Mem. Inst. Oswaldo Cruz, Rio de Janeiro, Vol. *86* (1): 107-113 jan./mar. 1991

KEY TO THE SPECIES OF BRAZILIAN *PROCAMALLANUS* WITH GENERAL CONSIDERATIONS (NEMATODA, CAMALLANOIDEA)

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In the present paper, the Peruvian Procamallanus (Spirocamallanus) incarocai *(Freitas & Ibañez 1970) is proposed as a junior synonym of* P. (S.) hilarii *Vaz & Pereira, 1934. The validity of the subgenera* Procamallanus *Baylis, 1923 and* Spirocamallanus *Olsen, 1952 is discussed. A check list and a key to the species of* Procamallanus *Baylis, 1923 occurring in Brazil are presented.*

Key words: Nematodes – *Procamallanus (Spirocamallanus)* spp. – *Procamallanus (Procamallanus)* spp. – fishes – Brazil

Nematodes in the genus *Procamallanus* Baylis, 1923, parasites of freshwater and marine fishes, with a few exceptions, have been investigated aiming the obtaintion of data on systematic, taxonomy, morphology and more recently subject of paleobiogeographic approaches (Petter, 1979). The present paper comprises considerations on the status of the Brazilian species in the genus with a key for their identification and of the two subgenera *Procamallanus* Baylis, 1923 and *Spirocamallanus* Olsen, 1952 regarded as valid ones.

MATERIALS AND METHODS

Samples are deposited either in the Instituto Oswaldo Cruz Helminthological Collection (CHIOC) or Instituto Biológico Helmintological Collection (CHIB), preserved as whole mounts (*) and wet material (Railliet & Henry's solution). Only whole mounts were reexamined. Holotypes, paratypes or voucher specimens are available in one of the above mentioned collections under file numbers indicated elsewhere as well as hosts and localities of capture. Unreported deposition number is followed by two asterisks (**). Figures were reproduced from original reports. Measurements are in micrometers unless otherwise indicated and averages within parentheses.

RESULTS

Procamallanus (Spirocamallanus) hilarii Vaz & Pereira, 1934 (Figs 1-11)

Synonyms: P. (S.) cearensis Pereira, Dias & Azevedo, 1936; *Spirocamallanus incarocai* Freitas & Ibañez, 1970 junior synonym.

Redescription (based on values after Vaz & Pereira, 1934, Pereira et al., 1936; Freitas & Ibañez, 1970; Pinto & Noronha, 1976): *Male:* body 4.0-6.9 mm (5.58) long, maximum width at its middle 120-200 (160). Buccal capsule 40-70 (53) long by 50-80 (57) wide, 13-18 spiral bands or tickenings on its inner surface. Muscular anterior portion of esophagus 270-460 (350) long and glandular posterior portion 7.70-1.50 mm (1.10 mm) long. Nerve ring and excretory pore 160-210 (180) and 200-360 (270) from anterior end, respectively. Caudal papillae 7-9 pairs, distributed, according their number, as follows: three pre, two ad and three postcloacal; four pre, three postcloacal; four pre, one ad and four postcloacal; three pre, one-two ad and three postcloacal. Spicules short, subequal 50-82 (64) long. Cloaca 120-180 (140) from posterior end. *Female:* body 8.5-27.0 mm (14.01) long, maximum width at its middle 160-530 (350). Buccal capsule 40-80 (57) long by 40-80 (59) wide, 13-18 spiral bands or thickenings on its inner surface. Anterior portion of muscular esophagus 370-450 (410) long and glandular posterior portion 1.54-2.02 mm (1.83) long. Nerve ring and excretory pore 120-270 (190) and 210-360

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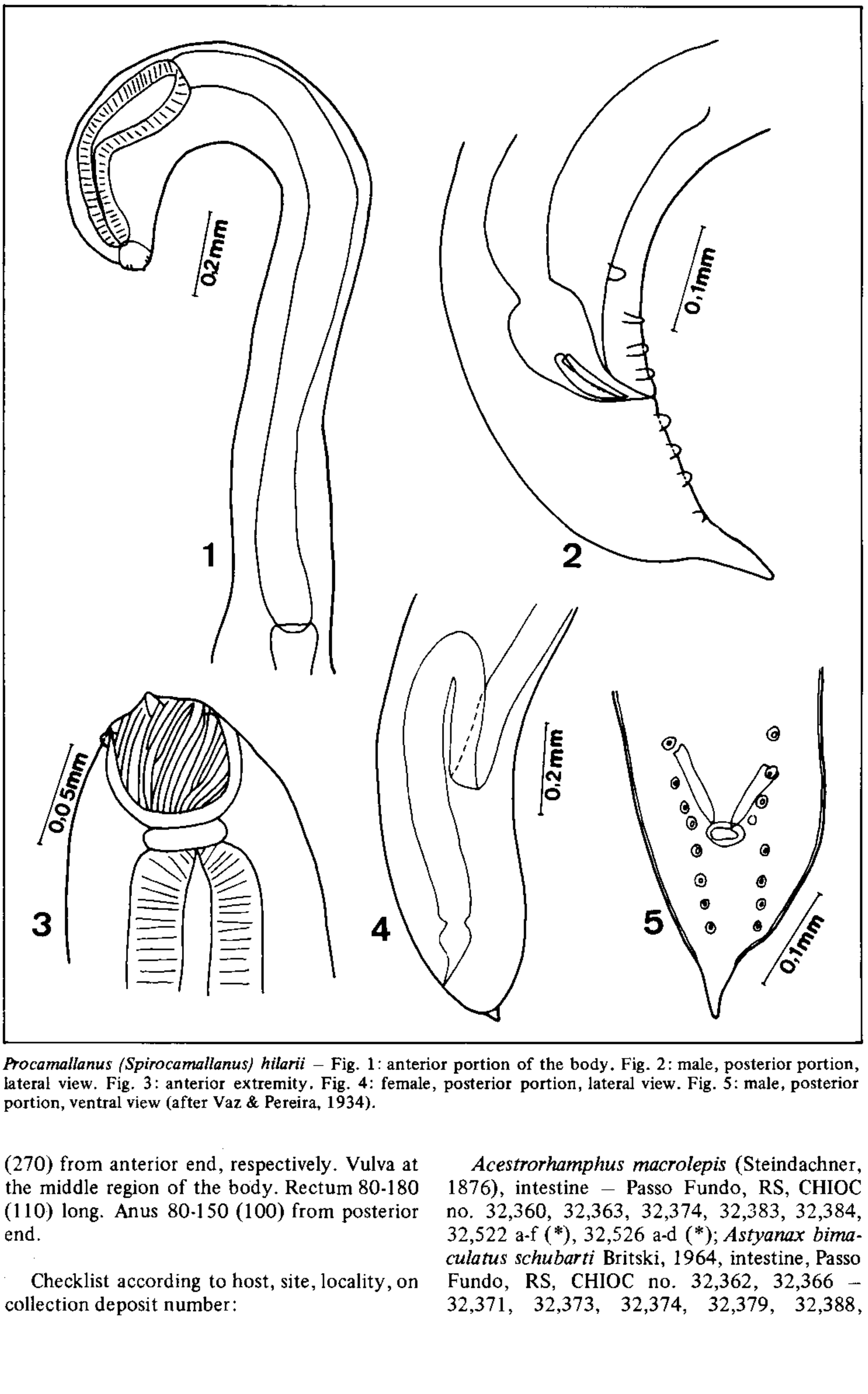
Received 8 August 1990.
Accepted 13 December 1990.

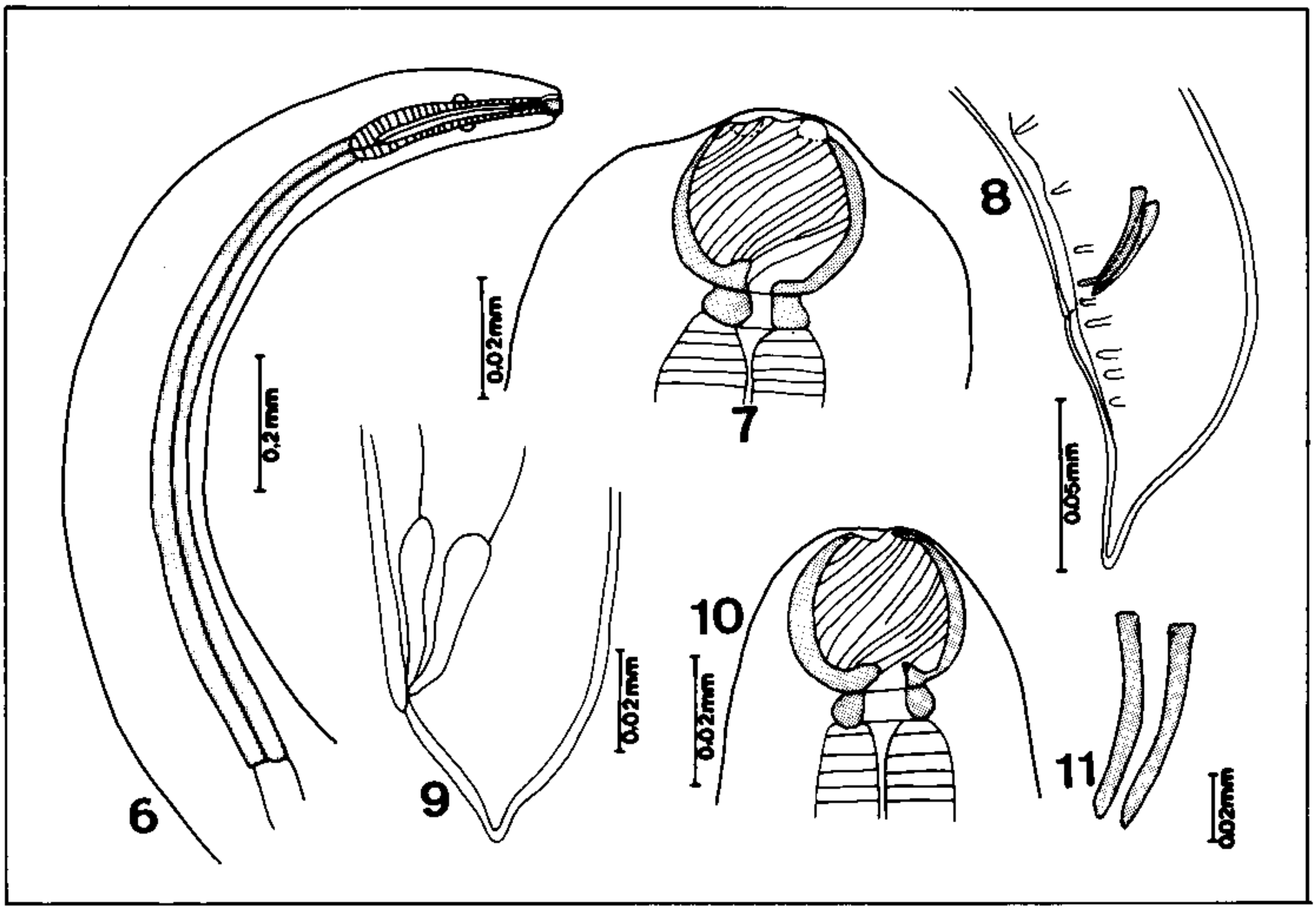


Procamallanus (Spirocamallanus) hilarii – Fig. 1: anterior portion of the body. Fig. 2: male, posterior portion, lateral view. Fig. 3: anterior extremity. Fig. 4: female, posterior portion, lateral view. Fig. 5: male, posterior portion, ventral view (after Vaz & Pereira, 1934).

(270) from anterior end, respectively. Vulva at the middle region of the body. Rectum 80-180 (110) long. Anus 80-150 (100) from posterior end.

Checklist according to host, site, locality, on collection deposit number:

Acestrorhamphus macrolepis (Steindachner, 1876), intestine – Passo Fundo, RS, CHIOC no. 32,360, 32,363, 32,374, 32,383, 32,384, 32,522 a-f (*), 32,526 a-d (*); *Astyanax bimaculatus schubarti* Britski, 1964, intestine, Passo Fundo, RS, CHIOC no. 32,362, 32,366 – 32,371, 32,373, 32,374, 32,379, 32,388,



Procamallanus (Spirocamallanus) hilarii – Fig. 6: female, anterior portion, lateral view. Fig. 7: female, buccal capsule. Fig. 8: male, posterior portion, lateral view. Fig. 9: female, posterior portion, lateral view. Fig. 10: male, buccal capsule. Fig. 11: male, spicules, ventral view (after Freitas & Ibañez, 1970).

32,525 (*); Pirassununga, SP (**); *A. b. vittatus* Castelnau, 1855, intestine, Tauapé, Soure and Porangaba Lakes, CE (**); *A. fasciatus* (Cuvier), intestine, Atuba, Curitiba, PR, CHIOC no. 31,347 (*); *A. fasciatus* (Cuvier, 1819), intestine, Passo Fundo, RS, CHIOC no. 32,387, 32,528 (*), 32,541 (*); *Curimatus elegans* Steindachner (alevins with 2nd/3rd stage larvae); *Diaptomus azevedoi* Wright, 1935, body cavity (1st/2nd stage larvae) and *D. cearensis* Wright, 1936, body cavity (1st/2nd stage larvae), Tauapé, Soure and Porangaba Lakes, CE (**); *Hoplias lacerdae* Ribeiro, 1908, intestine, Passo Fundo, RS, CHIOC no. 32,364; *H. malabaricus malabaricus* (Bloch, 1794), intestine, Passo Fundo, RS, CHIOC no. 32,380; Lambari amarelo (common name, unidentified)[1], intestine, Curitiba, PR, CHIOC no. 31,341 a-d (*); Lambari de cauda vermelha (common name, unidentified)[2] intestine, Pirassununga, SP, CHIOC no. 31,318 (*); *Pygidium punctulatum* (Cuv. & Val.), intestine, Cajamarca, Peru, CHIOC no. 29, 986 a-b (*); *Rhamdia quelen* (Quoy & Gaimard, 1842), intestine, Passo Fundo, RS, CHIOC no. 32,361; *Salminus hilarii* Valenciennes, 1849, intestine, Santo Amaro, SP, CHIB no. 243, 244, 276.

1: probably *Astianax bimaculatus schubarti* Britski, 1964

2: probably *A. fasciatus fasciatus* (Cuvier, 1819) according to Kohn & Fernandes (1987).

KEY TO THE BRAZILIAN SUBGENERA AND SPECIES OF *PROCAMALLANUS* BAYLIS, 1923

(Modified and updated after Pinto & Noronha, 1976)

1 – Buccal capsule with spiral ridges – Subgenus *Spirocamallanus* 2
– Buccal capsule smooth – Subgenus *Procamallanus* 8
2 – Spicules short and similar 5
– Spicules otherwise 3
3 – Spicules long and similar 6
– Spicules otherwise 4
4 – Spicules long and dissimilar 7
5 – 13-18 thin continuous spiral ridges covering all the inner surface of the buccal capsule in both sexes. Ratio muscular/glandular esophagus 1: 3-4. Seven-eight pairs of caudal papillae . . . . *P. (S.) hilarii*

– 15-19 thin continuous spiral ridges covering 2/3 of the inner surface of the buccal capsule in both sexes. Ratio muscular/glandular esophagus 1:1. The posterior portion narrows toward the tip of the tail in both sexes. Eighten pairs of caudal papillae . . . . . *P. (S.) inopinatus*
– 15-16 thin interrupted spiral ridges covering the inner surface of the buccal capsule in both sexes. The male posterior portion first broadening and then narrowing toward the tip of the tail. Eighteen pairs of caudal papillae . . *P. (S.) paraensis*
– Males with 5-7 thin spiral ridges covering the inner surface of the buccal capsule. Females with 3-4 thick spiral ridges. Seven pairs of strongly pedunculate, globose and hyaline caudal papillae. . . . . *P. (S.) pexatus*
– Male with 6 spiral ridges covering 2/3 of the inner surface of the buccal capsule. Females with 9-10 continuous spiral ridges on the inner surface of the buccal capsule. Ratio muscular/glandular esophagus 1: 2-3. Six pairs of caudal papillae . . . . . *P. (S.) pintoi*

6 – Six thin spiral ridges covering the inner surface of the buccal capsule in both sexes. Fourteen pairs of caudal papillae . . . . . *P. (S.) amarali*
– 12-14 spiral ridges covering the inner surface of the buccal capsule in both sexes. Ten pairs of sessile and 5 pairs of pedunculate papillae. Parasite of marine fish. . . . . *P. (S.) cruzi*
– Males with 7-9 thin spiral ridges covering the inner surface of the buccal capsule. Females with 3-4 thick spiral ridges. Twelve pairs of caudal papillae. . . . . *P. (S.) iheringi*
– Males with 14 and females with 12 thin spiral ridges covering the inner surface of the buccal capsule. Right spicule laterally alate having a hook-like tip, 615 long. Parasite of marine fish. . . . . *P. (S.) macaensis*
– 13-14 spiral ridges covering the inner surface of the buccal capsule in both sexes. Nine pairs of pedunculate papillae. Parasite of marine fish . . . *P. (S.) pereirai*
– Male with 12 and females with 17 thin spiral ridges covering the inner surface of the buccal capsule. Right spicule 430-450 long. Nine pairs of caudal papillae. . . . . *P. (S.) solani*

7 – Males with 6 and females with 9 thin spiral ridges covering the inner surface of the buccal capsule. Nine pairs of caudal papillae . . . . . *P. (S.) intermedius*
– 6-7 thin spiral ridges covering the inner surface of the buccal capsule. Caudal alae meet ventrally with strongly muscular fringed rim. 6 pairs of caudal papillae . . . . . *P. (S.) pimelodus*
– 3-4 thin spiral ridges in both sexes. Eight pairs of caudal papillae . . . . . *P. (S.) rarus*

8 – Buccal capsule smooth, with 5 teeth-like structures on its base and 4 plate-like ones on the anterior margin of the buccal capsule. Spicules short and similar. Five pairs of caudal papillae *P. (S.) annipeterae*
– Buccal capsule smooth, without teeth or plate-like structures. Espicules complex, simulating a gubernaculum at its posterior end. Nine pairs of caudal papillae . . . . . *P. (S.) peraccuratus*

DISCUSSION

Brazilian species of *Procamallanus* Baylis, 1923, were extensively reviewed by Pinto et al. (1974, 1975, 1976) and Pinto & Noronha (1976), adding new data and diagnoses to that previously known. The acceptance of the two subgenera *Procamallanus* Baylis, 1923 and *Spirocamallanus* Olsen, 1952 to design smooth and spiraled buccal capsules, respectively, remains controversial, but has proved to be an useful parameter to the prompt classification of these nematodes.

In fact, there is no doubt concerning the generic status but, considering the buccal ornamentations, a subgeneric concept seems to be adequate since in this nematode group there is no standard pattern to properly define buccal capsule models as already stated previously (Pinto et al., 1974), when *Procamallanus* and *Spirocamallanus* were referred to indicate only a subgeneric status. Some of the species, besides the internal striations, present teeth-like structures (Petter & Thatcher, 1988) and conversely, in the capsules regarded as smooth, other structures as plate-like, or even teeth can be evidenced, as well, even though without the internal ridges (Kohn & Fernandes, 1988a).

Earlier, samples of nematodes identified as *P. (S.) amarali* Vaz & Pereira, 1934 by Pinto et al. (1975) showed great diversity of buccal capsule structure since, from a same necropsy,

different evolutionary stages regarding this character were observed. Immature worms presented an apparently smooth buccal capsule, while older ones developed thin ridges in the inner surface of the capsule and these ridges or bands were fully complete and thicker in adult specimens.

Based on these observations the validity of the two subgenera is reinforced in agreement with the proposition mentioned above. In this way, definitely, the subgenus *Procamallanus* does not present typical striations while *Spirocamallanus* does, despite other correlated ornamentations, including plates, teeth or similar structures which can evenly be associated.

As for the herein proposed junior synonym, a retrospect on the two discussed species as well as a brief report on the valid Brazilian species of the genus *Procamallanus* up to the present is presented as follows.

In a survey of nematodes from Brazilian freshwater fishes Vaz & Pereira (1934) proposed *Procamallanus hilarii* from small intestine of *Salminus hilarii* Valenciennes, 1849, captured in Santo Amaro Reservoir, State of São Paulo. This species was characterized mainly by the extremely long glandular esophagus and according to the authors, the longest ever observed among the Brazilian species of the genus, known up to that date.

Freitas & Ibañez (1970) identified *Spirocamallanus incarocai* as parasite of *Pygidium punctulatum* (Cuv. & Val.) from Chilete, Cajamarca, Peru. This species was then compared to *Procamallanus (Spirocamallanus) inopinatus* Travassos, Artigas & Pereira, 1928, *P. (S.) xenopodis* Baylis, 1929, *P. (S.) wrighti* Pereira, 1935 and *P. (S.) cearensis* Pereira, Dias & Azevedo, 1936, considering shape and size of spicules, number of caudal papillae and length of glandular esophagus. Data on these characters observed in *P. (S.) incarocai* are, however, undoubtely very close to those previously referred as *P. (S.) hilarii* of which, unfortunately, Freitas & Ibañez (1970) were not aware. Moreover, even before the proposition of the Peruvian species, some of those to which it was compared had already been invalidated. Since 1966 *P. (S.) wrighti* was considered a junior synonym of *P. (S.) hilarii*, as well.

The above summarized considerations on these synonyms were fully discussed by Pinto & Noronha (1976), during a report on the Brazilian procamallanid nematodes from Characidae fishes.

After examining holotypes of *P. (S.) incarocai*, paratypes of *P. (S.) inopinatus* and voucher specimens of *P. (S.) hilarii* and comparing available data on *P. (S.) xenopodis* with those on the former species, *P. (S.) incarocai* is herein proposed as junior synonym of *P. (S.) hilarii* found in Peru, in a new host. Data on *P. (S.) hilarii* from Vaz & Pereira (1934), Pereira et al. (1936), Freitas & Ibañez (1970) and Pinto & Noronha (1976) were compiled to amplify its specific diagnosis, known geographical distribution and host species, as well (Table).

Datum on the glandular esophagus after Pinto & Noronha (1976) is rectified from 1.54-20.02 to 1.54-2.02 mm. This error was due to a misprint. More recently, *P. (S.) hilarii* was listed in a catalogue of the nematode parasites of fishes in Brazil (Vicente et al., 1985) and its occurrence was also reported from freshwater fishes from Rio Mogi-Guassu (Kohn & Fernandes, 1987) and Brazilian waters of the Uruguay River (Kohn et al., 1988; 1989).

From 1928 up to 1976 the valid species in this genus, recovered from Brazilian hosts, are: *P. (S.) iheringi* Travassos, Artigas & Pereira, 1928, *P. (S.) inopinatus* Travassos, Artigas & Pereira, 1928, *P. (S.) rarus* Travassos, Artigas & Pereira, 1928, *P. (S.) amarali* Vaz & Pereira, 1934, *P. (S.) hilarii* Vaz & Pereira, 1934 (?), *P. (S.) barroslimai* Pereira, 1935, *P. (S.) macaensis* Vicente & Santos, 1972, *P. (S.) intermedius* Pinto, Fabio, Noronha & Rolas, 1974, *P. (S.) pimelodus* Pinto, Fabio, Noronha & Rolas, 1974, *P. (S.) solani* Pinto, Fabio, Noronha & Rolas, 1975, *P. (S.) pexatus* Pinto, Fabio, Noronha & Rolas, 1976, *P. (P.) peraccuratus* Pinto, Fabio, Noronha & Rolas, 1976 and *P. (S.) paraensis* Pinto & Noronha, 1976 (Pinto et al., 1974; 1975; 1976; Pinto & Noronha, 1976).

Procamallanus (S.) cruzi was identified later, but in the same year (1976) by Guimarães et al., in *Polydactylus virginicus* (L.) from State of Bahia and *P. (S.) pereirai* Annereaux, 1946 was recorded in Brazil (Pinto et al., 1984).

TABLE

Comparative data on *Procamallanus (Spirocamallanus) hilarii* Vaz & Pereira, 1934 (in mm.)

Parameter/Character	Vaz & Pereira (1934)		Pereira et al. (1936) *(a)*		Freitas & Ibañez (1970) *(b)*		Pinto & Noronha (1976)	
	male	female	male	female	male	female	male	female
Length of body	6.0	14.0	4.0	10.3-14.0	6.6-6.9	8.5-27.0	4.0-6.0	10.3-14.0
Width of body	0.20	0.36	0.18	0.28-0.42	0.12-0.16	0.16-0.53	0.15-0.18	0.28-0.42
Excretory pore from anterior end	0.36	0.36	0.20	0.21-0.26	0.30	0.35	0.20-0.30	0.21-0.26
Nerve ring from anterior end	0.20	0.20	0.16	0.12-0.16	0.19-0.21	0.25-0.27	0.16-0.21	0.12-0.21
Buccal capsule (length x width)	0.057 x 0.057	0.062 x 0.062	0.04 x 0.04	0.04-0.05 x 0.04	0.05-0.06 x 0.05	0.06 x 0.05-0.06	0.04-0.07 x 0.05-0.07	0.04-0.08 x 0.06-0.08
Ridges or bands (no.)	16	16	18	18	14	16	13-18	13-18
Muscular esophagus	0.41	0.41	0.27	0.37-0.39	0.32-0.37	0.45-0.47	0.27-0.46	0.37-0.43
Glandular esophagus	1.50	2.02	1.03	1.75-1.93	0.77-0.82	1.76-1.83	1.03-1.50	1.54-2.02
Caudal papillae (no.)	16		14		18		14-16	
Distribution of papilae (pairs)	3 precloacal 2 adcloacal 3 postcloacal		4 precloacal 3 postcloacal		4 precloacal 1 adcloacal 4 postcloacal		3 precloacal 1-2 adcloacal 3 postcloacal	
Spicules	0.062-0.082		0.057		0.056-0.071		0.05-0.07	
Cloaca from posterior end	0.16		0.15		0.13-0.15		0.12-0.16	
Anus from posterior end	0.12		0.08-0.14		0.09		0.07-0.15	
Rectum	0.028				0.08		0.08-0.18	

a: originally described as *Procamallanus cearensis* Pereira, Dias & Azevedo, 1936.
b: originally described as *Spirocamallanus incarocai* Freitas & Ibañez, 1970.

The two above mentioned species and *P. (S.) macaensis* are the only representatives from marine fishes in Brazil. More recently, two other species, also from freshwater fishes were proposed, namely *P. (P.) annipetterae* Kohn & Fernandes, 1988 (Kohn & Fernandes, 1988 a, b) and *P. (S.) pintoi* Kohn & Fernandes, 1988 (Kohn & Fernandes, 1988a), recovered from *Plecostomus albopunctatus* Regan, 1908 and *Corydoras paleatus* (Jenyns, 1842), respectively, captured in Rio Iguaçu, State of Paraná.

From 1928 up to the present, there are 16 valid species in the genus *Procamallanus* occurring in Brazil. Of these, three were recovered from marine fishes and two belong to the subgenus *Procamallanus*.

The status of *P. (S.) barroslimai* remains uncertain and probably must it be regarded as a junior synonym of *P. (S.) inopinatus*, as mentioned elsewhere (Pinto & Noronha, 1976).

ACKNOWLEDGEMENTS

To SICT/IOC for final photographic processings.

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