process and is accomplished by rapid movements of the jaws and neck in which a backward acceleration is imparted to the prey. Analysis of the kinematic gape profile and the muscle activities indicates three inertial bite types (repositioning, killing/crushing, transport) and a non-inertial swallowing cycle. During jaw opening the lower jaw is depressed by contraction of the m. depressor mandibulae and the upper jaw is elevated by dorsal cervical muscles. Fast jaw closure is achieved by simultaneous contraction of all jaw adductors in all inertial bites. Pulsatile activity of all jaw adductors generates the crushing force at the end of the killing/crushing bites. Toward the end of the feeding sequence closing of the jaws is achieved by the activity of less muscles, in swallowing cycles only two jaw adductors remain active. Supported by FKFO grant nr. 2.9005.90.

STRESS INDICATORS IN THE ENERGY METABOLISM OF THE COMMON CARP.

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The aim of our study is to measure the energy status of the common carp as a subclinical and sensitive indicator of environmental stress. Establishing a direct quantitative relationship between short-term physiological responses of the organism and its long-term performance (survival, growth, reproduction) under the mixed stress of a changing environment, would allow to detect stress and predict its results before irreversible changes have occurred. Different aspects of the changes in the energy metabolism of *Cyprinus carpio* are investigated. First of all the energy status of the carp is examined by the AEC or adenylate energy charge (ATP + 1/2ADP)/(ATP + ADP + AMP) which is monitored using NMR (Nuclear Magnetic Resonance) scanning. Secondly, the oxygen consumption/nitrogen production ratio is measured in order to know the relative use of protein versus lipid and carbohydrate consumption. For this purpose a respiration chamber has been developed in which pH, O_2 and NH_4^+ can be measured directly. As it is possible to change the water during the experiment, short-term effects as well as long-term effects can be monitored. Finally glycogen, lipid and protein content is determined in order to evaluate the general condition of the fish, and RNA/DNA ratio to assess for protein synthesis activity.

FUNCTIONAL MORPHOLOGICAL STUDY OF THE CERVICAL SYSTEM IN *TRIONYX* (REPTILIA : CHELONIA : CRYPTODIRA).

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The relationship between the form and movement in the neck of softshell turtles (*Trionyx spiniferus* and *T. ferox*) was studied by descriptive anatomical and biomechanical approaches. The change in orientation between the neck vertebrae during head and neck retraction was recorded in anaesthetized animals using radiography and computerized tomography. Predictions concerning the potential range of movements are based on anatomical analysis and manipulation of bone-ligament preparations. Rotations in the sagittal plane are possible in all joints, but dorsiflexions are larger than ventroflexions, except in joint D1-V8. Lateral flexions and small axial rotations are limited to the distal region of the neck, anterior to V6. The bicipital intercentral hinge joints between the proximal vertebrae and the greatly enlarged zygapophyseal joints in D1-V8 restrict motion to rotations in the sagittal plane. Judging from the CT scans, most of the head and neck retraction results from sagittal rotations at the five proximal most cervical joints (D1-V8 through V5-4). The kinematic pattern during head retraction is characterized by ventroflexion in joint D1-V8 followed by a sequence of successive dorsi- and ventroflexions in joints V8-7 through V5-4 progressing in proximo-distal direction. The range of angular changes is approximately equal in all joints. An hypothesis concerning muscular activities during head retraction and extension is proposed. Supported by FKFO grant nr. 2.9005.90.

IMMUNOCYTOCHEMICAL LOCALIZATION OF THE DOPAMINERGIC AND SEROTONINERGIC SYSTEM IN THE BRAIN OF THE CHICKEN (*GALLUS DOMESTICUS*).

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The present work is situated in a long term project trying to elucidate the role of the biogenic amines in the antithesis between growth and reproduction in the chicken (*Gallus domesticus*). From several observations it has become clear that the monoamines play an important role in the modulation of appetite and food intake and at the same time exert effects on the male and female reproductive behavior as well as on the secretion of the gonadotrophic hormones. In a first approach, we analysed the distribution of these monoaminergic neurotransmitters in the brain of two physiologically different groups of a broiler chicken breed, i.e. *ad libitum* fed broiler chickens and food restricted animals, designated for reproduction. A light microscopic immunocytochemical study revealed the dopaminergic and the serotoninergic system in the brains of food restricted and *ad libitum* fed broiler chickens of 4, 10 and 16 weeks old. We were able to describe the localization of tyrosine hydroxylase (TH), L-DOPA, dopamine (DA) and serotonin (5-HT) throughout the whole central nervous system of the chicken. From this semiquantitative study we could, however, not find any clear differences in the distribution pattern nor concentration between the two types of food regime.

FEEDING IN *AGAMA STELLIO* (REPTILIA) : KINEMATICS AND MUSCLE ACTIVITY.

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The feeding in *Agama stellio* (a generalised insectivorous lizard) was examined. For that purpose cineradiographic and electromyographic experiments were undertaken. Some aspects of the physiology of the jaw muscles were studied by stimulation experiments. In the EMG experiments the activity of the jaw, tongue and hyoid muscles was recorded simultaneously, in combination with cineradiography or high speed film (200 fps). The feeding cycle is divided into different bite types : strike, reduction/transport (which could not unambiguously be separated) and swallowing. Bites are further divided into subsequent kinematic phases : slow open (SO), fast open (FO), fast close (FC) and slow close/power stroke (SC/PS). Reduction and transport cycles are characterized by a clear FO and a pronounced SC/PS. Swallowing differs from reduction and transport by a short FO and the absence of SC/PS. The depression of the lower jaw during FO is achieved by activity in the jaw opener ; however no activity in this muscle is present during SO. Our experiments have shown this phase to be the result of the protrusion of the tongue and the fitting of the tongue to the prey. Jaw closure is achieved by simultaneous contraction of all jaw adductors. Stimulation experiments show that during feeding the neuronal stimulation frequency is 80Hz, which is twice the fused tetanus frequency. Supported by FKFO grant nr. 2.9005.90.

SELECTION OF STABLY TRANSFORMED *DROSOPHILA* S2 CELLS AFTER COTRANSFECTION WITH pBmNPV IEG lacZ AND pUChsHyg BY HYGROMYCIN B RESISTANCE.

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Recombinant baculovirus mediated expression of foreign proteins in insect cells is by definition transient, because of the lytic properties of the virus. By using the promoter of an immediate early gene from a silkmoth specific baculovirus, *Bombyx mori* Nuclear Polyhedrosis Virus (BmNPV), we developed a continuous expression system with *Drosophila* S2 cells. Up till now the gene coding for β-galactosidase under BmNPV IEG promoter control (pBmNPV IEG lacZ) is used as reporter gene. After cotransfection with this reporter gene and an antibiotic resistance gene, the selection of stably transformed cells can be carried out in the presence of the antibiotic. Methotrexate and hygromycin B have both been tested but only hygromycin B is lethal to S2 cells. The hygromycin resistance construct (pUChsHyg) contains the resistance gene under control of a *Drosophila* heat-shock promoter. The cotransfection was done both with linear and supercoiled DNA using different ratio's of both constructs. Three weeks after transfection, antibiotic resistant colonies appeared. The majority of the transformed cells expressed the β-galactosidase IEG fusion protein, even after subculturing these cells for up to 6 months. This expression remained present in non-selective conditions. Western blotting showed that the expression of β-galactosidase is limited to the transformed cells. Southern analysis of these cells proved that the foreign DNA was integrated in the hosts genome.

ASSESSMENT OF MORPHOLOGICAL DEFORMITIES IN *CHIRONOMUS RIPARIUS* LARVAE (DIPTERA, NEMATOCERA) IN A CHRONIC EXPOSURE TEST WITH CADMIUM.

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Chronic exposure tests with cadmium (0, 3, 9, 27 ppm; static with replacement; cellulose substrate) were performed on *Chironomus riparius* larvae (Diptera, Nematocera) during three successive generations. Head capsule deformities were assessed in 4th instar larvae of each generation. Heavy mechanical wearing of the buccal structures and a high percentage of antennae lacking distal segments was observed in each experimental condition. Moreover, there was a general trend towards maximum percentages of larvae with structures showing mechanical wear and loss of antennal segments in the 9 and 27 ppm conditions of the second generation and in the 27 ppm condition of the third generation. This indicates a gradual weakening of the chitineous structures in subsequent generations of larvae which were subjected to a constant cadmium stress. This experiment could not induce so-called « Kohn-gaps » (mentum gaps), as usually encountered in aquatic systems polluted with heavy metals. However, splitting of the medial teeth of the menta increased abruptly when the larvae were exposed to cadmium stress.

THE SIGNIFICANCE OF MORPHOLOGICAL DEFORMITIES IN CHIRONOMID LARVAE (DIPTERA, NEMATOCERA) FOR SEDIMENT QUALITY ASSESSMENT.

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There is increasing field and experimental evidence that morphological deformities in riparian chironomid larvae do reflect contaminant stress (heavy metals and pesticides) of fluvial sediments (Hamilton/Saether Hypothesis). Domestic pollution of inland waters in Flanders (Belgium) is commonly assessed with the Belgian Biotic Index (BBI), which relies on the presence of oxygen sensitive macro-invertebrates in the macrobenthos community. In order to investigate whether there is any relationship between water quality (organic pollution) and sediment quality (micropollutants), deformities in *Chironomus riparius* larvae were matched against BBI for several watercourses in Flanders. Preliminary results, relying on 14 sites, show an inverse relationship between BBI and deformities of the median teeth of the mentum and a positive relationship between BBI and deformities of the pecten epipharyngis and the inner teeth of the mandibles. Deformities in other zonations of mentum and mandibles and in the antennae showed no relationship with BBI. The deformity response is clearly not unequivocally associated with domestic water pollution (BBI), but is rather reflecting the presence of other stress factors, which occur in the aquatic system independently from organic pollution. Therefore, deformities in chironomid larvae give complementary information to the BBI about the pollutional state of a water body.

MORPHOLOGICAL DEFORMITIES IN *CHIRONOMUS RIPARIUS* LARVAE (DIPTERA, NEMATOCERA) FROM THE DYLE WATERSHED : IN SITU EVIDENCE OF A RELATIONSHIP WITH MICROPOLLUTANTS.

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Morphological deformities in mentum, mandibles, antennae, premandibles and pecten epipharyngis of the head capsules of 4th instar *Chironomus riparius* (Diptera, Nematocera) larvae from the Dyle watershed were quantified. These data were matched against total concentrations of 7 sediment bound heavy metals and 20 sediment bound pesticides, using canonical correlation analysis and multiple regression analysis. The 7 sites were ranked in the same order for the deformity scores, as for the overall pollution. HCB and a number of PCB's appeared to be associated to antennal deformities, while the other pollutants showed a more disparate association with the other structures. Deformed larvae contained significantly more lead and copper than normal larvae. These field data strongly suggest a positive relationship between the occurrence of morphological deformities in midge larvae and the presence of heavy metals and pesticides in the fluvial sediments. Adequate interpretation of these deformities will conduct towards the elaboration of a practical biomonitoring tool for the screening of industrial and agro-chemical pollution in the lowland rivers of Flanders, Belgium.

BIOMECHANICAL ANALYSIS OF THE VERTICAL JUMP OF *GALAGO SENEGALENSIS*.

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Galago senegalensis (a small prosimian), is known to jump as high as 2.25 m. A simple model was used to calculate the power required for jumping, assuming a strict synchronization between joint rotations and muscular contraction. Judging the power demands for a 2.25 m jump, at least 125 % (!) of the body mass of *Galago* must be jumping muscle. To explain this obvious discrepancy, three hypotheses can be formulated : (a) the used model overestimates the required power, (b) the muscles can produce much more power than generally assumed and (c) a power amplifying mechanism is in play (*i.e.* a catapult system, implying pre-straining of elastic structures). To test these hypotheses, the push-off phase of 19 jumps of three animals were recorded by means of a force plate (measuring ground reaction forces) and a NAC 1000 video (500 frames/s ; registration of the body kinematics). The obtained data allow to calculate the required instantaneous external power output very accurately. On the basis of these results the first hypothesis must be rejected. The second hypothesis is considered to be doubtful as then muscles should perform more than four times better than the estimated optimum for vertebrate muscles. Thus the results point at the presence of a power amplifying mechanism. However, preliminary morphometry excludes the most obvious system : the achilles tendon. Further research is required.

LEAF QUALITY AND HERBIVORY PATTERNS IN *AGROMYZA PHRAGMITIDIS* (DIPTERA, AGROMYZIDAE).

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Agromyza phragmitidis Hendel, 1922 is a monophagous leafminer of common reed *Phragmites australis* (Cav.) Trin. ex Steud. We examined the distribution of *A. phragmitidis* within its macrohabitat, the reed bed, and its microhabitat, the reed stems. Reed stems were collected in different reed beds. In the laboratory the following leaf characteristics were measured : leaf height on the shoot, total leaf and mine area, water, protein and sugar content. We observed the highest concentrations of leafmines of *A. phragmitidis* in the shaded areas of the reed bed. In its microhabitat, the mines of *A. phragmitidis* are concentrated on the leaves in the mid-region of the reed stem. We provided evidence that the leaves in this mid-region have a higher water content and a larger leaf area than the other leaves on the reed stem. Further analyses showed a strong positive relation between leaf area and number of larvae in the mine of that leaf. When the leaf characteristics of the leaves with and without mines of the mid-region were compared, we observed a higher water content, a lower protein content, and a larger total leaf area in the mined leaves. L.D.B. is a senior research assistant of the N.F.S.R.

CERVICAL MOVEMENTS DURING PREY CAPTURE IN THE AUSTRALIAN SNAKE-NECKED TURTLE *CHELODINA LONGICOLLIS* (REPTILIA ; CHELONIA ; PLEURODIRA). *J. Van Damme*, *P. Aerts* and *F. De Vree*. Dept. of Biology, University of Antwerp (U.I.A.), Universiteitsplein 1, B-2610 Antwerpen.

Kinematics of the neck movements in *Chelodina longicollis* during frontal strike movements were studied by means of X-ray cinematography (50 frames/s). Radio-opaque markers were inserted in the neck vertebrae of two specimens of *Chelodina longicollis*. Digitalisation of these markers allowed to calculate the degree of head retraction and joint angles between the successive vertebrae during neck movements. In *Chelodina* lateral rotations between cervical vertebrae are most important (i.e. Pleurodira). A frontal strike cycle consists of a fast extension of the head and neck towards the prey item, followed by a much slower retraction phase. Individual differences in joint rotations are noticeable during the strike : the main centres of motion are observed in V5-4 (i.e. joint between vertebrae 4 and 5), V6-5 (V5 = biconvex vertebra) and, depending on the individual, V8-7 (turtle 2) or V9-8 (turtle 1). These joints also show the largest starting angle at the beginning of the strike. Angular changes in V7-6 are less conspicuous. During the head retraction phase, angular changes in the more proximal joints are an inversion of those during protraction. Supported by IWONL grant nr. 910091 and FKFO grant nr. 2.9005.90.

A MORPHOLOGICAL STUDY OF THE *PHYLLOTRETA TETRASTIGMA* COMPLEX (COLEOPTERA, CHRYSOMELIDAE, ALTICINAE). *P. Verdyck, L. De Bruyn, J. Scheirs,* and *J. Verwaerde.* University of Antwerp (RUCA), Department of Biology, Evolutionary Biology Group, Groenenborgerlaan 171, 2020 Antwerpen, Belgium.

The *Phyllotreta tetrastigma*-complex comprises three sibling species : *P. tetrastigma, P. flexuosa* and *P. dilatata.* At present the separation of these species is based on colour characteristics. However intraspecific colour variation is often very large and interspecific overlap exists. To find out whether these sibling species differ morphologically, we started a biometrical study of their habitus. For each species a population was analyzed. Fifteen measurements were taken from the habitus of both males and females. We found that differences between males and females of the same species were smaller than differences between animals of the same sex but from different species. To see which characters attributed the most to the separation of the species a discriminant analysis was performed. Different characters attributed to a greater or lesser extent to the separation of the three species. P.V. is an I.W.O.N.L.-bursar, L.D.B. is a senior research assistant of the N.F.S.R.

SEQUENCE DETERMINATION OF THE SMALL RIBOSOMAL SUBUNIT RNA OF *PHASCOLOSOMA GRANULATUM* LEUCKART 1828 (SIPUNCULA).

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The phylogenetic relationships of the Sipuncula, a phylum of unsegmented coelomate worms, are difficult to evaluate on the basis of morphological, anatomical, embryological or paleontological data. We determined the first complete 18S rRNA sequence of a representative of the phylum, viz. *P. granulatum*. The new sequence was aligned by hand with those of other Metazoa, including Chordata, Arthropoda, Mollusca, Pentastomida, Platyhelminthes and Cnidaria. From the tree we obtained using the neighbour-joining distance method to this data set, it is concluded that the Sipuncula are a sister group to the Mollusca. The latter phylum, represented by Bivalvia, Gastropoda and Polyplacophora, appeared to be a monophyletic group. However this is a very preliminary hypothesis, which has to be tested further by addition of complete 18S rRNA sequences of some crucial metazoan groups (e.g. Annelida) to our data set.

IN SITU HYBRIDISATION FOR GAP-43 IN THE BRAIN OF THE ADULT CAT (*FELIS CATUS*).

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After development of the cat has been completed, the GAP-43 (Growth Associated Protein-43) concentration substantially decreases in most of the adult neurons that are thought to be involved in memoryformation (1). We examined in which of the brain structures the level of GAP-43 remains high. We approached the problem at genetic level, searching for the localisation of GAP-43-mRNA by radioactive (^{35}S) in situ hybridisation. Summarizing, we can say that the hippocampus and structures that are involved in smell-processes show the highest levels of GAP-43-mRNA. In the tractus opticus, the corpus callosum and the commissura anterior there is no RNA detectable. Worth mentioning are the structures which express more GAP-43 anterior in the brain compared to posterior : the caudate-putamen, parts of the amygdala and nuclei in the thalamic domain, including the colliculus superior and the corpus geniculatum mediale.

(1) M.B. KENNEDY (1988) — Nature *335* : 770-772.

SOME HISTOPATHOLOGICAL EFFECTS OF PCBs (AROCLOR 1260) ON THE LIVER AND GONADS OF THE BARBEL (*BARBUS BARBUS*).

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PCBs are widely distributed in the environment and have been reported to reach high concentrations in upper trophic levels of aquatic food chains. Liver as the main organ of detoxication is likely to accumulate high quantities of such xenobiotics which can alter its morphology. Common barbels were contaminated with food containing 12.5 µg/g of Aroclor 1260 for 75 days. Samples of livers, testes and ovaries were taken from contaminated and control fish and observed under light and electron microscopy. The light microscopic study showed that there were no observable differences in the general architecture of the liver and the testes of PCB-treated and untreated fish. Electron microscopic study indicated some alteration of the liver ultrastructure of contaminated fish. The most frequently encountered changes were increase of rough endoplasmic reticulum, drastic reduction of glycogen, dissolution of mitochondria contents and appearance of myelin figures. Some damage appeared in the spermatozoa originating from contaminated fish, particularly in the head region. Light and electron microscopic studies of ovaries showed that this organ is less developed in contaminated fish than in control fish. PCBs induce changes in the ultrastructure of liver and spermatozoa, and also affect the development of the ovary ; hence, we can suppose that they could affect the reproduction processes. J.L.H. acknowledges an IRSIA grant.

EFFECTS OF TUMOR NECROSIS FACTOR-α (TNF-α) ON THE PROLIFERATION AND DIFFERENTIATION OF PORCINE PREADIPOCYTES.

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TNF-α is a cytokine having multiple effects notably on the immune system, the general metabolism and the development of adipose tissue. The effects of TNF-α (5, 10, 25, 100 and 200 U/ml) were analysed on the proliferation and differentiation of pig preadipocytes. The cells obtained from inguinal adipose tissue of pietrain pig (± 7 days), were inoculed in a serum-free DMEM/F12 (1:1) medium containing 5,5 nM fibronectin and in a serum-additioned medium (10 % FBS). After 24 hours, the defined medium was replaced by another containing 10mg/ml transferrin, 0,2 nM T3, 8,7 nM insulin, 100 nM cortisol, 50 µM β-mercaptoethanol and 100 µM ascorbic acid and the FBS medium was replaced by another containing 2,5 % PS, 14,5 nM insulin and 100 nM cortisol. The different doses of TNF-α were also added at this time. In both media, the proliferation was estimated by tritiated thymidine uptake on the third day of culture and differentiation was recorded by determining LPL activity (early marker) and GPDH activity (late marker). The total cell number and the ratio of differentiated cells were also counted at the end of the culture. In the serum-added medium, the stimulation of proliferation reached 150 % (tritiated thymidine uptake) when 10U/ml TNF-α was added and the cells were numerically 2,5 times more when 200 U/ml of TNF-α was added. In contrast, the LPL activity was less than 1 % of the control values and the GPDH activity less than 20 %. The number of differentiated cells was also dramatically too low. In the chemically-defined medium, the stimulation of proliferation reached 500 % with 200 U/ml TNF-α. The inhibition of the differentiation was less pronounced in comparison with the serum-added medium. FBS : Fetal Bovine Serum, T3 : Tri-iodothyronin, PS : Porcine Serum, GPDH : Glycerol-3-Phosphate Dehydrogenase, LPL : Lipoprotein Lipase.

SPATIAL DISTRIBUTION OF THE WESTERN FLOWER THRIPS *FRANKLINIELLA OCCIDENTALIS* (PERGANDE) ON SWEET PEPPER PLANT.

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With a long term aim to develop a viable biological thrips management programme on sweet pepper, the spatial distribution of the population of different stages of *Frankliniella occidentalis* (*i.e.* egg, larvae 1, larvae 2, nymph 1, nymph 2 and adult) was determined on the plant. Out of the total number of eggs, 99,8 % were found to be on the leaves, and the rest on the flowers sepals, whereas the mobile individuals were found to be on the leaves, within the flowers, and on the fruits. In this last case, many individuals were found between the ovary and the sepals. Among the immature individuals, larvae 1 showed a higher preference for fruits (48,2 %) than flowers (27,7 %) and leaves (24,1 %), and larvae 2 prefered principally flowers (46,5 %) and fruits (40,1 %) rather than leaves (13,4 %). On the other hand, nymphs (1 and 2) were exceptionally found on the plants as nymphosis takes place predominantly in soil. The few nymphs inhabiting the plant were distributed equally within the flowers and under the sepals of the fruits. Adults were principally met within the flowers (68 %), then on fruits (26,5 %) and on leaves (5,5 %).

MORPHOLOGICAL AND PHYSIOLOGICAL APPROACH OF BIOLUMINESCENCE IN THE OPHIUROID *AMPHIPHOLIS SQUAMATA* (DELLE CHIAJE, 1828) (ECHINODERMATA).

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Amphipholis squamata is a small bioluminescent polychromatic ophiuroid (max. disc diameter *ca.* 2.5 mm) in which only the arms are bioluminiscent. Ultrastructural studies done before and after light emission allowed to determine that the light-producing cells occur within the spinal ganglia of the arms (these ganglia occur at the spine base along the arms). It was demonstrated that black-coloured adult individuals produce a much more intense light than those having a beige colouration. This could be related to a difference in the number of photocytes and/or in the amount of photoproteins within these cells. It was also demonstrated that, in each investigated group of ophiuroids (i.e., black-coloured *versus* beige-coloured), small and large individuals behave differently as far as the cinetic parameters of the produced light are considered. It is suggested that these differences could be related to either the maturation of the nervous system or the acquiring of sexual maturity.

PRELIMINARY ESTIMATIONS OF FORAGING AND POPULATION DENSITIES OF GREAT APOIDS (HYMENOPTERA, APOIDEA : *BOMBUS, HABROPODA)* IN SOUTHERN FRANCE.

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During the year 1992, the author has estimated the densities of the populations of great apoids in the « Massif des Maures » (SE-France, Var) by testing marking-recapture observations. The foraging densities were : 1-10 spec./m^2 for *Bombus terrestris,* 1-7 spec./m^2 for *Megabombus ruderatus,* 1-7 spec./m^2 for *Megabombus pascuorum,* < 1 spec./m^2 for *Habropoda tarsata.* For *Bombus terrestris* the population density was estimated only once and was < 1 spec./m^2 . Good relations between the estimations of marking-recapture observations and eliminatory trapping were obtained.

INVESTIGATIONS ON THE METAMORPHIC PROCESSES IN THE ECHINOID, *PARACENTROTUS LIVIDUS* (ECHINODERMATA).

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Three successive stages occur during the metamorphic period of the echinoid *Paracentrotus lividus* where individuals are able to metamorphose (competent larvae), transform (metamorphic larvae), and carry out their imaginal organogenesis (postlarvae) respectively. The postlarval life ends when the mouth and the anus are open, which leads to the appearance of exotrophic juveniles. Competent larvae possess appendages (viz. primary podia) allowing them to test the substrate and to fix on it (the occurrence of metamorphosis depends on the inductive capabilities of the substrate). Metamorphosis is a short event (1 h) in which eversion of the adult rudiment and the lyse of most larval tissues takes place. Imaginal organogenesis starts before larvae become competent (differentiation of the rudiment) but takes place mostly in postlarvae which are endotrophic. During postlarval life, the echinoid skeleton starts its organogenesis and the ambulacral system and imaginal gut start differentiation. Postlarvae bear protective and adhesive appendages (pedicellariae and multifid spines ; primary podia) that will regress in early juveniles.

EFFECT OF PCB ON THE REPRODUCTION OF BARBEL (*BARBUS BARBUS*) : FIRST EXPERIMENTAL RESULTS.

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PCBs are ubiquitous micropollutants, which are known to be inductors of hepatic microsomal oxydases in fishes. These enzymes are involved in the catabolism of steroid hormones. As a consequence, chronic exposure of fishes to PCBs may cause adverse effects on reproduction and hatchability of eggs. 4-years old common barbels from a captivity-reared brood-stock were held in aquaria and intoxicated by food containing supra-environmental concentrations of 2.5 and 12.5 µg PCB/g, respectively during 50 and 75 days. All male fish became sexually mature at the same time. The PCBs content of their milt increased in relation to the contamination level. However, neither the number of spermatozoa per mm^3, nor the duration of their stages of mobility was affected. Control females and those contaminated with 2.5 µg PCBs/g in the food became gravid at the same moment. The number of eggs artificially stripped from the treated fish was reduced by 50 % compared to the control fish. The mean weight of the ovules was not affected by the intoxication. Female fish contaminated at a higher value never reached sexual maturity, as a possible consequence of the PCB intoxication. Control and contaminated eggs were artificially fertilized with sperm of control fish. A significant correlation was observed between total egg mortality and PCB burden in the gonad. High PCB concentrations in the eggs affected hatching success, and increased hatching duration and malformation rate of larvae. As a conclusion, supra-environmental

PCB concentrations can affect the reproduction biology processes of the common barbel. Further research is needed to verify experimentally the impact of intermediate and environmental concentrations. J.L.H. acknowledges an IRSIA grant.

INFLUENCE OF GRAZING RATE ON THE PCBs TRANSFER DYNAMICS IN APLANKTONIC ROTIFER SPECIES, *BRACHIONUS CALYCIFLORUS* PALLAS.

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The presence of PCBs in terrestrial and aquatic ecosystems has been reported by many authors since the sixties. These widespread micropollutants are highly resistant to any biodegradation process and possess acute lipophilic characteristics. As a consequence, these xenobiotics are accumulated in living organisms. Such a contamination can occur via two pathways : the direct route through exchange surfaces ; the indirect way by contaminated food ingestion. This study deals with the establishment of the relative importance of both these pathways in the contamination of plankton, which has not yet been actually defined. In a medium contaminated by means of 5 µg PCBs/l, rotifers (*Brachionus calyciflorus*) accumulated up to 40 µg PCBs/g D.W. within a few hours. When fed with PCB contaminated algae (*Dictyosphaerium ehrenbergianum* containing 20 µg PCBs/g D.W.), rotifers reached a concentration of 4 µg PCBs/g D.W. after 48 hours. Finally, if the animals were contaminated by both pathways at the same time, a concentration of 30 µg PCBs/g D.W. was measured after 24 hours. Obviously, in these experiments where a high PCB concentration in water was considered, *Brachionus calyciflorus* was mainly contaminated by the direct pathway. Nevertheless, when using the ingestion rate determined in laboratory experiments and the concentration of PCBs reported in natural phytoplankton of the river Meuse, the calculated PCB contamination level of rotifers coincides with the PCB concentration measured in situ. This would mean that in natural ecosystems, the PCB contamination of zooplankton can entirely occur by the indirect pathway i.e. by absorption of contaminated food.

INTRASPECIFIC GROUP EFFECT IN THE FALSE SPIDER MITE (*BREVIPALPUS PHOENICIS* (GEIJSKES)) POPULATION.

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« Group effect » is defined as the effect of population density on the physiological processes of the individuals in a population which is *sensu stricto* different from the « density-dependant » effects. To study this effect in the population of false spider mite (*Brevipalpus phoenicis* (Geijskes)), a pest on citrus, tea, papaya, passion fruit, palms and many other ornamental plants, two levels of densities were considered *viz.*, 3 and 50 mites per leaf discs of 9.5 cm^2 size respectively. The results of the experiment are presented below :

1	Density levels	3 eggs/disc	50 eggs/disc
2	Number of eggs kept	120	500
3	Fertility of the eggs	118 (98.33 %)	470 (94.00 %)
4	Egg hatching period	10.25 days	9.53 days
5	Developmental time	26.77 days	19.55 days
6	Immature mortality	6 (5.00 %)	52 (10.40 %)

7	Total life cycle	52.01 days	41.01 days
8	Eggs laid per female	40.68	39.71

It seems from this study that grouping of the individuals shortens the developmental time and total life span without significantly reducing the oviposition of eggs. The mechanism for such reduction can be explained by two hypotheses. The first one postulates that the presence of cumulatively more hormones present in the higher density level could have stimulated the faster development. However it would be necessary to demonstrate the secretion of such hormones. The second hypothesis rests upon the tactile stimulation among the immature mites as observed in many mite populations (1). The « group effect » discussed here will probably influence the demography of the false spider mite.

(1) G. VAN IMPE (1984) — In : D.A. GRIFFITHS and C.E. BOWMAN (Eds.) Acarology *VI* : 1 : 617-621.

INU I : THE INULINASE GENE OF *KLUYVEROMYCES MARXIANUS* VAR. *MARXIANUS*.

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Inulinase (E.C.3.2.1.7.) hydrolyses inulin, a plant polymer which consists of long linear chains of D-fructoses (5 to 40 moieties) ended at one extremity by a glucose moiety, used as carbohydrate storage essentially in the family Compositae. Among the microorganisms producing inulinase the yeast *Kluyveromyces marxianus* (ATCC12424) is commonly used for its ability to ferment inulin to ethanol directly or as an enzymatic source for pure fructose production (1). The cell wall inulinase was purified from *K. marxianus* by anion exchange chromatography and its N-terminal 33-amino acid sequence was established. On the basis of this sequence, two sets of oligonucleotide primers were derived and used in a PCR reaction on *K.m.* cDNA. A completely homologous probe deduced from the sequence of the PCR fragment was used successfully in a screen of a *K.m.* genomic library. The inulinase gene (*INU 1*, accession number X57202) encodes a 555-amino acid precursor protein with a typical N-terminal signal peptide flanked by 3 consecutive putative cleavages sites (2). In addition, it was shown that *Saccharomyces cerevisiae* transformants produce and secrete inulinase at high level (70 % of the inulinase activity was in the supernatant). Comparison of the inulinase sequence with known invertases suggests that they belong to the same family. A structural and functional analysis of the promoter sequence is currently in progress.

(1) E. J. VANDAMME and D. G. DERYCKE (1983) — Adv. appl. microbiol., *29* : 139-176.
(2) O. LALOUX, J.-P. CASSART, J. DELCOUR, J. VAN BEEUMEN and J. VANDENHAUTE (1991) — FEBS Lett., *289* : 64-68.

ECOTOXICOLOGY OF THE POSIDONIA MEADOW IN THE MEDITERRANEAN : DISTRIBUTION OF THE HEAVY METALS AND DYNAMICS OF CADMIUM ACCUMULATION IN *POSIDONIA OCEANICA* (L.) DELILE.

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The seagrass, *Posidonia oceanica,* is widely distributed in the infralittoral zone of the Mediterranean region where it forms dense communities called « meadows ». Due to their situation close to the coast, these meadows are directly subjected to anthropogenic pollution. The present work focuses on the contamination of this ecosystem by heavy metals. The concentration of 7 metals (Zn, Pb, Cd, Fe, Cr, Cu, Ti) was measured in 4 anatomic compartments of the seagrass (*viz.* photosynthetically active leaf, dead leaf, rhizome, and root) during the annual cycle in 3 stations of the western Mediterranean region (Calvi, Corsica ; Ischia, Italy ; Marseille, France). The results show that (1) seagrasses sampled in Ischia were the most contaminated, (2) there is a seasonal determinism in the contamination of the photosynthetically active leaves, (3) such a determinism is not observed in the rhizomes sampled in Marseille and Calvi. Experimental contaminations *in situ* of the *P. oceanica* by Cd in solution showed that (1) the accumulation of Cd by the leaves is an active process resulting in a concentration of it ranging from 652 to 1088 after 5 days, (2) the Cd-loaded leaves quickly decontaminate when returned to natural conditions (a contamination level corresponding to 10 % of the initial burden is reached after 6 days), and (3) Cd concentration in rhizomes is not affected by short-term contaminations (5 days). These experiments suggest that *P. oceanica* is a bio-indicator of metal pollution at two temporal scales : short-term for the leaves, long-term for the rhizomes.

STIMULATION AND REGULATION OF EGG-LAYING OF THE COCCIDIPHAGOUS LADYBIRD *CRYPTOLAEMUS MONTROUZIERI.*

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C. montrouzieri is a coccidiphagous ladybird, often used in biological control against the populations of mealybugs. We have studied the stimulation and the regulation of the ladybird's egg-laying. These two features are almost unknown for the predaceous insects.The stimulation initiating the oviposition behaviour is due to the presence of a substance in the cuticular waxes of every stage of *Planacoccus citri* and only in the ovisacs of *Eupulvinaria hydrangeae.* Afterwards, a second stimulation occurs, which is due to the perception of enclosed places where the eggs have to be laid. We pointed out the existence of an epideictic pheromone which inhibits the female's laying proportionally to the number of conspecific larvae encountered. This pheromone is present in the larvae's cuticular waxes, which are lost when the larvae forage. In addition, when *C. montrouzieri* meets this pheromone it moves to an acceptable laying place and scatters its eggs.

ELIMINATION OF BRYOZOAN COLONIES DEVELOPING IN THE COOLING SYSTEMS OF THE NUCLEAR POWER PLANT OF TIHANGE.

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For many years, the development of bryozoan colonies has induced strong disturbance in the functioning of cooling systems of thermoelectric and thermonuclear power plants. In the nuclear power plant of Tihange (Belgium), significant biomasses of these organisms (essentially *Plumatella emarginata*) have developed in the basins beneath the cooling towers. The chlorine injection (as NaClO) is the usual way to clean the pipe of the cooling system. The free available chlorine (FAC) is relatively inefficient towards bryozoans. However the bryozoan colonies appear to be more sensitive to chlorine when ammonia present in water induces monochloramines formation. We had confirmed this hypothesis by ecotoxicological experiments. The aim of this work was to study 1) the stability of monochloramines when humic acids are present in the water, 2) the biocide efficiency of monochloramines towards bryozoans and 3) the NH_4^+ concentrations necessary to form, *in situ,* sufficient concentrations of monochloramines. These experiments have shown that : monochloramines are more toxic than free chlorine for bryozoans ; monochloramines are more stable than free chlorine in the presence of humic acids ; young colonies (1 to 10 polypids) are more sensible than the old ones ; the maximal effect of chlorination in the cooling system is obtained when the ammonia concentrations reach 1 to 1,5 mg NH_4^+/l and when the monochloramine concentrations reach 6 mg/l for 1 to 2 hours.

ISOLATION AND PURIFICATION OF A FROG-DERIVED PROTEINACEOUS CHEMOATTRACTANT ELICITING PREY ATTACK BY GARTER SNAKES.

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A potent proteinaceous chemoattractant, eliciting prey attack by checkered garter snakes (*Thamnophis marcianus*), was isolated from aqueous washes of the frog *Rana temporaria* by means of preparative electrophoresis. The biological activity of frog extract was not modified by lyophilization but was lost after proteolytic digestion. A purified glycoprotein appeared highly attractive to garter snakes, as demonstrated by a snake bioassay (lures covered with test sample or control solution). This protein showed an apparent molecular weight of 21 kDa estimated by polyacrylamide gel electrophoresis in the presence of sodium dodecyl sulfate (PAGE-SDS). If a reducing agent (β-mercaptoethanol) was omitted during isolation, the chemoattractant tended to form high-molecular-weight aggregates suggesting the presence of free thiols in freshly prepared frog extract. However, in contrast to other studies, the biological activity seemed to be retained in the extracts even in the absence of reducing agents. These results suggest that a water-soluble glycoprotein molecule, produced by frogs, may be a vomeronasal stimulus used by garter snakes for prey trailing.

SEXUAL AND SOCIAL BEHAVIOUR OF *OREOCHROMIS AUREUS* (PISCES : CICHLIDAE) : ENDOCRINE PROFILES.

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The relationships between relative social dominance and T4, T3, Testosterone (T), Estradiol 17β (E2) and 11-ketotestosterone (11-keto) plasma levels were determined for 14 pairs of males and 7 pairs of females Tilapia *Oreochromis aureus* in aquaria. Sexually mature males show a ritual aggressive behaviour. Significant lower levels of circulating E2 and 11-keto have been observed in the subordinate males, but circulating T4, T3 and T levels were not significantly affected. Dominant females exhibit higher levels of circulating T3, T and 11-keto than the subordinates. A significant linear correlation has been observed in the females between circulating T levels and five aggressive patterns (« mouth fighting », « jagen », « lateral display », « tail beating », « biting »). Isolated males exhibit significantly higher levels of circulating T3, E2 and 11-keto than the isolated females, but T level was not significantly affected. The reproductive behaviour exhibits the mating patterns of « quivering » or « body quiver » which are unusual in the other species of the genus *Oreochromis.* After spawning and fertilization of the eggs, the females develop a mouthbreeding behaviour for the protection of eggs and young.

MORPHOLOGICAL VARIATIONS BETWEEN POPULATIONS OF *CARABUS PROBLEMATICUS* (CARABIDAE : COLEOPTERA), AT THE INTRAREGIONAL, INTERREGIONAL AND INTRACONTINENTAL LEVELS.

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What is the influence of *Carabus problematicus* population isolation on their morphology, their isolation being natural or due to human activities? To answer this question, 19 measurements of 756 specimens, from 18 populations, were taken and analysed using multivariate techniques (PCAs, CDAs, FDAs). There are morphological differences at all the levels of the analysis, and a reallocation discriminant analysis shows that at least 60 % of the females and 54 % of the males are correctly assigned to their original populations. At the intraregional level, the differences shown are mainly shape differences. Surprisingly, two populations of *C. problematicus* separated by 8 kilometers show significant morphological differences. At the interregional level, the differences of size become more important but the shape variation stays the most significant. The first axis of the intracontinental DCAs, analysed on populations grouped by region, separates the 3 regions (Scotland, Ardennes, Provence). All the areas of a same country stay together. This discrimination is based, for the greatest part, on size differences, but there is an overlapping zone between Scotland and Belgium. Only French specimens are well isolated. For the Provence sample, all the males are reallocated to their group. This study confirms the classic systematics of *C. problematicus* (1).

(1) R. JEANNEL (1941) — Faune de France, *39*, Paris ; Ed. LECHEVALIER, 571 pp.

BIOGEOGRAPHY OF SMALL CARPENTER BEES OF NORTH AFRICA AND OCCIDENTAL EUROPE (HYMENOPTERA, ANTHOPHORIDAE, CERATININI).

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The authors have studied the small carpenter bee fauna of Occidental Europe, focusing on France and Belgium. 2600 specimens were studied from museum origins and from personal collections on flowers and in nests. 13 species are found in Occidental Europe. Of them, 2 are new for Europe and 1 is new for France. Their systematics has been revisid. A numerical taxonomic analysis emphazises the most discriminant characters between similar species (1). The present results complete the check-list of North African species of DALY (2). The presence of endemic species in Maghreb and South Spain and the reduction of the number of species in north of Mediterranean Sea emphazises the presence of a secondary dispersion center in this region for small carpenter bees.

(1) M. TERZO (1992) — Mémoire de licence, Université de Mons-Hainaut, 98 + XI pp. Mons, Belgique.
(2) H. V. DALY (1983) — Systematic Entomology, *8* : 29-62.

PREY CAPTURE IN SCLEROGLOSSAN LIZARDS.

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Many studies have shown that scleroglossan lizards capture preys with the jaws only (1). The prey capture kinematics of four species (*Lacerta viridis, Gerrhosaurus major, Zonosaurus laticaudatus,* and *Tiliqua scincoides*) of three families (Lacertidae, Cordylidae, and Scincidae) was quantitatively studied. Two prey items (mealworm and cricket) were used. The lacertid *L. viridis* always captured both prey types with the jaws only. The cordylid *G. major* captured the mealworm with the tongue and the cricket with the jaws. The cordylid *Z. laticaudatus* and the scincid *T. scincoides* captured the mealworm with the tongue, and the cricket with the jaws. In *G. major* and *T. scincoides,* the tongue was used for prey bringing into the buccal cavity as in iguanians, whereas, in *Z. laticaudatus,* the tongue was used for maintaining the prey on the substratum and facilitate the capture by the jaws. The mode of prey capture is highly variable in the studied scleroglossans. The gape cycle in *G. major* and *T. scincoides* is divided in three stages ; slow opening, fast opening, and fast closing as in iguanians. The division in slow and fast stages of the gape angle during prey capture with the jaws only or with the tongue by *Z. laticaudatus* was not present.

(1) K. SCHWENK and G.S. THROCKMORTON (1988) — J. Zool. (Lond.), *219* : 153-175.

QUANTITATIVE ANALYSIS OF FEEDING BEHAVIOUR IN THE SCLEROGLOSSAN *ZONOSAURUS LATICAUDATUS* (REPTILIA : SQUAMATA : CORDYLIDAE).

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The four phases of the feeding behaviour (capture, reduction, transport into the buccal cavity, and deglutition or cleaning) were studied quantitatively. 7-13 cycles were digitized per phase for four individuals. The displacements of the head, the tongue, the jaws, and the prey were measured for each cycle. Two types of prey were used (mealworm and cricket). The mealworms were captured with the tongue or the jaws, and the cricket with the jaws only. The tongue in mealworm capture was used for maintaining the prey on the substratum and facilitate the capture by the jaws. A multivariate analysis of variance (MANOVA) was performed on 18 kinematic variables. This analysis was a mixed-model design that crossed the fixed phase effect with the fixed prey effect and the fixed use of the tongue. In order to explore the kinematic relationships between the four feeding phases, a principal component analysis was performed using 10 variables depicting the jaw displacements. Three main conclusions were obtained from the data : (a) the tongue was used for prey reduction, transport and deglutition as in *Lacerta viridis* (1), and the iguanians (2), (b) the capture phase was highly variable, and (c) the evolutionary transformation of the tongue to chemoreception does not prevent its use during all the feeding phases.

(1) V. GOOSSE and V.L. BELS (1992) — Zool. Jahr. 122/2 (in press).
(2) V. DELHEUSY and V.L. BELS (1992) — J. exp. Biol. (in press).

THE HABITAT OF THE *OLIVA* (MOLLUSCA, GASTROPODA) OF HANSA BAY (PAPUA-NEW GUINEA).

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Oliva are burrowing, mainly nocturnal carnivores, feeding on live or dead prey. They are a typical (and often dominant) component of the molluscan assemblage of tropical soft benthos. Their ecology is practically unknown. 73 stations in Hansa Bay have been sampled by SCUBA diving or dredging. For each station, accurate depth was recorded, the water motion estimated and the sediment analyzed for carbonates, organic carbon, granulometric distribution and color. 27 species of *Oliva* were collected, each having a limited spatial distribution. Most *Oliva* species were found to be cryptic : the colour of the mantle and the shell closely match the sediment. No decisive substrate choice was exhibited in aquarium experiments on several species. The distribution is explained neither by depth alone nor by the nature of substrate alone. The observed distribution of the *Oliva* seems largely controlled by predator selection. The hitherto unknown predator(s) must have a good vision and be diurnal (as evident by the generalized crypsis in *Oliva* and the higher mortality of non-cryptic specimens). Predation must be very important (as evident by the large percentage of scar-bearing individuals). We suggest that the nocturnal activity of *Oliva* might be a counter-adaptation to diurnal predation.

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BOOK REVIEWS

M. Shamim Jairajpuri and Wasim Ahmad : « Dorylaimida — Free-living, Predaceous and Plant-parasitic Nematodes », 1992, 458 + xii pp. E. J. Brill, Leiden. ISBN 9004092293.

Nematodes are the most abundant multicellular animals on earth, preying or parasitising on virtually every life-form, and saturating sediments and soils in numbers that dwarf those of all other invertebrates taken together. They are also extremely diverse, their number of species probably being second only to that of the insects.

Unlike the zoological subdiscipline of entomology, however, nematology has known little more than a century of substantial growth to reach its current state. In many respects it is still in its infancy, especially where the ecology and physiology of these organisms is concerned. With the notable exception of research on the laboratory model organism *Caenorhabditis elegans,* most progress in nematology has been made in the taxonomical field, in the shape of an explosive growth of the number of species and higher taxa being discovered and described. In consequence, specialists found it more and more difficult to survey this taxonomical « oilspill », and it became less and less easy for the non-initiated to enter into the field. It is therefore extremely fortunate that several works dealing with different orders of soil nematodes have appeared in recent years.

The new book by Dr. Jairajpuri and Dr. Ahmad now tackles the largest and probably least accessible of these : the Order Dorylaimida. This group consists of nematodes which feed with a protrusible needle-like tooth, along or through which nutrients are sucked up. In the microscopic universe of interstitial soil space, this mode of feeding clearly opened up a bonanza of niches and foodsources, for dorylaims have developed into a stunning array of forms and taxa. As a result, a presentation of the current taxonomical knowledge of Dorylaimida is no easy task, and the authors clearly chose to direct their effort towards the compilation of a factual and concise book.

After an introductory preface, the first chapter of « Dorylaimida » deals with the morphology of these animals, providing an outline of the structure, diversity and taxonomic importance of the various organs. Next is a chapter summarising the history of dorylaim classification above superfamily level, presenting a key to the superfamilies, and listing the classification adhered to in the book. The following eight chapters each deal with one of the dorylaimid superfamilies recognised by the authors, and the final chapter gives information on the order Triplonchida, an aberrant group that is considered related to, but distinct from Dorylaimida. The book ends with nineteen pages of references, and an index to the taxa mentioned.

The chapters on the dorylaimid superfamilies and on Triplonchida form the main body of the book, each starting with an outline of the history of the taxon in question, and then presenting keys and diagnoses to the families, subfamilies and genera within it. For each genus the authors also give a list of species, references to available keys, and illustrations of at least one species.

Undeniably, there are some flaws in this book. Thus, it contains more than its due share of printing errors, and even several cases of consistently erroneous spelling. The genus *Takamangai* is always referred to as *Takamangi,* for instance, and the name of J. G. DE MAN, one of nematology's pioneers, is written with capital « D » throughout, giving further life to an old and persistent error.

More importantly, where matters of contents and scope are concerned, the succinct style of the book has resulted in the unfortunate omission of various interesting facts and topics. It is said, for instance, that dorylaims have four juvenile stages during development, just like other nematodes, while in fact some members of the family Longidoridae go through one stage less. In general, hardly any attention is given to the small but interesting body of knowledge available on the ecology, physiology and culture of dorylaims. This results in a text that somewhat fails to draw attention to the living processes of these animals as active organisms, and one feels that an opportunity was missed to provide a source book for other research areas than the purely taxonomical.

Nevertheless, « Dorylaimida » will clearly be the major reference work to these animals for many years to come, and it is to be hoped that it will provide a strong impulse to further research by specialists and non-specialists alike. For identification, the dichotomous keys in the book are more than adequate, but it proves to be a particularly powerful tool in combination with DORY, the computerised key to Dorylaimida of ZULLINI and MANGANELLI (1989), where the flexibility of character input of the program perfectly complements the illustrations, diagnoses, species lists and references provided by the book. And as for research aimed at further investigation of the complicated relationships between dorylaims, there can be no better starting point than a publication like this one, compiling and ordering the unwieldy amount of current literature on the taxonomy of Dorylaimida into a single, easily accessible volume.

ZULLINI, A. and G. MANGANELLI (1989) — « A new computer program for nematode identification ». *CABIOS,* **5** : 243-244.

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Liliane BODSON et Roland LIBOIS : « CONTRIBUTIONS À L'HISTOIRE DE LA DOMESTICATION » (*Journée d'étude, Université de Liège, 2 mars 1991*), 1992, 106 pp. Liège : Université de Liège (Colloques d'histoire des connaissances zoologiques 3).

Since 1989, a working group sponsored by the Belgian National Science Foundation (NFWO/FNRS) convenes each year to study and discuss the history of zoological knowledge. Last year the colloquium focused on the history of domestication. Several lectures were given of which the titles follow : Ethnoveterinary Medecine in the Tibetan Himalayas (A. von den Driesch) ; Domestication animale et animaux domestiques prétendument oubliés (A. Gautier) ; Le cheval dans le Proche Orient ancien (domestication, entretien, soins) (H. Limet) ; Medieval Ferrets and Rabbits in the Castle of Laarne (East-Flanders, Belgium). A Contribution to the History of a Predator and its Prey (D. Van Damme and A. Ervynck) ; Approches linguistiques de la domestication : les noms des rapaces en fauconnerie et en zoologie (B. Callebaut) ; Utilisation de singes capucins comme aide aux personnes ayant une déficience physique (M. Mercier). As the reader can see for himself, the fare at this third symposium was quite varied and perhaps even too diverse to serve exactly the purpose of the meeting, but the initiative to bring together scholars of the so-called alpha and beta disciplines is recommendable. The present volume, third in the series published by the working group, contains the papers read, summaries in English and French of these and the discussions following each presentation. It closes with a description of a computer programme presented by L. Bodson, the driving force behind the working group and its enthusiastic president. It deals with a data bank for the inventory of the knowledge and popular traditions concerning the herpetofauna in French speaking European countries. The book can be ordered from Institut de Zoologie, U.L., quai Ed. Van Beneden 22, B-4020 Liège 2.

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