Nematol. medit. (1995), 23: 131-145

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ON THE SYNONYMY OF *XIPHINEMA VULGARE* TARJAN, 1964 WITH *X. SETARIAE* LUC, 1958 (NEMATODA, DORYLAIMIDA)

by
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Summary. Principal component and hierarchical cluster analysis of morphometric characters of type populations of *X. setariae* Luc, 1958, *X. vulgare* Tarjan, 1964 and *X. insulanum* Lamberti, Arias, Agostinelli *et* Espirito Santo, 1995 suggest that the three are separate entities. Cumulative and single character diversities of morphometrics of populations of different geographic origin, obtained from the literature, confirm this observation and indicate that a population of *X. vulgare* from Mauritius and a population of *X. setariae* from Príncipe might represent different phenotypes.

In 1972 Cohn and Sher proposed the junior synonymy of *Xiphinema vulgare* Tarjan, 1964 with *X. setariae* Luc, 1958. This was accepted by Loof and Luc (1990) and by Heyns and Coomans (1991), their opinion being based mainly on the fact that there are overlaps of the measurements among populations of the two species.

Tarjan (1974), Luc and Dalmasso (1975), Williams and Luc (1977) and Phukan and Sanwal (1982) rejected this synonymy claiming that there are sufficient morphological and morphometrical differences between populations of the two species to distinguish them as separate entities. We support the opinion of these authors and emphasize that to distinguish between species, the mean values of the morphometric characters should be compared and not the ranges.

To study relationships between *X. setariae* and *X. vulgare*, populations attributed to each species were processed by principal component (PCA) and hierarchical cluster (HCA) analysis.

Materials and methods

Analysis was performed twice. The first analysis was undertaken with original measurements of populations from São Tomé and Príncipe, identified either as *X. setariae* or *X. vulgare* and on paratypes of *X. insulanum* Lamberti, Arias, Agostinelli *et* Espirito Santo, 1995, a recently described species from São Tomé, similar to *X. setariae* and *X. vulgare* (Lamberti *et al.*, 1995) and on paratypes of the two species (Table I). For the second analysis populations of *X. setariae*, *X. vulgare* and *X. insulanum* from São Tomé and Príncipe were processed with the type populations of *X. setariae* and *X. vulgare* and other populations of the two species, of different geographic origin, using the measurements reported in the literature (Table II). In this case fewer morphometric characters were considered since some of them are not given by the authors.

The morphometric characters considered in

the analyses are given in Tables III and IV. Multivariate statistics were performed with the SAS programme, released 6.03. The correlation matrix was used for PCA and the results of principal components were used for HCA based on the average distance method (SAS, 1985). In both groups of populations, analysis was first done cumulatively for all the characters taken into consideration and then for each single character.

TABLE I - *Populations selected for principal component (PCA) and hierarchical cluster analysis (HCA) in the first analysis.*

Species and authority	PCA symbol	Geographic origin
Xiphinema vulgare Tarjan, 1964	A	Florida (paratypes)
X. vulgare	B	Florida, Tampa
X. vulgare	C	Mauritius
X. vulgare	D	São Tomé, Bemposta
X. vulgare	E	São Tomé, Ferreira Governo
X. vulgare	F	Príncipe, Sundi
X. insulanum Lamberti *et al.*, 1995	G	São Tomé (paratypes)
X. setariae Luc, 1958	H	Ivory Coast (paratypes)
X. setariae	I	Príncipe, Montalegre
X. setariae	J	Príncipe, Bela Vista
X. setariae	K	São Tomé, São Carlos
X. setariae	L	Príncipe, São Joaquim (Oeste)
X. setariae	M	São Tomé, Mesquita

TABLE II - *Populations selected for PCA and HCA in the second analysis.*

Species	PCA symbol	Geographic origin	Reference
Xiphinema vulgare	A	Florida (paratypes)	Tarjan, 1964
X. vulgare	B	Surinam	Loof and Maas, 1972
X. vulgare	C	Mauritius	Williams and Luc, 1977
X. vulgare	D	Brazil	Rashid *et al.*, 1986
X. vulgare	E	Java	Brown *et al.*, 1981
X. vulgare	F	São Tomé, Bemposta	original
X. vulgare	G	São Tomé, Ferreira Governo	original
X. vulgare	H	Príncipe, Sundi	original
X. setariae	I	Príncipe, Montalegre	original
X. setariae	J	Príncipe, São Joaquim (Oeste)	original
X. setariae	K	Ivory Coast (paratypes)	Tarjan, 1964
X. insulanum	L	São Tomé (paratypes)	original

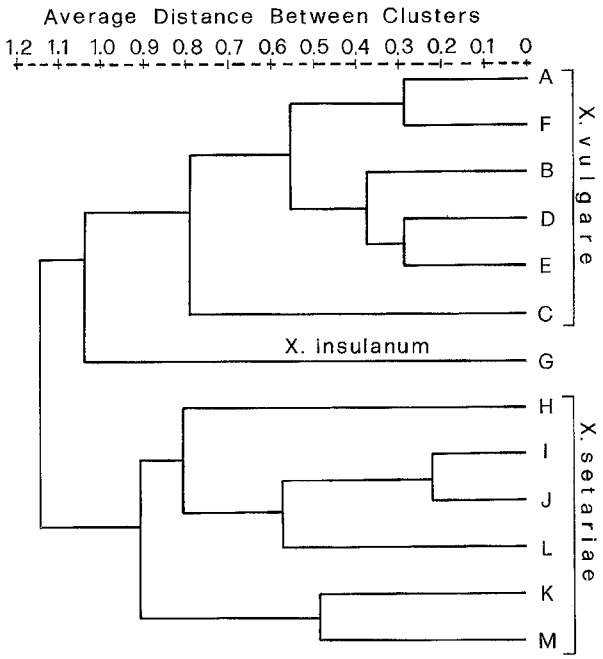


Fig. 1 - Dendrogram showing the clustering of 13 populations of *Xiphinema setariae*, *X. vulgare* and *X. insulanum* based on original measurements (first analysis). Population codes in Table I.

Results

The correlation coefficients among the variables used for PCA in the first analysis, the eigenvalues of the correlation matrix and the eigenvectors are given in Tables V, VI and VII, respectively. The variance associated with the three principal components was 83% of the total. The first principal component was positively correlated with the variables L, a, c, sty and J and the second principal component was negatively correlated with L, V and b. However, the second principal component was also positively correlated with ag and J.

Correlation coefficients among the variables used for PCA, eigenvalues of the correlation matrix and eigenvectors of the second analysis are listed in Table VIII, IX and X, respectively. In this case, the variance associated with the three first principal components was 85.4% of the total. The first principal component showed a positive correlation with characters c and b, but was negatively correlated with character c'. Conversely, the second principal component was positively correlated with characters tal, est, c' and a.

In the first analysis the HCA dendrogram (Fig. 1) and the PCA scatterplot (Fig. 2) show the occurrence of three distinct phenotypes: a group constituted by all the populations identified as *X. vulgare*, including paratypes of the species; a second group with all populations identified as *X. setariae*, including the paratypes; and a single population, namely *X. insulanum*.

The range – value plottings of the eleven morphometric characters individually analyzed show that for the ratio c and for the length of odontostyle and J (tail hyaline portion) three distinct phenotypes occur (Fig. 3): the *X. seta-*

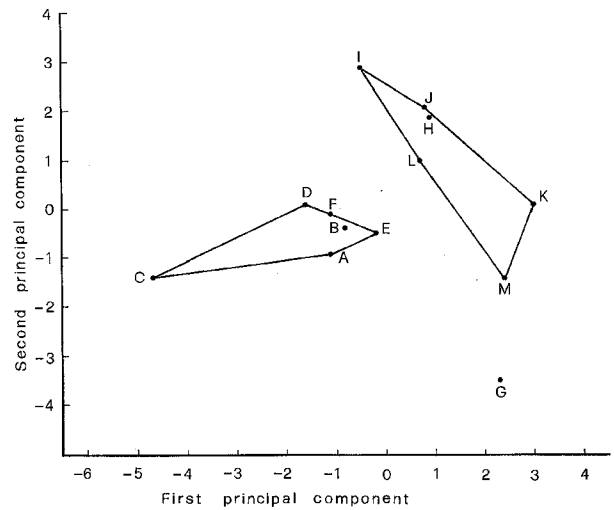


Fig. 2 - Scatterplot of 13 populations of *X. setariae*, *X. vulgare* and *X. insulanum* on the first and second principal component axes (first analysis). Population codes in Table I.

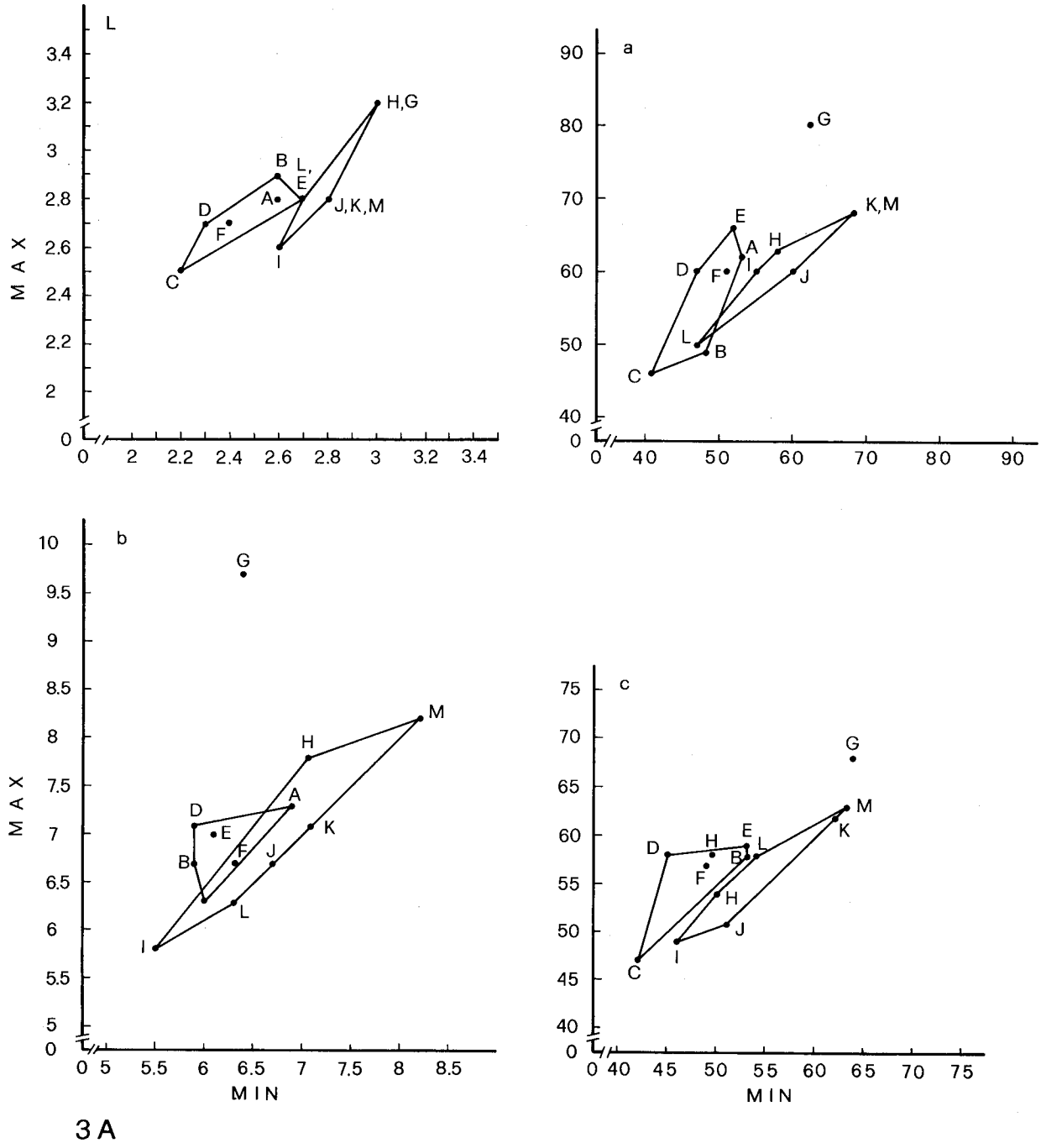
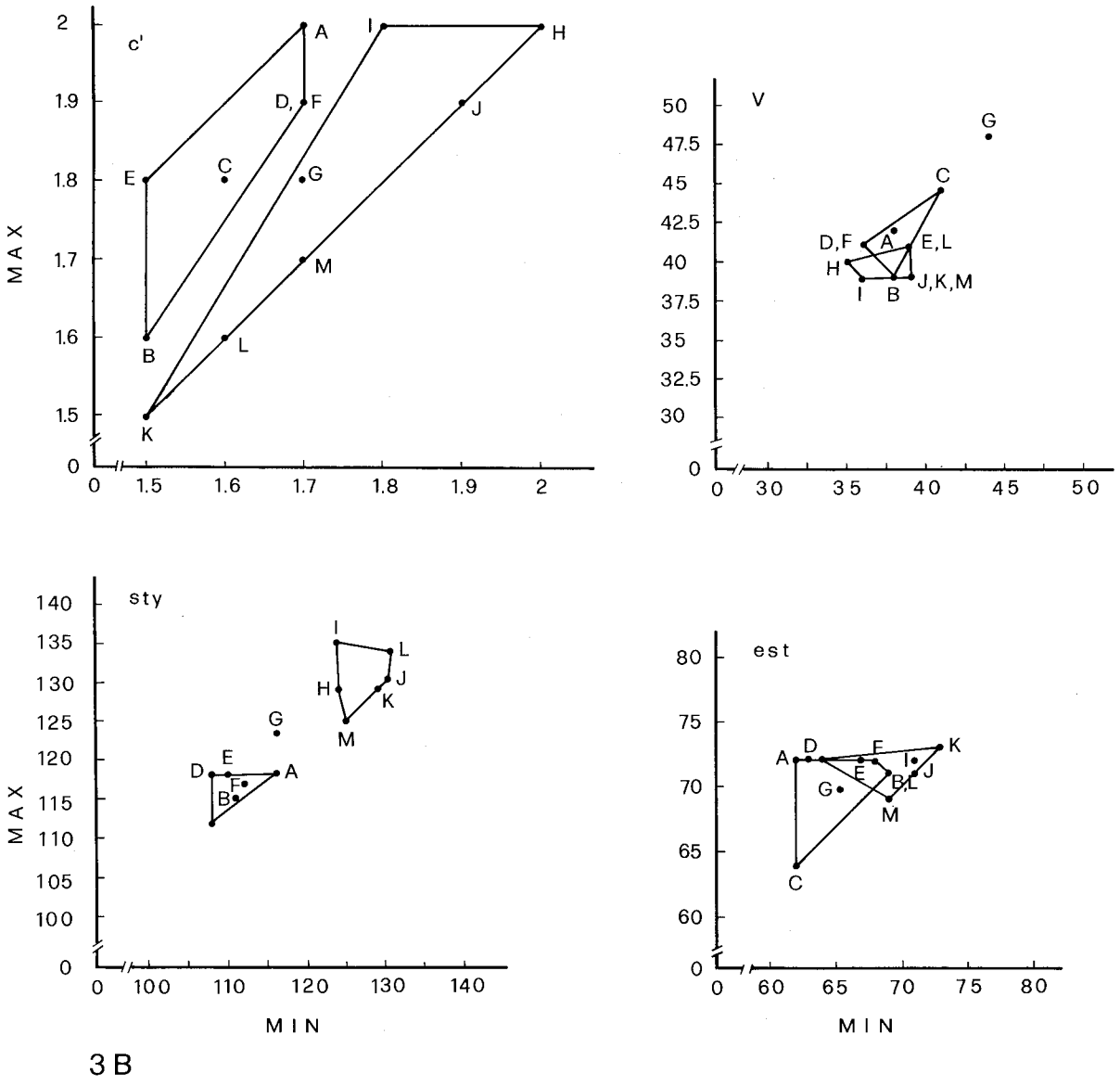
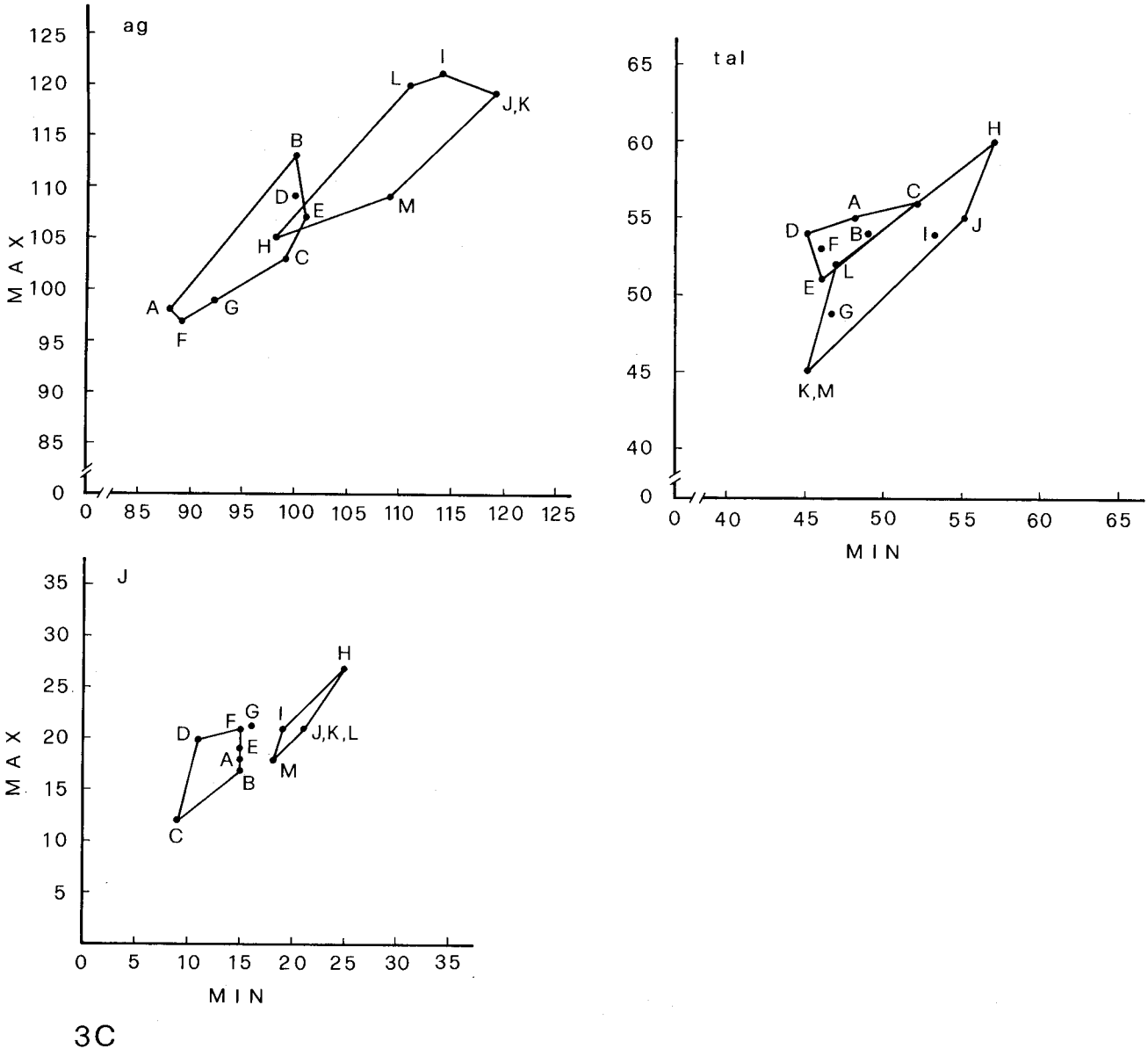


Fig. 3A, B, C. Graphic display of the morphometric values (codes in Table III) of the populations (codes in Table I) of *X. setariae*, *X. vulgare* and *X. insulanum* (first analysis).



3 B

riae group, the *X. vulgare* group and *X. insulanum*. The separation between *X. setariae* and *X. vulgare* is also clear for c' for which *X. insulanum* falls in the *X. setariae* group. *X. insulanum* appears to be isolated from both *X. setariae* populations and *X. vulgare* populations also for ratios a and b and for V. With reference to the length of the body, populations of *X. setariae* seem to be distinct from those of *X. vulgare*, with the exception that population L (*X. setariae*, Príncipe, São Joaquim) and population E (*X. vulgare*, São Tomé, Ferreira Governo) are coincident; for this character *X. insulanum* (pop. G) is coincident with population H (*X. setariae* paratypes). Evident overlapping between populations of *X. setariae* and *X. vulgare* appears for the ratio b, the value of V, the length of the odontophore and for the length of tail.



3C

For the ratio a, only population L (*X. setariae*, Príncipe, São Joaquim) falls within the range of the *X. vulgare* group and for the distance of the guide ring of the odontostyle from the anterior extremity only population H (*X. setariae* paratypes) falls in the range of the *X. vulgare* group. Finally, *X. insulanum* overlaps the *X. vulgare* group in the lengths of odontophore and tail and distance of the guide ring from the anterior extremity.

The second analysis, made with measurements taken from the literature, confirms that *X. insulanum* represents an isolated phenotype and that *X. setariae* and *X. vulgare* are two distinct groups (Figs 4 and 5). However, this analysis also reveals that population C (*X. vulgare* from Mauritius in Williams and Luc 1977) might be a different entity, as already indicated by Heyns and Coomans (1991), which is closer to *X. setariae* than to *X. vulgare* and that popu-

TABLE III - *Morphometric values (all original) used for PCA and HCA in the first analysis.*

Codes	Number of specimens	L	a	b	c	c'	V	styl	est	ag	tal	J
A	6	2.7±0.1 (2.6-2.8)	58.0±3.6 (53.0-61.5)	6.9±0.3 (6.6-7.3)	52.0±4.1 (47.5-58.0)	1.8±0.1 (1.7-2.0)	40.0±1.8 (38.0-42.0)	115.5±1.4 (115.0-118.0)	68.0±3.5 (62.0-72.0)	94.0±4.6 (88.0-98.0)	52.0±2.5 (48.0-55.0)	16.0±0.8 (15.0-18.0)
B	3	2.8±0.2 (2.6-2.9)	49.0±1.0 (48.0-49.0)	6.4±0.4 (5.9-6.7)	55.0±3.1 (53.0-58.0)	1.5±0.1 (1.5-1.6)	39.0±0.3 (38.5-39.0)	113.0±2.1 (111.0-115.0)	70.0±1.2 (69.0-71.0)	106.0±5.6 (100.0-112.0)	51.0±2.9 (49.0-54.0)	16.0±1.4 (15.0-17.0)
C	3	2.3±0.1 (2.2-2.5)	44.0±2.8 (41.0-46.0)	6.1±0.1 (6.0-6.3)	44.0±3.8 (40.0-47.0)	1.7±0.1 (1.6-1.8)	43.0±3.8 (41.0-47.0)	110.0±2.2 (108.0-112.0)	63.0±1.1 (62.0-64.0)	100.0±2.2 (99.0-103.0)	54.0±2.1 (52.0-56.0)	11.0±1.4 (9.0-12.0)
D	15	2.5±0.1 (2.3-2.7)	56.0±3.1 (47.0-60.0)	6.4±0.3 (5.9-7.1)	50.0±3.4 (45.0-58.0)	1.8±0.1 (1.7-1.9)	39.0±1.5 (36.0-41.0)	112.0±2.7 (108.0-118.0)	69.0±2.3 (63.0-72.0)	105.5±2.7 (100.0-109.0)	51.0±2.3 (45.0-53.5)	17.0±2.0 (11.0-20.0)
E	7	2.7±0.1 (2.7-2.8)	58.0±4.1 (52.0-63.0)	6.5±0.3 (6.1-7.0)	56.0±2.1 (53.0-59.0)	1.7±0.1 (1.5-1.8)	40.0±1.0 (39.0-41.0)	114.0±2.9 (110.0-118.0)	71.0±1.7 (67.0-72.0)	105.0±1.9 (101.0-107.0)	49.0±1.8 (46.0-51.0)	17.0±1.4 (15.0-19.0)
F	4	2.6±0.1 (2.4-2.7)	53.0±4.4 (51.0-60.0)	6.5±0.2 (6.3-6.7)	52.0±3.9 (49.0-57.0)	1.8±0.1 (1.7-1.9)	38.0±2.1 (36.0-41.0)	114.0±2.7 (112.0-116.5)	70.0±1.8 (68.0-72.0)	93.0±3.4 (89.0-97.0)	49.0±3.3 (46.0-53.0)	19.0±2.7 (15.0-21.0)
G	4	3.1±0.1 (3.0-3.2)	68.3±8.1 (62.5-80.0)	8.2±1.5 (6.6-9.7)	65.2±1.6 (63.5-67.2)	1.8±0.1 (1.7-1.8)	46.5±1.7 (44.0-48.0)	119.7±2.9 (104.7-129.5)	67.2±1.9 (65.3-68.8)	95.5±2.4 (92.3-98.2)	48.2±1.1 (46.5-48.8)	18.8±2.4 (17.1-22.3)
H	4	3.0±0.1 (3.0-3.2)	59.0±2.2 (58.0-62.5)	7.3±0.3 (7.1-7.8)	52.0±2.0 (50.0-54.0)	2.0±0.0 (2.0-2.0)	37.0±2.4 (35.0-40.0)	127.0±2.4 (123.5-129.0)	68.0±3.6 (63.5-72.0)	102.0±3.1 (98.0-105.0)	59.0±1.2 (57.0-60.0)	25.5±1.2 (25.0-27.0)
I	3	2.6±0.1 (2.6-2.6)	56.5±2.7 (55.0-59.5)	5.7±0.1 (5.5-5.8)	48.0±1.3 (46.0-49.0)	1.9±0.1 (1.8-2.0)	37.0±1.3 (36.0-38.5)	128.5±5.7 (124.0-135.0)	71.0±0.7 (71.0-72.0)	118.0±3.6 (114.0-121.0)	54.0±0.3 (53.0-54.0)	20.0±1.2 (19.0-21.0)
J	1	2.8	60.0	6.7	51.0	1.9	39.0	130.0	71.0	119.0	55.0	21.0
K	1	2.8	68.0	7.1	62.0	1.5	39.0	129.0	73.0	119.0	45.0	21.0
L	2	2.8±0.1 (2.7-2.8)	48.5±2.1 (47.0-50.0)	6.3±0.0 (6.3-6.3)	56.0±2.8 (54.0-58.0)	1.6±0.0 (1.6-1.6)	40.0±1.4 (39.0-41.0)	132.2±1.8 (131.0-133.5)	70.0±1.4 (69.0-71.0)	115.5±6.4 (111.0-120.0)	49.2±3.9 (46.5-52.0)	21.0±0.0 (21.0-21.0)
M	1	2.8	68.0	8.2	63.0	1.7	39.0	125.5	69.0	109.0	45.0	18.0

L = body length (mm); *a*, *b*, *c*, *V* = de Man's ratios; *c'* = ratio tail length - body diameter at anus; *sty* = odontostyle length (µm); *est* = odontophore length (µm); *ag* = distance of the guide ring from the anterior extremity (µm); *tal* = tail length (µm); *J* = length of the hyalin portion of tail (µm). Population codes as indicated in Table I.

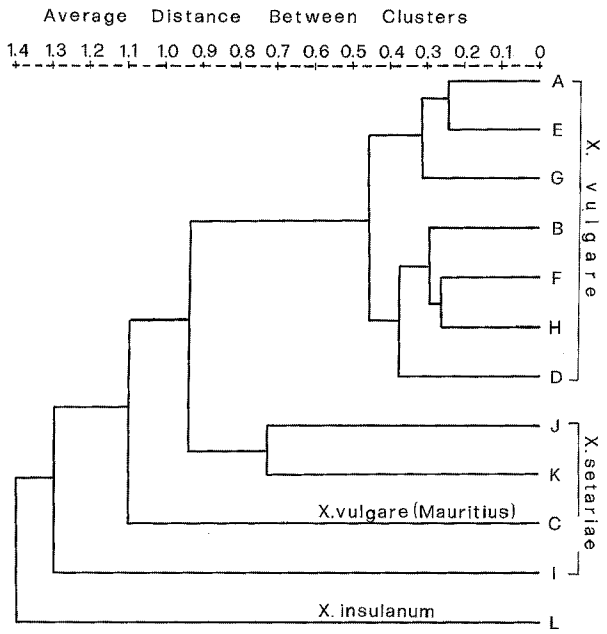


Fig. 4 - Dendrogram showing the clustering of 12 populations of *X. setariae*, *X. vulgare* and *X. insulanum* based on measurements from the literature (second analysis). Population codes in Table II.

lation I (*X. setariae*, Príncipe, Montalegre) might represent a different phenotype.

The range - value plottings of the second analysis show that of the nine individual considered characters, three of them (namely ratios a and c and odontostyle length) clearly separate the four phenotypes: *X. insulanum*, *X. vulgare* from Mauritius, the *X. setariae* group and the *X. vulgare* group (Fig. 6). With regard to length of the body, *X. vulgare* from Mauritius and *X. insulanum* are again isolated, whereas the *X. setariae* and the *X. vulgare* groups coincide in the population G (*X. vulgare*, São Tomé, Ferreira Governo) and I (*X. setariae*, Príncipe, Montalegre). For ratio b, value of V and odontophore length, *X. vulgare* from Mauritius and *X. insulanum* are isolated, while the groups *X. vulgare* and *X. setariae* more or less overlap. For tail length, *X. insulanum* remains separated from all the others while *X. setariae* and *X. vulgare*, including the population from Mauritius, overlap to a different extent. Finally, a homogenous group is formed by all the populations for the ratio c'.

Discussion and conclusions

There is no doubt that *X. setariae*, *X. vulgare* and *X. insulanum* are similar and related to each other on the basis of their morphological characters (lip region and tail shapes). This similarity is, however, very subjective, and therefore mean morphometric characters must be taken into account to separate and identify the species.

The analysis of individual morphometric characters originally measured in the first analysis,

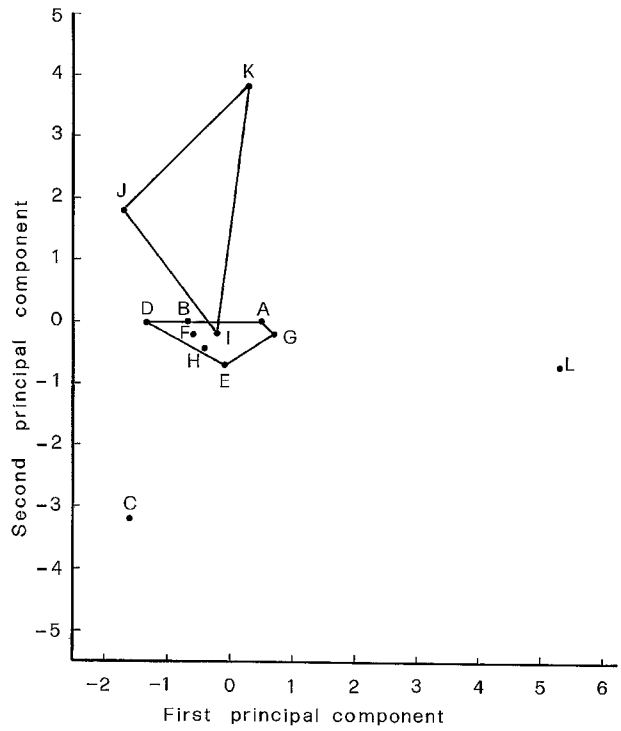


Fig. 5 - Scatterplot of 12 populations of *X. setariae*, *X. vulgare* and *X. insulanum* on the first and second principal component axes (second analysis). Population codes in Table II.

TABLE IV - *Morphometric values (from literature) used for PCA and HCA in the second analysis.*

Codes	Number of specimens	L	a	b	c	c'	V	sty	est	ag
A	13	2.6 (2.4-2.8)	56.3 (52.3-61.4)	7.2 (6.7-8.0)	53.2 (48.1-57.7)	1.8 (1.7-2.0)	39.0 (37.0-40.0)	109.0 (104.0-120.0)	72.0 (67.0-78.0)	49.0 (46.0-53.0)
B	25	2.5 (2.4-2.7)	53.0 (49.0-60.0)	6.4 (5.7-7.1)	52.0 (48.0-56.0)	1.7 (1.6-1.9)	39.0 (38.0-41.0)	112.0 (108.0-119.0)	71.0 (68.0-74.0)	54.0 (*)
C	80	2.1 (1.8-2.3)	52.3 (46.0-61.0)	5.9 (4.9-7.3)	44.0 (38.5-52.0)	1.8 (1.5-2.0)	42.1 (39.0-45.0)	106.0 (98.0-113.0)	60.0 (55.0-65.0)	48.0 (41.0-55.0)
D	32	2.5 (2.2-2.8)	55.9 (47.0-62.0)	5.4 (4.6-6.2)	49.0 (40.0-64.0)	1.7 (1.5-2.1)	39.8 (36.0-42.0)	117.0 (110.0-126.0)	71.6 (67.0-76.0)	53.0 (40.0-60.0)
E	25	2.5 (2.2-2.8)	59.6 (55.0-65.0)	6.1 (5.7-6.9)	52.7 (44.0-66.0)	1.7 (1.4-1.9)	38.7 (37.0-41.0)	111.3 (103.0-118.0)	71.3 (67.0-74.0)	47.5 (40.0-53.0)
F	15	2.5 (2.3-2.7)	56.0 (47.0-60.0)	6.4 (5.9-7.1)	50.0 (45.0-58.0)	1.8 (1.7-1.9)	39.0 (36.0-41.0)	112.0 (108.0-118.0)	69.0 (63.0-72.0)	51.0 (45.0-53.5)
G	7	2.7 (2.7-2.8)	58.0 (52.0-63.0)	6.5 (6.1-7.0)	56.0 (53.0-59.0)	1.7 (1.5-1.8)	40.0 (39.0-41.0)	114.0 (110.0-118.0)	71.0 (67.0-72.0)	49.0 (46.0-51.0)
H	4	2.6 (2.4-2.7)	53.0 (51.0-60.0)	6.5 (6.3-6.7)	52.0 (49.0-57.0)	1.8 (1.7-1.9)	38.0 (36.0-41.0)	114.0 (112.0-116.5)	70.0 (68.0-72.0)	49.0 (46.0-53.0)
I	2	2.7 (2.7-2.8)	48.5 (47.0-50.0)	6.3 (6.3-6.3)	56.0 (54.0-58.0)	1.6 (1.6-1.6)	40.0 (39.0-41.0)	132.5 (131.0-133.5)	70.0 (69.0-71.0)	49.2 (46.5-52.0)
J	3	2.6 (2.6-2.6)	56.5 (55.0-59.5)	5.7 (5.5-5.8)	48.0 (46.0-49.0)	1.9 (1.6-2.0)	37.0 (36.0-38.5)	128.5 (124.0-135.0)	71.0 (71.0-72.0)	54.0 (53.0-54.0)
K	13	3.0 (2.8-3.2)	63.7 (60.2-67.4)	7.2 (6.6-8.1)	50.7 (46.3-54.3)	2.1 (1.9-2.3)	37.0 (35.0-39.0)	120.0 (110.0-130.0)	70.0 (64.0-82.0)	59.0 (55.0-63.0)
L	5	3.0 (3.0-3.2)	69.6 (62.5-80.0)	8.5 (6.6-9.7)	64.8 (63.5-67.2)	1.7 (1.7-1.8)	46.7 (44.0-48.0)	112.2 (104.7-129.5)	66.8 (65.3-68.8)	47.3 (46.5-48.8)

L = body length (mm); *a*, *b*, *c*, *V* = de Man's ratios; *c'* = ratio tail length - body diameter at anus; *sty* = odontostyle length (μm); *est* = odontophore length (μm); *tal* = tail length (μm). Population codes as indicated in Table II.
* Derived by drawings.

indicate that *X. insulanum* differs from *X. setariae* in eight characters (ratios a, b, c, value of V, lengths of odontostyle, odontophore and J and distance of the guide ring from anterior extremity) and from *X. vulgare* in nine characters (ratios a, b, c, c', value of V and lengths of body, odontostyle, tail and J). Conversely, *X. vulgare* differs from *X. setariae* in five characters (ratios c and c' and lengths of body, odontostyle and J).

The second analysis of individual morphometric characters shows that *X. insulanum* differs from *X. vulgare*, including the population from Mauritius, in all the characters considered and from *X. setariae*, including the population I from Príncipe, Montalegre, in all the characters except ratio c'; *X. setariae* differs from *X. vulgare* in three characters (ratios a and c and odontostyle length) and from *X. vulgare* from Mauritius in all the considered characters except ratio c'; *X. vulgare* differs from *X. vulgare* from Mauritius for all characters except tail length and from population I (Príncipe, Montalegre) of *X. setariae* in five characters (ratios a, c, and c' and odontostyle and odontophore length); finally, *X. vulgare* from Mauritius differs from *X. setariae* population from Príncipe, Montalegre in all the characters considered except tail length.

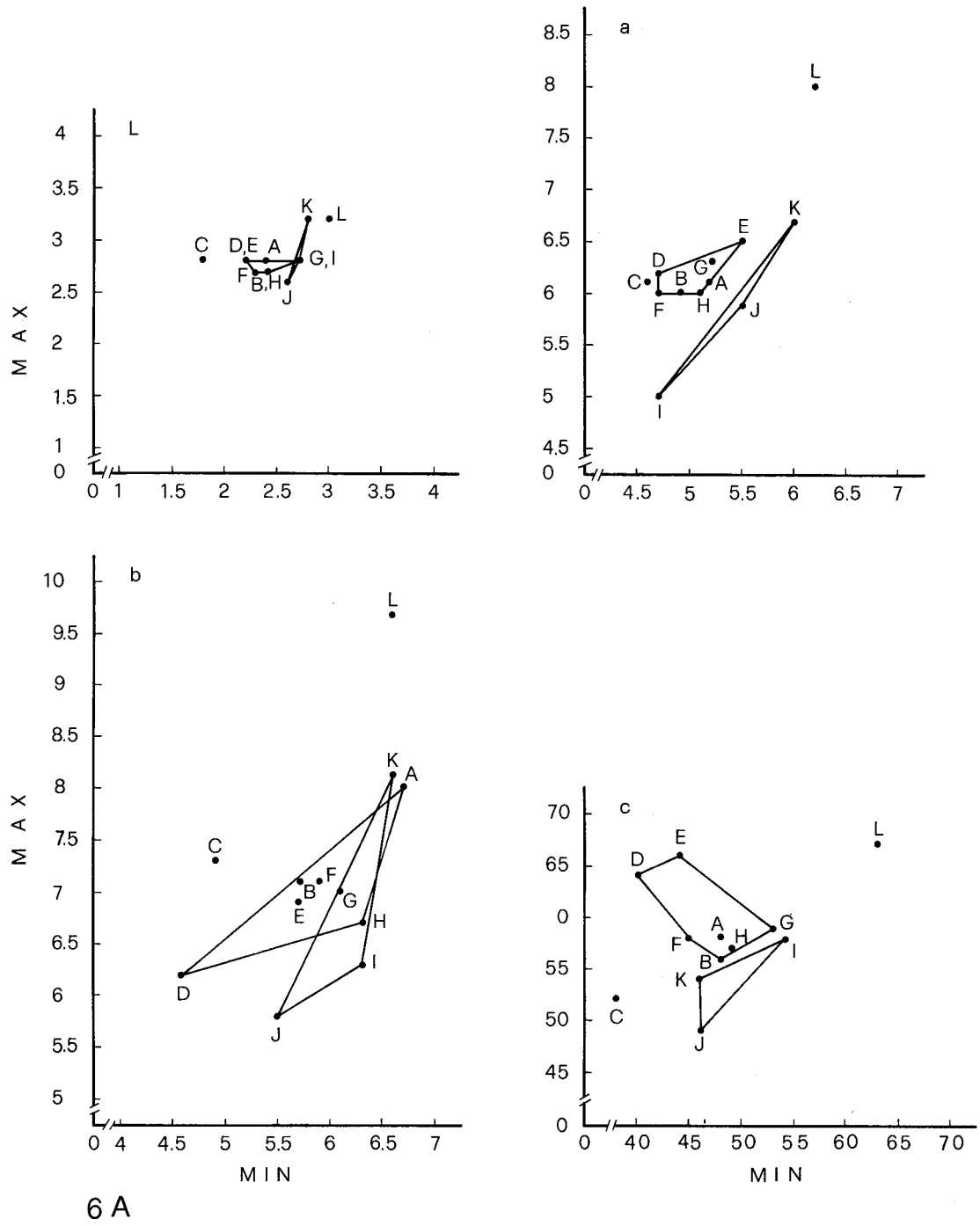
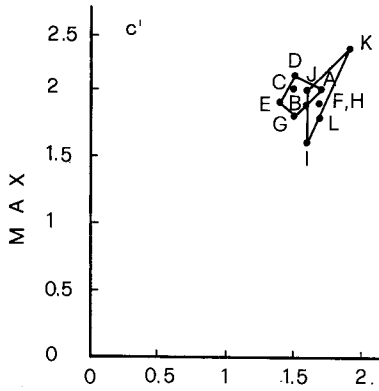
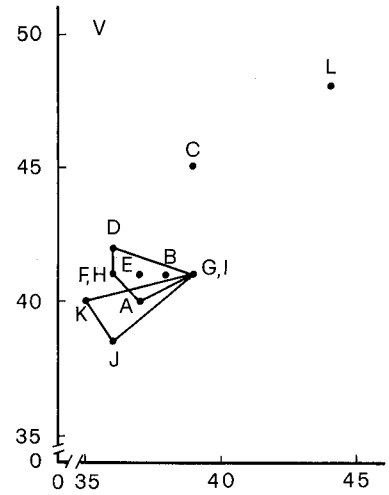
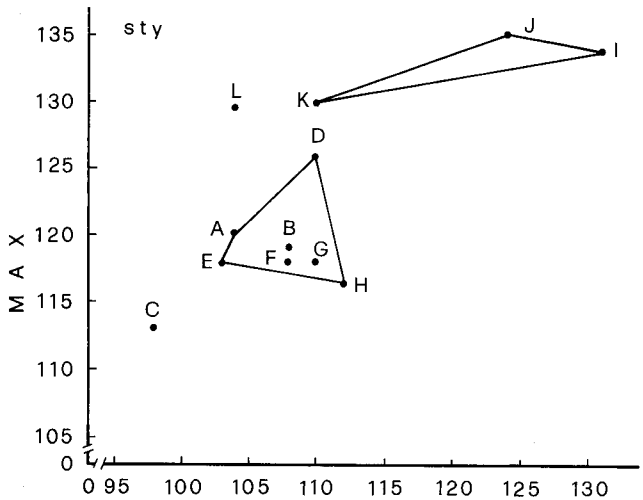
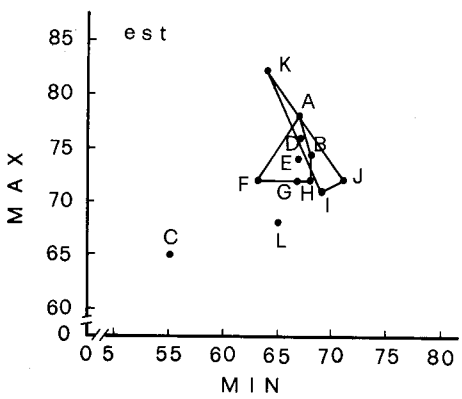


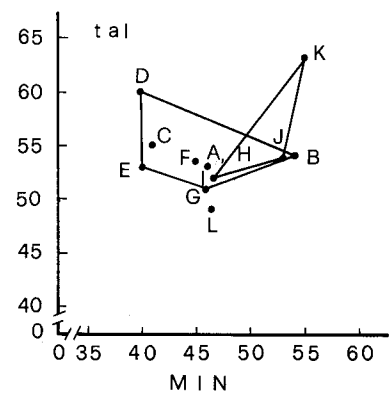
Fig. 6A, B - Graphic display of the morphometric values (codes in Table IV) of the populations (codes in Table II) of *X. setariae*, *X. vulgare* and *X. insulanum* (second analysis).


c'
MAX
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2.
2.5
K
D
J
A
C
E
B
F,H
G
L
I


V
50
45
40
35
0
0 35
40
45
L
C
D
E
B
F,H
G,I
A
K
J


sty
MAX
135
130
125
120
115
110
105
0
0 95
100
105
110
115
120
125
130
J
I
L
K
D
A
B
E
F
G
H
C


est
MAX
85
80
75
70
65
60
0
0 5
55
60
65
70
75
80
MIN
K
A
D
B
E
F
J
G
H
I
C
L


tal
65
60
55
50
45
40
0
0 35
40
45
50
55
60
MIN
K
D
C
J
E
F
A
H
B
G
L

6 B

TABLE V - *Correlation coefficients among the variables used for PCA in the first analysis.*

	L	a	b	c	c'	V	sty	est	ag	tal
a	0.6161*									
b	0.6942*	0.7805**								
c	0.7302**	0.7427**	0.7916**							
c'	0.0848	0.1325	0.0477	-0.3856						
V	0.1449	0.1001	0.3759	0.3263	-0.1718					
sty	0.5017	0.3928	0.1740	0.2942	0.1270	-0.2976				
est	0.2958	0.3736	-0.0864	0.3443	-0.2103	-0.5495	0.4925			
ag	0.0407	0.1363	-0.2422	0.0554	-0.2070	-0.3912	0.7236**	0.6060*		
tal	-0.0968	-0.4187	-0.3842	-0.7327	0.6778*	-0.2528	0.0185	-0.3380	-0.0653	
J	0.6724*	0.4321	0.2484	0.2851	0.3665	-0.4490	0.7743**	0.5452	0.3710	0.1831

(*) = $P \leq 0.05$; (**) = $P \leq 0.01$. Character codes as indicated in Table III.

TABLE VI - *Eigenvalues of the correlation matrix in the first analysis.*

	Eigenvalue	Difference	Proportion	Cumulative
* PRIN 1	4.21669	1.31374	0.38333	0.3833
PRIN 2	2.90295	0.89665	0.26390	0.6472
PRIN 3	2.00630	1.25877	0.18239	0.8296
PRIN 4	0.74753	0.21078	0.06796	0.8976
PRIN 5	0.53675	0.25277	0.04879	0.9464
PRIN 6	0.28398	0.09218	0.02582	0.9722
PRIN 7	0.19181	0.13601	0.01744	0.98964
PRIN 8	0.05579	0.01405	0.00507	0.99471
PRIN 9	0.04174	0.02609	0.00379	0.99850
PRIN 10	0.01565	0.01486	0.00142	0.99993
PRIN 11	0.00079		0.00007	1.00000

* PRIN = principal component.

On the basis of these results it is suggested that *X. setariae* Luc, 1958 and *X. vulgare* Tarjan, 1964 should be regarded as distinct species, as certainly is *X. insulanum.*

The second analysis indicates that population C from Mauritius and population I from Príncipe might represent different phenotypes from all other populations considered. However, the population from Príncipe is constituted by only three specimens, too few to allow

worthwile analysis, and the population from Mauritius should be studied in detail before taking a definitive decision.

The valuable assistance of Mr. V. Radicci in preparing the illustrations is gratefully acknowledged.

Literature cited

BROWN D.J.F., LUC M. and PURBADI, 1981. A description of some juvenile stages of *Xiphinema vulgare* (Nematoda: Dorylaimoidea). *Nematol. medit.*, *9*: 205-210.

COHN E. and SHER S. A., 1972. A contribution to the taxonomy of the genus *Xiphinema* Cobb, 1913. *J. Nematol.*, *4*: 36-65.

TABLE VII - *Eigenvectors in the first analysis.*

	PRIN 1	PRIN 2	PRIN 3	PRIN 4	PRIN 5	PRIN 6	PRIN 7	PRIN 8	PRIN 9	PRIN 10	PRIN 111
L	0.3998	-0.0563	0.2571	0.1184	-0.5178	0.1706	0.2738	0.3386	-0.0414	-0.1665	-0.4904
a	0.4066	-0.1201	0.1252	-0.2242	0.5402	0.1554	0.2657	-0.3459	-0.4105	-0.2497	-0.1305
b	0.3328	-0.3269	0.2595	-0.0553	0.1333	-0.4582	0.2016	0.0693	0.2085	0.6257	0.0618
c	0.4143	-0.2872	-0.0999	-0.0138	-0.1321	-0.0111	-0.0287	0.1271	0.2380	-0.4595	0.6583
c'	-0.0420	0.2087	0.5969	-0.1727	0.3908	0.2639	-0.2689	0.3924	0.3336	-0.0911	0.0157
V	-0.0185	-0.4708	0.1017	0.5559	0.0589	0.5693	-0.1800	-0.1935	0.0251	0.2419	0.0441
sty	0.3332	0.3238	0.0207	0.4618	0.1156	-0.2414	-0.3872	0.2608	-0.5077	0.0748	0.1321
est	0.2908	0.2827	-0.3316	-0.3689	-0.0928	0.5268	0.0458	0.1612	-0.0782	0.4767	0.2045
ag	0.1823	0.3647	-0.3326	0.4525	0.3415	0.0178	0.3656	-0.0016	0.4969	-0.0583	-0.1319
tal	-0.2197	0.3152	0.4483	0.1928	-0.1696	0.0738	0.5467	-0.1444	-0.1829	0.0569	0.4728
J	0.3364	0.3326	0.2286	-0.0467	-0.2849	-0.0369	-0.3515	-0.6621	0.2708	0.0312	-0.0543

Character codes indicated in Table III.

TABLE VIII - *Correlation coefficients among the variables used for PCA in the second analysis.*

	L	a	b	c	c'	V	sty	est
a	0.6616*							
b	0.7083*	0.6969*						
c	0.7240*	0.5372	0.7736**					
c'	0.2432	0.3633	0.1134	-0.3927				
V	0.1181	0.4133	0.5396	0.5875	-0.4128			
sty	0.3765	-0.2166	-0.2184	0.0651	0.0522	-0.3220		
est	0.4137	0.0177	-0.0682	0.2248	-0.0594	-0.5440	0.3621	
tal	0.2928	0.0870	-0.1426	-0.3576	0.7175*	-0.5706	0.3703	0.3100

(*) = $P \leq 0.05$; (**) = $P \leq 0.01$. Character codes as indicated in Table IV.

TABLE IX - *Eigenvalues of the correlation matrix in the second analysis.*

	Eigenvalue	Difference	Proportion	Cumulative
* PRIN 1	3.41053	0.74647	0.378948	0.37895
PRIN 2	2.66406	1.05074	0.296007	0.67495
PRIN 3	1.61332	0.87584	0.179258	0.85421
PRIN 4	0.73748	0.44802	0.081942	0.93615
PRIN 5	0.28946	0.06783	0.032162	0.96832
PRIN 6	0.22163	0.17930	0.024626	0.99294
PRIN 7	0.04234	0.02706	0.004704	0.99765
PRIN 8	0.01528	0.00938	0.001698	0.99934
PRIN 9	0.00590		0.000656	1.00000

* PRIN = principal component.

TABLE X - *Eigenvectors in the second analysis.*

	PRIN 1	PRIN 2	PRIN 3	PRIN 4	PRIN 5	PRIN 6	PRIN 7	PRIN 8	PRIN 9
L	0.3779	0.4156	0.1235	0.1087	-0.1043	-0.0166	-0.4837	0.6346	-0.0976
a	0.4137	0.1995	-0.3063	-0.1599	0.6308	-0.3196	-0.0976	-0.3083	-0.2548
b	0.4927	0.0861	-0.1426	-0.0431	-0.6147	0.1096	0.3154	-0.2380	-0.4262
c	0.4933	0.0230	0.3148	-0.0094	-0.0668	0.0805	-0.1430	-0.3797	0.6938
c'	-0.0774	0.4045	-0.5572	0.0658	-0.1684	-0.3332	0.3372	0.1731	0.4821
V	0.3924	-0.3424	-0.0858	0.3275	0.3546	0.3244	0.4726	0.3909	0.0835
sty	-0.0939	0.3290	0.4235	0.7087	0.0766	-0.2774	0.2314	-0.2049	-0.1517
est	-0.0233	0.3681	0.4803	-0.5784	0.1580	0.0282	0.4911	0.1777	-0.0111
tal	-0.1748	0.5048	-0.2086	0.1108	0.1547	0.7649	-0.0691	-0.2122	-0.0006

Character codes as indicated in Table IV.

HEYNS J. and COOMANS A., 1991. Longidoridae from Botswana (Nematoda). *Phytophylactica, 23*: 29-37.

LAMBERTI F., ARIAS M., AGOSTINELLI A. and ESPIRITO SANTO S. N., 1995. Longidoridae from São Tomé and Príncipe with descriptions of two new species of *Xiphinema* (Nematoda, Dorylaimida). *Nematol. medit., 23*: 105-129.

LOOF P.A.A. and LUC M., 1990. A revised polytomous key for the identification of species of the genus *Xiphinema* Cobb, 1913 (Nematoda: Longidoridae) with the exclusion of the *X. americanum* - group. *System. Parasitol., 15*: 35-66.

LOOF P.A.A. and MAAS P.W.T.H., 1972. The genus *Xiphinema* (Dorylaimida) in Surinam. *Nematologica: 18*: 92-119.

LUC M. and DALMASSO A., 1975. Considerations on the genus *Xiphinema* Cobb, 1913 (Nematoda: Longidoridae) and a "lattice" for the identification of species. *Cah. Orstom*, serie Biol., *10*: 303-327.

PHUKAN P. N. and SANWAL K. C., 1982. Taxonomic studies on six species of *Xiphinema* from Assam. *J. Res. Assam Agric. Univ. 3*: 76-83.

RASHID F., COOMANS A. and SHARMA R. D., 1986. Longidoridae (Nematoda, Dorylaimida) from Bahia State, Brazil. *Nematol. medit., 14*: 235-250.

SAS, 1985. *User's Guide: Statistics*, version 5. SAS Institute, Cary N.C. (U.S.).

TARJAN A. C., 1964. Two new American dagger nematodes (*Xiphinema*: Dorylaimidae) associated with citrus, with comments on the variability of *X. bakeri* Williams, 1961. *Proc. helminthol. Soc. Wash.*, *31*: 65-76.

TARJAN A. C., 1974. The dagger nematodes (*Xiphinema*, Cobb) of Florida. *Proc. Soil Crops Soc. Florida*, *33*: 92-95.

WILLIAMS J. R. and LUC M., 1977. The species of *Xiphinema* Cobb, 1913 (Nematoda: Longidoridae) in the sugar cane fields of Mauritius. Mauritius Sugar Industry Research Institute. Occasional paper n. 30, 19 pp.

Accepted for publication on 10 February 1995.