# THE SECONDARY SEX CHARACTERISTICS OF THE GENUS BLENNIUS OF THE MEDITERRANEAN SEA (PISCES : BLENNIIDAE)

by

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## I. INTRODUCTION

The Blennioidei as they first appear in the Eocene period (BERG,1958) are characterized as highly differentiated from the evolution point of view. The families Blenniidae, Clinidae and Tripterigiidae are found in the Mediterranean Sea and inhabit the mediolittoral and infralittoral zones. Most of the species inhabit holes in the rocks and the male ones attract the females for fertilization and then guard the fertilized eggs until spawning.

Very little literature is available on the secondary sex characteristics of Blenniidae and especially on the different species of the genus *Blennius* of the Mediterranean Sea.

FACCIOLA (1885) mentioned as secondary sex characteristics for *B.ocellaris* the height of the second hard ray of the dorsal fin and of the orbital-tentacles and for the *B.tentacularis* the height of the orbital-tentacles. Other characteristics have also been mentioned for other species, but have not been confirmed. GUITEL (1893) studied the behaviour and ecology of *B.sphinx* and *Coryphoblennius galerita*, and noted som sex differences in the first as far as the bigger height of the hard dorsal fin and of the orbital-tentacles of the males are concerned. These characteristics have been neglected by ERAZI (1941), STEINTZ (1949a,b,1950) and SLASTENENKO (1934,1965), while some others (VINCIGUERRA,1880; BINI,1967) mentioned these without any comments or confirmation. SEGANTIN (1968) disputed the higher dorsal fin in the males.

ABEL (1964) studied the ecology and behaviour of *B. canevai* and *B. inaequalis* and described some sex characteristics in this species. ZANDER (1975) studied some sex characteristics in various species of the Blenniidae family and tried to explain the role of these during the attraction of the females by the males for fertilization. He also supports the view that attraction takes place with olfactorial and optical signs.

The purpose of this paper is to study the secondary sex characteristics of the species of genus Blennius of the Mediterranean Sea and the modifications which take place during the act of reproduction.

## II. MATERIAL AND METHODS

### a) Material

The largest part of the studied specimens has been fished from the Ligurian coast (Italy). They were collected from different biotopes at various times of the year, so that a more complete, as far as it was possible, picture of the frequency and distribution of the different species of the genus Blennius could be obtained. A smaller part of the specimens came from the coast of Messina (Sicily). Different fishing methods were used for the collection of the specimens such as hand net, fishing line, nets and diving.

The collected material, preserved in the usual way, is kept in Natural History Museum of Genoa . A substantial number of specimens, which includes the holotypes of many species, have been studied from the collections of various Museums and Institutes of Italy and France.

### b) Methods

A detailed study of the secondary sex characteristics includes, on the one hand, the morphological description of each species and, on the other hand, the statistical treatment of the meristic and metric characteristics which have been found to be relevant to the sex.

Apart from the simple statistical treatment an attempt was made to calculate the relationships which characterize the height variation of the dorsal fin° and of the orbital-tentacles with the body°° length. These characteristics in some species (*B.sphinx*, *B.ponticus incognitus*, *B.tentacularis*, *B.rouxi*, *B.zvonimiri*) appeared to be in relationship with sex, the first maturity, and the time of reproduction.

From the scatter diagram it can be seen that the exponential function or the allometric growth model ($y = a\ x^B$) fits very well with the actual data. In fact from the statistical analysis of the corresponding logarithmic equations ($\log y = \log a + B \log x$), using regression analysis, it was found that the correlation coefficient (r) in all cases was nearly 1.

The analysis of covariance of two variables for the statistical difference, in the studied morphological characteristics, between the two sexes and between the different seasons of the year (winter, summer) was made as described by SNEDECOR and COHRAN (1976). $F_1$ and $F_2$ refer to the tests for confirming possible statistical differences in the regression coefficients and the adjusted means.

## III. RESULTS AND DISCUSSION
### MORPHOLOGY OF THE SECONDARY SEX CHARACTERISTICS

a) Body length

It is usual for the length of the female, which ensures the largest fecundity of the stock, to be larger than the male. The males are longer than the females in only a few species where the males protect the eggs ie. the size is only a protective adaptation.

In *B.sphinx* and *B.ponticus incognitus* the males are bigger than the females. The males of *B.sphinx* protect and aerate the eggs which are placed by the females in the holes of rocks, by staying near them for the period of hatching (GUITEL, 1893). This is probably why the males are rare during the end of spring and beginning of summer (May, June and part of July).

As can be concluded from the state of the sex glands and the appearance of the secondary sex characteristics, the first maturity of the females, in both the above species, preceeds that of the males. Taking into consideration the competition between growth and maturity,

° height of 2nd hard ray
°° standard body length

TABLE I.Relationship between standard body length and sex.

| Standard length in mm | B. sphinx % F | B. sphinx % M | B. ponticus incognitus % F | B. ponticus incognitus % M | Standard length in mm | B. pavo % F | B. pavo % M | B.gattorugine % F | B.gattorugine % M |
|---|---|---|---|---|---|---|---|---|---|
| 10-15 | - | 3.1 | - | - | 10-20 | | | | |
| 15-20 | 5.4 | 4.3 | 0.9 | 2.0 | 20-30 | | | | |
| 20-25 | 9.2 | 5.9 | 8.5 | 13.0 | 30-40 | | | | |
| 25-30 | 26.0 | 11.4 | 19.7 | 10.0 | 40-50 | 18.9 | 4.0 | | |
| 30-35 | 33.4 | 15.4 | 41.9 | 14.0 | 50-60 | 22.6 | 10.0 | 2.6 | 2.5 |
| 35-40 | 15.0 | 25.5 | 17.1 | 14.0 | 60-70 | 35.8 | 28.0 | 2.6 | 2.5 |
| 40-45 | 5.6 | 22.2 | 9.4 | 19.0 | 70-80 | 20.8 | 16.0 | - | - |
| 45-50 | 4.5 | 9.2 | 2.6 | 14.0 | 80-90 | - | 24.0 | 5.1 | 2.5 |
| 50-55 | 0.4 | 1.5 | - | 7.0 | 90-100 | 1.9 | 12.0 | 20.5 | 7.5 |
| 55-60 | - | 0.6 | - | 4.0 | 100-110 | - | 4.0 | 23.1 | 7.5 |
| 60-65 | - | 0.9 | - | 3.0 | 110-120 | - | 2.0 | 15.4 | 22.5 |
| | | | | | 120-130 | - | - | 12.8 | 15.0 |
| | | | | | 130-140 | - | - | 7.7 | 10.0 |
| | | | | | 140-150 | - | - | 2.6 | 15.0 |
| | | | | | 150-160 | - | - | 5.1 | 10.0 |
| | | | | | 160-170 | - | - | - | - |
| | | | | | 170-180 | - | - | 2.6 | 2.5 |
| | | | | | 180-190 | - | - | - | 2.5 |
| N | 446 | 325 | 117 | 100 | | 53 | 50 | 39 | 40 |

S.G.

the males must continue to grow after the first maturity of the females and until their own, so that, finally the length of the females is shorter (Table 1).

A bigger difference in length between males and females has been observed in *B.ponticus incognitus* than in *B.sphinx* (Table 1). This is obviously due to the fact that the first maturity of the males of *B.ponticus incognitus*, as compared to the females, delays more than that of *B.sphinx*. (*B.ponticus incognitus* : first maturity of female at about 25 mm, male at about 35 mm. *B.sphinx* : first maturity of females at about 28 mm, male 31-32 mm).

The difference in size between the sexes has been observed and in the species, *B.gattorugine*, *B.pavo*, *B.ocellaris* (Table 1), as well as probably in *B.trigloides* and *B.fluviatilis*. The small number of studied specimens of the last two species did not allow us to draw safe conclusions.

b) Dorsal fin

The height of the dorsal fin as well as the height of its 2nd hard ray differ in some species between sexes. The males of *B.ocellaris* are distinguished from the females due to the higher second hard ray (FACCIOLA, 1885).

*B.sphinx* is the only Blennius species of the Mediterranean Sea for which it is mentioned that the height of the dorsal fin of the males is definitely higher than that of the females and has wavy coloured decorations, especially intense during the period of reproduction.

The relationships between height of dorsal fin (HD) and body length (SL) during the summer (reproduction period) and winter for each sex are given below by the equations (Fig. 1).

Male-summer (1) : $HD = 0.025SL^{1.515}$ $R^2 = 0.948$ $r = 0.974$ N=232

Male-winter (2) : $HD = 0.027 \cdot SL^{1.481}$ $R^2 = 0.932$ $r = 0.965$ N=116

Female-summer (3) : $HD = 0.061 \cdot SL^{1.206}$ $R^2 = 0.913$ $r = 0.956$ N=230

Female-winter (4) : $HD = 0.083 \cdot SL^{1.126}$ $R^2 = 0.879$ $r = 0.938$ N= 215

The above results showed that 94.8 %,91.3 %,93.2 % and 87.9 % of the dorsal height variations were related to the body length.

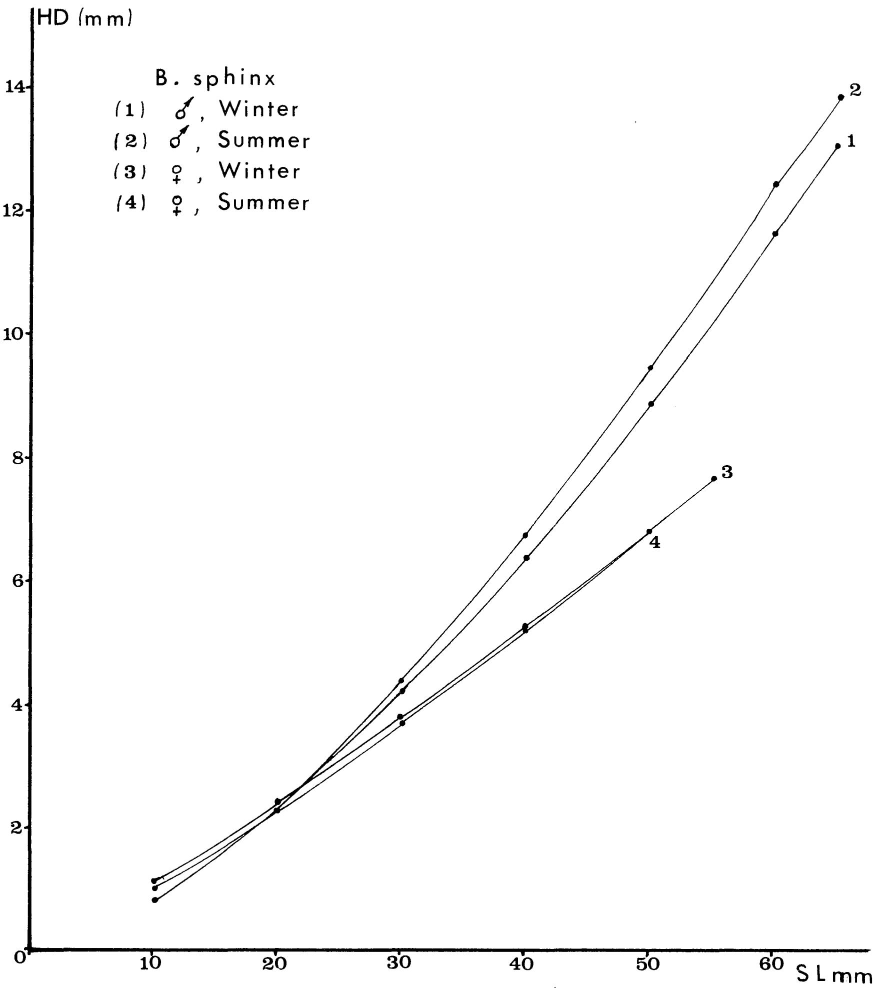


Fig. 1. Relationship between height of dorsal fin (HD) and standard body length (SL) in *B.sphinx*.

TABLE II.Height of the head of species which have a crest on the heads.

| | M ± μ | σ | V | Range | N |
|---|---|---|---|---|---|
| B. PAVO | 23,995±0,401 | 1,652 | 6,885 | 21,162 - 26,333 | 17 |
| | 21,13±0,114 | 0,656 | 3,105 | 19,231 - 22,625 | 33 |
| B. FLUVIATILIS | 24,516±0,579 | 2,165 | 8,831 | 21,111 - 28,378 | 14 |
| | 19,736±0,21 | 0,839 | 4,251 | 18,028 - 21,094 | 16 |
| B. BASILISCUS | 22,335±0,267 | 1,363 | 6,097 | 19,431 - 24,726 | 27 |
| | 21,741 - | - | - | 21,327 - 22,249 | 3 |

Comparing the dorsal fin height-body length relationship for males and females during summer and winter by analysis of covariance test, indicates a significant statistical difference ($P > 0.05$) for the morphological characteristics

$$(1) - (2) \quad F_1 = 0.548 \quad F_2 = 15.278$$

$$(3) - (4) \quad F_1 = 4.423 \quad F_2 = 12.65$$

$$(1) - (3) \quad F_1 = 78.861 \quad F_2 = 304.34$$

$$(2) - (4) \quad F_1 = 54.045 \quad F_2 = 126.645$$

under question, on the one hand, between summer and winter in both sexes ( (1)-(2), (3)-(4) ), and on the other hand, between the two sexes in both seasons of the year ( (1)-(3), (2)-(4) ). Thus, the above relationships cannot be expressed by a common equation for each sex during the whole year.

From the above relationships it is concluded that in both sexes of *B.sphinx* the height of the dorsal fin increases allometrically and is bigger in the males throughout the year. It also fluctuates seasonally so that in the males is bigger in summer than winter. In the females it appears to be slightly smaller in summer. ZANDER (1975) stated that no diminishing occured after the spawning period. From Fig.1 it can be seen that the secondary sex characteristics first appear in females between 28-30 mm and in males 30-32 mm, this length corresponding to the commencement of the first maturity in nature.

Similarly for the *B.sphinx* it has been observed that the membrane, which joins the last rays of the dorsal fin with the caudal penduncle, extends to the caudal fin for a longer distance in the males.

An allometric growth has been confirmed for the dorsal fin height of *B.ponticus incognitus*. The relationships between the dorsal fin height (HD) and the body length (SL) are given below (Fig.2).

Male-summer (1) : $HD = 0.073 \cdot SL^{1.135}$ $R^2 = 0.941$ $r = 0.970$ N=43

Male-winter (2) : $HD = 0.133 \cdot SL^{0.961}$ $R^2 = 0.902$ $r = 0.95$ N=38

Female-summer (3) : $HD = 0.148 \cdot SL^{0.914}$ $R^2 = 0.738$ $r = 0.859$ N=78

Female-winter (4) : $HD = 0.212 \cdot SL^{0.814}$ $R^2 = 0.878$ $r = 0.937$ N=23

The above results showed that 94.1 %,90.2 %,73.8 % and 87.8 % of the dorsal fin height variations were related to the body length.

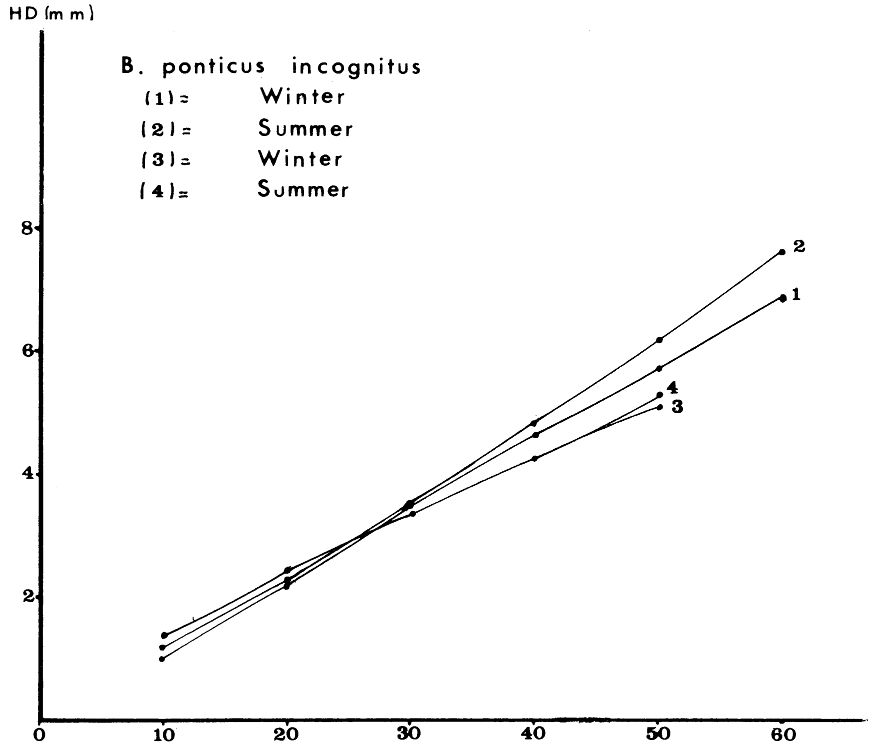


Fig. 2.

Relationship between height of dorsal fin (HD) and standard body length (SL) in *B.ponticus incognitus.*

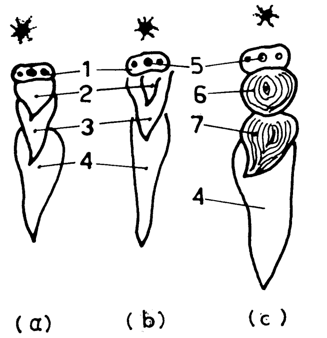


Fig. 3.

Details in the anal refion of *B.sanguinolentus.*
(a) Male-immature (SL = 50 mm), (b) Male-immature (SL = 58 mm), c) Male-mature (SL = 107 mm)
1. urinary opening, 2. 1st hard ray of the anal fin, 3. 2nd hard ray of the anal fin, 4. 1st soft ray of the anal fin, 5. genital opening, 6-7. bulbike glands on the 1st and 2nd hard rays of the anal fin, respectively.

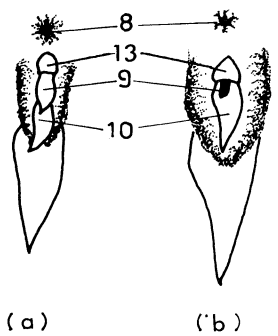


Fig. 4.

Details in the anal region of *B.sanguinolentus.*
(a) female-immature (SL = 35 mm), (b) Female-mature (SL = 49 mm).
8. anus, 9. 1st hard ray of the anal fin, 10. 2nd hard ray.

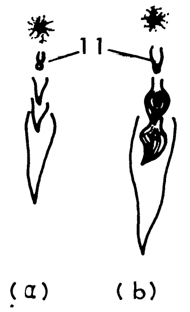


Fig. 5.

Details in the anal region of *B.ponticus incognitus.*
(a) Male-immature (SL = 26 mm), (b) Male-nature (SL = 49 mm).
11. urinogenital tubercle.

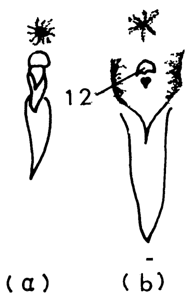


Fig. 6.

Details in the anal region of *B.ponticus incognitus.*
(a) Female-immature (SL = 27 mm), (b) Female-mature (SL = 41 mm).
12. urinogenital opening.

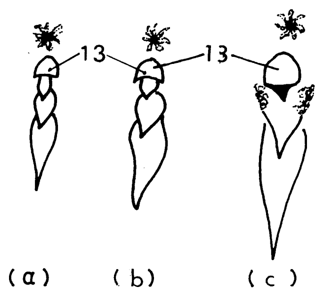


Fig. 7.

Details in the anal region of *B.sphinx.*
(a) Female-immature (SL = 18 mm), (b) Female-immature (SL = 25 mm), (c) Female-mature (SL = 41 mm),
13. membrane which forms a kind of poorly developed sinus.

It is confirmed by comparing the curvilinear regression of the dorsal fin height with body length for males and females in summer and winter that a significant statistical difference ($P > 0.05$)

| | | |
|---|---|---|
| (5) - (6) | $F_1 = 6.328$ | $F_2 = 1.334$ |
| (7) - (8) | $F_1 = 0.74$ | $F_2 = 0.557$ |
| (5) - (7) | $F_1 = 8.054$ | $F_2 = 10.172$ |
| (6) - (8) | $F_1 = 2.182$ | $F_2 = 4.132$ |

exists in the males in the studied characteristics between summer and winter ( (5)-(6) ). On the contrary no significant difference has been confirmed in comparing the curvilinear regressions of equations (7)-(8), that is, in the females the dorsal fin height does not undergo fluctuations in growth during the year and consequently the characteristics under question can be given by a common equation which would include all the female specimens throughout the year (9).

$$(9) : HD = 0.163 \cdot SL^{0.888} \quad R^2 = 0.759 \quad R = 0.871 \quad N=101$$

By then comparing the curvilinear regressions of dorsal fin height-body length of males (collected during summer and winter) separately with all the females, a statistical difference is confirmed.

| | | |
|---|---|---|
| (5) - (9) | $F_1 = 13.121$ | $F_2 = 10.177$ |
| (6) - (9) | $F_1 = 0.995$ | $F_2 = 10.690$ |

By taking into consideration the above, and the equations (5) and (6) it may be concluded that the dorsal fin height in the males (a) is bigger than in the females throughout the year and (b) fluctuates with its maximum in the summer.

c) Anal fin and anal region

The 1st and 2nd hard rays of the anal fin in the males are well developed and the membranes which surround them are strongly folded, in some species (*B.pavo, B.basiliscus, B.fluviatilis, B.sanguinolentus, B.gattorugine, B.cristatus, B.tentacularis, B.ponticus incognitus, B.rouxi, B.zvonimiri*), forming two grey bulbs. It is noted that these bulbs are bigger and more folded during the period of reproduction. EGGERT (1932) assumed that those glands produce secreta which attract the females and ZANDER (1975) reported that they have an antibacterial effect to protect the eggs against attacts from microorganisms.

The first hard ray in the females is smaller than the second. A small tubercle, just behind the urinogenital opening, protruding slightly from the body surface, is distinguished in the mature females. This tubercle is only the top of the 1st hard ray of the anal fin which has been covered completely by the skin rises which develop with age. Due to this modification, many writers (CARUS, 1893; MOREAU, 1883; FACCIOLA, 1875) considered the number of the hard rays a type of sexual dimorphism. Others, more recent workers (STEINTZ, 1949 a,b, 1950; BINI, 1967) mention one to two hard rays on the anal fin because in the immature specimens both hard rays are distinguishable and differ very little between them.

In the females the urinogenital opening, which is situated immediately before the anal fin, is covered by a membrane which forms a kind of poorly developed sinus. The development and the form of the above membrane varies depending on the species, maturity, and very possibly on the season of the year too (Fig. 4,6,7).

The urinogenital opening in the males ejects out directly in *B.ocellaris* and *B.gattorugine* and through a urinogenital tubercle in all the others species (Fig. 5). *B.sanguinolentus* is the only species of the Mediterranean blennii which has two urinary openings, one on either side of the genital one (Fig. 3).

Sexual dimorphism also appears in anatomical osteological characteristics. The base of the hard rays of the anal fin are pentagon-shaped and have a hole through which the head of the pterygiophore passes. A strong sexual dimorphism in the shape of the above two rays has been observed. The height of the first one is much smaller in the females and the diameter of the base in the males is smaller (Fig. 8,9). The height of the second hard ray is always bigger than the first one and, in the males, bigger than in the females. The soft rays of the anal fin are uniform in both sexes.

d) Head

In some species (*B.pavo, B.fluviatilis*)and *B.basiliscus* a crest is formed on the head of the mature males and is more developed during the period of reproduction. The above crest in *B.fluviatilis* would be more correct to be considered as membrane. This does not extend to the beginning of the dorsal fin and it is definitely separated from it (Table II).

Sexual dimorphism is observed on the neurocranium of *B. pavo* as far as the height of the frontal and parietal crest is concerned. The crest is higher in the males. A similar possible sexual dimorphism is found and in *B.fluviatilis* (PAPACONSTANTINOU 1975, 1977a).

*B.fluviatilis* shows sexual dimorphism in the mouth opening (Male:M:±u = 36.625± 0.61, o = 2.828 ,V= 6.226 ,range = 31.818-40.551. -Female : M± u = 30.784 ± 0.648 ,o =2.591 ,V= 8.417,range = 23.482-33.831 ), and in the number of teeth (there are more canine teeth in the females, PAPACONSTANTINOU, 1977c).

e) Head tentacles

The tentacles on the head is a characteristic of the genus Blennius. The height and shape of these differ from species to species. Small tentacles exist around the anterior nostrils in all species, above the eye (orbital-tentacles) in many of them, and on the neck (neck-tentacles) or above the posterior nostrils in very few species.

For the species *B. ocellaris, B.sphinx, B.ponticus incognitus, B.zvonimiri, B.rouxi* and *B.tentacularis* differences were observed between the two sexes as far as the height and shape of the orbital-tentacles are concerned. For some species, differences were also observed between the seasons of the year in natural fish stocks (PAPACONSTANTINOU 1975, for *B.sphinx* and *B.ponticus incognitus*) and in aquaria (ZANDER 1975, for *B.sphinx* and *B.zvonimiri*). Further below, the observed differences between the two sexes during summer and winter for the species *B.sphinx* and *B.ponticus incognitus* and between the two sexes for *B.tentacularis* will be proved statistically.

The small number of studied specimens of the species *B.ocellaris, B.zvonimiri* and *B.rouxi* did not allow a statistical treatment but a sexual dimorphism was confirmed as far as the height and shape of the orbital-tentacles are concerned.

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The mouth opening is given as % of the length of the head
The height of the head is given as % of the standard length
M = mean (average) - u = standard error - o = standard deviation -
V = coefficient of variation - N= number of specimen

Fig. 8. Anatomy of the hard rays of the anal fin of *B.gattorugine*.
(a), (b) 1st and 2nd hard rays in female.
(c), (d) 1st and 2nd hard rays in male

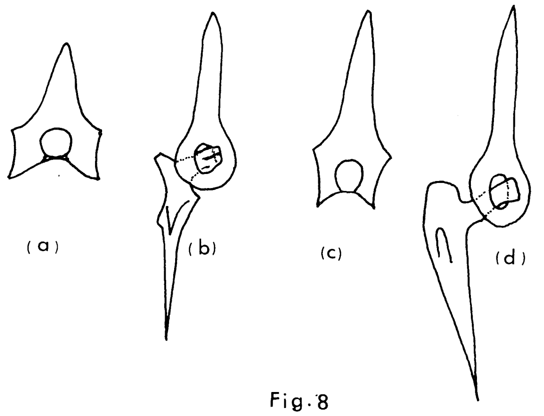


Fig. 8

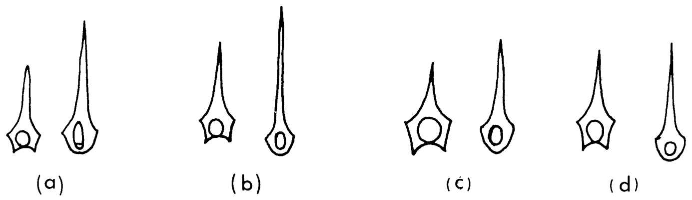


Fig. 9

Fig. 9. Anatomy of the hard rays of the anal fin of *B.canevai*.
(a) 1st and 2nd hard rays in male-mature
(b) 1st and 2nd hard rays in male-mature
(c) 1st and 2nd hard rays in male-mature
(d) 1st and 2nd hard rays in male-mature.

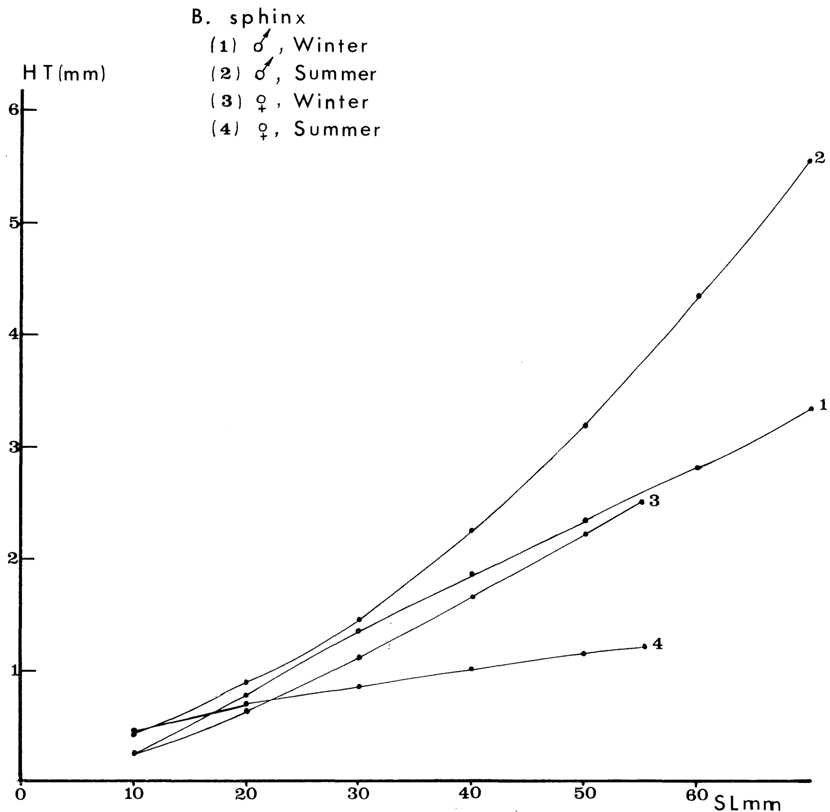


Fig. 10

Fig. 10. Relationship between height of orbital-tentacles (HT) and standard body length (SL) in *B.sphinx*.

*B.ocellaris* : The orbital-tentacles consist of a main tentacle, from the posterior side of which grow smaller and thinner secondary ones. The orbital-tentacles in the males are usually larger than the eye-diameter.

*B.zvonimiri* : The orbital-tentacles consist of 4-9 tentacles which grow on a common base (tassel-form). One of them is sometimes more developed. From the available material it is confirmed that the orbital-tentacles in the males are more numerous and developed.

*B.rouxi* : The orbital-tentacles are tassel-shaped consisting of 4-7 tentacles, one of which, usually the anterior, is more developed. The orbital-tentacles in the males appear to be higher than those in the females.

The orbital-tentacles of *B.sphinx* are small and simple, usually smaller than the diameter of the eyes. The relationships between the height of the orbital-tentacles (HT) and the body length (SL) during the period of reproduction and winter for both sexes are given by the following equations (Fig. 10).

Male - summer (10) : $HT = 0.006 \cdot SL^{1.590}$ $R^2 = 0.759$ r= 0.871 N=232

Male - winter (11) : $HT = 0.038 \cdot SL^{1.055}$ $R^2 = 0.594$ r= 0.771 N=136

Female - winter (12) : $HT = 0.012 \cdot SL^{1.340}$ $R^2 = 0.677$ r= 0.823 N=200

Female - summer (13) : $HT = 0.133 \cdot SL^{0.549}$ $R^2 = 0.187$ r= 0.432 N=230

The above equations showed that 75.9 %,59.4 %,67.7 % and 18.7 % of the orbital-tentacle height variations were related to the body length.

It is concluded that the characteristics under study follow an allometric growth model. The orbital-tentacles in the females during the summer do not seem to follow the above rule but they are more or less equal in all specimens. This is probably due to the fact that the females during the period of love-making are being attacked by the males with a consequent mutilation of the tentacles.

By comparing the curvilinear regressions of the height of the orbital-tentacles with the body length for both sexes during winter and for males only during summer, it can be seen that a significant

(10) - (11) $F_1$= 24.671 $F_2$= 30.734

(11) - (12) $F_1$= 7.877 $F_2$= 36.517

statistical difference exists between winter and summer for males and between the two sexes in winter. Taking also into consideration the equations (10), (11) and (12) it is concluded that the height of the orbital-tentacles in the males (for constant body length), (a) is larger during summer than winter and (b) it is longer than in the females throughout the year.

*B.ponticus incognitus* : The orbital-tentacles in the males, usually consist of a main tentacle from the base of which grow smaller and thinner secondary ones, while in the females consist of 4-7 tentacles which grow on a common base (tassel-shape).

The relationships between height of orbital-tentacles (HT) and body length (SL) during the summer and winter for both sexes are given by the following equations (Fig. 11).

| | | | | | |
|---|---|---|---|---|---|
| Male-winter | (14) | : $HT = 0.155 \cdot SL^{0.759}$ | $R^2 = 0.549$ | r= 0.741 | N=38 |
| Male-summer | (15) | : $HT = 0.08 \cdot SL^{1.602}$ | $R^2 = 0.772$ | r= 0.879 | N=46 |
| Female-winter | (16) | : $HT = 0.093 \cdot SL^{0.870}$ | $R^2 = 0.299$ | r= 0.547 | N=25 |
| Female-summer | (17) | : $HT = 0.199 \cdot SL^{0.556}$ | $R^2 = 0.136$ | r= 0.369 | N=81 |

By computing $R^2$ for the above equations, it is concluded that 54.9 %,77.2 %,29.9 % and 13.6 % of the orbital-tentacle height variations were related to the body length.

From the above it can be seen that the characteristics under study follow an allometric growth model. From the scatter diagrams and a simple statistical treatment it appears that in the females the height of the orbital-tentacles is more or less related to the body length but, the small number of available specimens during winter and the possible mutilation of the tentacles during the love-making period did not allow a reliable computation of the growth equations. It is also probable that the hormone functions, which take place during reproduction, helps to increase the height of the orbital-tentacles in the males and to reduce it in the females.

By comparing the curvilinear regressions of the height of the orbital-tentacles with the body length for the males between winter and summer it is confirmed that a significant statistical difference

$$(14) - (15) \quad F_1 = 21.753 \quad F_2 = 2.122$$

exists, and in combination with the equations (14) and (15) it is concluded that the height of the orbital-tentacles is bigger during the summer for constant body length,ie. annual height fluctuations are observed.

*B.tentacularis* : The orbital-tentacles consist of a main tentacle, from the posterior side of which grow smaller and thinner secondary ones. The orbital-tentacles in the males are larger than the eye-diameter.

By comparing the body length with the height of the orbital-tentacles between males and females, an allometric growth model is confirmed (Fig. 12), as well as a significant statistical difference between the two sexes ($F_1 = 5.477$ ,$F_2 = 77.270$)

Male (18) : $HT = 0.012 \cdot SL^{1.522}$ $R^2 = 0.706$ $r = 0.84$ N=63

Female (19) : $HT = 0.053 \cdot SL^{1.038}$ $R^2 = 0.49$ $r = 0.7$ N=39

The above results showed that 70.6 % and 49 % of the orbital-tentacle height variations were related to the body length.

The low correlation coefficient is attributed to (a) the fact that no distinction was made between specimens collected during summer or winter (b) possible mutilation of the orbital-tentacles during the love-making period (summer) and (c) the fact that preserved material was used.

f) Colouration

It is very difficult to distinguish body colour changes between the two sexes or between summer and winter as the body colour changes very easily with the biotope. Thus, the populations of the species

*B.sphinx* and *B.ponticus incognitus* in the Ligurian Sea and Sicily had a brown colour in October owing, possibly, to their adaptation to the biotope as during this period the amounts of phaeophycae and rhodophycae were increased as compared to the chlorophycae.

ZANDER (1975) mentions that the nuptial colour of *B.trigloides* is dark brown for males and light brown for females. *B.trigloides* is the only Blennius species of the Mediterranean Sea which reproduces between October and March. During the above period, the colour of the males is light brown and during the summer dark brown. *C.galerita* shows the same colouration and marmorate decorations are more intense in the summer.

Similarly, *B.zvonimiri* shows a darker colouration (greenish, reddish green) during the period of reproduction especially in the males.

During the keeping of many Blennius species in aquaria of different biotopes, during the period of reproduction, it was confirmed that the body colour of the specimens depends only on the biotope of the aquarium and is independent of the sex and species (especially for homogeneous biotope eg.sand).

At any rate, all studied Blennius species show a more intense and bright colouration during the summer. This difference was attributed to the adaptation to the biotope which, during this period, was richer in species and in seaweeds.

Many blennii have decorations during the period of reproduction, especially the males. Along the margin of the dorsal fin in the males of *B.sphinx* wavy red or blue decorations were observed. These are more intense in the bigger specimens. Similarly along the lips of *B.ponticus incognitus* alternately blue and green wavy striples were observed. These stripes were evident in both sexes, but were more intense in the males.

ABEL (1964) and ZANDER (1975) describe the colour of the body and head mask of the males of many species *(B.canevai, B.nigriceps, B.adriaticus* and *B.dalmatinus*).

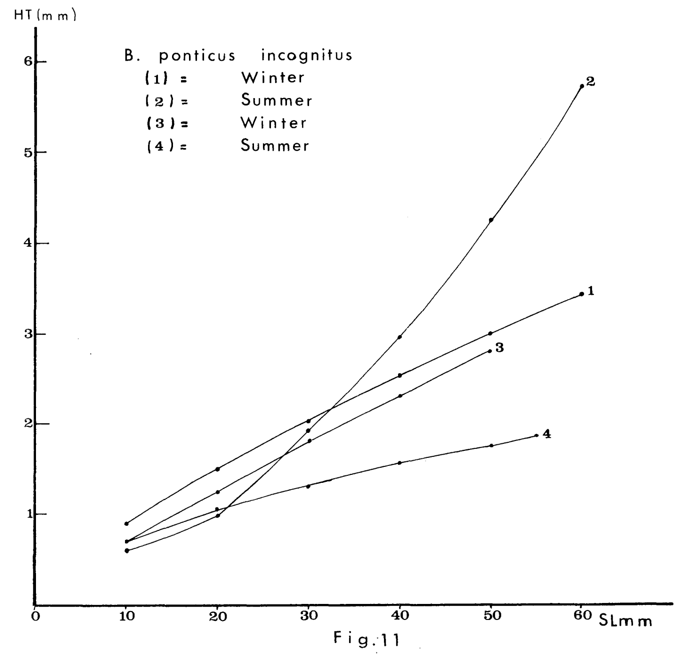


Fig. 11 Relationship between height of orbital-tentacles (HT) and standard body length (SL) in *B.ponticus incognitus.*

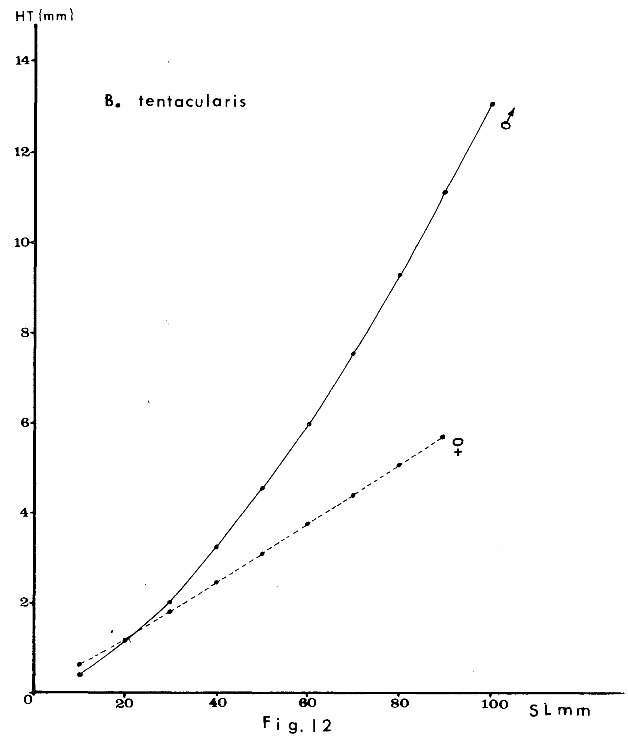


Fig. 12 Relationship between height of orbital-tentacles (HT) and standard body length (SL) in *B. tentacularis.*

## IV. CONCLUSIONS

The secondary sex characteristics of the Blenniidae are mainly adaptations which aim in the attraction of the females by the males. ZANDER (1975) supports the view that this attraction takes place with olfactorial and optical signs, depending on the phylogenetic evolution of the species.

1. - The body length of the males in some Blennius sp. (*B.sphinx*, *B.ponticus incognitus*, *B.gattorugine*, *B.pavo* and *B.ocellaris*) is bigger that that of the females. This is common only in the fishes where the males protect the eggs or the juveniles, something which has been proved to take place in the above species (GUITEL 1893; BROWN 1929; BREDER and ROSEN 1966).

2. - The height of the dorsal fin in both sexes of *B.sphinx* and *B.ponticus incognitus* increases allometrically in relation to body length and is bigger in the males althroughout the year. This height in the males of both the above species fluctuates seasonally, so that in the summer is bigger than in winter. In the females of *B.sphinx* this height appears to be slightly smaller in the summer but in *B.ponticus incognitus* the height remains the same all through the year.

3. - The anal region and the hard rays of the anal fin vary between the two sexes in different species. In the females, the urinogenital opening is covered by a membrane which forms a kind of poorly developed sinus. In the males the urinogenital opening ejects out directly or through a urinogenital tubercle. The bases of the hard rays of the anal fin are pentagonal and their diameter is smaller in the males. Similarly the height of the second hard ray is always bigger than that of the first, and in the males is bigger than in the females.

4.- A crest is formed on the head of the males of *B.pavo*, *B. basiliscus* and *B.fluviatilis*, which is more developed in the period of reproduction. Similarly the height of the frontal and parietal crest of the neurocranium of *B.pavo* is bigger in the males. Sexual dimorphism was observed in *B.fluviatilis*, as far as the number of teeth (there are more canines in the females) and the mouth opening (it's bigger in the males) are concerned.

5.- The height of the orbital-tentacles in both sexes of *B.sphinx, B.ponticus incognitus, B.tentacularis* increases allometrically with the body length and in the males is bigger althroughout the year at least for the first two species. The height of the orbital-tentacles in the males of *B.sphinx* and *B.ponticus incognitus* undergoes seasonal fluctuations so that in the summer is bigger than in winter. In the females, this height in the summer is equal to, and sometimes even smaller than that in winter. This is probably due to the mutilation of the orbital-tentacles of the females during the love-making period.

6.- The body colour of all the studied blennii is brighter and more intense during the summer. This was attributed to the biotope which, during this period, is richer in quantity and number of species of seaweeds. Similarly many Blennius species (*B.sphinx, B. ponticus incognitus, B.pavo, B.fluviatilis, B.canevai, B.dalmatinus, B.adriaticus* and *B.nigriceps*) have decoration on the head, body and fins which are more intense in the males during the reproduction period.

ABSTRACT

The secondary sex characteristics of the genus Blennius of the Mediterranean sea are described, and an attempt is made to study statistically the variations in that which occur during the spawning period.

SUMMARY

The secondary sex characteristics of the genus Blennius of the Mediterranean Sea are described in detail. The males show some characteristics which are developed only during the spawning season.

The body length of the males in *B.sphinx, B.ponticus incognitus, B.ocellaris,, B.pavo* and *B.gattorugine* is bigger, while the first maturity of the females, in the first two species, was found to proceed that of the males.

The height of the dorsal fin of *B.sphinx* and *B.ponticus incognitus* increases allometrically. This height in the males undergoes seasonal fluctuations with its maximum during the spawning seasons.

The height of the orbital-tentacles for the species *B.sphinx*, *B.ponticus incognitus*, *B.tentacularis*, *B.zvonimiri*, *B.ocellaris* and *B.rouxi* is bigger in the males and increases allometrically. This height undergoes seasonal fluctuations so that during the spawning seasons it is bigger.

The anal region and the hard rays of the anal fin vary between the two sexes. A urogenital tubercle is found in the males, while in the females the urogenital opening, which is covered by a membrane, forms a kind of poorly developed sinus.

The crest in the males of *B.pavo*, *B.fluviatilis* and *B.basiliscus* is more developed during the spawning season and in the older specimens. In *B.fluviatilis* the number of teeth is bigger in the females and the mouth opening is bigger in the males.

The body colour of all the studied blennii is brighter and more intense during the spawning season (summer). This was attributed to the biotope, which during this period is richer in quantity and number of species of seeweeds.

RESUME

Les caractères sexuels secondaires des espèces du genre Blennius de la Méditerranée sont décrits en détails. Les males présentent quelques caractères qui se développent seulement pendant la période reproductrice.

La taille du corps du mâle de *B.sphinx*, *B.ponticus*, *B.ocellaris*, *B.pavo* et *B.gattorugine* est plus grande que celle de la femelle. La première maturité sexuelle des femelles pour les deux premières espèces est plus avancée que pour les mâles.

La hauteur des nageoires dorsales de *B.sphinx* et *B.ponticus incognitus* augmente allométriquement. Pour les mâles, cette hauteur a subi des fluctuations saisonnières. Pendant la période reproductrice, cette hauteur devient maximum.

La hauteur des tentacules orbitaires des mâles n'est pas plus grande que celle des femelles pour l'espèces de *B.sphinx* et *B.ponticus incognitus*. Ces tentacules s'accroissent allométriquement. Cette hauteur a subi des fluctuations saisonnières. Pendant la période reproductrice, cette hauteur devient maximum et elle est plus grande chez les mâles que chez les femelles.

La région anale et les rayons durs des nageoires anales sont différents chez les deux sexes. Chez les mâles, nous pouvons distinguer la tubercule génito-urinaire, par contre les femelles ont une apperture génito-urinaire qui est couverte par une membrane qui forme une espèce de sinus peu développé.

La gibbosité frontale des mâles de *B.pavo*, *B.fluviatilis* et *B.basiliscus* est plus développée pendant la période reproductrice. Chez les vieux individus, celle-là est plus développée que chez les jeunes. Chez les femelles d'espèce *B.fluviatilis*, les dents sont plus nombreuses que chez les mâles de même espèce. Les mâles ont une apperture de bouche plus grande que les femelles.

La couleur du corps de tous les blennius qui ont été étudiés est claire et plus vive pendant la période reproductrice (été). On attribue cette couleur au biotope, qui est, pendant la période reproductrice,plus riche en algues (en quantité et en espèces différentes).

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