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Comparative analysis of morphological and morphometrical characters in six isolates of *Pratylenchus vulnus* Allen & Jensen, 1951 (Nemata : Tylenchida)

Marcelo Doucet *, Jorge Pinochet ** and Julio A. Di Rienzo ***

* *Facultad de Ciencas Agropecuarias, Escuela Para Graduados, Universidad Nacional de Córdoba, CC 509, 5000 Córdoba, Argentina,*

** *Departamento de Patología Vegetal, Institut de Ricerca i Technologia Agroalimentàries, IRTA, Ctra. de Cabrils s/n, 08348, Cabrils, Barcelona, Spain and*

*** *Unidad de Procesamiento Electrónico de Datos, Facultad de Ciencias Agropecuarias, Universidad Nacional de Córdoba, Argentina.*

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Summary – Morphological and morphometrical characters of six isolates of *Pratylenchus vulnus*, from Europe and America were studied. Some differences were found in relation to morphological characters (structure of the post uterine sac, shape of spermatheca and width of lateral fields). Significant differences in all morphometrical characters (except ratio « m ») were detected among isolates. An analysis of canonical correlations suggests that the relationships among isolates could be influenced by their geographical origine and/or hosts.

Résumé – ***Analyse comparative des caractères morphologiques et morphométriques de six isolats de* Pratylenchus vulnus *Allen & Jensen, 1951 (Nemata : Tylenchida).*** – Six populations de *Pratylenchus vulnus* Allen & Jensen, 1951 provenant d'Europe et d'Amérique ont été analysées du point de vue morphologique et morphométrique. Certaines différences ont été observées pour quelques caractères morphologiques (structure du sac post-vulvaire, forme de la spermathèque, largeur des champs latéraux). Par contre, des différences significatives concernant tous les caractères morphométriques (excepté le rapport « m ») ont été constatées entre les populations. Une analyse de corrélation canonique montre que les relations entre populations pourraient être fonction de leur origine géographique et/ou de leur plante hôte.

Key-words : *Pratylenchus vulnus*, taxonomy, morphology, morphometrics.

Recent studies have shown that different isolates of the root-lesion nematode *Pratylenchus vulnus* exhibit different behaviours when on the same host and that the possibility of the existence of different pathotypes cannot be discarded (Pinochet *et al.*, 1993).

As different isolates could present different problems, the knowledge of the particular characteristics of those isolates and their variability is especially interesting.

Recently, eight isolates of *P. vulnus* from two different geographic areas (Europe and America) were studied in relation to their pathogenicity, reproductive potential and genetic variability (Pinochet *et al.*, 1993, 1994).

The objective of this research was to characterize the morphology and morphometrics of six of these isolates of *P. vulnus*.

Materials and methods

Six isolates of *P. vulnus* from different geographic origin and hosts were studied : Pv RO-S (Spain, Barcelona, associated with *Rosa multiflora*); Pv AP-S (Spain, Gerona, associated with *Malus silvestris*); Pv AT-F (France, Antibes, associated with *Prunus armeniaca*); Pv U-UK (England, locality and host unknown); Pv WA-A (Argentina, Córdoba, associated with *Juglans regia*) and Pv WA-U (USA, Idaho, associated with *Juglans regia*).

Nematodes were extracted from soil or roots and reared monoxenically on carrot disk cultures (Moody *et al.*, 1973). Once established, cultures were kept in an incubator at 23-24 °C for six months. Specimens from each isolate were recovered from stock cultures, fixed (Netscher & Seinhorst, 1969) and transferred to anhydrous glycerin (Seinhorst, 1959).

Measurements and drawings were made with a camera lucida.

The morphometrical characters used are those normally considered for species identification. The following statistics for each character from different isolates were considered : mean, standard deviation, range and coefficient of variation. The differences between isolates for each character were studied by an analysis of variance taking into account the following factors : isolate (considering all of the male and female characters), sex, and interaction between sex and isolate (considering only the characters that are common to both sexes).

A multivariate analysis of canonical correlations was used to study the relationships between sets of variables

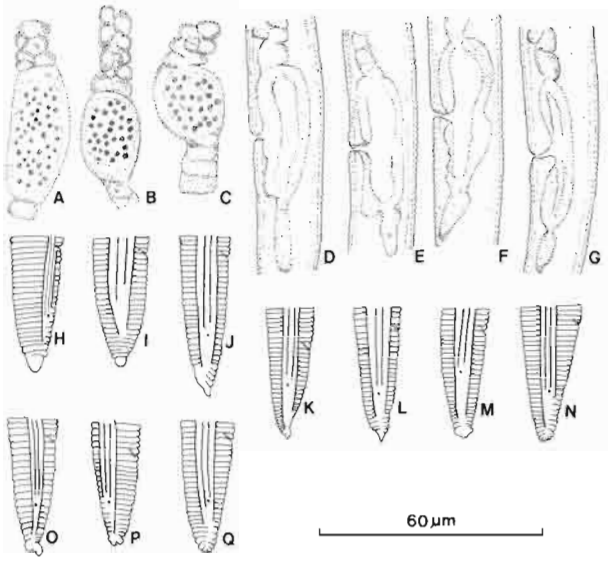

Fig. 1. Pratylenchus vulnus *Allen & Jensen, 1951. Female. A - C : Spermatheca (lateral view); D - G : Vulvar region and post vulvar sac (lateral view); H - Q : Tail (lateral view).*

(Gnanadesikan, 1977) for those characters in which significant differences were obtained between populations in the analysis of variance.

Results

Morphological characters

Most of the morphological characters observed agree with those defining the species (Allen & Jensen, 1951; Sher & Allen, 1953; Loof, 1960; Roman & Hirschmann, 1969; Corbett, 1974; Doucet, 1988; Mizukubo, 1990), except : the post uterine sac without cellular structure, which is not in agreement with what has been reported for other populations (Allen & Jensen, 1951 ; Corbett, 1974; Mizukubo, 1990); the inner band of lateral fields, in a few cases, is wider than the external bands instead of being the same width or narrower (Corbett, 1974); the spermatheca, sometimes rounded to elongate-oblong instead of only oblong (Corbett, 1974).

Measurements

See Tables 1 and 2.

Discussion

The present study was made using specimens reared in the same media (carrot tissue) and subjected to homogeneous and controlled conditions. This allows determining that any observed differences depend only on intrinsic factors for each isolate.

No appreciable differences were found between the six isolates of *P. vulnus* with regard to morphological characters in both females and males. For certain characters, variations were observed which had no relation to a particular population (such as the shape and crenation of the female tail terminus). Such variability is frequent among species of the genus *Pratylenchus,* although there is no existing information suggesting that they could be used to distinguishing populations of the same species (Tarte & Mai, 1976 *a, b*). However, it does allow species differentiation (Mizukubo, 1990).

The morphological characters evaluated in each isolate showed different degrees of variability. The most variable character was the tail terminus in females, ranging from smooth to crenate and digitate, and from conical pointed to rounded. This pronounced variability has been reported in specimens within a population (Roman & Hirschmann, 1969; Mizukubo, 1990). None of the tail forms observed in the studied populations can be considered to be characteristic of a given isolate.

Certain morphometrical characters show differences with the values given by other authors (Allen & Jensen, 1951; Sher & Allen, 1953; Loof, 1960; Roman & Hirschmann, 1969; Corbett, 1964; Doucet, 1988; Frederick & Tarjan, 1989; Mizukubo, 1990). The ranges observed are : narrow than those known (females and males « body length » : 0.51 - 0.86 mm and 0.45 - 0.64 mm *vs* 0.46 - 0.91 mm and 0.46 - 0.73 mm; « Stylet length » : 14 - 17 µm *vs* 14 - 19 µm and 13 - 16 µm *vs* 13 - 18 µm respectively; « post vulvar sac length » : 1.5 to 1.8 vulval body width *vs* 2 vulval body width); wider than those known (« ratio a » of females and males : 19.67 - 40.35 *vs* 26.6 - 39.5 and 21.92 - 39.37 *vs* 28 - 39 respectively; « ratio V » : 76 - 85 *vs* 78 - 84.1; « ratio c » of males : 17.30 - 26.52 *vs* 17.50 - 29.40); in other cases, only one of the limits of the range varies (lower limit of females and males « ratio b » : 5.73 - 8.34 *vs* 5.3 - 7.7 respectively) or both limits show slight differences with respect to the known values (female « ratio c » : 17.85 - 31.09 *vs* 14.2 - 27.7). On the other hand, the USA isolate (Pv WA-U) has slightly higher values for most of the characters.

The morphometrical characters showed differences among isolates. The variability of the evaluated characters can differ depending on sex and isolate. Specimens from isolate Pv RO-S showed the lowest CV for the majority of the characters whereas isolate Pv WA-A had the highest values.

The lowest CV correspond to « V ratio » and « Stylet length » measurements in all female isolates. The CV are in general higher in males than in females. The constancy of the character « conus length » for the isolates Pv RO-S, Pv AP-S and Pv AT-F is remarkable. Along with « Stylet length », it shows the lowest CV values.

The analysis of variance shows significant differences for all the characters ($P < 0.01$), except for ratio « m ». For a group of characters common to both sexes (body length, body diameter, ratio « a », distance from anterior end to nerve ring, to valve of median bulb, and to excretory pore, oesophageal length, conus length, distance

Table 1. *Measurements of females of six isolates of* Pratylenchus vulnus (n = 20).

Character	Pv RO-S	Pv AP-S	Pv AT-F	Pv U-UK	Pv WA-A	Pv WA-U
Body length (mm)	0.65 ± 0.03	0.67 ± 0.04	0.63 ± 0.04	0.66 ± 0.04	0.61 ± 0.06	0.73 ± 0.05
	(0.59-0.71)	(0.61-0.76)	(0.56-0.71)	(0.58-0.72)	(0.51-0.75)	(0.63-0.86)
	4.01	5.98	6.86	6.25	9.30	6.69
Body diameter	22.00 ± 1.35	22.00 ± 2.05	20.00 ± 2.61	20.00 ± 2.05	25.00 ± 3.29	29.00 ± 3.63
	(19.00-24.00)	(18.00-26.00)	(16.00-24.00)	(17.00-26.00)	(20.00-31.00)	(24.00-38.00)
	6.27	9.36	12.74	10.12	13.03	12.36
a	30.06 ± 1.95	30.60 ± 2.37	31.30 ± 3.58	32.68 ± 2.63	24.51 ± 2.27	25.19 ± 2.39
	(26.69-35.21)	(25.81-34.45)	(26.77-40.35)	(27.69-37.36)	(19.67-28.69)	(20.81-30.00)
	6.47	7.73	11.44	8.04	9.26	9.48
Distance from anterior end	90.00 ± 5.14	97.00 ± 5.82	93.00 ± 4.88	91.00 ± 4.04	89.00 ± 7.62	100.00 ± 6.11
to oesophago-intestinal valve	(83.00-103.0)	(86.00-108.0)	(86.00-101.0)	(84.00-101.0)	(76.00-109.0)	(91.00-118.0)
	5.69	6.01	5.24	4.42	8.55	6.12
b	7.18 ± 0.48	6.88 ± 0.30	6.76 ± 0.42	7.22 ± 0.37	6.86 ± 0.57	7.38 ± 0.59
	(6.11-8.01)	(6.21-7.49)	(6.07-7.62)	(6.51-8.00)	(5.73-8.21)	(6.35-8.34)
	6.69	4.41	6.20	5.08	8.31	7.95
Distance from anterior end to nerve ring	73.00 ± 3.83	79.00 ± 4.12	74.00 ± 4.33	73.00 ± 3.46	73.50 ± 3.97	82.00 ± 5.56
	(66.00-81.00)	(71.00-86.00)	(65.00-81.00)	(69.00-82.00)	(67.00-83.00)	(74.00-99.00)
	5.28	5.20	5.83	4.74	5.40	6.77
Distance from anterior end to valve	59.00 ± 3.25	64.00 ± 3.80	61.00 ± 4.20	61.00 ± 3.32	61.00 ± 3.95	66.00 ± 5.95
of median bulb	(54.00-64.00)	(57.00-71.00)	(54.00-68.00)	(57.00-69.00)	(57.00-71.00)	(58.00-86.00)
	5.47	5.92	6.88	5.47	6.48	9.01
M.B.	47.13 ± 2.46	45.68 ± 1.71	46.73 ± 3.93	47.01 ± 2.58	46.52 ± 5.57	48.84 ± 4.22
	(43.21-52.89)	(41.78-47.55)	(41.00-57.62)	(41.91-52.89)	(31.60-54.23)	(42.75-57.02)
	5.23	3.75	8.41	5.48	11.98	8.63
Distance from anterior end to excretory pore	90.00 ± 4.08	99.00 ± 5.16	92.00 ± 6.65	94.00 ± 4.42	91.00 ± 6.43	99.00 ± 7.02
	(82.00-100.0)	(89.00-111.0)	(79.00-102.0)	(86.00-104.0)	(79.00-104.0)	(86.00-121.0)
	4.54	5.20	7.27	4.68	7.07	7.10
Oesophageal length	126.00 ± 5.03	140.00 ± 7.91	131.00 ± 9.05	129.00 ± 5.79	134.00 ± 22.24	133.00 ± 9.68
	(121.0-136.0)	(121.0-154.0)	(118.0-150.0)	(118.0-139.0)	(114.0-193.0)	(110.0-148.0)
	3.99	5.63	6.90	4.49	16.65	7.28
b′	5.23 ± 0.47	4.76 ± 0.25	4.84 ± 0.36	5.11 ± 0.30	4.63 ± 0.54	5.54 ± 0.49
	(4.47-6.89)	(4.27-5.21)	(4.36-5.93)	(4.48-5.61)	(3.31-5.36)	(4.75-6.71)
	8.97	5.30	7.51	5.91	11.57	8.76
Stylet length	15.00 ± 0.60	15.00 ± 0.64	15.00 ± 0.55	15.00 ± 0.64	15.00 ± 0.62	16.00 ± 0.52
	(14.00-16.00)	(14.00-16.00)	(14.00-16.00)	(14.00-16.00)	(14.00-16.00)	(15.00-17.00)
	3.88	4.30	3.73	4.24	4.05	3.31
Conus length	8.00 ± 0.49	7.00 ± 0.44	7.00 ± 0.31	7.00 ± 0.41	7.00 ± 0.45	8.00 ± 0.44
	(7.00-8.00)	(7.00-8.00)	(7.00-8.00)	(7.00-8.00)	(7.00-8.00)	(7.00-9.00)
	6.40	6.13	4.34	5.70	6.04	5.59
m	49.66 ± 2.40	48.56 ± 2.79	47.99 ± 2.49	47.73 ± 2.79	48.66 ± 2.00	49.57 ± 3.21
	(46.66-53.33)	(43.75-54.14)	(43.75-53.33)	(43.75-53.33)	(46.60-53.30)	(43.75-60.00)
	4.82	5.75	5.19	5.84	4.10	6.47
o	16.28 ± 1.89	16.80 ± 0.72	18.40 ± 2.97	18.42 ± 3.23	16.55 ± 0.33	15.83 ± 0.53
	(12.51-20.01)	(15.62-17.85)	(15.62-27.66)	(15.62-26.66)	(15.62-16.66)	(14.70-16.66)
	11.63	4.30	16.12	17.54	1.98	3.35
V	79.95 ± 0.94	81.50 ± 1.10	81.50 ± 2.12	81.30 ± 1.30	79.80 ± 1.96	81.00 ± 1.41
	(78.00-81.00)	(79.00-84.00)	(76.00-85.00)	(79.00-83.00)	(76.00-83.00)	(78.00-84.00)
	1.18	1.35	2.60	1.60	2.46	1.75
Tail length	31.00 ± 2.40	30.00 ± 3.28	28.00 ± 3.34	29.00 ± 2.32	29.00 ± 2.88	31.00 ± 2.86
	(27.00-37.00)	(24.00-36.00)	(22.00-35.00)	(25.00-33.00)	(23.00-34.00)	(24.00-36.00)
	7.78	11.18	12.23	7.97	9.99	9.21
c	21.10 ± 1.36	22.90 ± 2.21	23.73 ± 3.24	22.06 ± 1.92	21.26 ± 2.16	23.73 ± 2.04
	(18.97-23.81)	(20.02-28.03)	(17.85-31.09)	(19.06-25.55)	(18.78-26.78)	(19.16-26.78)
	6.45	9.63	13.63	8.52	10.14	8.58
Body diameter at anus	13.00 ± 1.25	13.00 ± 1.29	12.00 ± 1.17	12.00 ± 1.02	15.00 ± 1.46	14.00 ± 1.47
	(12.00-16.00)	(11.00-15.00)	(11.00-15.00)	(10.00-14.00)	(12.00-17.00)	(11.00-16.00)
	9.56	9.88	9.42	8.44	9.97	10.67
c′	2.37 ± 0.24	2.25 ± 0.30	2.20 ± 0.36	2.36 ± 0.22	1.98 ± 0.22	2.27 ± 0.24
	(1.87-2.84)	(1.76-3.01)	(1.46-2.91)	(2.00-2.90)	(1.64-2.46)	(1.93-2.91)
	9.99	13.52	16.12	9.34	10.97	10.60
Post vulvar sac length	37.00 ± 2.89	32.00 ± 3.28	31.00 ± 3.69	36.00 ± 3.49	40.00 ± 4.78	43.00 ± 4.83
	(31.00-42.00)	(27.00-39.00)	(22.00-39.00)	(29.00-43.00)	(32.00-46.00)	(32.00-53.00)
	7.91	10.15	11.93	9.77	11.84	11.35
Distance from vulva to anus	93.00 ± 7.08	88.00 ± 8.96	85.50 ± 14.46	90.00 ± 10.28	95.00 ± 14.54	104.00 ± 9.12
	(83.00-106.0)	(67.00-105.0)	(63.00-125.0)	(76.00-115.0)	(74.00-130.0)	(90.00-126.0)
	7.65	10.16	16.92	11.43	15.36	8.75
Tail annules	27.00 ± 1.54	27.00 ± 3.61	25.00 ± 2.89	26.00 ± 2.75	23.0 ± 2.41	25.00 ± 2.06
	(24.00-30.00)	(21.00-34.00)	(19.00-29.00)	(20.00-31.00)	(19.00-29.00)	(20.00-27.00)
	5.71	13.17	11.59	10.54	10.41	8.35

All measurements are in μm, except body length. The measurements are given as : arithmetic mean ± standard deviation, (minimum - maximum) and coefficient of variation.

Table 2. *Measurements of males of six isolates of* Pratylenchus vulnus (n = 20).

Character	Pv RO-S	Pv AP-S	Pv AT-F	Pv U-UK	Pv WA-A	Pv WA-U
Body length (mm)	0.60 ± 0.03 (0.55-0.64) 4.26	0.55 ± 0.02 (0.51-0.61) 4.34	0.54 ± 0.03 (0.48-0.60) 5.61	0.60 ± 0.03 (0.56-0.64) 4.28	0.50 ± 0.03 (0.45-0.56) 6.55	0.57 ± 0.02 (0.52-0.61) 4.26
Body diameter	19.00 ± 1.06 (17.00-21.00) 5.50	17.00 ± 1.05 (15.00-19.00) 6.20	17.00 ± 1.03 (15.00-19.00) 6.17	17.00 ± 0.97 (16.00-19.00) 5.60	18.00 ± 1.38 (16.00-22.00) 7.80	19.00 ± 0.93 (17.00-21.00) 5.00
a	30.67 ± 2.61 (21.92-33.84) 8.50	32.54 ± 2.20 (28.57-37.75) 6.76	32.89 ± 2.15 (29.93-36.62) 6.54	35.07 ± 2.29 (30.52-39.37) 6.54	28.27 ± 2.37 (24.51-32.94) 8.39	30.62 ± 1.76 (27.36-34.11) 5.74
Distance from anterior end to oesophago-intestinal valve	87.00 ± 3.85 (79.00-92.00) 4.43	90.00 ± 4.50 (80.00-97.00) 4.98	89.00 ± 3.71 (82.00-96.00) 4.19	90.00 ± 3.55 (86.00-97.00) 3.96	86.00 ± 5.23 (77.00-97.00) 6.11	88.00 ± 5.20 (81.00-97.00) 5.90
b	6.91 ± 0.44 (6.26-7.84) 6.44	6.10 ± 0.37 (5.58-7.01) 6.11	6.16 ± 0.34 (5.58-6.78) 5.50	6.75 ± 0.42 (6.08-7.44) 6.22	5.83 ± 0.41 (5.17-6.87) 7.01	6.49 ± 0.50 (5.65-7.28) 7.76
Distance from anterior end to nerve ring	70.00 ± 3.34 (63.00-75.00) 4.79	71.00 ± 3.85 (62.00-76.00) 5.43	68.00 ± 2.92 (62.00-73.00) 4.29	70.00 ± 3.41 (65.00-76.00) 4.88	66.00 ± 3.29 (61.00-76.00) 4.99	72.00 ± 4.26 (64.00-80.00) 5.95
Distance from anterior end to valve of median bulb	57.00 ± 3.51 (50.00-61.00) 6.13	58.00 ± 3.58 (50.00-64.00) 6.15	56.00 ± 2.80 (50.00-61.00) 4.99	58.00 ± 3.10 (54.00-64.00) 5.35	55.00 ± 3.76 (50.00-64.00) 6.79	58.00 ± 4.31 (52.00-68.00) 7.46
M.B.	47.46 ± 2.69 (43.21-51.69) 5.68	48.03 ± 3.27 (42.37-57.65) 6.82	47.21 ± 2.36 (43.18-50.46) 5.00	49.04 ± 1.86 (47.10-53.50) 3.79	49.55 ± 2.41 (45.04-54.81) 4.86	51.00 ± 3.89 (45.58-61.81) 7.63
Distance from anterior end to excretory pore	88.00 ± 3.41 (79.00-93.00) 3.90	82.00 ± 4.72 (75.00-96.00) 5.76	82.00 ± 4.25 (75.00-89.00) 5.20	86.00 ± 3.33 (79.00-93.00) 3.89	78.00 ± 6.10 (68.00-95.00) 7.80	86.00 ± 3.62 (79.00-91.00) 4.23
Oesophageal length	121.00 ± 3.96 (114.0-125.0) 3.29	121.00 ± 4.77 (111.0-129.0) 3.93	119.00 ± 6.31 (107.0-132.0) 5.30	118.00 ± 4.33 (111.0-125.0) 3.67	112.00 ± 7.14 (104.0-128.0) 6.37	133.00 ± 5.99 (103.0-124.0) 5.30
b′	4.97 ± 0.25 (4.51-5.64) 5.09	4.54 ± 0.22 (4.06-4.99) 4.87	4.58 ± 0.19 (4.24-5.03) 4.23	5.11 ± 0.31 (4.71-5.67) 6.07	4.46 ± 0.28 (3.92-5.14) 6.28	5.05 ± 0.25 (4.56-5.51) 4.96
Stylet length	14.00 ± 0.60 (13.00-15.00) 4.19	14.00 ± 0.31 (13.00-14.00) 2.21	14.00 ± 0.47 (13.00-14.00) 3.43	14.00 ± 0.60 (14.00-16.00) 4.15	14.00 ± 0.49 (14.00-15.00) 3.41	15.00 ± 0.67 (14.00-16.00) 4.52
Conus length	7.00 ± 0.00 (7.00-7.00) 0.00	7.00 ± 0.00 (7.00-7.00) 0.00	7.00 ± 0.00 (7.00-7.00) 0.00	7.00 ± 0.31 (7.00-8.00) 4.34	7.00 ± 0.41 (6.00-8.00) 5.92	7.00 ± 0.41 (7.00-8.00) 5.70
m	48.52 ± 2.09 (46.66-53.84) 4.30	50.38 ± 1.18 (50.00-53.84) 2.35	51.15 ± 1.81 (50.00-53.84) 3.53	49.33 ± 1.75 (46.66-53.33) 3.54	48.64 ± 3.20 (40.00-53.50) 6.58	48.52 ± 2.49 (43.75-53.33) 5.13
o	17.47 ± 1.61 (13.33-22.01) 9.23	19.73 ± 2.96 (16.01-23.57) 15.02	21.92 ± 4.13 (17.85-29.64) 18.84	19.05 ± 2.99 (15.62-26.66) 15.68	18.06 ± 1.75 (16.60-23.57) 9.67	17.07 ± 1.39 (15.62-22.13) 8.15
Tail length	29.00 ± 2.24 (26.00-34.00) 7.81	26.00 ± 1.80 (23.00-29.00) 6.96	25.00 ± 1.68 (22.00-27.00) 6.76	28.00 ± 2.64 (24.00-32.00) 9.48	26.00 ± 2.18 (22.00-29.00) 8.51	27.00 ± 1.93 (23.00-31.00) 7.28
c	20.93 ± 1.45 (18.05-23.61) 6.94	21.31 ± 1.25 (19.21-23.61) 5.86	21.96 ± 1.74 (19.16-26.26) 7.92	21.83 ± 1.92 (17.81-25.83) 8.82	19.53 ± 1.68 (17.30-22.41) 8.62	22.12 ± 2.11 (18.70-26.52) 9.53
Body diameter at anus	12.00 ± 0.49 (11.00-13.00) 4.03	12.00 ± 0.59 (10.00-13.00) 4.95	12.00 ± 0.59 (11.00-13.00) 4.95	12.00 ± 0.45 (11.00-13.00) 3.76	12.00 ± 1.11 (11.00-15.00) 9.06	12.00 ± 0.60 (11.00-13.00) 5.02
c′	2.37 ± 0.19 (2.01-2.75) 7.93	2.19 ± 0.15 (1.91-2.41) 6.96	2.10 ± 0.17 (1.83-2.45) 8.10	2.34 ± 0.28 (1.92-2.90) 11.76	2.09 ± 0.26 (1.46-2.41) 12.47	2.21 ± 0.21 (1.76-2.58) 9.65
Spicules	20.00 ± 1.52 (17.00-23.00) 7.68	18.00 ± 1.19 (16.00-21.00) 6.63	17.00 ± 0.57 (16.00-18.00) 3.30	19.00 ± 0.94 (17.00-20.00) 5.01	18.00 ± 1.59 (14.00-20.00) 9.00	18.00 ± 1.26 (17.00-21.00) 6.89
Gubermaculum	6.00 ± 0.59 (5.00-7.00) 9.55	6.00 ± 0.75 (5.00-7.00) 12.12	5.00 ± 0.55 (5.00-7.00) 10.48	6.00 ± 0.55 (5.00-7.00) 9.36	6.00 ± 0.88 (5.00-8.00) 13.79	6.00 ± 0.94 (4.00-7.00) 17.02

All measurements are in µm, except body length. The measurements are given as : arithmetic mean ± standard deviation, (minimum - maximum) and coefficient of variation.

from vulva to anus, body diameter at anus) the differences between populations depend upon the sex under consideration (the interaction sex × isolate is significant). For the remaining characters, differences are not sex dependent.

The most abundant specimens in the soil samples are females. In this study, the diffeences founds between populations depended mainly on whether males or females were considered. Thus, the discriminatory analysis was made only with females.

Figure 2 shows the relative location of the centroids for each population in a canonical space. Table 3 presents correlation values between the original variables and the canonical axes.

The first canonical axis, which summarizes the main source of variation (84 %), clearly separates American isolates (Pv WA-A and Pv WA-U) from European isolates. This axis is mostly related with the characters : « Post vulvar sac length », « a ratio » and « body diameter ». The second cannonical axis (8 %) separates the Argentinian isolate (Pv WA-A) from the USA isolate (Pv WA-U) and is related to the characters : « body lenth », « distance between anterior end and nerve ring and to oesophago-intestinal valve ». The third axis sep-

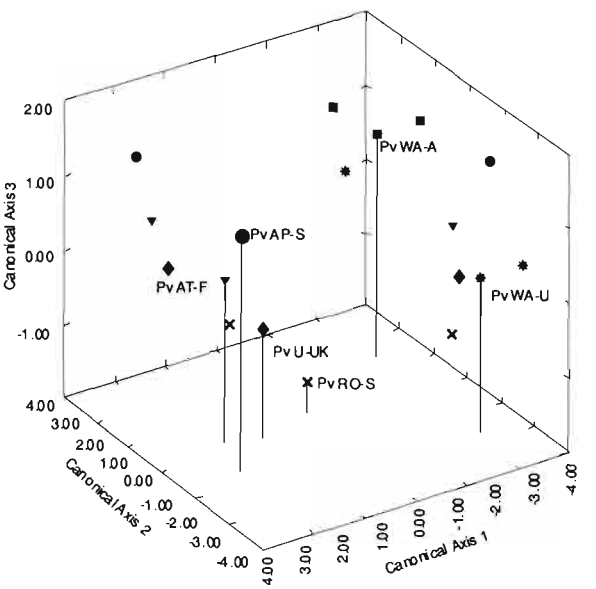

Fig. 2. *Relative location of six isolates of* Pratylenchus vulnus *in the canonical space.*

Table 3. *Correlation among original characters (variables) and canonical axes.*

Original character	Canonical Axis 1	Canonical Axis 2	Canonical Axis 3
Body length (mm)	− 0.22	* − 0.79	− 0.11
Body diameter	* − 0.77	− 0.43	0.26
a	* 0.80	0.02	− 0.38
Distance from anterior end to oesophago-intestinal valve	− 0.06	* − 0.65	0.23
b	− 0.22	− 0.31	− 0.36
Distance from anterior end to nerve ring	− 0.19	* − 0.71	0.37
Distance from anterior end to valve of median bulb	− 0.17	− 0.51	0.35
M.B.	− 0.17	− 0.16	− 0.11
Distance from anterior end to excretory pore	0.01	− 0.59	− 0.37
Oesophageal length	0.03	− 0.14	* 0.45
b′	− 0.24	− 0.51	* − 0.53
Stylet length	− 0.50	− 0.24	− 0.24
Conus length	− 0.47	− 0.23	− 0.25
m	− 0.18	− 0.09	− 0.12
o	0.34	0.16	− 0.00
V	0.29	− 0.29	0.22
Tail length	− 0.25	− 0.26	− 0.28
c	0.12	− 0.39	0.20
Body diameter at anus	− 0.52	0.12	0.32
c′	0.22	− 0.28	* − 0.46
Post vulvar sac length	* − 0.79	− 0.12	− 0.06
Distance from vulva to anus	− 0.49	− 0.31	− 0.09
Tail annules	0.37	− 0.19	− 0.25

* Indicate the three highest absolute values of coefficients of correlation.

arates one of the Spanish isolates (Pv Ro-S) from the rest and is related to the characters : « b' ratio », « body diameter at anus » and « oesophageal length ». It is interesting to note that this axis also separates the Spanish isolate Pv RO-S from the Spanish isolate Pv AP-S, both of which are originally from different hosts.

The differences observed between the values of the morphometrical characters of the studied isolates and those known for the species, as well as the differences related to some morphological characters suggest that *P. vulnus* is a species subject to certain variability whose limits need to be determined.

There are marked differences between the studied isolates which should be considered as morphometrical variants within the species. The differences observed between the isolates appear to be related, at least partially, to their geographical origin and/or hosts. These results corroborate those of recent studies conducted with the same isolates (Pinochet *et al.*, 1993, 1994). The first study shows that the different isolates have a differencial behavior; agressiveness and reproductive potential in relation to the same host are different. The second reveals the existence of a considerable genetic diversity.

This study shows the existence of a significant intraspecific variability for the morphometrical characters of *P. vulnus*.

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