

**SEXUAL DIMORPHISM IN *STYLOCHEIRON INDICUM* SILAS AND MATHEW
(CRUSTACEA : EUPHAUSIACEA)**

K. J. MATHEW

Central Marine Fisheries Research Institute, Cochin-682 018

ABSTRACT

Many species of euphausiids are found sexually dimorphic, the characters being manifested with several of their body organs. This phenomenon has been investigated in some species in detail and as a result it has been found that the morphological variations between the two sexes are more pronounced in species of the genera namely *Thysanoessa*, *Nematoscelis*, *Nematobranchion* and *Stylocheiron*. The organs thus found to vary in males and females are the antennules, their flagellae, photophores, lateral denticles on carapace, abdominal segments, eye or even the preanal spine. Considering the manifestation of sexual dimorphic characters in diverse body organs in euphausiids an attempt has been made here to study the degree of sexual dimorphism in *Stylocheiron indicum* Silas and Mathew. In this species differences were observed with some of the body parts in the adult males and females. In order to assess the magnitude of such differences a few morphological characters were compared in both the sexes statistically. Of the characters examined it was found that the proportion of length to depth of the sixth abdominal segment, and the proportion of the width of the upper part of the eye to the width of the lower part of the eye were significantly different in the two sexes.

INTRODUCTION

IN EUPHAUSIACEA many species exhibit sexual dimorphic characters. Such morphological differences in both the sexes are greatly pronounced in species of the genera *Thysanoessa*, *Nematoscelis*, *Nematobranchion* and *Stylocheiron*. The differences may be manifested mainly with organs such as the antennules, their flagellae, photophores, lateral denticles on carapace, abdominal segments especially the last segment, eye or the preanal spine (Mauchline and Fisher, 1969; Taniguchi, 1967; James, 1973; Gopalakrishnan, 1975). Sheard (1953) who investigated on the relative growth of body parts in *Nyctiphanes australis* found that the third antennular segment exhibited sexual dimorphism. A correlation between the length and width of this segment indicated that the width increased at a slower rate than the length in the females, but at a rate more nearly

approximating to the rate of increase of length in male. Nemoto (1966) has made a detailed study on the comparative morphology and allomorphy including that of sexual dimorphic characters of species of the genus *Thysanoessa*. He found that in some species sexual dimorphism was present with the eyes, the antennular flagellae and the preanal spine.

In *Stylocheiron indicum*, differences were observed in the adult males and females. In order to assess the magnitude of such differences a few morphological characters were compared in both the sexes. The combinations of characters thus considered for comparison were (1) length and depth of sixth abdominal segment, (2) width of the upper and lower parts of eye, (3) length of eye and width of upper part of eye (4) length of eye and width of lower part of eye and (5) length of fourth and fifth abdominal segments in relation to the total

length. The scatter diagrams for the combinations of characters considered and regression lines obtained for both males and females are given in Fig. 1. The significance of the sexual dimorphic characters were statistically tested (Table 1) and discussed in this paper.

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MATERIAL AND METHODS

The material for the study was obtained from the continental slope areas of the southwest coast of India. Fully mature specimens of both the sexes were selected for the purpose of measurements. The measurements of the body parts were made under the low magnification of a monocular microscope using an ocular

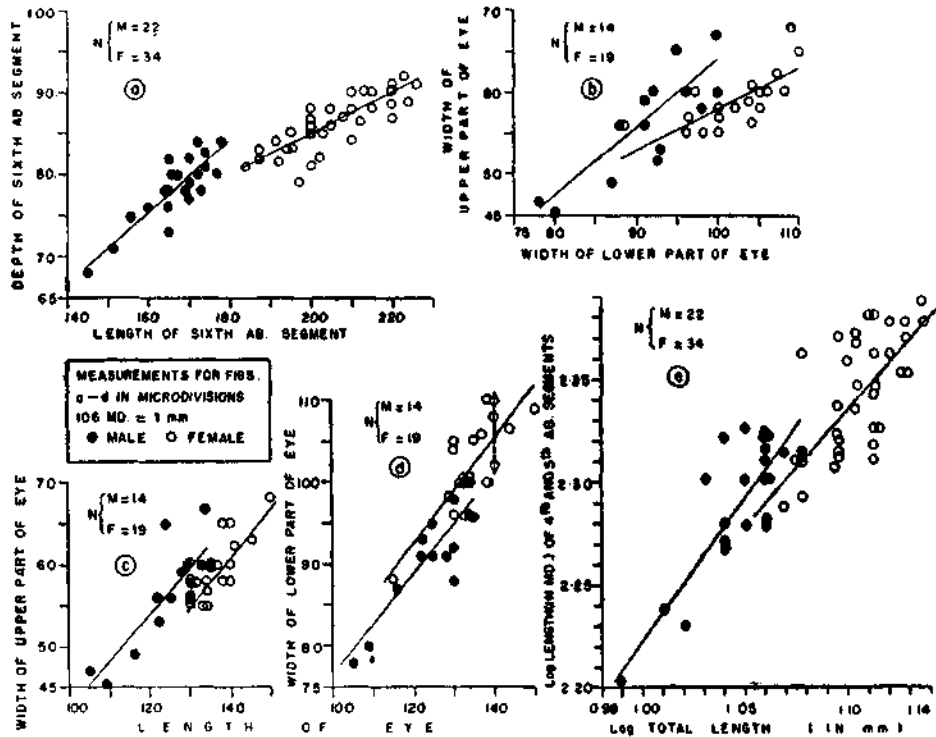


FIG. 1. Scatter diagrams for combinations of body characters considered for morphometric measurements in *Stylocheilron indicum*.

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micrometer calibrated with a stage micrometer. The length of sixth abdominal segment was measured along the dorsal margin while its depth was measured along the widest region. Similarly the width of upper part of the eye was measured at the region just below the curved crust formed by the crystalline cones while the

TABLE 1. Corrected sums of squares and products of morphometric data, regression coefficients and deviation from average regression for males and females of *Stylocbeiron indicum*

Sex	X	Y	d.f.	Sums of squares and products			b	Errors of estimate	
				Sx ²	Sy ²	Sxy		s.s.	d.f.
Females	Length of 6th ab. segment	Depth of 6th ab. segment	33	3860.740	374.383	996.325	0.2580658	117.26558	32
Males	..	..	21	1216.955	305.319	499.410	0.4103767	100.37276	20
Females	Width of lower part of eye	Width of upper part of eye	18	589.685	247.157	279.948	0.4747415	114.25493	17
Males	..	..	13	569.429	519.500	466.000	0.8183636	138.14253	12
Females	Vertical length of eye	Width of upper part of eye	18	834.422	247.157	300.474	0.3600983	138.95770	17
Males	..	..	13	1081.500	519.500	632.500	0.5848358	149.59130	12
Females	Vertical length of eye	Width of lower part of eye	18	834.422	589.685	534.843	0.6407766	246.86442	17
Males	..	..	13	1081.500	569.429	693.000	0.6409742	125.37074	12
Females*	Total length	Length of 4th & 5th ab. seg.	33	0.01035	0.02578	0.01147	1.10821	0.01307	32
Males*	..	..	21	0.00828	0.02312	0.01121	1.35386	0.00795	20

* Converted to logarithmic values

lower part of the eye was measured along the widest plane of that part. The measurements for the length of eye were taken along the plane of maximum height.

The Sixth abdominal segment

The striking dissimilarity in the two sexes was observed with regard to the sixth abdominal segment, the length being proportionately more in females in relation to the depth of the same segment. The correlation coefficient of length to the depth was worked out to be 0.819 in males and 0.829 in females. In order to test whether the observed dissimilarity in the sixth abdominal segment in the two sexes was significant the analysis of covariance was done and the results are given in Table 2.

TABLE 2. *Testing the identicalness of the regression lines for length and depth of sixth abdominal segment in males and females*

Source of variation	d.f.	s.s.	m.s.	F
Between sexes ..	2	53.19	26.60	6.36**
Within sexes ..	52	217.64	4.19	
Total	54	270.83	5.02	

** Significant at 1% level.

In 'Tables', $F_{0.01}(2, 52)$ is 5.06. Hence the above 'F' value is highly significant even at 1% level which indicates that the length/depth proportion of the sixth abdominal segment is not identical in the two sexes. In the light of the above finding it was considered desirable to find out whether the slopes were equal and the results of the test are given in Table 3.

TABLE 3. *Test of equality of slopes for length of sixth abdominal segment to its depth*

Source of variation	d.f.	s.s.	m.s.	F
Between sexes ..	1	21.46	21.46	5.12*
Within sexes ..	52	217.64	4.19	
Total	53	239.10	4.51	

* Significant at 5% level.

From the above Table it is clear that 'F' value of 5.21 is greater than the tabulated values of 'F' 0.05 (1, 52) which is equal to 4.03 and therefore is significant. However, at 1% level it is not significant. Hence, from the above analysis it may be concluded that the rate of increase in width of the sixth abdominal segment for every unit of increase in length in males and females are different when tested at 5% level.

The eyes

The eyes in males and females were measured in three different planes and comparisons were made between (1) width of upper part and width of lower part, (2) vertical length and width of lower part and (3) vertical length and width of upper part. The scatter diagrams and the regression lines obtained on account of the analyses are given in Fig. 1 b-d. It is seen from the figures that the regression lines are seemingly not identical in the two sexes with regard to the width of upper part in relation to the width of the lower, slightly identical for vertical length in proportion to width of lower part and almost parallel in case of vertical length to the width of upper part. The regression lines thus obtained suggest that there was dissimilarity in the proportionate growth of width of lower part in relation to the width of upper part in males and females, *i.e.* in females the rate of growth in width of the lower part is proportionately more than in males. Similarly with regard to the proportionate growth in vertical length and width of lower part of eye, slight difference was found in the two sexes. And finally no appreciable difference could be observed in males or females as far as the relative growth of upper part of eye and the vertical length were compared. The correlation coefficient obtained for the various combinations of characters of the eye in males and females are given in Table 4.

TABLE 4. *Correlation coefficients of eye measurements*

Characters compared	r values	
	Males	Females
Width of upper part of eye to width of lower part of eye ..	0.857	0.733
Length of eye to width of lower part of eye ..	0.883	0.763
Length of eye to width of upper part of eye ..	0.844	0.662

The quantum of identicalness in the regression lines and the equality of the slopes (wherever necessary) with regard to the eye measurements in both the sexes were tested for their significance and the results are given in Tables 5 - 8.

TABLE 5. *Testing the identicalness of the regression line for width of upper part of eye and width of lower part of eye in males and females*

Source of variation	d.f.	s.s.	m.s.	F
Between sexes ..	2	121.69	50.85	6.99**
Within sexes ..	29	252.40	8.70	
Total	31	374.09	12.07	

** Significant at 1% level.

In 'Tables', $F_{0.01}(2,29)$ is 5.42. Therefore the 'F' value of 6.99 appears to be highly significant. It indicates that the proportion between the width of the upper part of eye to the lower part is definitely not the same in males and females and therefore this can be considered as a sexually dimorphic character. The test for equality of slopes was also carried out and the results are given in Table 6.

TABLE 6. *Test for equality of slopes for width of upper part of eye to the width of lower part of eye*

Source of variation	d.f.	s.s.	m.s.	F
Between sexes ..	1	34.20	34.20	3.93
Within sexes ..	29	252.40	8.70	
Total	30	286.60	9.55	

The tabulated value of 'F' 0.05 (1, 29) is 4.18. Therefore the results given above show that the 'F' value of 3.93 is not significant at 5% level.

A further comparison was made between the length of eye and the width of the lower part of eye. As a result it was found that the males had proportionately longer eyes than in females. However, the difference was not much pronounced when tested statistically (Table 7). An 'F' value of 3.53 was obtained whereas the 'Table' value for $F_{0.05}(0, 29)$ was found to be 3.33. Therefore the observed value can be considered as border value and does not have much significance.

TABLE 7. *Testing the identicalness of the regression line for vertical length of eye and width of lower part of eye in males and females*

Source of variation	d.f.	s.s.	m.s.	F
Between sexes ..	2	90.75	45.38	3.53
Within sexes ..	29	372.24	12.84	
Total	31	462.99	14.94	

A third comparison of eye measurements was made between the vertical length and the width of the upper part of the eye. The regression lines obtained for both the sexes were found to be almost parallel suggesting that the two parameters considered were interrelated in the two sexes. However, the 'F' value was also found which is given in Table 8.

TABLE 8. *Testing the identicalness of the regression line for vertical length of eye and width of upper part of eye in males and females*

Source of variation	d.f.	s.s.	m.s.	F
Between sexes ..	2	59.99	30.00	3.02
Within sexes ..	29	288.85	9.95	
Total	31	248.54	11.24	

The observed 'F' value of 3.02 is not significant as the 'Table' value for 'F' (0, 29) at 5% level, as mentioned earlier is 3.33.

Hence it can be safely concluded that as far as the length of eye and the width of upper part of the eye are concerned the proportions are identical in the males and females and there is no possibility of finding sexual dimorphism in this set of characters.

Fourth and fifth abdominal segments

It was sought to understand whether any significant differences were present in respect of the length of fourth and fifth abdominal segments in the two sexes. Therefore a comparison of their length was made with the total length of the specimens. The scatter diagram for these parameters indicated a curvilinear relationship. Therefore the lengths were converted to the logarithmic scale and the log values are plotted in Fig. 1. For the transformed measurements the correlation coefficient was 0.810 for males and 0.702 for females. The regression line obtained suggested that

there was slight difference in the proportionate growth of these segments in the two sexes. However, the 'F' value when worked out showed that the observed difference was not at all significant at any level (Table 9).

TABLE 9. *Testing the identicalness of the regression lines for total length and length of 4th and 5th abdominal segments in males and females*

Source of variation	d.f	s.s	m.s.	F
Between sexes ..	2	0.0194	0.0097	2.4009
Within sexes ..	52	0.2102	0.0040	
Total ..	54	0.22961	0.0042	

Out of the three organs considered for sexual dimorphism, two namely the sixth abdominal segment and the eye are found to differ in the two sexes and thus could be taken as organs of sexual dimorphism in *Stylocheiron indicum*.

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