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A PRELIMINARY ANALYSIS OF THE CERCOPOD SETATION PATTERN OF ALGERIAN ANOSTRACA (*CRUSTACEA*) SPECIES

by

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SUMMARY

The position, number and length of the setae on the cercopods of Anostraca species are graphically represented and analysed. All species found in Algeria are used as examples. This revealed significant differences among the representatives of the genera *Artemia, Branchinella, Branchipus, Chirocephalus, Streptocephalus* and *Tanymastigites*, and between the related congeners *Streptocephalus torvicornis* and *S. rubricaudatus*, and *Tanymastigites perrieri* and *T. mzabica*.

Key words : Anostraca, cercopod armature, morphometric analysis, Algeria.

INTRODUCTION

Description of anostracans traditionally includes an illustration of the telson with the cercopods. However, the setation pattern on the cercopods has never been used as a character of any major taxonomic importance. Even LINDER (1941) did not mention the cercopods in his monograph on morphology and taxonomy of Anostraca.

Recently, BELADJAL *et al.*, 1995 described the setation on the limbs in some Anostraca, quantifying morphological differences among genera and species, and

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explored the possibility of using these data taxonomically. In the present study we demonstrate that such analysis is also applicable to the cercopod morphology. As far as we know this technique has not been used in other crustacean taxa.

MATERIAL AND METHODS

The cercopod material analysed herein was obtained from specimens collected in their natural habitats in Algeria and preserved in 4 % formalin (Table 1). As far as possible the same material was used as for the limb analysis in BELADJAL *et al.* (1995). All data are derived from the cercopods from one male of each species, except for the parthenogenetic *Artemia* sp. population (female).

TABLE 1

Names, sampling locality (province), coordinates and dates of collection of the species used as material for this paper.

Species	*Locality*	*Coordinates*	*Date*
Streptocephalus torvicornis	Dider (Djanet)	24° 34′ N 09° 30′ E	30.10.1991
Streptocephalus rubricaudatus	Bei Bei (Djanet)	24° 38′ N 09° 26′ E	09.06.1978
Branchipus schaefferi	Sidi Makhlouf (Djelfa)	34° 14′ N 03° 14′ E	02.11.1991
Branchinella spinosa	Boughzoul (Medea)	35° 42′ N 02° 51′ E	02.11.1991
Chirocephalus diaphanus	Theniet El Had (Tissemsilt)	35° 47′ N 02° 01′ E	20.05.1989
Tanymastigites perrieri	Sidi Makhlouf (Djelfa)	34° 14′ N 03° 14′ E	02.11.1991
Tanymastigites mzabica	Tilrhemt (Laghouat)	33° 10′ N 03° 21′ E	13.05.1990
Artemia spec.	Tougourt (Tougourt)	33° 06′ N 06° 07′ E	08.02.1977

After dissection, cercopods were mounted on slides in such a way that all setae were extended. To avoid overlap of setae, the left cercopod was separated from the right by cutting the telson in two.

A video camera, fixed on a microscope (Leitz Laborlux 5) was connected to a video-printer. A series of video prints provided the elements for an accurate com-

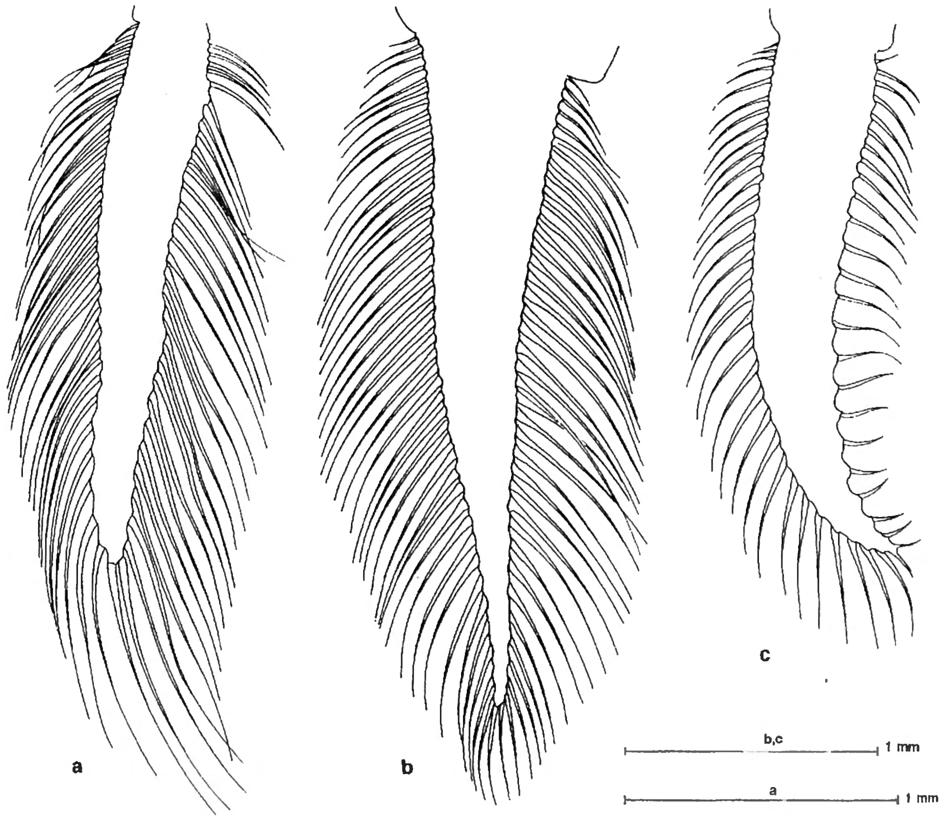


Fig. 1. — Left cercopod of (**a**) *Tanymastigites mzabica* (**b**) *Streptocephalus torvicornis* and (**c**) *Branchipus schaefferi.*

pound picture of the cercopod at high magnification. The length and distance between the successive setae were measured on that picture using a relative pointing device of graphics tablet (Summasketch III professional) and stored in the memory of the computer.

The arrangement of the setae on the cercopods of the three species is visualized in Fig. 1. In order to compare different species of different age classes, we converted the above measurements to relative values using the lengths of the cercopod as the standard length. The setae are numbered from the lateral outer basis of the cercopod near the telson, to the top and back on the inner side to the medial inner basis near the telson (Fig. 2). Fig. 3 shows the relative length of the setae, arranged according to their insertion from lateral to median on the cercopod. These values are summarised in Table 2.

TABLE 2

Numerical analysis of the cercopod structure of the different species : m = mean relative length of setae ; N = number of setae ; other explanations in the text.

	Parameters	*− curve (outer)*	*+ curve 1*	*+ curve 2*	*− curve (apical)*	− curve (inner)
S. torvicornis	start	0.000	0.190	1.247	0.810	1.886
m = 0.236	length	−0.190	0.620	0.639	0.437	0.113
N = 85	max. height	−0.187	0.054	0.091	−0.094	−0.158
	eccentricity	−1.000	−0.426	−0.047	−0.192	1.000
	n (setae)	12	26	25	16	6
S. rubricaudatus	start	0.000	0.080	1.269	0.633	1.878
m = 0.218	length	0.080	0.553	0.610	0.636	0.122
N = 86	max. height	−0.158	0.055	0.090	−0.112	−0.094
	eccentricity	−1.000	−0.238	0.042	0.038	1.000
	n (setae)	6	24	26	26	4
B. schaefferi	start	0.000	0.141	1.708	1.054	1.904
m = 0.157	length	0.141	0.913	0.196	0.654	0.096
N = 57	max. height	−0.135	0.094	0.015	−0.124	−0.112
	eccentricity	−1.000	0.654	0.735	−0.957	1.000
	n (setae)	8	25	14	6	4
Artemia spec.	start	0.000	0.376			1.380
m = 1.282	length	0.376	1.004			0.620
N = 16	max. height	−0.360	0.508	—	—	−0.956
	eccentricity	−1.000	−0.018			1.000
	n (setae)	3	9			4
T. perrieri	start	0.000	0.321			1.733
m = 0.356	length	0.321	1.411			0.228
N = 64	max. height	−0.310	0.192	—	—	−0.270
	eccentricity	−1.000	0.133			1.000
	n (setae)	17	37			10
T. mzabica	start	0.000	0.264			1.801
m = 0.336	length	0.264	1.537			0.200
N = 53	max. height	−0.201	0.099	—	—	−0.220
	eccentricity	−1.000	0.025			1.000
	n (setae)	12	32			9
B. spinosa	start	0.000	0.216			1.860
m = 0.302	length	0.216	1.644			0.139
N = 49	max. height	−0.246	0.095	—	—	−0.228
	eccentricity	−1.000	−0.156			1.000
	n (setae)	9	33			7
C. diaphanus	start	0.000	0.247			1.613
m = 0.262	length	0.247	1.366			0.388
N = 61	max. height	−0.176	0.111	—	—	−0.184
	eccentricity	−1.000	−0.026			1.000
	n (setae)	11	36			14

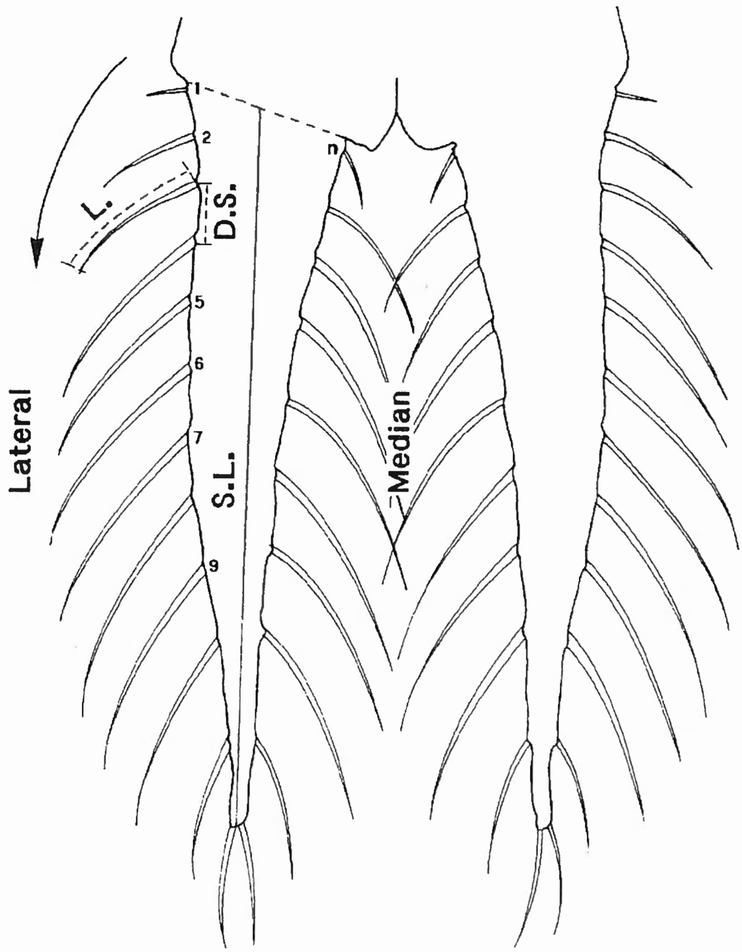


Fig. 2. — Outline of the different symbols and values used in the morphometric analysis of the setation on the cercopods. S.L. = standard length of the cercopod ; L. = length of setae, *D.S.* = distance between setae ; 1,2....n = number of setae (arrow indicates the direction).

It is desirable to relate the length of each seta x to the mean length m of all setae, total number = N, as follows : $m = \sum x/n$. Taking the difference between the mean length m and the length x of the setae successively, we obtain a distribution (x − m), as presented in Fig. 4, which follows the turning value x = m on the abscissa. Thus all lengths of the setae smaller than m, give negative x values and vice versa, and x = 0 (turning value) corresponds to the mean setae length. Now these data can be analysed as follows : the distribution above can be split into in series of positive (x > m) and negative (x < m) deviations from the mean m or x = 0, corresponding to the different columns in Table 2. Each curve has a starting and an end point intersecting the mean m or x-axis, so defining the length of that curve. This is represented in the first row of Table 2 (starting point) and the second row (length of the curve), for each species analyzed. All curves have a maximum value (third row in Table 2), corresponding to the longest ($x > m$), or shortest seta ($x < m$) in the positive curves ($x - m > 0$) or negative curves ($x - m < 0$). Geometrically this maximum value can be situated in the middle (0) between the extremes (−1 or +1), where the curve joins the x-axis. This eccentricity is quantified in the fourth row of Table 2. The bottom row, gives the number of setae building up each curve.

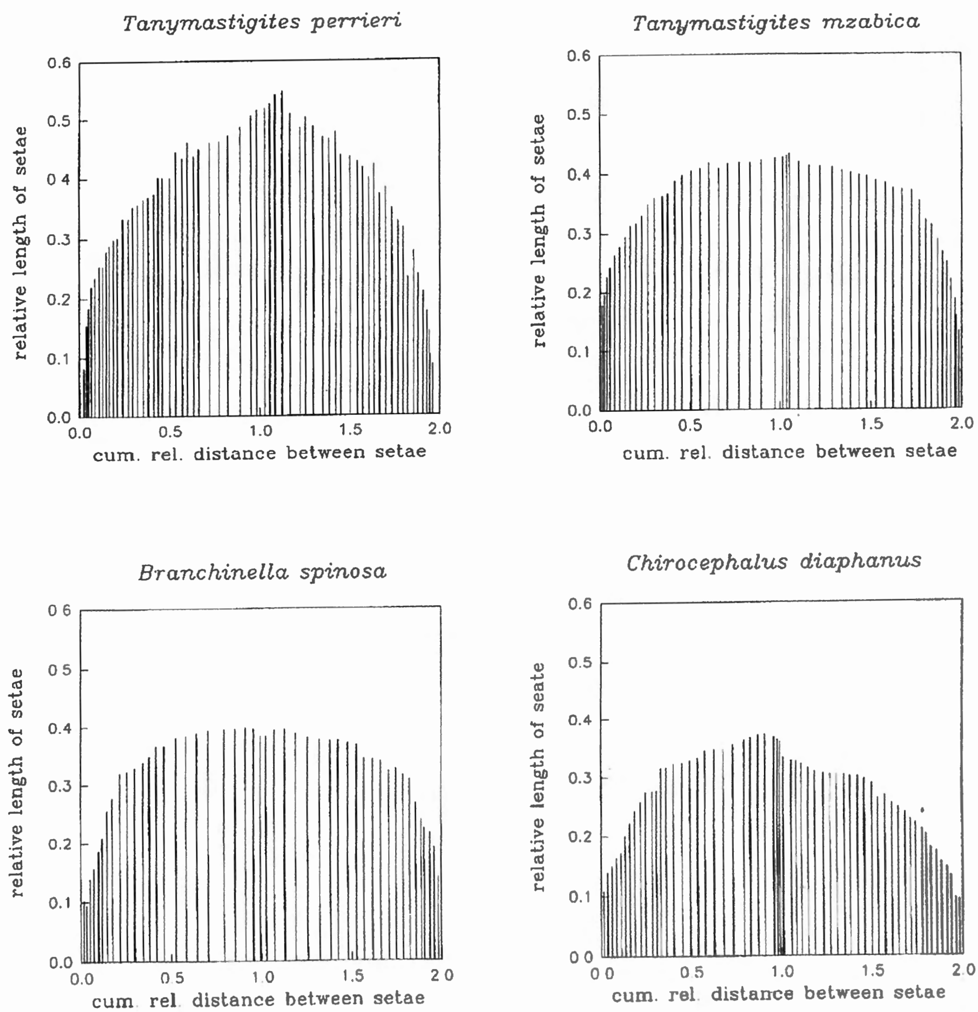
Finally, the relative distance between setae is calculated by dividing the absolute distance between these setae by the total absolute length of the cercopod. Thus, the relative length of the cercopod equals one, and the total setal insertion zone on the cercopod (lateral + medial) equals 2, being the sum of the relative distances of the setae.

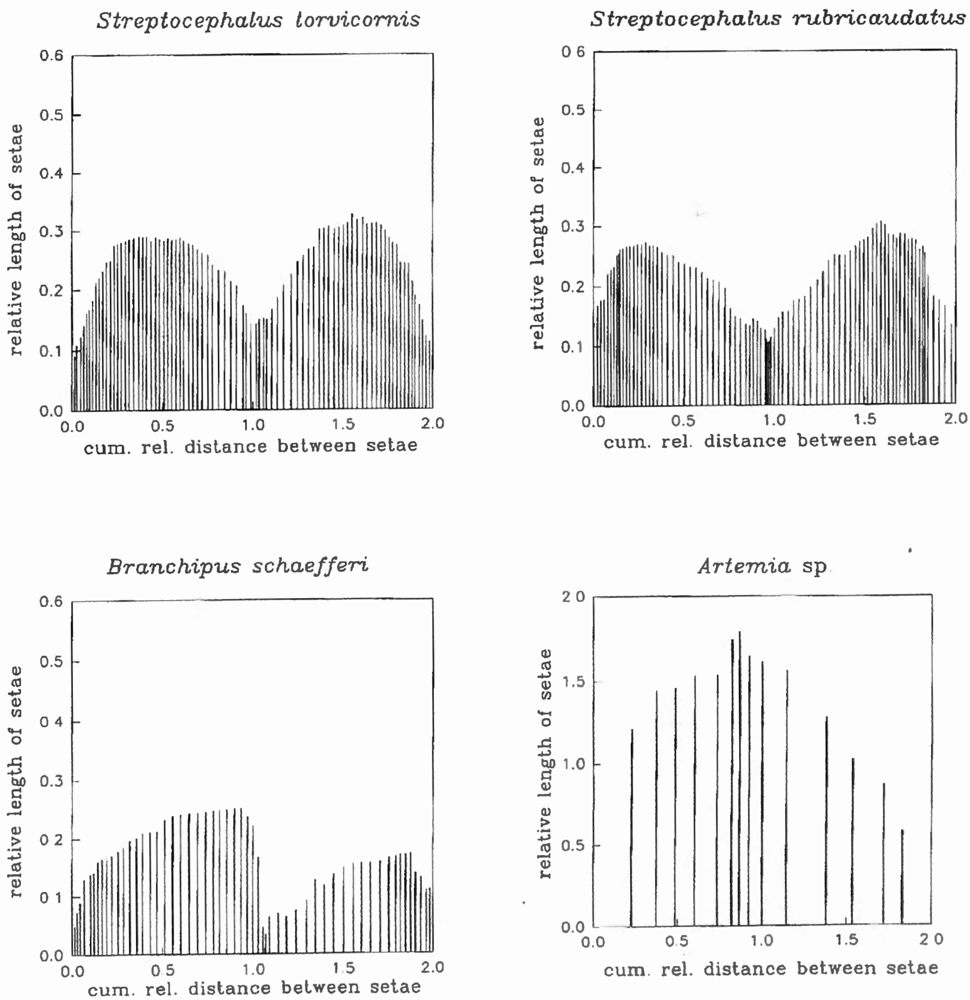
RESULTS AND DISCUSSION

Artemia sp. differs profoundly from all other fairy shrimps. It has few (16) extremely long setae (the mean is 1.282 times the length of the cercopod; max. 2.286, min. 0.906). The other species can be divided in two major groups : the first group (containing *Tanymastigites perrieri* (Daday, 1910), *T. mzabica* (Gauthier, 1928), *Chirocephalus diaphanus* Prévost, 1803 and *Branchinella spinosa* (Milne-Edwards, 1840)) shows only one positive curve ; the second group has two positive curves separated by an apical negative curve (*Streptocephalus torvicornis* (Waga, 1842), *S. rubricaudatus* (Kulunzinger, 1867) and *Branchipus schaefferi* (Fisher, 1834)).

Amongst members of the first group, *B. spinosa* is the simplest representative. The lengths of its setae are quite homogeneously distributed. Only few setae (9 and 7) are shorter than the mean, giving the positive curve a very broad basis (1.644). In *C. diaphanus*, the outer negative curve is shorter, and contains less setae than the inner negative curve. In *Tanymastigites* the inverse situation is seen : the positive curve is shorter (1.366 versus 1.411 and 1.537) and the setae are not as long (max 0.373, mean 0.262 versus max 1.767, mean 0.356, and max 1.873, mean 0.336). Although both species present the same *Tanymastigites* basic pattern of setation, specific differences can be pointed out. In *T. perrieri* the negative curves are wider (0.321, 0.228) than in *T. mzabica* (0.264, 0.200). Since the shortest setae in

T. perrieri (−0.310, −0.270) are smaller than in *T. mzabica* (−0.201, −0.220), and the longest seta is much bigger in *T. perrieri* (0.192) than in *T. mzabica* (0.099), the difference between the shortest and the longest seta is 0.502 in *T. perrieri* while only a difference of 0.300 is found in *T. mzabica*. This is seen in Fig. 3a as a rounded profile for *T. mzabica*, in contrast to a rather pointed profile in *T. perrieri*.

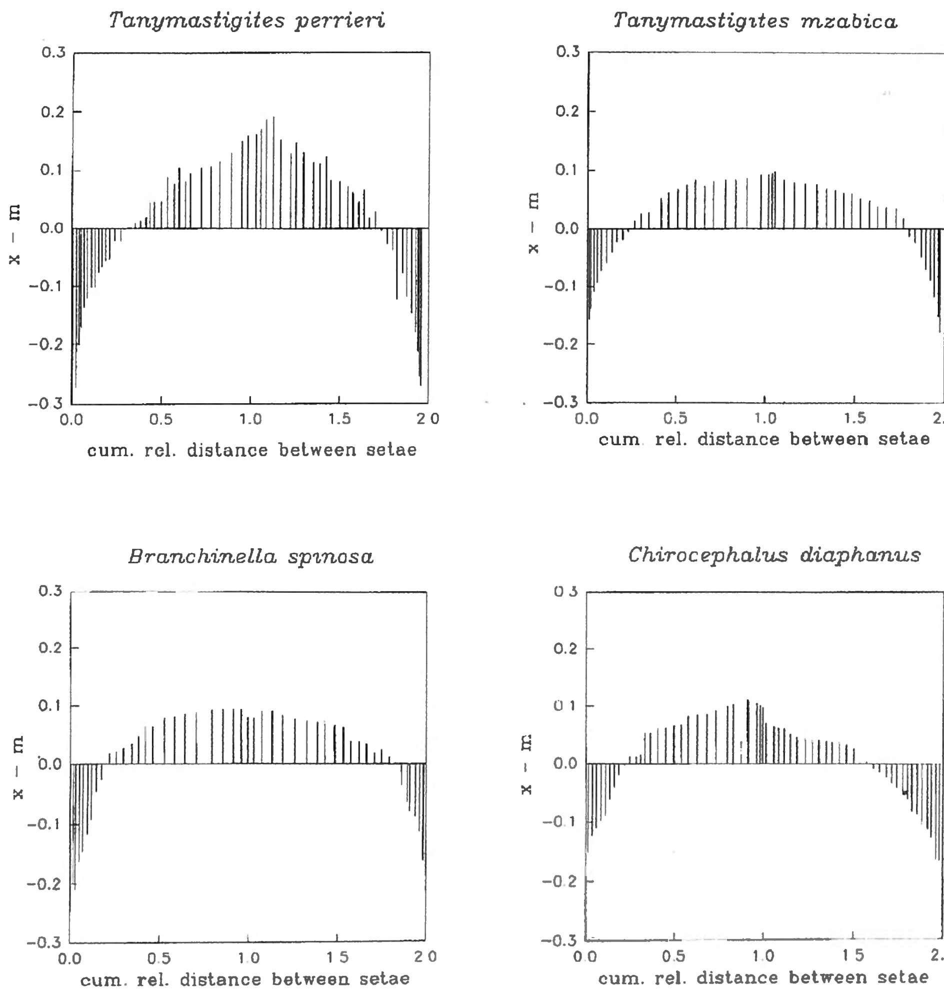


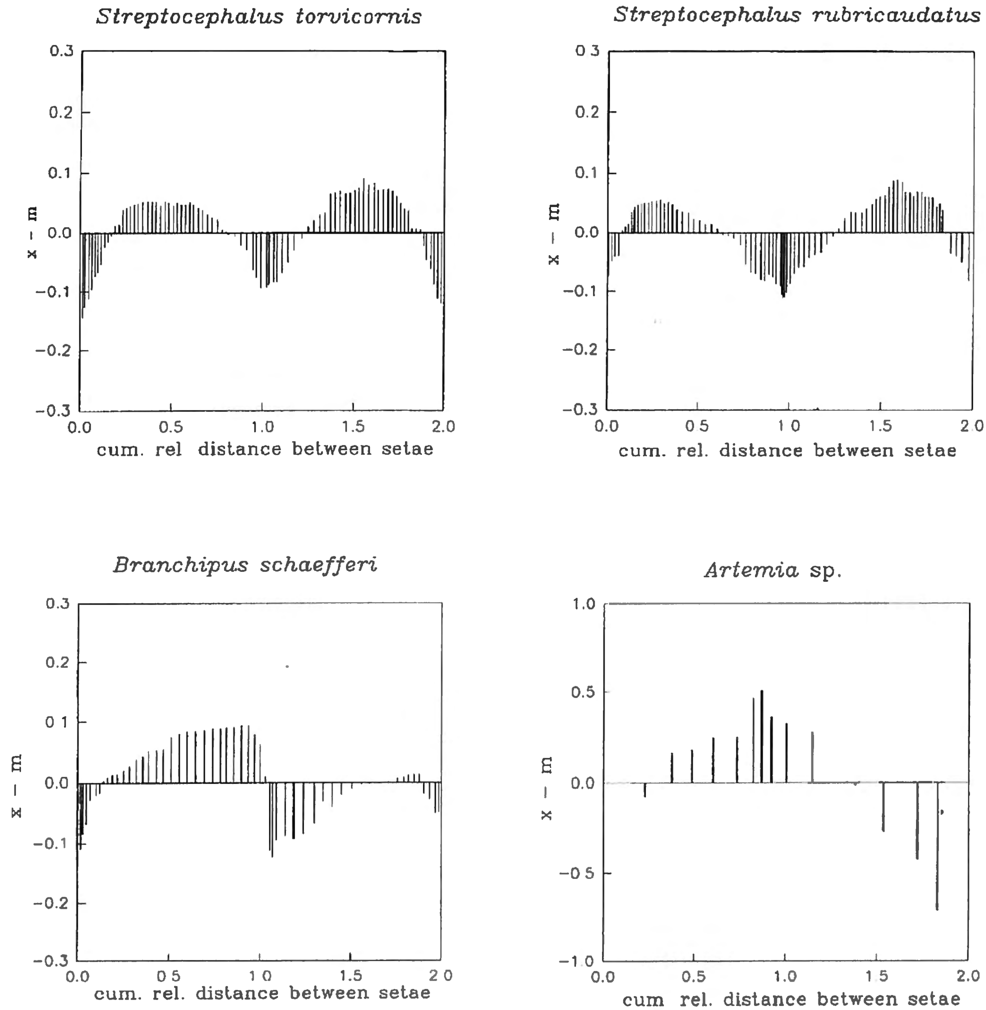


Figs 3a-b. — The relative length of the setae arranged according to their insertion from lateral to median on the cercopod.

The two genera representing the second group are extremely different. In *B. schaefferi* the second positive curve is very small, separated from the first positive curve by a highly asymmetric (0.957) apical curve. In *Streptocephalus* two well developed positive curves alternate with a normal (symmetrical) apical curve. However, as for *Tanymastigites*, this basic pattern shows discriminative features for both species. In *S. torvicornis* the inner curve is wider (0.190) and the apical negative curve shorter (0.437) than in *S. rubricaudatus* (0.080 and 0.636, respectively).

The data for the analysis presented in this paper are based on calculations derived from a single male of each species (except for *Artemia*). The species-specific setation pattern of the cercopods presented in Fig. 3 and Table 2 is striking and the methodology appears to be promising. It must, however, be examined in a number of individuals of each species and statistical analyses must be performed before its taxonomic value can be assessed.





Figs 4a-b. — The length differences of the setae $(x - m)$ in relation to the mean length m, arranged according to their insertion from lateral to median on the cercopod.

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