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# STUDIES ON THE MORPHOLOGY AND TAXONOMY OF THE ADRIATIC SPECIES OF MAENIDAE

by

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With Plates I - IV, and 21 Figures in the Text
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## Contents

# STUDIES ON THE MORPHOLOGY AND TAXONOMY OF THE ADRIATIC SPECIES OF MAENIDAE

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## PREFACE

The suggestion to work on the family of *Maenidae* was made by the Oceanographic Institute. The *Maenidae* are important in the fish industry of the Adriatic Coast in so far as the fish does not migrate and therefore can be caught near the coast all the year round. The catch of *Maenidae* amounts in average to about 40% of the total of non-migrating fish, and about 8% of the total fishing of the Yougoslav Coast on the Adriatic; the *Maenidae* come in importance next to the Sardine and Mackerel. The best fishing districts are Split and Šibenik, while Kotor is somewhat less important. The fish is chiefly eaten by the poorer population of the coast.

As taxonomy and morphology of our *Maenidae* are not sufficiently known, I have decided to work on these as a basis for further biological investigations.

The work has been done in the Oceanographic Institute in Split from April, 1938, till June, 1939, and I feel my duty to express my thanks to the Curatorium of the Institute, in particular to Prof. J. Đorđević, Prof. V. Vouk and Director A. Ercegović for the facilities and useful advice they offered me, as vell as for the special interest they have shown in my work. Further I wish to thank Dr. Brian of Genova, Dr. Cipria of Rodi and Dr. Fedele of Cagliari, who supplied me with preserved specimens of *Maenidae* from their stations.

It is my especial duty and pleasure to thank Professor J. Hadži, who followed my investigations closely, and helped me in many ways with suggestions and advice.

## INTRODUCTION

Before we begin to describe and discuss the taxonomic and morphological part of the family *Maenidae*, we shall deal with the most important data known about this family till now.

In the ichthyological literature which deals with the family *Maenidae*, there is no special work or monography on them, but only here and there we find a few stray remarks which are imperfect and inadequate. Most of these data are to be found in various ichthyological works together with the description of many other fish and, on that account, they are rather insufficient. They only enumerate the species and genera of that family and give briefly their chief characteristics.

Cuvier and Valenciennes gave the name of *Maenidae* to the fish of this family, which were considered by Artedi to belong to the same group as the *Sparus*. The successors of Cuvier and Valenciennes already consider the *Maenidae* as a separate family. Bonnaparte (1832-41) distinguished in the family *Maenidae* two groups or subfamilies *Maenini* and *Caesionini*. A little later, however, he divides them into *Maenini* and *Ditrematini*. Later on Pelegrin (1905-12) mentions the species *Smaris melanurus* Cuvier Valenciennes, which are to be found on the West African Coast, under the name of *Sparidae*. L. Fage (1918) considers Cuvier's family *Maenidae* as the *Maninae* subfamily together with the subfamily *Sparinae* of the genus *Sparidae*. Here and there we find representatives of the family *Maenidae* enclosed into the family *Pristipomatidae* (Canestrini, Günther etc.). The newest literature (F. de Buen 1935, Nobre 1935, Cadenat 1937) is again considering this family as a separate one. Fowler gives (1936) it the name of *Centracanthidae* after Rafinesque's genus *Centracanthus* (Cuvier's *Smaris)*.

Cuvier and Valenciennes (1830) differentiate in the family *Maenidae* (not taking into account the exotic genera) two genera: *Maena* and *Smaris*. The only difference between them is, that the genus *Maena* has vomerine-teeth and the genus *Smaris* not. Bonaparte writes that the genus *Maena* and *Smaris* could be united, if their representatives had teeth on the

palate, as they are in all other characteristics very similar. Canestrini (1872) has united the genus *Maena* with *Smaris* without any data. Both genera, however, are distinguished on account of the vomerine-teeth, which are to be found in genus *Maena* and not in the other *(Smaris)*, as it was earlier stressed by Cuvier and also by Günther (1858-70), Moreau (1881-92), Doderlein (1889), Carus (1889-92), Facciolà, Griffini (1903), Nobre (1935) and others.

Pietschmann was the only one who (1906) found in the genus *Smaris* vomerine-teeth. In four examined specimens of the species *Maena smaris* L., he found two without teeth, one with very few teeth and the fourth with some more vomerine-teeth. Therefore, he believes that there are not two genera *Maena* and *Smaris*, but that there is only one genus. It is also proved by others marks, such as: same teeth on the jaw, similar shape of body, coloration etc. F. de Buen (1935) distinguished (in his Portuguese Catalogue of Fish) in the family *Maenidae* three genera, namely *Maena* (Cuv. 1817), *Spicara* (Raf. 1810) and *Centracanthus* (Raf. 1810).

Species of the genus *Maena*.

Most of the descriptions of these species made before Cuvier and Valenciennes are very problematic. Many authors ignored and did not distinguish the separate species. Cuvier and Valenciennes (1830) were the first who described exactly the four species of that genus, namely, *Maena vulgaris, Maena jusculum, Maena Osbeckii* and *Maena vomerina*.

Canestrini (1872) added to the genus *Maena* Cuvier's species *Smaris*, and gave the same description as Cuvier. Günther in his Catalogue of the British Museum for the genus *Maena* enumerates three species; he does not mention the species *Maena jusculum*. Some years after, Moreau gave an account and similar description as that of Cuvier. He distinguished in his key to the species four of them, namely, *Maena vulgaris, Maena Osbeckii* and *Maena jusculum*, which had according to him vomerine-teeth arranged in a longitudinal line, while the teeth of *Maena vomerina* were grouped. *Maena jusculum* is different from the other three species, because it

has longer scale on the base of the pelvic fin. Doderlein (1889) completely agrees with Moreau's opinion. Carus (1889-93) mentions for the Adriatic species *Maena vulgaris, Maena zebra* and *Maena jusculum*. Later we find just the same remarks in the »Ihtiologia Italiana« by Griffini (1903). Facciolà who described the species *Maena vulgaris* and *Maena Osbeckii* as one, considered the differences between the two species in question as a sexual dimorphism. Nobre and F. de Buen mention only one species, *Maena vulgaris*, which is to be found on the Portuguese Coast.

Species of the genus *Smaris*.

In the ichthyological literature of recent years, the same genus appears under the different names of *Smaris, Spicara* and *Centracanthus*.

Cuvier and Valenciennes were not only the first to describe the genus *Maena*, but also have the priority of describing the genus *Smaris*, viz. the species *Smaris vulgaris, Smaris alcedo, Smaris gagarella* and *Smaris insidiator*.

Bonaparte enumerates several species among which there are two new ones: *Smaris Mauri* and *Smaris gracilis*. The chief difference between these two species consists in the different length of the soft rays of the dorsal and anal fin. In his publication I discovered a mistake, namely, that the descriptions do not agree with the illustrations. The picture of *Smaris alcedo* corresponds to the description of *Smaris chryselis* and vice versa. He distinguishes the species *Smaris alcedo* from *Smaris chryselis* on account of the longer soft rays of the dorsal and anal fins and lower body (length 5 times the height). The species *Smaris vulgaris* is in his description and picture quite different from the same species as described by Cuvier.

Günther united the species *Smaris chryselis* with *Smaris alcedo* on the one hand and *Smaris gagarella* with *Smaris vulgaris* on the other hand. He considered *Smaris gracilis* and *Smaris Mauri* as two different species. Later, many ichthyologists were of the same opinion, except Steindachner (Ichtiologische Berichte), who thought, that the species *Smaris chryselis* is the male of *Smaris vulgaris*, while *Smaris gagarella*

may be a different name for the female *(Smaris vulgaris).* Canestrini (1872) changed the name of *Smaris* into *Maena,* why, it is not known.

Moreau (1880) distinguished several species of the genus *Smaris* and gave also a key to these species, which takes into account the different number of scales, the proportions of the body and the colour differences. Doderlein (1889) mentions five species of that genus for the Mediterranean. He considered the species *Smaris Mauri* and *Smaris gracilis* as one. He thought the latter was a postlarval specimen of the former. In his opinion the species *Smaris chryelis* and *Smaris gagarella* were only one species with a sexual dimorphism. Carus (1889-93) did not distinguish the same number of species as Moreau, and his description of various species does not agree always with that of other contemporaries. For the Adriatic he enumerates the following species: *Smaris vulgaris, Smaris chryselis, Smaris alcedo* and *Smaris Mauri.* The same data are to be found in Griffini's work. L. Facciolà (1899) considered *Smaris vulgaris* and *Smaris alcedo* on the one hand, and *Smaris chryselis* and *Smaris gagarella* on the other hand, as two different species with some sexual dimorphism. Nobre (1935) distinguished on the Portuguese Coast three species of *Smaris,* viz. *Smaris smaris* Lin., *Smaris chryselis* and *Smaris insidiator.* At the end of the same year, F. de Buen quotes in his Catalogue of Fishes the species of Cuvier's genus *Smaris,* such as *Spicara smaris* Lin. (with two subspecies: *Spicara smaris smaris* Lin. and *Spicara smaris flexuosa* Rafin.) and *Spicara alcedo* Risso with the synonym *Smaris Mauri.*

Kolombatović was the Croatian ichthyologist, who studied these fishes in the Adriatic. He wrote that the following species are to be found in the Adriatic: *Maena vulgaris* Cuv. Val. (modrak), *Smaris vulgaris* Cuv. Val. (♂ prč, ♀ oštrulja) and *Smaris alcedo* C. V. (♂ objak, ♀ oblica). He still considered in the year 1881 the species *Smaris Mauri* as a separate one, but later added it to the species *Smaris alcedo* Risso. He considered the differences between *Smaris Mauri* and *Smaris alcedo* as a seasonal dimorphism! Kolombatović's contemporaries Kišpatić and Kosić gave some inadequate data about the

family *Maenidae*. At last we have to mention Lorini who distinguished only two species, viz. *Smaris vulgaris* and *Smaris alcedo*.

On the whole, we see that the ichthyological literature of the family *Maenidae*, is extremely insufficient and inadequate. The data about the morphology and taxonomy of the species of that family are often conflicting for the same species. Therefore, all the keys to distinguish various species of this family are imperfect and inexact, so that it is impossible to give a precise diagnosis of the separate genera and species.

Before beginning to explain our own investigations about the morphological characters and taxonomy of the family *Maenidae*, we shall mention the fact, that during these investigations only three species of this family could be found in the Adriatic, all of them belonging to the same genus:

*Maena maena* Linné — modrak.
*Maena chryselis* (Cuv. Val.) — oštrulja.
*Maena smaris* (Cuv. Val.) — oblica.

## MATERIAL AND METHODS.

The material, which we investigated, included all the representatives of the family *Maenidae*, which are generally found in the Yougoslav part of the Adriatic. We got the fish straight from the Split Fish Market or directly from the fishermen who caught it. For my morphological research I also used the periodical fishery investigations of the Oceanographic Institute for the years 1938-39, made in the northern part of the Adriatic and in the Channels of Central Dalmatia right up to the islands of Vis and Korčula.

I used only fresh material for dimensional characters, which can be subjected to the measurement of the body, the coloration and the measurement of the skeleton. For the research of the other morphological characters, such as scales, fin-rays, vertebral column etc., I used also material, preserved in 3—4 per cent of formalin.

Owing to the difficulty to procure specimens of the species *Maena maena*, only few of them were examined (about 150),

while specimens of the other two species of the family *Maenidae* were examined in a much greater number. The samples of *Maena maena,* which we investigated, were never smaller than 13 cm , while the specimens of *Maena smaris* and *Maena chryselis* were measured already from 3 cm on.

The shape of the body of the species of that family were measured in millimetres, but in all tables and figures they are arranged in whole-centimetre groups, as this seems the most appropriate measurement-interval for a fish ranging in size from 5—25 centimetres.

On the whole, I used fresh material for the measurement and counting of the jaw-teeth, particularly vomerine-teeth, but here and there the samples were also preserved in 3—4 per cent of formalin. The maceration of the vomer and jaws (praemaxillare and dentale) with the fresh fish was quite easy, on account of the dropping of the fish into hot water (70° C) for some minutes. I had to cut the vomer and jaws from the skull in the preserved fish, being very careful not to damage the teeth. After cleaning the bones of connective tissue, I put them into the solution of alizarin-alcohol, according to the method of V. Taning (Copenhagen 1922). As the bones become stained in this solution sooner than the teeth, they can be measured and examined easier which is particularly important for the vomerine-teeth.

Our Institute got representatives of *Maenidae* from three Biological Stations of the Mediterranean, in order to solve some important questions with regard to the identification and comparison of our species of this family with those of the Mediterranean especially from Rhodos (Dr. Cipria), Cagliari (Dr. Fedele) and from Genova (Dr. Brian). The material preserved in formalin consisted of about 1 kg of all the species of *Maenidae,* except the very rare species of *Smaris insidiator.* I used only preserved material of the Mediterranean species of *Maenidae.* These investigations were conducted on the same line as my observations of preserved Adriatic species. Dimensional characters and coloration have not been examined.

## MORPHOLOGY

### I. Shape of body and its proportions.

On account of sexual and seasonal dimorphism shown by these fishes, we were obliged to measure dimensional characteristic features of the body singly for both sexes in two seasons. The measurements were made in the period after the spawning of these fishes, i. e. at the time of the stage of ripeness of the gonads II*[1] (mostly in Autumn and at the beginning of Winter) and in the period when the fish is to spawn soon, viz. when the maturity stages of gonads are IV—VI (in Spring).

Below are the characteristic features of the body which I have measured and which can be seen on fig. 1.

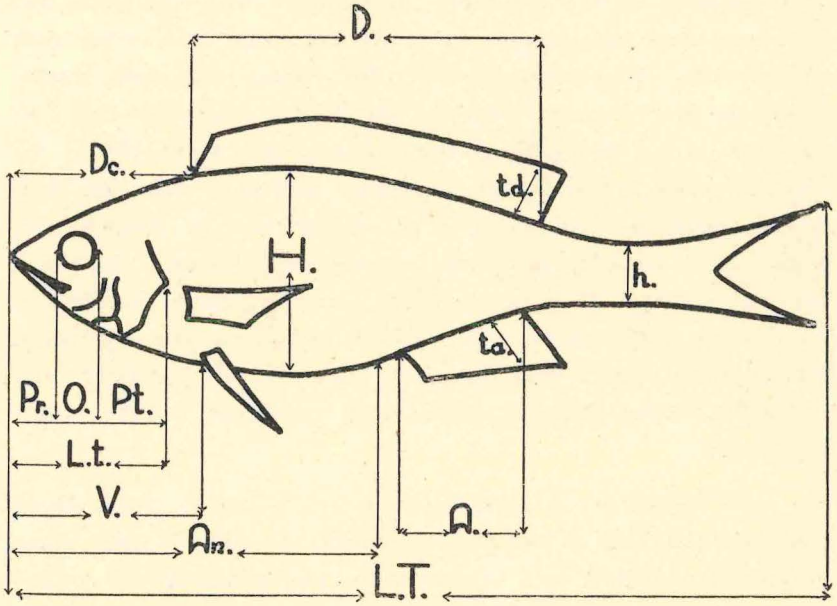



Fig. 1. — Shows the dimensional characters examined on the Adriatic representatives of Maenidae. Explanation in text.

| | |
|---|---|
| 1. Total length of the body | LT*[2] |
| 2. Greatest height of the body | H |
| 3. Minimal height of the body | h |

*[1] For ascertaining the maturity of the gonads, I made use of the norms applied by Heincke to the herring in 1898.

*[2] The abbreviations are taken after French nomenclature.

| | |
|---|---|
| 4. Point of snout to anus | An |
| 5. Point of snout to dorsal fin | Dc |
| 6. Point of snout to ventral fin | V |
| 7. Length of the dorsal fin | D |
| 8. Length of the anal fin | A |
| 9. Length of the head | Lt |
| 10. Size of the preorbital space | Pr |
| 11. Diameter of eye | O |
| 12. Size of the postorbital space | Pt |
| 13. Height of the last rays of the dorsal fin | td |
| 14. Height of the last rays of the anal fin | ta |

Many of the above mentioned characters (from 1 till 9) are expressed in relation to the total length. The size of the preorbital and postorbital part of the head, as well as the size of the diameter of eye, was compared with the length of the head. Likewise, the height of the last part of the impared fins was taken together with the length of corresponding fin into one proportion.

1. Total length of the body.

The length was measured from the tip of the snout to the ends of the longest caudal fin-rays.

The characteristic shape of the body in the species *Maena smaris* is that of a spindle, somewhat flattened from side to side, while the other two species, especially species *Maena maena* are much higher; this is also the chief difference between these three species, as we shall show later.

The males of all the three species, are on average larger in size than their females. The greatest length of the body, which I measured for the species of the family *Maenidae* are the following:

*Maena smaris* 193 mm for male and 150 mm for female
*Maena chryselis* 183 mm for male and 150 mm for female
*Maena maena* 235 mm for male and 210 mm for female.

These values for total length of the body were found on material from the Adriatic. The material from the Mediterranean forms of the family *Maenidae* was naturally far from being so satisfactory as that for the Adriatic forms, yet we could find in these species specimens which were some millimetres longer. The values for the total length, however, cannot be considered as completely exact, because the material was not sufficiently

represented (about 1000 specimens of the species *Maena smaris*, 2000 specimens of the species *Maena chryselis* and 150 samples of *Maena maena*).

It is quite sure that the species *Maena maena* is the longest of the species of this family, while the other two species are some centimetres smaller (the species *Maena smaris* is approximately one centimetre longer than species *Maena chryselis*). The females in all the three species are about 3 cm smaller than their males.

On the whole we made no age-investigations. The only exception was the species of *Maena smaris*, for which we determined the limit of the total length at the first onset of maturity, viz. at the end of the first year of its life (Age-group »O« respectively just entering Age-group I).

The length-frequency curves of Age-group O in the season 1938/39 singly for October, December and May are given in figur 2. and are made after the table I. which follows below. In

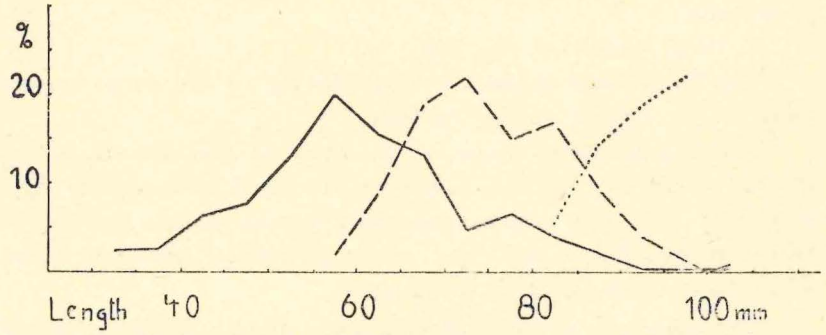



Fig. 2. — Shows the length-frequency curves of the specimens of *Maena smaris* belonging to Age-group O in the season 1938/39 singly for October (———) December (— — —) and May (.....). Ordinate: number of specimens in %, abscise: total length.

this figure, as well as in the table, one can see the total number of specimens and the percentage of length-frequency of *Maena smaris* in the Age-group O. The data are given for the sector of Central Dalmatia (Split). The curve for May, for instance, shows the minimal length of this fish which is about to enter into Age-group I. (The spawning time for this fish is May and June).

To sum up these results it may be said, that the average size of this fish at the onset of the first year i. e. the limit between the Age-group O and Age-group I., is approximately 8

Table I

| Length mm | October | | December | | May | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % |
| 30—35 | 7 | 2.2 | | | | |
| 36 - 40 | 8 | 2.6 | | | | |
| 41 - 45 | 20 | 6.6 | | | | |
| 46—50 | 24 | 7.8 | | | | |
| 51--55 | 40 | 13 1 | | | | |
| 56—60 | 62 | 20.1 | 3 | 2.1 | | |
| 61—65 | 48 | 15.5 | 13 | 8.9 | | |
| 66—70 | 41 | 13 3 | 28 | 19.1 | | |
| 71—75 | 15 | 4.8 | 32 | 21 9 | | |
| 76—80 | 21 | 6.8 | 22 | 15.1 | | |
| 81—85 | 13 | 4.2 | 25 | 17.1 | 9 | 5.5 |
| 86—90 | 6 | 2.0 | 14 | 9.6 | 24 | 14 6 |
| 91—95 | 1 | 0.3 | 6 | 4.1 | 31 | 18.9 |
| 96—100 | 1 | 0.3 | 2 | 1.4 | 36 | 21.9 |
| 101—105 | 1 | 0.3 | — | — | 31 | 18.9 |
| 106 110 | — | — | 1 | 0 7 | 33 | 20 1 |
| Total | 308 | | 146 | | 164 | |

till 10 cm . This is also the limit between »virgin specimens« (which have newer spawned before) and recovering fish (which have spawned before).

2. Maximal height of the body.

The greatest height of the body (H) expressed in relation to the total length (LT), vith the index $\frac{100\ H}{LT}$ shows the percentage in relation to the total length of body.

The greatest height is measured on the dark spot on the side on the fish.

*Maena smaris.* For the smallest specimens (Age-group O) the value for index $\frac{100\ H}{LT}$ undergoes a change, namely it increases slightly with the length of the body until a length of 10 cm is reached. For a further increasing of the length, the value of this index remains constant, as shown by the table II.

Table II

| Length mm | No of spec. | $\frac{100\ H}{LT}$ |
|---|---|---|
| 30 - 50 | 24 | 14 5 |
| 51 - 70 | 93 | 15.7 |
| 71 - 90 | 25 | 16 2 |

I need only mention, that the value for the index $\frac{100\ H}{LT}$ depends on different sex and on different seasons (different degree of ripeness of the gonads). In Autumn, i. e. in the period when the gonads are in an undeveloped condition (Stage of ripeness II), the average value of the index $\frac{100\ H}{LT}$ for 145 females (90—163 mm of length) is 17.4, and for 83 males (124—187 mm of length) 17.7. In Spring (stage of maturity IV—VI) this value increases for 164 females till 18.8, and for for 117 males till 19.0.

*Maena chryselis.* The average value of the index $\frac{100\ H}{LT}$ is in Autumn for 242 females (80—140 mm in length) 21.3 and for 117 males (130—174 mm in length) 22.3, while in Spring these values increase somewhat, viz. for males to 23.1 and for females to 21.6. For 20 examined specimens, which are smaller than 8 cm, the value for the index $\frac{100\ H}{LT}$ increases slightly with increased length of the body, as seen in the species *Maena smaris.* The folloving numbers give the increased length of the index $\frac{100\ H}{LT}$ for different lengths of the body.

Table III

| Length mm | $\frac{100\ H}{LT}$ |
|---|---|
| 30 - 60 | 19.3 |
| 60—65 | 19.6 |
| 65—70 | 19.7 |
| 70—80 | 20.0 |

*Maena maena.* The average value of the index $\frac{100\ H}{LT}$ is for 78 females (140—215 mm in length) 24.8 and for 53 males (150—235 in length) 26.3 (degree of ripeness of the gonads is IV—VI). For the specimens smaller than 14 cm, which we got from the Mediterranean preserved in formalin the values of the index $\frac{100\ H}{LT}$ are as follows:

Table IV

| Length mm | $\frac{100\ H}{LT}$ |
|---|---|
| 110 | 22.5 |
| 130 | 23.8 for females |
| 140 | 24.9 for females |
| 150 | 25.0 |
| 180 | 25.7 for males |

One can notice also in this species, that the value of $\frac{100\ H}{LT}$ increases for specimens smaller than 13—14 cm slightly in relation with the growing of the length of the body.

To sum up these results, the following table V may be given:

Table V

| SPECIES | VALUE FOR $\frac{100\ H}{LT}$ degree of maturity | | |
|---|---|---|---|
| | II | II—IV | IV—V |
| *Maena maena* | ♂<br>♀ | 26.3 (25—27.5)<br>24.7 (24—26.2) | |
| *Maena chryselis* | ♂ 22.3 (22—23)<br>♀ 21.3 (20—22.5) | | 23.1 (23—24.5)<br>21.6 (21—22.8) |
| *Maena smaris* | ♂ 17.7 (17—19)<br>♀ 17.4 (17—19) | | 19.0 (17.7—20)<br>18.8 (17—22) |

Thus, it is clear, that the species *Maena maena* has relatively the highest body, while *Maena smaris* the lowest one. The species of *Maena chryselis* takes an intermediate but well marked position. The males are relatively higher than the females. The height of the body undergoes a seasonal change.

The extreme values of the index $\frac{100\ H}{LT}$ for separate species (comparing the specimens of the same sex and of the same degree of the maturity) do not touch one another. Therefore, when expressed in this way, the differences between these three species are quite considerable, and useful for distinguishing them. But one has to compare the same sexes at the same season.

3. Minimal height of the body.

We have expressed the minimal height of the body in percentage to the total length also with the index $\frac{100\ h}{LT}$

The values of $\frac{100\ h}{LT}$ are different for the separate species.

For 433 specimens of *Maena smaris* of a total length from 30—187 mm, the average of the index $\frac{100\ h}{LT}$ is 5.9, while for 145 specimens of *Maena chryselis* it is 6.9. The species *Maena maena* has for this index the value of 8.0 (for 90 examined specimens over 14 cm in length).

The minimal height of the body does not undergo a change with regard to the different sexes or seasons.

4. Position of the anus.

The position of the anus (An), i. e. its distance from the point of the snout, is expressed in relation to the total length with the index $\frac{100\ An}{LT}$ (fig. 3).

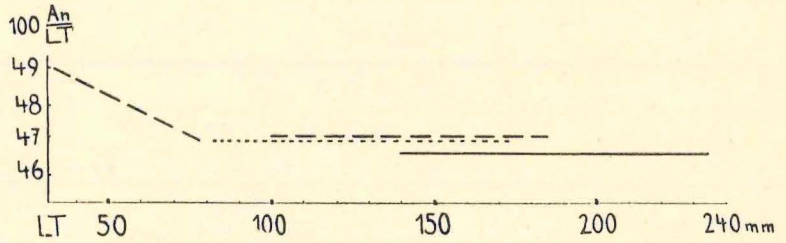



Fig. 3. — Shows the position of the anus expressed with $\frac{100\ An}{LT}$. *Maena maena* (——), *Maena smaris* (— — —), *Maena chryselis* (. . . .).
An — point of snout to anus
LT — total length of body

*Maena smaris.* For 682 examined specimens of this species (30—187 mm) the value for the index $\frac{100\ An}{LT}$ amounts in average to 47.1. The samples, which belong to the Age-group O, have different values for this index, which depends on different total length, as we can see from the following numbers (table VI).

Table VI

| Length mm | No of specim. | $\frac{100\ An}{LT}$ |
|---|---|---|
| 30—40 | 5 | 48.9 |
| 41—50 | 23 | 48.2 |
| 51—60 | 55 | 48.1 |
| 61—70 | 39 | 47.0 |
| 71—80 | 21 | 46.0 |

Summing up, we may conclude, that the position of the anus for specimens, which are smaller than approximately 7 cm , are not yet stable. For the smaller samples (under 7 cm in length, of course) the distance from anus to the point of the snout is relatively higher than for longer specimens.

*Maena chryselis.* For 470 examined specimens (85—177 mm) the value of $\frac{100\ An}{LT}$ is on average 46.9. It is nearly constant for the specimens over 8 cm of total length.

*Maena maena.* The average value of $\frac{100\ An}{LT}$ amounts to 46.5, and does not undergo any change with regard to the growth.

The value of $\frac{100\ An}{LT}$ for all the three species shows no variations with regard to different seasons (spawning-and non-spawning time).

5. Position of the dorsal fin.

Position of the dorsal fin (Dc), i. e. the distance from point of snout to the beginning of the dorsal fin is expressed in proportion to the total length of the body with the index $\frac{100\ Dc}{LT}$ (fig. 4).

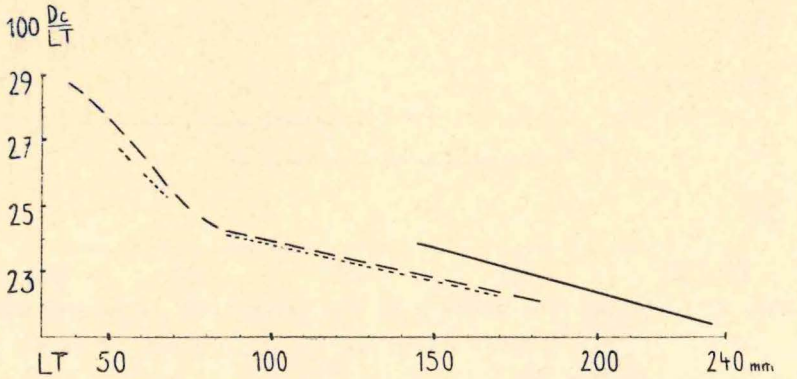



Fig. 4. — Shows the position of the dorsal fin expressed with $\frac{100\ Dc}{LT}$. Legend as in fig. 3. Dc - point of snout to dorsal fin.

The value of $\frac{100\ Dc}{LT}$ is for all the three species, as shown in the fig. 4., nearly the same, and shows some variation with regard to the growth. The value of this index decreases with increased length of body, i. e. the position of the dorsal fin moves forward in relation to the growth.

The following numbers (table VII) show the average values of the index $\frac{100\ Dc}{LT}$ for the three species, viz.:

Table VII

| SPECIES | Total length in mm | Average of $\frac{100\ Dc}{LT}$ |
|---|---|---|
| *Maena maena* | 140—236 | 22.8 |
| *Maena chryselis* | 85—177 | 23.2 |
| *Maena smaris* | 90—190 | 23.2 |

No differences were found in the position of the dorsal fin of the two sexes, as well as for the two seasons (spawning, etc.).

6. Position of the ventral fin.

The position of the pelvic fin (V), i. e. the distance from the point of snout to the insertion of the pelvic fin is compared with the total length, as shown by the index $\frac{100\ V}{LT}$ (fig. 5.)

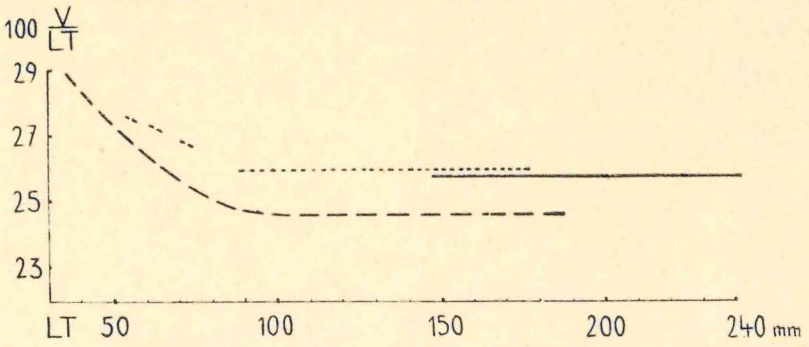



Fig. 5. — Shows the position of the ventral fin expressed with $\frac{100\ V}{LT}$ Legend as in fig. 3. V — point of snout to ventral fin.

For the species *Maena smaris* the walue for the index $\frac{100\ V}{LT}$ is for 683 specimens (34—185 mm) on average 25.2. The value of this index is nearly constant for the specimens which are over 9 cm long, i. e. on average 24.6, while for the specimens under this length the values of $\frac{100\ V}{LT}$ show some variations. The values of $\frac{100\ V}{LT}$ are for specimens of 30 mm length on average 29, for specimens of 60 mm length 26.3 and for those of 90 mm length 24.8.

The other two species have nearly the same values for this index, i. e. for *Maena maena* 25.8 and for *Maena chryselis* 26.1.

The 20 examined specimens of *Maena chryselis*, also show the forward move of the pelvic fin in the smaller specimens, due to the growth. The values of index $\frac{100\ V}{LT}$ are for the length of 5—6 cm on average 27.5, for the length of 6—7 cm 27.1, and for the length of 7—8 cm 26.8.

The position of the pelvic fin for the smallest specimens is variable, while for the samples longer than approximately 8 cm the position of the vetral fin is fixed.

7. Length of the dorsal and anal fins.

The value of $\frac{100\ An}{LT}$ for all the three species shows no variations with regard to different seasons (spawning-and non-spawning time).

5. Position of the dorsal fin.

Position of the dorsal fin (Dc), i. e. the distance from point of snout to the beginning of the dorsal fin is expressed in proportion to the total length of the body with the index $\frac{100\ Dc}{LT}$ (fig. 4).

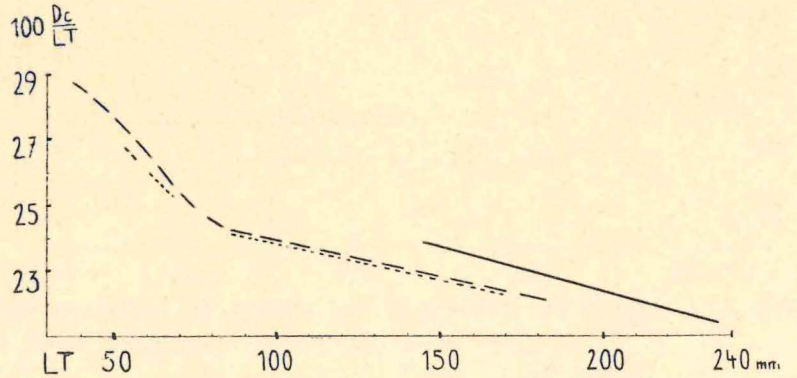



Fig. 4. — Shows the position of the dorsal fin expressed with $\frac{100\ Dc}{LT}$. Legend as in fig. 3. Dc - point of snout to dorsal fin.

The value of $\frac{100\ Dc}{LT}$ is for all the three species, as shown in the fig. 4., nearly the same, and shows some variation with regard to the growth. The value of this index decreases with increased length of body, i. e. the position of the dorsal fin moves forward in relation to the growth.

The following numbers (table VII) show the average values of the index $\frac{100\ Dc}{LT}$ for the three species, viz.:

Table VII

| SPECIES | Total length in mm | Average of $\frac{100\ Dc}{LT}$ |
|---|---|---|
| *Maena maena* | 140—236 | 22.8 |
| *Maena chryselis* | 85—177 | 23.2 |
| *Maena smaris* | 90—190 | 23.2 |

No differences were found in the position of the dorsal fin of the two sexes, as well as for the two seasons (spawning, etc.).

6. Position of the ventral fin.

The position of the pelvic fin (V), i. e. the distance from the point of snout to the insertion of the pelvic fin is compared with the total length, as shown by the index $\frac{100\ V}{LT}$ (fig. 5.)

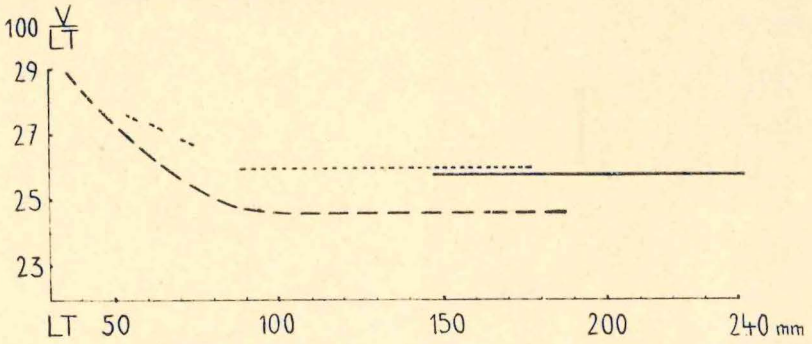



Fig. 5. — Shows the position of the ventral fin expressed with $\frac{100\ V}{LT}$ Legend as in fig. 3. V — point of snout to ventral fin.

For the species *Maena smaris* the walue for the index $\frac{100\ V}{LT}$ is for 683 specimens (34—185 mm) on average 25.2. The value of this index is nearly constant for the specimens which are over 9 cm long, i. e. on average 24.6, while for the specimens under this length the values of $\frac{100\ V}{LT}$ show some variations. The values of $\frac{100\ V}{LT}$ are for specimens of 30 mm length on average 29, for specimens of 60 mm length 26.3 and for those of 90 mm length 24.8.

The other two species have nearly the same values for this index, i. e. for *Maena maena* 25.8 and for *Maena chryselis* 26.1.

The 20 examined specimens of *Maena chryselis*, also show the forward move of the pelvic fin in the smaller specimens, due to the growth. The values of index $\frac{100\ V}{LT}$ are for the length of 5—6 cm on average 27.5, for the length of 6—7 cm 27.1, and for the length of 7—8 cm 26.8.

The position of the pelvic fin for the smallest specimens is variable, while for the samples longer than approximately 8 cm the position of the vetral fin is fixed.

7. Length of the dorsal and anal fins.

The length of the dorsal fin is expressed in relation to the total length with the index $\frac{100\ D}{LT}$. This proportion differs a little for the three species and varies according to the total length of the body. The length of this fin increases a little quicker than the total length, i. e. the proportion $\frac{100\ D}{LT}$ increases with the growth of these fishes. These variations of the proportion $\frac{100\ D}{LT}$ are shown in the fllowing tables (VIII, IX, X), as well as on the fig. 6.

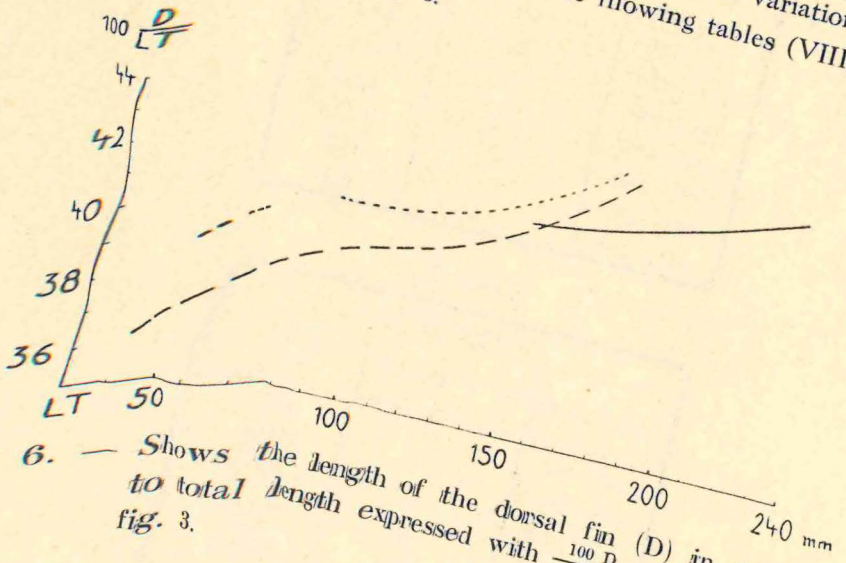



*Fig. 6. — Shows the length of the dorsal fin (D) in relation to total length expressed with* $\frac{100\ D}{LT}$. *Legend as in fig. 3.*

Table VIII

| Maena smaris | | |
|---|---|---|
| Length mm | No of specim. | $\frac{100\ D}{LT}$ |
| 30— 50 | 23 | 36.0 |
| 51— 70 | 93 | 37.8 |
| 91—110 | 28 | 39.1 |
| 71— 90 | 28 | 39.2 |
| 111—130 | 187 | 40.5 |
| 131—150 | 141 | 40.5 |
| 151—170 | 91 | 43.0 |
| 171—187 | 67 | 43.4 |

Table IX

| Maena chryselis | | |
|---|---|---|
| Length mm | No of specim. | $\frac{100\ D}{LT}$ |
| 85– 90 | 11 | 40 9 |
| 91–100 | 46 | 40.9 |
| 101–110 | 71 | 41.0 |
| 111–120 | 79 | 41 3 |
| 121–130 | 55 | 41.3 |
| 131–140 | 67 | 41.8 |
| 141–150 | 74 | 42 0 |
| 151–160 | 79 | 42.5 |
| 161–170 | 17 | 43.7 |
| 171–177 | 4 | 43.3 |

Table X

| Maena maena | | |
|---|---|---|
| Length mm | No of specim. | $\frac{100\ D}{LT}$ |
| 140–150 | 7 | 41.2 |
| 151–160 | 9 | 42 0 |
| 161–170 | 9 | 42.2 |
| 171–180 | 14 | 41.5 |
| 181–190 | 30 | 42.7 |
| 191–200 | 15 | 42 7 |
| 201–210 | 24 | 42.3 |
| 211–220 | 17 | 43.1 |
| 221–230 | 14 | 43.8 |
| 231–240 | 4 | 42.8 |

The value for the index $\frac{100\ D}{LT}$ is for 658 specimens of *Maena smaris* (30—187 mm) on average 40.7, for 503 samples oi *Maena chryselis* (85—177 mm) 41.7, while for 143 specimens of *Maena maena* (140—235 mm) 42.5.

No differences were found in the length of the dorsal fin of the two sexes.

The length of the anal fin, expressed in relation to the total length $\frac{100\ A}{LT}$, is constant for all the specimens of the three species, except for the smallest samples (fig. 7.). They show some

variations in the growth of their anal fin, which grows a little quicker in relation to the total length.

We can find also some differences due to sex, viz. males have a relatively longer anal fin than females, but this difference is not too important (0.5—1.5%).

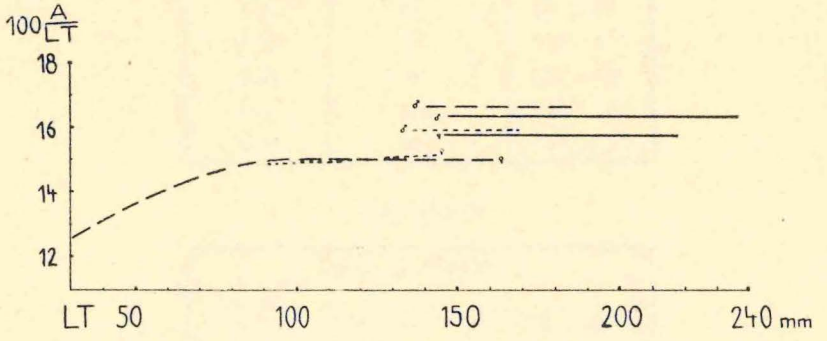



Fig. 7. — Shows the position of anal fin expressed with $\frac{100\ A}{LT}$. Legend as in fig. 3. A — point of snout to anal fin.

8. Length of the head.

The length of the head (Lt), measured from point of snout to the edge of operculum, is expressed in proportion to the total length with the index $\frac{100\ Lt}{LT}$ (fig. 8.).

The value of this index varies for the separate species, and depends from different total length, as shown below (tables XI, XII), as well as in the fig. 8.

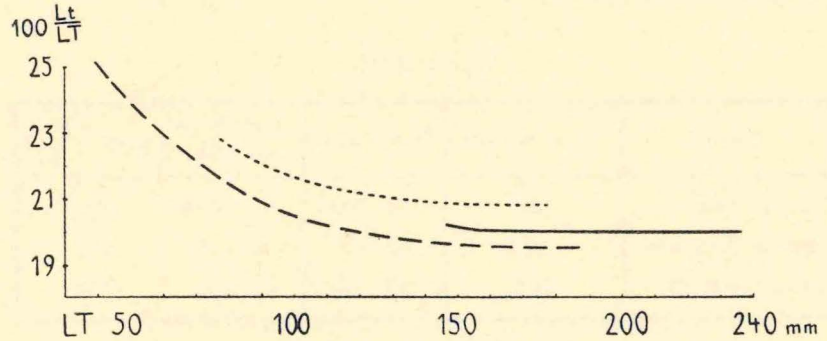



Fig. 8. — Shows the length of the head (Lt) in relation to total length expressed with $\frac{100\ Lt}{LT}$. Legend as in fig. 3.

Table XI

| Maena smaris | | |
|---|---|---|
| Length mm | No of specim. | $\frac{100\ Lt}{LT}$ |
| 40 – 60 | 71 | 23 7 |
| 61— 80 | 55 | 21.9 |
| 81 – 100 | 11 | 20.9 |
| 101—120 | 97 | 20.0 |
| 121 – 140 | 200 | 19.7 |
| 141—187 | 218 | 19.6 |

Table XII

| Maena chryselis | | |
|---|---|---|
| Length mm | No of specim. | $\frac{100\ Lt}{LT}$ |
| 50 – 60 | 8 | 23,8 |
| 60— 65 | 5 | 23.1 |
| 65 – 80 | 7 | 22.6 |
| 80— 90 | 11 | 22.0 |
| 90 – 100 | 47 | 21.7 |
| 100 – 110 | 73 | 21,4 |
| 110 – 120 | 74 | 21.3 |
| 120 – 130 | 45 | 21.0 |
| 130—177 | 217 | 20.8 |

The average values of $\frac{100\ Lt}{LT}$ for the separate species are the following (table XIII):

Table XIII

| Species | No of specim. | Total length | Length of the head | aver. $\frac{100\ Lt}{LT}$ |
|---|---|---|---|---|
| Maena smaris | 652 | 40 – 187 | 9.8—26.9 | 20.7 |
| Maena chryselis | 467 | 82—177 | 18 – 38 | 21.1 |
| Maena maena | 128 | 140—235 | 28– 48 | 19.8 |

9. Preorbital (Pr) and postorbital (Pt) space of the head and the diameter of eye (O).

variations in the growth of their anal fin, which grows a little quicker in relation to the total length.

We can find also some differences due to sex, viz. males have a relatively longer anal fin than females, but this difference is not too important (0.5—1.5%).

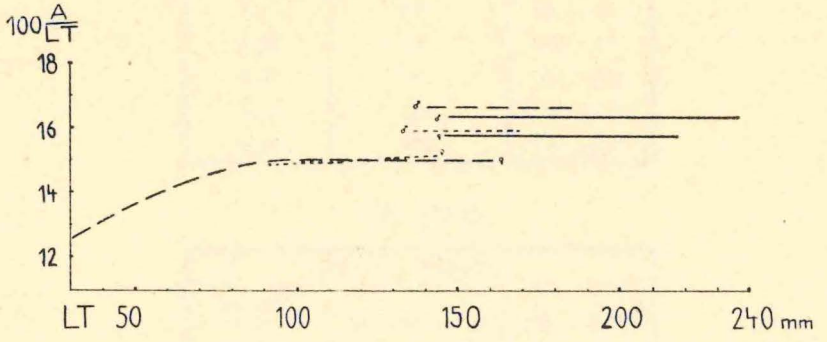



Fig. 7. — Shows the position of anal fin expressed with $\frac{100\ A}{LT}$. Legend as in fig. 3. A — point of snout to anal fin.

8. Length of the head.

The length of the head (Lt), measured from point of snout to the edge of operculum, is expressed in proportion to the total length with the index $\frac{100\ Lt}{LT}$ (fig. 8.).

The value of this index varies for the separate species, and depends from different total length, as shown below (tables XI, XII), as well as in the fig. 8.

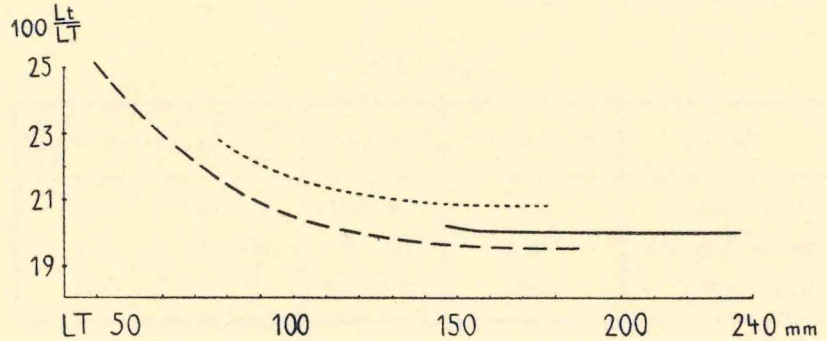



Fig. 8. — Shows the length of the head (Lt) in relation to total length expressed with $\frac{100\ Lt}{LT}$. Legend as in fig. 3.

Table XI

| Maena smaris | | |
|---|---|---|
| Length mm | No of specim. | $\frac{100\ Lt}{LT}$ |
| 40 – 60 | 71 | 23 7 |
| 61 – 80 | 55 | 21.9 |
| 81 – 100 | 11 | 20 9 |
| 101 – 120 | 97 | 20.0 |
| 121 – 140 | 200 | 19.7 |
| 141 – 187 | 218 | 19.6 |

Table XII

| Maena chryselis | | |
|---|---|---|
| Length mm | No of specim. | $\frac{100\ Lt}{LT}$ |
| 50 – 60 | 8 | 23,8 |
| 60 – 65 | 5 | 23.1 |
| 65 – 80 | 7 | 22.6 |
| 80 – 90 | 11 | 22.0 |
| 90 – 100 | 47 | 21.7 |
| 100 – 110 | 73 | 21,4 |
| 110 – 120 | 74 | 21.3 |
| 120 – 130 | 45 | 21.0 |
| 130 – 177 | 217 | 20.8 |

The average values of $\frac{100\ Lt}{LT}$ for the separate species are the following (table XIII):

Table XIII

| Species | No of specim. | Total length | Length of the head | aver. $\frac{100\ Lt}{LT}$ |
|---|---|---|---|---|
| Maena smaris | 652 | 40 – 187 | 9.8 – 26.9 | 20.7 |
| Maena chryselis | 467 | 82 – 177 | 18 – 38 | 21.1 |
| Maena maena | 128 | 140 – 235 | 28 – 48 | 19.8 |

9. Preorbital (Pr) and postorbital (Pt) space of the head and the diameter of eye (O).

All the three parts of the head are expressed in relation to the length of the head with the indexes $\frac{100\ Pr}{Lt}$, $\frac{100\ Pt}{Lt}$ and $\frac{100\ O}{Lt}$. These values are quite different for the separate species and are due to the length of the head (fig. 9.).

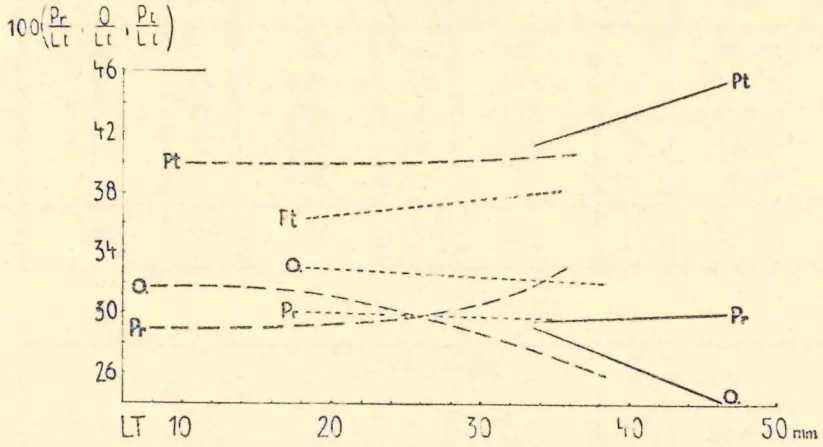



Fig. 9. — Shows the size of the preorbital (Pr) and postorbital (Pt) space of the head and the diameter of the eye (O) in relation to the length of the head (Lt), expressed with $\frac{100\ Pr}{Lt}$, $\frac{100\ Pt}{Lt}$, $\frac{100\ O}{Lt}$ for *Maena maena* (——), *M. smaris* (— — — —), *M. chryselis* (. . . . .).

The decreases and the increases of the head of the separate species are shown in the following tables, (XIV, XV, XVI) as vell as in the fig. 9.

Table XIV

| Maena smaris | | | | | | |
|---|---|---|---|---|---|---|
| Length of the head cm | No spec. | 100 Pr / Lt | No spec | 100 O / Lt | No spec. | 100 Pt / Lt |
| 9—10 | 4 | 28.9 | 5 | 31.5 | 4 | 39.6 |
| 11—15 | 68 | 29.0 | 70 | 31.3 | 68 | 39.7 |
| 16—20 | 25 | 29.2 | 32 | 30.8 | 26 | 40.0 |
| 21—25 | 39 | 29.8 | 107 | 29.8 | 39 | 40.4 |
| 26—30 | 34 | 30.8 | 114 | 28.5 | 34 | 40.7 |
| 31—35 | 10 | 32.7 | 79 | 28.9 | 9 | 40.4 |
| 9—35 | 180 | 30.3 | 407 | 29.5 | 180 | 40.2 |

Table XV

| Maena chryselis | | | | | | |
|---|---|---|---|---|---|---|
| Length of the head cm | No spec | 100 Pr / Lt | No spec. | 100 O / Lt | No spec. | 100 Pt / Lt |
| 18–20 | 1 | 30 5 | 14 | 33.1 | 1 | 36.4 |
| 21–25 | 82 | 30.4 | 103 | 32.9 | 82 | 36.7 |
| 26–30 | 34 | 30.1 | 54 | 32.8 | 34 | 37.1 |
| 31–35 | 35 | 29.5 | 84 | 32.3 | 35 | 38.2 |
| 36—38 | — | — | 8 | 32.3 | — | — |
| 18–38 | 152 | 30.1 | 263 | 32.7 | 152 | 37.3 |

Table XVI

| Maena maena | | | | | | |
|---|---|---|---|---|---|---|
| Length of the head cm | No spec. | 100 Pr / Lt | No. spec. | 100 O / Lt | No spec. | 100 Pt / Lt |
| 32.6 | 14 | 30.1 | 14 | 29 0 | 14 | 40.9 |
| 34.3 | 14 | 29.4 | 14 | 29.4 | 14 | 41.2 |
| 36.4 | 26 | 29.4 | 27 | 27.7 | 27 | 42.9 |
| 38.6 | 13 | 29.8 | 13 | 26.9 | 13 | 43.3 |
| 41.0 | 24 | 30.2 | 24 | 26.3 | 24 | 43.5 |
| 42.7 | 13 | 30.4 | 14 | 25.1 | 14 | 44.4 |
| 44.8 | 13 | 29.6 | 13 | 24.7 | 13 | 45.7 |
| 46.0 | 4 | 30.4 | 4 | 24.3 | 4 | 45.3 |
| 32.6—46 | 121 | 29.8 | 123 | 26.9 | 123 | 43.3 |

Summing up all these data, we come to the following conclusion.

The preorbital space of the head is very similar in all the three species, with the slight difference, that this part of the head in *Maena smaris* depends more from different total length than in the other two species.

The size of the eye decreases in proportion with the growth of the head, especially for the species of *Maena smaris* and *Maena maena*. The diameter of eye for the species *Maena chryselis* is larger than the preorbital part of the head. In the other two species (*Maena maena, Maena smaris*), for specimens

longer than approximately 12—14 cm, the eye is smaller than the preorbital part of the head, while for the smaller specimens it is larger than the preorbital part of the head.

10. The last fin-rays of the dorsal and anal fin.

The height, as well as the quality of the last fin-rays of the fins above mentioned, depend on different sex and seasons.

On the whole, the males have these fin-rays longer than the females, and the membrane between the rays of the males is of a better consistency than that of the females. It is interesting, that these fin-rays grow at the time of ripeness of the gonads and they reach their maximum of length when the fish spawns.

The values for the length of the last fin-rays of the dorsal and anal fin, are expressed in relation to the length of the corresponding fins. These relations, viz. $\frac{100\ td}{D}$ and $\frac{100\ ta}{A}$ are the following (table XVII):

Table XVII

| Species | Average $\frac{100\ td}{D}$ | | Average $\frac{100\ ta}{A}$ | |
|---|---|---|---|---|
| | non-breeding season | breeding season | non-breeding season | breeding season |
| Maena smaris | ♀ 16 | 16 | 70 | 70 |
| | ♂ 19 | 30 | 70 | 82 |
| Maena chryselis | ♀ 20 | 20 | 48 | 48 |
| | ♂ 22 | 30 | 52 | 63 |
| Maena maena | ♀ 20 | 20 | 50 | 50 |
| | ♂ 23 | 35 | 58 | 70 |

Summing up all the above observations, we come to the following conclusions.

On the whole, the proportions of the body are subjected to changes due to growth, especially in the smallest specimens. These changes affect the position and length of the dorsal fin, the size of the eye, the size of the pre-, post-orbital part of the head, and the length of the head. On the other hand, the other characteristics (such as the greatest height of the body, position of anus and length of the last fin-rays of the dorsal and anal fin) vary according to the stages of ripeness of the gonads (i. e. different seasons).

The separate proportions of the body of all the three species are of a similar character, as well as the variations due to different sex and seasons.

From this we conclude, that it is not possible to distinguish in these three species two genera, on the basis of dimensional characters, as it was done till now by different authors.

The various dimensional characters were considered till now as characteristic features for distinguishing the species of the genus *Maena* and *Smaris*, without furnishing any data as to different sexes, seasons or total length. In this way expressed, the distiguishing of the various species is not sufficiently precise and often even incorrect.

From the dimensional characters of the body, which may be of importance for distinguishing the separate species of the family *Maenidae*, are the size of the eye and the maximal height of the body, expressed in proportion to total length. These proportions should not be given without data as to different sex, season, and length of the body.

In all the other proportions the three species are almost precisely alike.

## II. Scales.

On account of the very different data, known till now about the scales, we made some observations on numerous material. These observations were especially made in order to ascertain the number of scales along the lateral line.

The scales are »ctenoid«, except the smallest ones, found on the basis of the pectoral fin, which are cycloid. The scales exhibit much diversity of form, which varies for each separate part of the body (Fig. 10, 11). The scales from the flank of the fish have the most characteristic shape. They are a little higher than long, as shown by fig. 10.

The scales found on other parts of the body differ a little from this characteristic form, especially the scales to be found on each side of the basis of the pelvic fin (Moreau 1881: »écaille axillaire externe de la ventrale«), which can be seen on the fig. 11 (No. 3). After Moreau's etc. data, the length of

these scales ought to be a characteristic feature to distinguish the species of *Maena vulgaris* from *Maena zebra*. The former ought to have this scale shorter than half of the length of the pelvic fin, while the scale of the latter should be somewhat longer than half of the pelvic fin. We found for the species

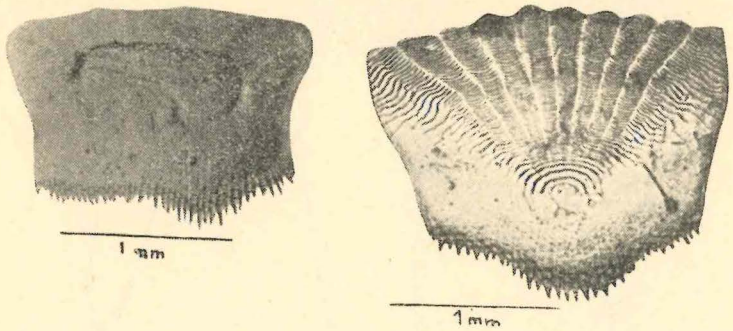



Fig. 10. — Left: scale from lateral line of *Maena smaris;* right: scale from flank, of same species.

*Maena maena* the following values of these scales. For 65 examined females the proportion $\frac{\text{length of pelvic fin}}{\text{length of scale}}$ amounts on average to 2.37 (abs. val. 1.9—3.7) and for 48 males to 2.68 (abs. val. 2.2—3.3).

The length of the mentioned scale is therefore from ½ till ⅓ of the length of the pelvic fin. Therefore, it is impossible to distinguish the species *Maena vulgaris* and *Maena zebra* merely on the basis of the length of this scale.

At the base of the pectoral fin there are also some scales which are different from the typical form (fig. 11, No. 4—8).

On the so called *genae* (on the whole, on the preopercul) a different number of ranges of the scales is to be found for the separate species. *Maena smaris* has four till five of these ranges, *Maena chryselis* always five, while *Maena maena* five or six.

The scales along the lateral line are perforated by two or three apertures, through which the sensory canal communicates with the exterior (fig. 10).

We give the different numbers of the scales along the lateral line for the separate species in the table XVIII.

Although the number of the scales is different for the separate species, it is clear, that it cannot be a specific character for them, as it was considered for the family *Maenidae* till now.

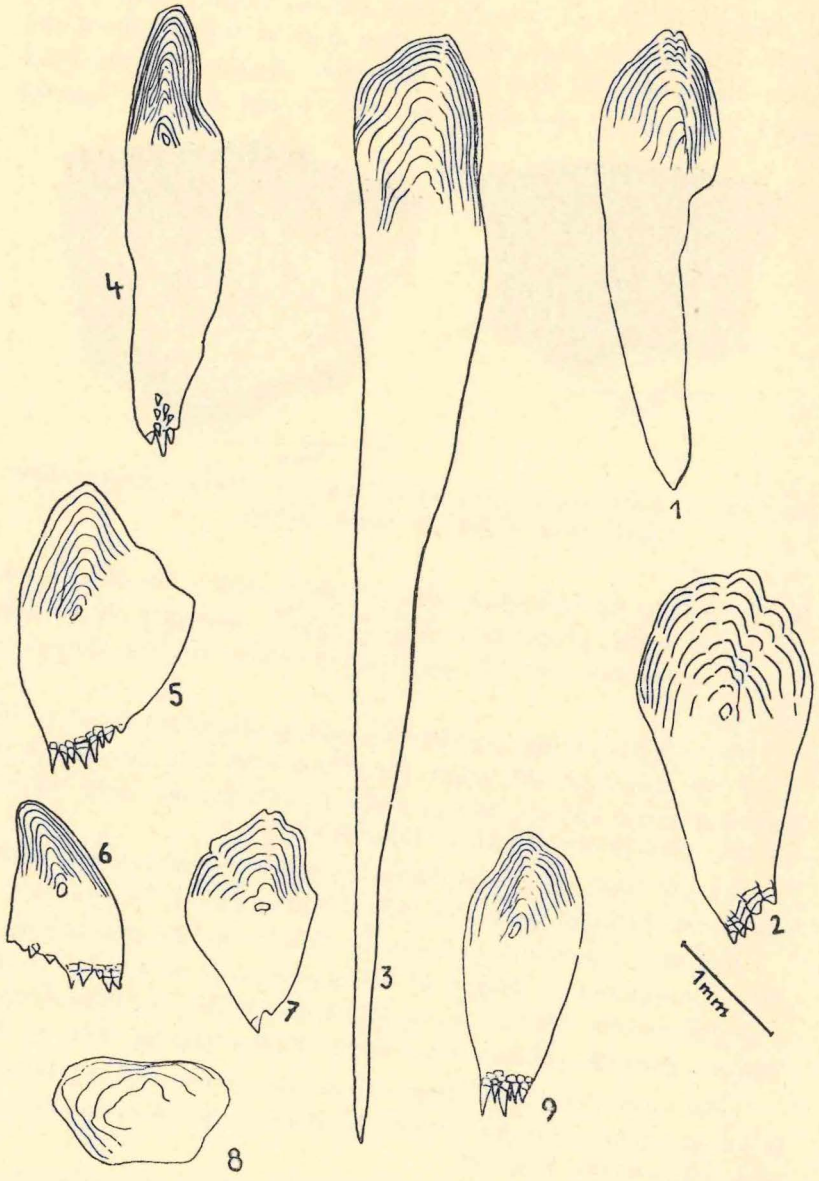



Fig. 11. — *Maena smaris:* Scales from base of the ventral fin (1—3) and pectoral fin (4—9). No 3 represents the scale from each side of the base of the ventral fin (»écaille axillaire«).

Table XVIII

| Maena smaris | | | Maena chryselis | | | Maena maena | | |
|---|---|---|---|---|---|---|---|---|
| No of scales | No of specimens | % | No of scales | No of specimens | % | No of scales | No of specimens | % |
| 80 | 6 | 3.0 | 70 | 6 | 3.5 | 70 | 3 | 2.2 |
| 81 | 6 | 3.0 | 71 | 2 | 1.2 | 71 | 9 | 6.6 |
| 82 | 13 | 6.5 | 72 | 13 | 7.6 | 72 | 20 | 14.7 |
| 83 | 13 | 6 5 | 73 | 23 | 13.5 | 73 | 32 | 23.5 |
| 84 | 28 | 14.0 | 74 | 26 | 15.3 | 74 | 32 | 23.5 |
| 85 | 32 | 16.0 | 75 | 24 | 14.1 | 75 | 23 | 16.9 |
| 86 | 29 | 14.5 | 76 | 24 | 14.1 | 76 | 14 | 10.3 |
| 87 | 20 | 10.0 | 77 | 19 | 11.3 | 77 | 3 | 2.2 |
| 88 | 18 | 9.0 | 78 | 14 | 8.2 | | | |
| 89 | 16 | 8.0 | 79 | 8 | 4 7 | | | |
| 90 | 12 | 6 0 | 80 | 9 | 5.3 | | | |
| 91 | 4 | 2.0 | 81 | 1 | 0.6 | | | |
| 92 | 1 | 0.5 | 82 | 1 | 0.6 | | | |
| 93 | 1 | 0 5 | | | | | | |
| 94 | 1 | 0.5 | | | | | | |
| average 85.24 $\pm$ 0.6 | | | 75 58 $\pm$ 0.615 | | | 73.184 $\pm$ 0.321 | | |

We must replace the present numbers of scales along the lateral line with the following numbers: *Maena maena* 70—77, *Maena chryselis* 70—82 and *Maena smaris* 80—94 scales.

These data are not quite complete, because it is probable that the range of variations would increase with more numerous material, especially material from other seas.

The key to the species of *Maenidae*, based on the mere number of scales along the lateral line, as it was done till now, is therefore insufficient and not precise.

The number of scales for specimens from the Mediterranean agrees completely with the number found on specimens from the Adriatic.

### III. Fins.

The data known till now about the fin-rays give the following results: Dorsal fin XI/11 for all the species except *Smaris insidiator* which has XIII/11, anal fin III/9 except *Smaris insidiator* III/10, ventral fin I/5, caudal fin 17, pectoral fin 15—16.

For the sake of comparison I have counted the number of rays in the separate fins with the following result.

The range of variation in the pectoral fin is from 15 till 17 for *Maena smaris* and *Maena chryselis* while for *Maena maena* 14—16.

Table XIX

| Pectoral fin | Maena smaris | | Maena chryselis | | Maena maena | |
|---|---|---|---|---|---|---|
| No of rays | No of spec. | % | No of spec. | % | No of spec. | % |
| 14 | — | — | — | — | 2 | 1.3 |
| 15 | 27 | 13 7 | 62 | 35 | 117 | 76.9 |
| 16 | 159 | 80.7 | 114 | 64.4 | 33 | 21.9 |
| 17 | 11 | 5.6 | 1 | 0.6 | — | — |
| Total | 197 | | 177 | | 152 | |

The average values for the number of rays of the pectoral fin are the following

| | |
|---|---|
| *Maena smaris* | 15.915 ± 0.0225 |
| *Maena chryselis* | 15.655 ± 0.0338 |
| *Maena maena* | 15.204 ± 0.0278 |

All three species have the same range of variation, but the average value of the number of rays is different for each species.

The same number was found for the ventral (I/5) and caudal fin (17), as was already known hitherto.

The dorsal and anal fins show quite a different number than known till now (table XX).

Table XX

| Species | Anal fin | | | | | |
|---|---|---|---|---|---|---|
| | No of fin-rays | | | | | |
| | 8 | | 9 | | 10 | |
| | No of spec. | % | No of spec. | % | No of spec. | % |
| Maena smaris | 1 | 0.7 | 138 | 98.6 | 1 | 0.7 |
| Maena chryselis | 1 | 0.4 | 251 | 96.4 | 8 | 3.2 |
| Maena maena | 1 | 1.0 | 101 | 93.0 | 1 | 1.0 |

Table XXI

| Species | Dorsal fin — No of fin-rays | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | X/9 | X/11 | X 10 | XI/11 | XI/12 | XII 9 | XII 10 | Total |
| Maena smaris | 1 | — | 2 | 132 | 1 | 1 | 5 | 142 |
| Maena chryselis | — | 2 | 7 | 258 | 1 | — | 4 | 272 |
| Maena maena | — | — | 2 | 117 | — | — | 3 | 122 |

Although the range of variation, especially for the dorsal fin is wide, it can be seen that the probable range of variation (i. e. the limits between which over 70 per cent of the cases occur) is due to one and the same number.

The present number of the rays is replaced by following number:

*Maena smaris* P 15—17 V I/5 D X—XII/ 9-12 A III/8-10 C x/17/x
*Maena chryselis* P 15-17 V I/5 D X—XII/10—12 A III/8—10 C x/17/x
*Maena maena* P 14-16 V I/5 D XI—XII/10—11 A III/8-10 C x/17/x

## IV. Skeleton.

1. The Vertebral Column.

In counting the vertebrae we reckon only the vertebrae normally developed. We may mentioned, that we counted the first little vertebra as one, as well as the posterior modified vertebrae. The following table gives the number of vertebrae.

Table XXII

| No of vertebrae | Maena smaris | Maena chryselis | Maena maena |
|---|---|---|---|
| | No of spec. | No of spec. | No of spec. |
| 23 | — | — | 1 |
| 24 | 120 | 100 | 86 |
| 25 | — | 1 | 1 |

The number of vertebrae in all the three species are very constant and is 24 (fig. 12). Only *Maena maena* and *Maena chryselis* show a little divergence. Till now only 23 vertebrae were known and it is probable that the first small vertebra was not counted.

2. Skull (fig. 13, plates II, III, IV).

The cranium of these fishes shows some pecularities, particular only these fishes. They also show some characters which differ for separate species and sex.

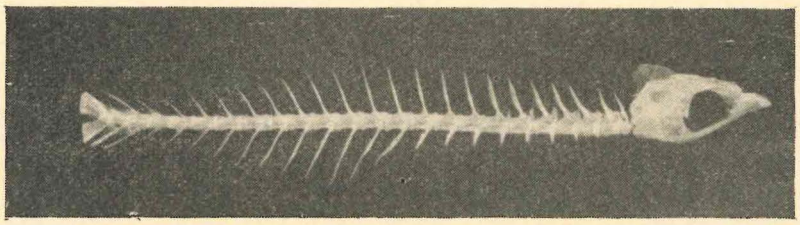


Fig. 12. — Vertebral column with cranium of *Maena maena* (150 cm of length).

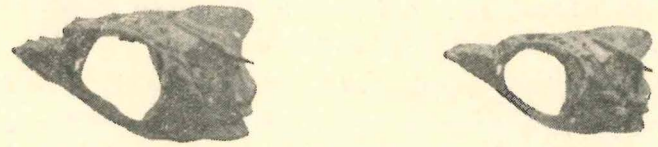
The examined material consists of over 120 specimens of all three species of both sexes. The skulls belong to the adult specimens of one and the same total length. We measured 3 dimensions of the cranium, viz. the length, the heigth and the width. They are expressed in the proportions as shown by the following table.

Table XXIII

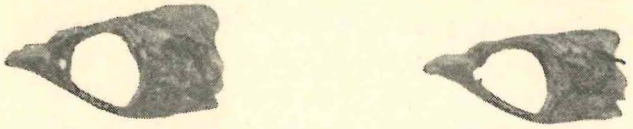
| Ratio | Maena maena ♂ | Maena maena ♀ | Maena chryselis ♂ | Maena chryselis ♀ | Maena smaris ♂ | Maena smaris ♀ |
|---|---|---|---|---|---|---|
| 100 width / length of cranium | 60 | 57 | 54 | 53 | 53 | 52 |
| 100 height / length of cranium | 66 | 59 | 55 | 49 | 46 | 44 |
| 100 width / height of cranium | 91 | 97 | 99 | 107 | 115 | 119 |

Summning up all these data, it results, that *Maena maena* shows the relatively highest cranium (compressed, because the width does not reach 100% of the height), while *Maena smaris* has the lowest cranium (depressed, because the width reaches over 100% of the height). *Maena chryselis* takes an intermediate position between the other two species. The males have a little higher cranium than the females (fig. 13.).

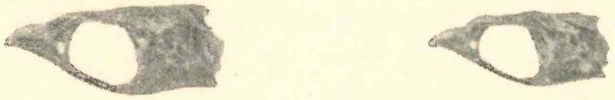
The dorsal profile of the cranium is very characteristic for these fishes on account of its straight course, which was never to be found in the representatives of similar families *(Sparidae, Serranidae)*. Likewise, the ventral profile of the cranium has some characteristics, as we shall show later.



♂ *Maena maena* ♀



♂ *Maena chryselis* ♀



♂ *Maena smaris* ♀

Fig. 13. — The side view of the cranium of *Maenidae*

In occipital region there is a median basioccipital — on the ventral side, partially covered by a parasphenoid — which forms in the median line a well-developed canal. This canal is a prolongation of the canal of prootic. The laterally-placed exooccipital bones touch above with the supraoccipital — the largest bone of this part of the cranium — which forms in the median line a large lamellate carina. This carina is different in the separate species and sexes, as shown on the fig. 13. and plates II., III.

In the otic region only four paired bones, viz. the epiotic sphenotic, pterotic and prootic are found. It is most characteristic for this region that no fifth bone — i. e. the sphenotic — is to be found. The epiotic bones form behind a fringed small lamella. The capsule for the otoliths is formed by the prootic, basioccipital and partially exooccipital.

The orbital region consists of two bones, viz. the laterosphenoid and the basisphenoid. The latter is a median Y-shaped bone, which is connected on the dorsal side with the prootic and the laterosphenoid. It partially helps to form the floor of the cranial cavity. The laterosphenoid, which converges forward towards the median line, forms a large aperture for the optic nerves.

In the olfactory region there are lateral ethmoids and a mesethmoid, which is slightly concave on the dorsal side.

A pair of large frontal bones, which form the cranial roof, show in the median line a very characteristic concave surface for the sliding motion of the extreme long premaxilla. Behind them, and separated from each other by the supraoccipital, there is a pair of polygonal parietals with a small lamella, which is prolonged in the fringed lamella of the epiotic. On the ventral side of the cranium, a very long parasphenoid forms a curve, which gives the characteristic ventral profile to the cranium. In front of the cranium is a small shovel-shaped vomer. The small nasal forms a well-developed canal. The 6 circum-orbital bones, which surround the eye from the sphenotic to the lateral ethmoids, are of a different size.

Several bones of the visceral skeleton are characteristic, such as the lower and upper jaws (dentary, maxilla, premaxilla), preoperculum, operculum etc.

The dentigerous dentary, which is connected by a zigzag line with the articular, differs a little for the separate species. The dorsal membrane part of this bone is in *Maena smaris* less roundish than in the other two species (table IV, fig. 17—18). The most characteristic bone in *Maenidae* is the premaxilla on account of its very long median side (Cuvier: »Pédicules«) which reaches, in the deep concave surface of the mesethmoid and the frontal bones, the supraoccipital. The proportion between the median and lateral side of the premaxilla is different in separate species and varies in *Maena smaris* from 1.8 till 2 and in *Maena chryselis* and *Maena maena* from 1.5 till 1.7. The median side of the premaxilla is therefore from 1½ to twice longer than its lateral side, which is the most characteristic peculiarity of this family. The maxilla differs a little in *Maena chryselis* from the other two species, as shown on the plate IV.

The gill-cover consists of four membrane bones. The different length of the two sides of the preoperculum is characteristic for all the three species. The proportion between the longer and the shorter side is in *Maena smaris* on average 1.25, in *Maena chryselis* 1.4 and in *Maena maena* 1.5. It is characteristic for all the three species, that the backside of operculum forms only one point, which is not much expressed.

The description of all the other bones, shown on the numerous figures (plate IV), should not be given, because they have no peculiarities and are similar to those of other allied families.

Briefly stated, the *Maenidae* are distinguished from other allied families by the following characters: the profile of the cranium, the concave surface of the frontal in the median line, the absence of the opisthotic, the characteristic shape of the premaxilla etc.

Representatives of allied families of *Maenidae,* such as *Sparidae, Serranidae* etc., have skulls a little different from those of *Maenidae.* We may mention, that for this comparison we used S u p i n o's work for the *Serranidae,* while for the *Sparidae* we had to make our own observations.

The dorsal profile has a straight course in *Maenidae,* while in the family *Serranidae* and *Sparidae* it is curved, particularly in the genus *Sargus* and *Charax.* The supraoccipital in the family *Sparidae* is somewhat larger and longer than in *Maenidae,* while in the family *Serranidae* it is of a different size. The concave surface of the frontal, and partially of the mesethmoid of *Maenidae,* are not found in the representatives of the other two families. Most of the representatives of *Serranidae* (such as *Labrax, Polyprion, Serranus, Epinephelus)* have the opisthotic, which is not to be found in *Maenidae.*

A particularly characteristic feature in *Maenidae* is the extreme long median side of the premaxilla. No representatives of the families of the group *Perciformes* show premaxilla thus shaped.

The pectoral and the pelvic girdle do not show any peculiarities.

3. The otoliths.

The otoliths (*sagitta,* fig. 14.) differ a little for each separate species. In the species *Maena smaris,* the otolith is on both side tapering, while in the other two species it is more roundish.

The width of the otolith in relation to its length is in *Maena smaris* (60 examined specimens) on average 1.8 (1.5—1.9) in *Maena chryselis* (50 spcm.) 1.5 (1.3—1.6) and in *Maena maena* the same as in the first species.

The length of the otolith amounts for *Maena smaris* to 3.4% of the total length, for *Maena chryselis* to 3.8% and for *Maena maena* to 3.5%.

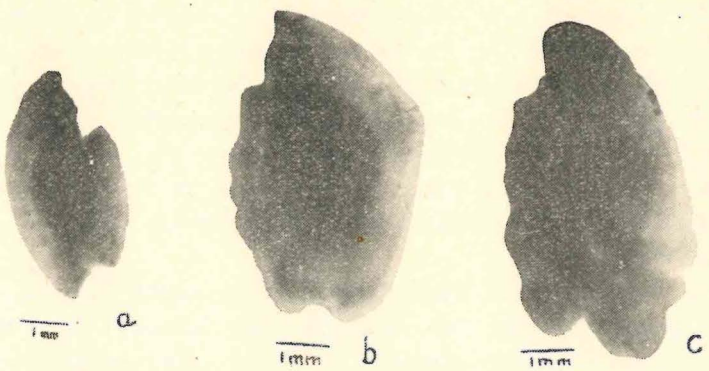



Fig. 14. — Otolith of *Maena smaris* (a)
*Maena chryselis* (b)
*Maena maena* (c)

## V. Dentition and the pyloric caeca.

The representatives of *Maenidae, Maena maena, Maena chryselis* and *Maena smaris* possess jaw-, vomerine and pharyngeal-teeth. The teeth on the jaws and vomer are particularly important and they were taken as specific character of a generic order (difference between *Maena* and *Smaris).* The other teeth are less important for the taxonomy of *Maenidae.*

The data for the teeth of the representatives of this family known till now, agree for the most part; but in the quotation of Pietschmann (1906) we find some different data, namely the existence of vomerine-teeth in the representatives of the genus *Smaris,* as it was mentioned already in the »Introduction«.

1. Jaw-teeth.

The number, size and position of the jaw-teeth, which are arranged on the first half of the shorter side of the premaxilla and on the dentary, agree in separate species of this family; but the tooth-form differs a little for all the three species. *Maena smaris* has on the whole obtuse and rather uncurved teeth, while the teeth of *Maena chryselis* are slender, more pointed and a little curved, as it is shown on the fig. 15. The species *Maena maena* has the jaw-teeth very similar to those of *Maena smaris.*

The teeth which are to be found on the anterior part of the jaw are bigger than the other ones. In the dentary some prominent big teeth, so called »canines«, are to be found, and

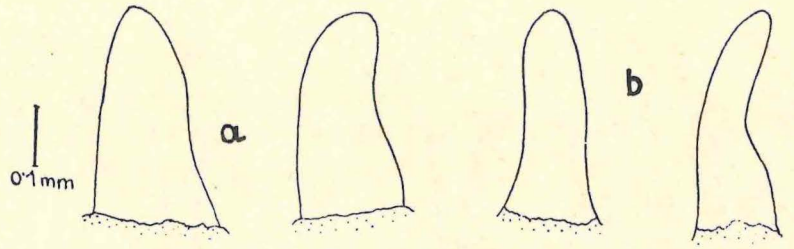



Fig. 15. — Tooth from the dentary of *Maena smaris* (a) and *Maena chryselis* (b). Left: transversal, right: longitudinal view

their number varies in separate species. *Maena smaris* has only one pair of them, while in the other two species there are from 2 to 3 pairs of canines; in some cases they are absent. All these teeth are not bigger than 2 mm.

The jaw teeth are the most dense in *Maena chryselis*.

2. Vomerine-teeth.

The most characteristic cases of the dentition of the vomer, observed on 549 examined specimens belonging to all three species, are shown in the fig. 16—18. The vomerine-teeth are very fine, uncurved and smaller than half a millimetre and similar to those of the jaw.

*Maena smaris*. Out of 177 examined specimens, belonging to both sexes, with a different length of the body, only in some cases were vomerine-teeth found. 17 per cent of the total number had teeth, while the others, i. e. 83%, were toothless. The following table XXIV gives the relation of the different dentition of the vomer.

Table XXIV

| *Vomer* | No of specim | % |
|---|---|---|
| toothless | 147 | 83.06 |
| with 1 tooth | 15 | 8.47 |
| with 2-3 teeth | 10 | 5.65 |
| over 3 teeth | 5 | 2.82 |

The teeth are mostly arranged in a median row (fig. 16.), or they are grouped in the anterior part of the vomer. Sometimes they are a little inclined backward.

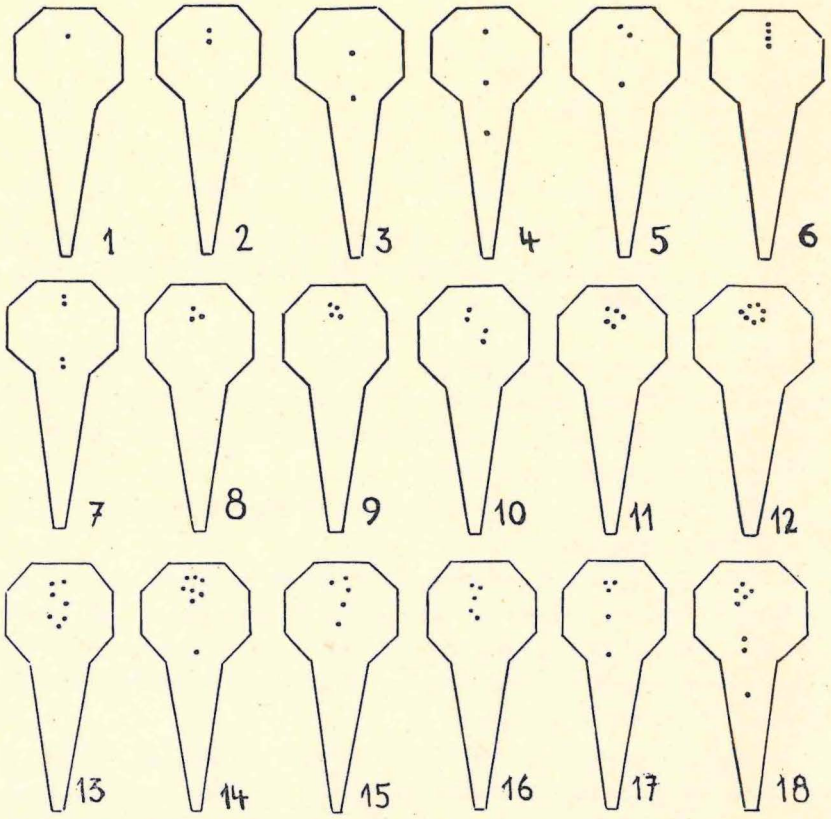



Fig. 16. — Shows the shematized vomer of *Maena chryselis* with the different arrangement of teeth (points).

*Maena chryselis*. The percentage of the toothless vomers is lower than in the above species, and the teeth are found in a greater number. The dentition of the vomer has some characte-

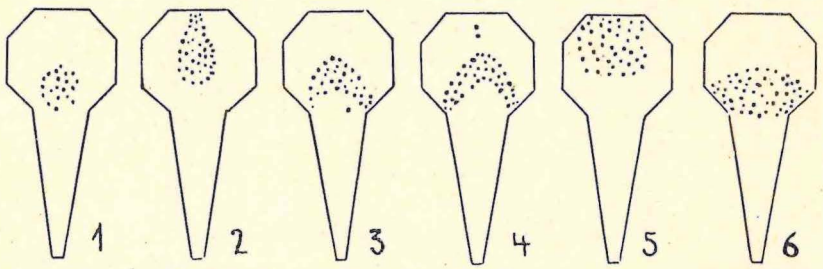



Fig. 17. — Shows the dentition of the vomer of specimens belonging to all three species and which are infected by *Cymothoe*.

ristics, the most important being the grouping of the teeth in the anterior part of the vomer (fig. 17.), which was considered by many authors as a specific character for the species *Maena vomerina*. The percentage of the dentigerous vomers is given with the following numbers (table XXV).

Table XXV

| *Vomer* | No of specim. | % |
|---|---|---|
| toothless | 91 | 33.4 |
| with 1 tooth | 61 | 22.5 |
| with 2-4 teeth | 62 | 22.7 |
| over 4 teeth | 58 | 21.3 |

From the theoretical point of view, each third specimen of *Maena chryselis* may have a toothless vomer.

*Maena maena*. The numerous teeth, which are found in a higher number than in the former two species, are inserted on a low longitudinal ridge in the median of the vomer. Particularly important for this species is the total absence of toothless vomers. The teeth are arranged either in a longitudinal row (fig. 16.) or in a group; frequently they form in the anterior part of the vomer a group which is prolonged backward in a more or less regular row.

Summing up all the above results we come to the conclusion, that it is impossible to distiguish the two genera *Maena* and *Smaris* by means of the presence or even absence of vomerine-teeth, as it was done till now. The differences between the examined three species with regard to the vomerine-teeth, if they are to be found at all, are not so remarkable and important, because all possible intermediate cases, from the toothless vomer to the vomer with perfect dentition (fig. 5., 16.—19.), are to be found. On the whole, we found for all the three species the teeth on the vomer: in *Maena smaris* 17% of the total, *Maena chryselis* 66% and *Maena maena* 100%.

The characteristic dentition of the *vomer*, considered till now as the only specific character for distinguishing the two genera *Maena* and *Smaris*, are found for the specimens of all

three species i. e. *Maena smaris, Maena chryselis* and *Maena maena.*

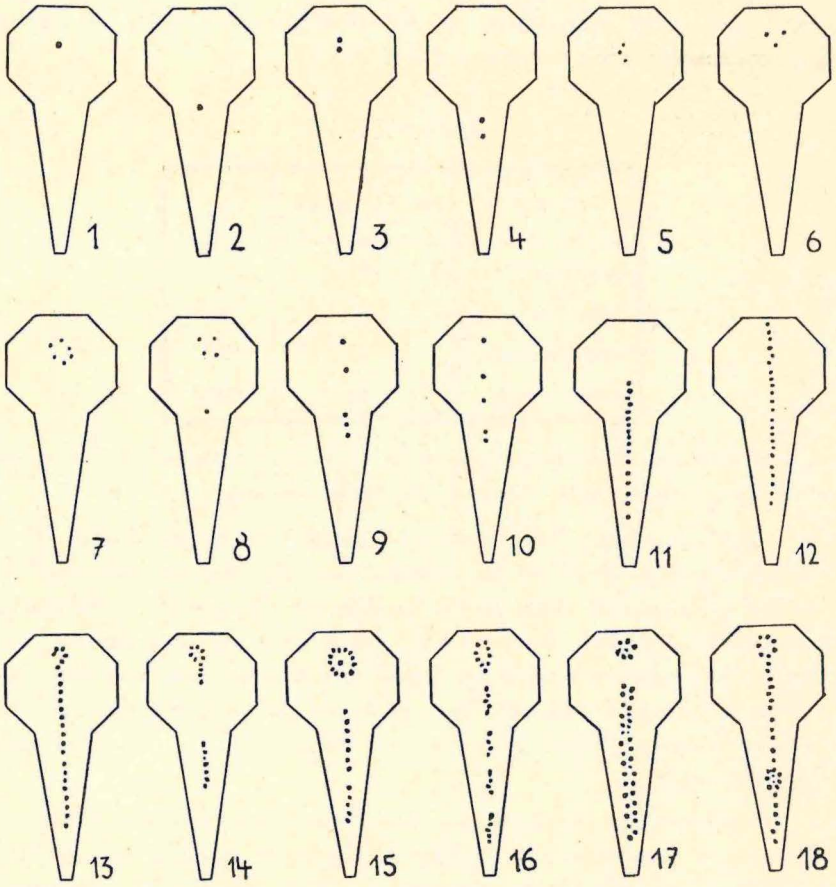



Fig. 18. — Shows the shematized vomer of *Maena smaris* (1—8) and *Maena maena* (9—18) with the different arrangement of teeth (points).

In addition to the vomerine-teeth, all the specimens of all the three species, which were infected, by the parasite *Cymothoe,* attached to the palate, showed a very characteristic dentition of the *vomer.* All these specimens had on the vomer very many fine, slender and very long (twice than normal) teeth, inclining backward. They were attached on a protuberance forming a round surface. The median section of such a vomer is seen on the fig. 20., while its ventral view is shown in the fig. 18.

3. The Pyloric Caeca.

All the 50 examined specimens of each of the three species

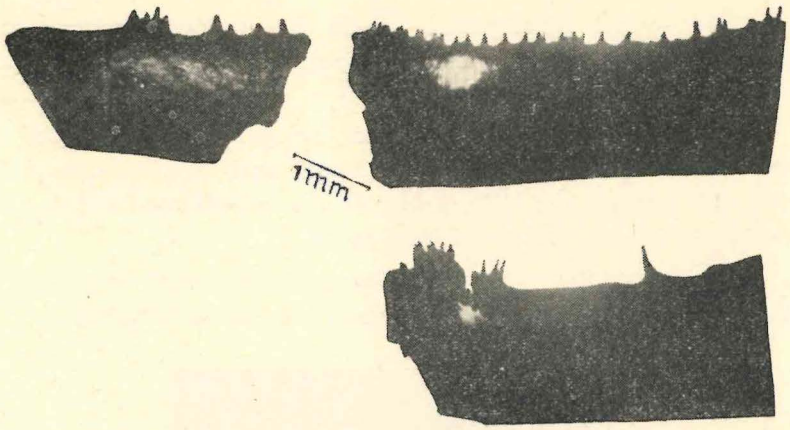



Fig. 19. — Median section of vomer of *Maena smaris* (above, left), *Maena maena* (above right) and *Maena chryselis* (below).

had only four pyloric caeca (fig. 19.). These four caecal outgrowths are not of the same length and are disposed in a whorl round the intestine.

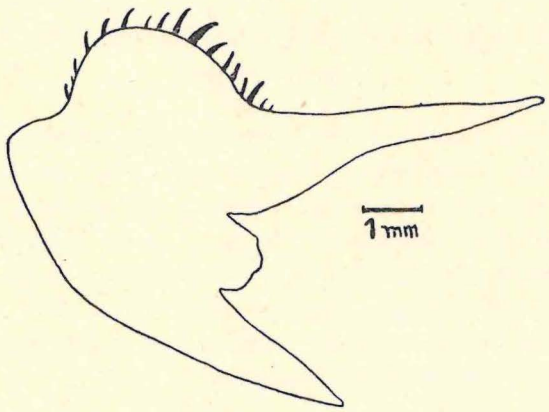



Fig. 20. — Shows the median section of vomer, infected by *Cymothoe*. The specimens of *Maenidae* which are infected by *Cymothoe* show a similar dentition of vomer.

## VI. Colouration.

With regard to the colouration we shall mentioned only the following:

The sexual dimorphism, which is in *Maena maena* less expressed than for the other two species, is very well developed during the spawning time.

The seasonal dimorphism can be particularly noticed in the males, which get some blue spots and lines on the body. For the females the differences in the colouration during the different seasons are of minimal value.

The colouration is one of the most important features for the distinguishing of *Maena maena* from *Maena chryselis*.

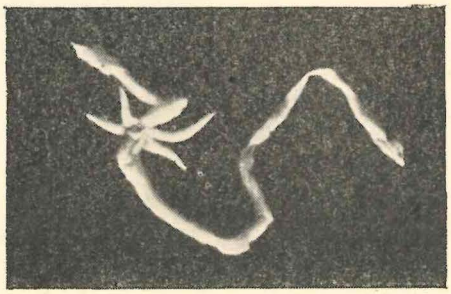


Fig. 21. — *Maena maena:* pyloric caeca

## COMPARISON OF THE SPECIES OF THE FAMILY MAENIDAE

As it was shown in the »Introduction«, all the authors separated on the whole *Maena* from *Smaris*. The specific characters of these two genera are: the presence of vomerine-teeth in the former and their absence in the latter genus. This characteristic was so well-marked, that it was not necessary to give any other diversities for distinguishing precisely these two genera. But, summing up our investigation with regard to the vomerine-teeth, we come to the following conclusion:

a) all the three species have vomerine-teeth;

b) the dentition of the vomer is the best developed in *Maena maena* and the least in *Maena smaris*, while *Maena chryselis* takes an intermediate position;

c) the presence of vomerine-teeth, expressed in percentage amounts in *Maena smaris* to 17%, in *Maena chryselis* to 66% and in *Maena maena* to 100%.

The above facts point out a well-marked intermediate position between *Maena maena* (with a well-developed dentition of the vomer) and *Maena smaris* (with an almost toothless vomer). This intermediate position belongs to *Maena chryselis*.

On the whole, therefore, the dentition (especially that of the vomer) is not distinctive and can hardly be used as a specific character. Therefore, the subdivision of the family *Maenidae* into two genera *Maena* and *Smaris*, according to the vomerine-teeth is impossible.

The two genera *Maena* and *Smaris* are thus indistinguishable by means of the dentition.

Taking a general view of the morphometrical features, which may be considered as specific characters for the species of *Maenidae* (Chapter I), it results that all the three species do not possess such distinctive differences, which would separate them into two genera. Most of the dimensional characters, which are proper to the separate species, show many intermediate cases, uniting them into one genus. The variation of the dimensional characters, taking place in separate seasons is the same in all the three species.

The scale-form is in all three species the same. Only the number of the scales in the lateral line, as well as the number of the scale-ranges on the *genae*, do not agree in these species. But we can see that even the two species *(Maena maena, Maena chryselis)*, which ought to represent two different genera *(Maena* and *Smaris)*, have very similar values of scale-numbers. These values cannot be used as a specific character for distinguishing the two genera.

These three species show also a great similarity with regard to the numbers of fin-rays.

The colouration differs, no doubt, in all three species and depends from sex and season. But this feature, which is not even adequate for distinguishing different species, cannot be considered as a specific character of a generic order.

The comparison of the anatomical structures, especially that of the skeleton, shows that there are no great differences between

the separate species, which could be considered as characteristic for separating the two genera.

There are, however, some differences in these species, particularly between *Maena maena* and *Maena smaris*. But the species *Maena chryselis* takes in nearly all such cases an intermediate position, uniting therewith the species *Maena maena* and *Maena smaris* into one genus.

Summarizing the results of the above comparison we come to the conclusion, that the differences which are to be found in the species *Maena maena, Maena chryselis* and *Maena smaris* are not of great importance and cannot be used as characteristics to distinguish the two genera *Maena* and *Smaris*.

It is impossible to group the species *Maena maena, Maena chryselis* and *Maena smaris* into two genera, as it was done hitherto. All the three species belong to the same genus of *Maena*.

Many representatives of *Maenidae* were insufficiently characterized in the data, known till now, and therefore it was very difficult, or even impossible, to recognize them or to give a diagnosis of them. Some authors, like Faciolà, Nobre, de Buen etc. already united certain species. Thus they quoted only 4—5 different species of *Maenidae*, but their fusions were often conflicting for the species in question, and were made without sufficient or without any evidence.

As shown in the »Introduction«, the specific characters for the separation of the species of the ancient genus *Maena* are based on the different length of the scale on the base of the ventral fin (for the separation of *Maena vulgaris* from *Maena zebra*), on the arrangement of vomerine-teeth (to distinguish the species *Maena vomerina)* and on the presence of canines (to separate *Maena jusculum* from the other species).

The arrangement of vomerine-teeth, found in the examined species of *Maena maena*, shows all the characteristic forms, which were »specific« for the species *Maena vulgaris* and *Maena vomerina*. The same similarity is also shown by the other characters, such as the canines, shape of body, number of scale-ranges on the *genae* etc. The numbers of scales in the lateral line, quoted till now for *Maena vomerina* were not exact in my opinion, because the data were often conflicting in the same species.

With regard to the species *Maena jusculum,* characterized by the absence of canines, we shall add that the canines are not always present in *Maena maena* either. This characteristic, as well as the same number of scales in the lateral line, the same proportions of the body, the same length of the scale on the base of the ventral fin etc. point to one and the same species. There are no evident differences between the description of *Maena jusculum* and our own data of *Maena maena,* which could be considered as characters for two different species.

*Maena zebra* Gthr. *(Maena Osbeckii* Bp.) was united already by Facciolà (1899) with *Maena vulgaris* into one species. We are of the same opinion, because it was proved, that the differences between these two species are due to sex.

Taking in account all the above results, we can state that all the species of former genus *Maena* were inexactly described, because different sexual and seasonal dimorphisms (particularly the colouration) were considered as *differentiae specificae.*

On account of the many characteristics, which were given as *differentiae specificae* for separate species of the genus *Maena* and were also found in the examined *Maena maena,* we united all the above mentioned species i. e. *Maena vulgaris* C. V., *Maena zebra* Gthr., *Maena jusculum* C. V. and *Maena vomerina* C. V. into one species of *Maena maena* Linné.

With regard to the species of the former genus *Smaris,* the same mistake was made, viz. different sexual and seasonal dimorphisms were considered as *differentiae specificae.* Different authors already united separate species, but their conclusions were often conflicting. Facciolà, for instance, united *Smaris vulgaris* C. V. with *Smaris alcedo* C. V. into one species, F. de Buen *Smaris alcedo* with *Smaris Maurii,* but Nobre united *Smaris alcedo* with *Smaris chryselis* C. V.

The specific characters belonging to the species of the former genus *Smaris* are the different number of scales in the lateral line, the proportions of body and the colouration.

Taking into account the number of scales in the lateral line, the investigated species of *Maena smaris* agrees with *Smaris vulgaris* C. V. (united with *Smaris alcedo* by Facciolà), while the species *Smaris chryselis* C. V. and *Smaris gagarella* C. V. correspond to the examined species of *Maena chryselis.* The identity of *Smaris alcedo* C. V. (on the basis of the scales

in the lateral line) with the examined species of *Maena chryselis* or *Maena smaris* is not sure. The data for *Smaris alcedo* C. V. are conflicting and inexact. At last, we have to identify *Smaris Maurii* Bp. (united often with *Smaris gracilis* Bp.) and *Smaris insidiator* C. V. The number of scales in the lateral line of the former could agree with that of *Maena smaris*. But the latter seems to be a separate species.

It was very difficult to identify and compare the separate species of the genus *Smaris*, which were described by various authors till now, with the representatives of the same genus, which we investigated. According to Facciolà *Smaris vulgaris* + *alcedo* agree with the examined species of *Maena smaris*, while *Smaris chryselis* + *gagarella* correspond to *Maena chryselis*. But according to the majority of other authors, *Smaris Maurii* Bp. corresponds to *Maena smaris* and all the other species such as *Smaris vulgaris*, *Smaris alcedo*, *Smaris chryselis*, *Smaris gagarella* agree with *Maena chryselis*.

The species of *Smaris alcedo* C. V., united already by Facciolà with *Smaris vulgaris* C. V., the description of which was given by Bonaparte, corresponds to the examined *Maena smaris*. We cannot classify this species neither as *Maena smaris* nor as *Maena chryselis*. *Smaris alcedo* C. V. was very insufficiently characterized and can be considered identical with either *Maena smaris* or *Maena chryselis*.

The few pictures which illustrate the representatives of *Maenidae* show one and the same mistake, already mentioned, viz. that the sexual and seasonal dimorphisms are considered as *differentiae specificae*.

In accordance with the above it seems reasonable to conclude, that in the genus *Smaris* (which we united with the genus *Maena*) only three different species can be distinguished (not taking into account the species from the West African Coast). Among them two are to be found in the Adriatic. According to the data known till now, the third species *Smaris insidiator* is not found in the Adriatic.

As it was already shown, many of the dimensional characters vary with regard to the growth and depend on different season and sex. Therefore, in order to give a diagnosis of these species, one must take into account all these factors.

The peculiarities of structure, which are useful in distinguishing the mentioned species, are the height of body in relation to its length, the eye-diameter and the length of the postorbital space of the head in proportion with its length. The cranium shows also some peculiarities. The characteristics mentioned above are of a morphological value, while it is probable that there are also physiological and biological differences for these species. But it is our intention to conduct further biological investigations of this fish in order to solve this problem.

In the following table XXVI some specific characters for the three species are compared.

Table XXVI

| Specific characters | *Maena maena* | characters in common between M. m. - M. chr. | *Maena chryselis* | characters in common between M. chr. - M. sm. | Maena smaris | characters in common. between M. sm. - M. m. |
|---|---|---|---|---|---|---|
| scales lat. line | 70—77 | 70—77 | 70—82 | 80—82 | 80—94 | — |
| vertebrae | 23—25 | 24—25 | 24—25 | 24 | 24 | 24 |
| pectoral fin | 14—16 | 15—16 | 15—17 | 15—17 | 15—17 | 15—16 |
| vomer with teeth | 100% | 66% | 66% | 25.5% | 17% | 17% |
| 100 width / height of cranium ♂ | 85—95 | — | 96—102 | — | 108—117 | — |
| 100 width / height of cranium ♀ | 93—102 | — | 105—113 | 111—113 | 111—123 | — |
| 100 H / LT *1) ♂ | 25—27.5 | — | 23—24.5 | — | 17.7-20 | — |
| 100 H / LT *1) ♀ | 24—26.2 | — | 20—22 7 | — | 17-18.8 | — |
| 100 Pt / Lt *2) | 40—46 | — | 36—39 | 38—39 | 38-42.5 | 40—42.5 |
| 100 O / Lt *2) | 24—30 | — | 32—33 | — | 26—31 | 26—30 |

*1) Valid for adults in non-breeding season.
*2) Valid for specimens over 14 cm.

## CHARACTERISTICS OF THE ADRIATIC SPECIES OF MAENIDAE

The family *Maenidae* belonging to the group of »*Percifor-mes*« are very well marked as a separate family by a peculiar jaw-arrangement, i. e. by a very long median part of the premaxilla, which renders an intensive protruding of snout possible.

This family is represented in the Adriatic by three species, belonging to one and the same genus of *Maena* (including *Smaris*).

1. *Maena maena* Linné.
2. *Maena chryselis* (C. V.).
3. *Maena smaris* (Linné).

The improved data of the characteristics of the genus *Maena (Smaris)* are the following:

vomer often with teeth; dorsal fin 10—12, 13?/9—12; anal fin 3/8—10; pectoral fin 14—17; vertebrae 23—25 (including the first little one and the urostyl considered as one vertebra).

The most practicable characteristics of the three species are given in the following key.

**Key to the Adriatic Species of *Maenidae*.**

1. Scales 80—94 (84—86) in lateral line; maximal height*1 of body one fifth till one sixth of total length (incl. C.); in the non-breeding season greatest height in males 17.7—20% of total length, in females 17—18.8%; vomer rather toothless, or sometimes with very few, small teeth; eye*2 3.2—3.8 in head and smaller than preorbital space; dorsal greyish-brown (non-breeding season), ventral whitish-grey; during the breeding season the males get a sprinkling of blue spots and lines. Maximum size ca. 20 cm in males, 15 cm in females... *Maena smaris* (Linné).
2. Scales 70—82 (73—76) in lateral line; maximal height*1 of body $^1/_4$ till $^1/_5$ of total length; in the non-breeding season greatest height in males 23—24.5%, in females 20—22.7% of total length; vomer rather dentigerous, few teeth; eye*2 3.1—2.9 in head and larger than preorbital space; dorsal yellowish brown (non-breeding season), ventral whitish gray; during the breeding season the males get blue lines and spots. Maximum size ca. 19 cm in males, 15 cm in females:... *Maena chryselis* (C. V.)
3. Scales 70—77 (73—75) in lateral line; maximal height to total length 1:3.6—4.2 in males greatest height 25—27.5%, in females 24—26.2% of total length; vomer always dentigerous, teeth present in a great number. Eye*2 3.3—4.2 in head and smaller than the preorbital space; dorsal leaden gray, below whitish

*1) Height of body depends from sex, season and size.
*2) Valid for specimens over 14 cm.

gray; during breeding season the males get some blue lines on head and blue spots on flank. Maximum size ca 24 cm in males, 21 cm in females... *Maena maena* Linné.

The **synonyms** being very complicated, we shall give only the most important ones.

### *Maena maena* Linné 1758

*Sparus maena* Linné 1758, Lacépède 1798, Risso 1810; *Sparus zebra* Brünnich 1768; *Maena vulgaris* Cuvier et Valenciennes 1830, Günther 1859, Canestrini 1872, Moreau 1881, Doderlein 1889, Carus 1889, Facciolà 1899 ♀, Griffini 1903, Nobre 1935, de Buen 1935; *Maena vomerina* Cuv. Val. 1830, Günther 1859, Moreau 1881, Carus 1889, Doderlein 1889, Griffini 1903; *Maena jusculum* Cuv. Val. 1830, Canestrini 1872; Moreau 1881, Doderlein 1889, Carus 1889, Griffini 1903; *Maena Osbeckii* Cuv. Val. 1830, Canestrini 1872, Moreau 1881, Doderlein 1889, Facciolà 1889 ♂; *Maena zebra* Günther 1859, Doderlein 1878, Carus 1889, Griffini 1903.

Fins: D XI—XII/10—11, A III/8—10, C x/17/x, P 14—16, V I/5.

Scales: On the *genae* there are 5—6 ranges of scales. Length of the scale on the base of the pelvic fin to length of the same fin 1:2—3.3. Scales in lateral line 70—77.

Dentition: The vomer is always dentigerous; the teeth are arranged in a longitudinal row or in a group; often they form in the anterior part of the vomer a group which is prolonged backwards in a more or less regular row. Canines on the dentary present; often there are 2—3 pairs. Sometimes they are absent.

Proportions of body: Greatest height 3.6—4.2 (males 3.6—4, females 3.8—4.2) in total length (not valid for breeding season). Head on average 5 times in total length. Preorbital space is larger than the eye-diameter and amounts nearly to 30% of the length of the head. Eye ca 24—30% of the size of the head, and is in the smaller specimens relatively larger than in larger ones. Maximum size in males 24 cm and in females 21 cm.

Skeleton: Vertebrae 23—25; the most frequent number is 24. The width of the cranium in males 85—95% of its height and in females 93—102%.

Colouration: Dorsal bluish leaden-gray, ventral whitish gray. Large rectangular blackish blot on the flank. In the breeding season the males get blue spots and lines and other colours.

Distribution: Mediterranean and adjacent seas and is met also in the Atlantic Ocean on the Portuguese Coast.

Common Serbo-croatian names: modrak, (modrulj, tragalj, trog).

***Maena chryselis*** (Cuvier et Valenciennes 1830)

*Smaris alcedo* Cuv. et Val. 1830?, Günther 1859, Moreau 1881, Doderlein 1889, Carus 1889?, Griffini 1903; *Maena alcedo* Canestrini 1872; *Maena smaris* Canestrini 1872; *Smaris vulgaris* Bonaparte 1836, Günther 1859, Doderlein 1889?, Carus 1889; *Smaris chryselis* Cuv. et Val. 1830, Bonaparte 1836, Moreau 1881, Doderlein 1889 ♂, Carus 1889 ♂, Facciolà 1889 ♂, Griffini 1903, Nobre 1935; *Smaris gagarella* Cuv. et Val. 1830, Bonaparte 1836, Moreau 1881, Doderlein 1889 ♀, Carus 1889 ♀, Facciolà 1899 ♀.

Fins: D X—XII/10—12, A III/8—10, C x/17/x, P 15—17, V I/5.

Scales: On the *genae* there are 5 ranges of scales. Scales in lateral line 70—82.

Dentition: Vomer rather with teeth (on average each third specimen with toothless vomer), teeth are in a few number and arranged in a longitudinal row or group. Canines on dentary present 1—3 pairs.

Proportion of body: Greatest height 4—5 (males 4.1—4.3, females 4.4—5) in total length (not valid for breeding season). Head on average 4.7 times in total length; its length depends from total length of body. Preorbital space is smaller than the eye-diameter and amounts nearly to 30% of the length of the head. Eye ca 32.7% of the size of the head. Maximum size in males 19 cm and in females 15 cm.

Skeleton: Vertebrae 24—25; the most frequent number is 24. The width of the cranium in males 96.2—101.3% of its height and in females 105.2—113%.

Colouration: Dorsal light brown with somewhat silvery lustre, ventral grayish-white. In the breeding season the males get blue and yellow lines on the head and flank; fins have blue spots. On the flank large rectangular blackish blot.

Distribution: Mediterranean and adjacent seas and is met also in the Atlantic Ocean on the Portuguese Coast.

Common Serbo-croatian names: ♂ — prč; ♀ — gira oštrulja (širolja).

### *Maena smaris* (Linné 1759)

*Sparus smaris* Linné 1758; *Smaris vulgaris* Cuv. et Val. 1830, Moreau 1881, Facciolà 1899♀, Griffini 1903; *Smaris smaris* Nobre 1935; *Smaris alcedo* Bonaparte 1836, Facciolà 1899 ♂; *Smaris Maurii* Bonaparte 1836, Günther 1859, Moreau 1881 ♂, Doderlein 1889, Carus 1889 ♂, Griffini 1903; *Maena Maurii* Canestrini 1872; *Smaris gracilis* Bonaparte 1836, Günther 1859, Moreau 1881 ♀, Doderlein 1889, Carus 1889 ♀; *Maena gracilis* Canestrini 1872.

Fins: D X—XII/9—12, A III/8—10, C x/17/x, P 15—17, V I/5.

Scales: On the *genae* there are 4—5 ranges of scales. Scales in lateral line 80—94.

Dentition: Vomer rather toothless (on average each sixth specimen with teeth on the vomer); teeth very few in number. One pair of canines present on dentary.

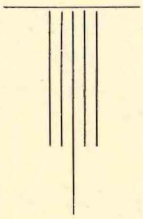
Proportions of body: Greatest height 5—6 (males 5—5.7, females 5.3—5.9) times in total length (not valid for breeding season). Head nearly 4—5 times in total length. Preorbital space ca. 30.3% of head; in the smallest specimens smaller than the eye; in the larger specimens vice versa. Eye-diameter on average 29.5% of head. Maximum size in males 20 cm, in females 15 cm.

Skeleton: Number of vertebrae is constant and amounts to 24. The width of the cranium in males 108.5—116.2% of its height and in females 111—123%.

Colouration: Dorsal grayish brown (males somewhat blue admixture with silvery lustre), ventral grayish white. Males possess hardly visible blue spots and lines on the flank and head. In the breeding season the spots become intensive in the males. The females get during spawning transverse brownish bands.

Distribution: The same as in the previous species.

Common Serbo-croatian names: ♂ — obljak (objak); ♀ — oblica, (gira oblica).



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## EXPLANATION OF PLATES

### Plate I

Fig. 1. — *Maena smaris* L i n. (Photo Dr. T. Šoljan)
Fig. 2. — *Maena chryselis* (C u v. V a l)
Fig. 3. — *Maena maena* (L i n.)

### Plate II

Fig. 1. — *Maena maena:* side view of the cranium
Fig. 2. — *Maena maena:* dorsal view of the cranium
Fig. 3. — *Maena maena:* ventral view of the cranium
Fig. 4. — *Maena maena:* the cranium seen from behind

### Plate III

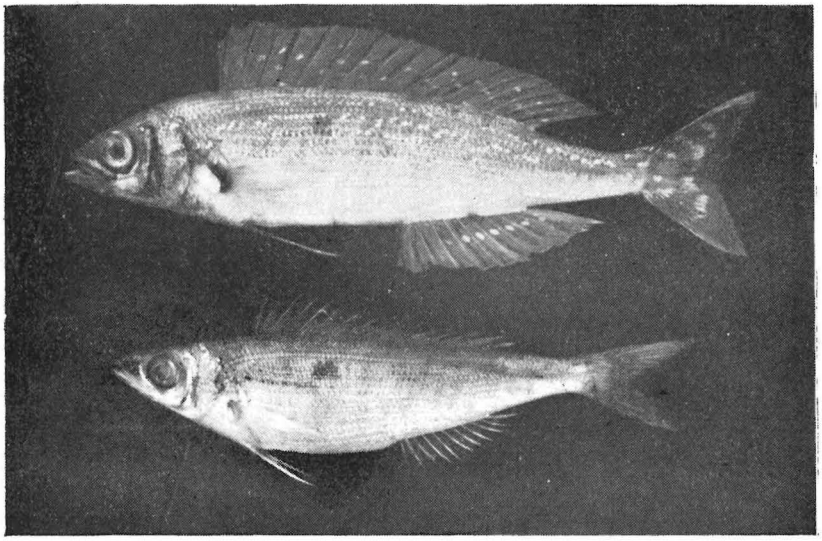
Fig. 5. — *Maena chryselis:* dorsal view of the cranium
Fig. 6. — *Maena chryselis:* side view of the cranium
Fig. 7. and 9. *Maena smaris:* side view of the cranium
Fig. 8. — *Maena smaris:* ventral view of the cranium
Fig. 10. — *Maena smaris:* the cranium seen from behind
Fig. 11. — *Maena chryselis:* the cranium seen from behind

### Plate IV

Fig. 12. — *Maena maena:* pre-operculum
Fig. 13. — *Maena chryselis:* pre-operculum
Fig. 14. — *Maena smaris:* pre-operculum
Fig. 15. — *Maena chryselis:* premaxilla and maxilla
Fig. 16. — *Maena maena:* premaxilla and maxilla
Fig. 17. — *Maena smaris:* dentary
Fig. 18. — *Maena chryselis:* dentary, articular, angular
Fig. 19. — *Maena chryselis:* varies bones belonging to the visceral skeleton
Fig. 20. — *Maena chryselis:* the branchial arches
Fig. 21. — *Maena smaris:* the hyoid arch
Fig. 22. — *Maena smaris:* the circum-orbital bones

**Reference letters used on plates.**

| | |
|---|---|
| Ang | angulare |
| Art | articulare |
| Bbr | basibranchialia |
| Bhy | basihyale |
| Bo | basioccipitale |
| Bs | basisphenoid |
| Cbr | ceratobranchiale |
| Ch | ceratohyale |
| Cl | clavicula |
| Crc | coracoid |
| D | dentale |
| E | ethmoideum |
| Ebr | epibranchiale |
| Ect | ectopterygoid |
| Eh | epihyale |
| El | ethmoidea lateralia |
| Ent | entoglossum |
| Ep | epioticum |
| Ept | entopterygoid |
| F | frontale |
| Hpbr | hypobranchiale |
| Hy | hyomandibulare |
| Hyp | hypohyale |
| Ino | interoperculum |
| Ls | laterosphenoid |
| Mt | metapterygoid |
| Mx | maxillare |
| O | operculum |
| Ol | occipitale laterale |
| Pa | parietale |
| Pal | palatinum |
| Pcl | postclavicula |
| Phbr | pharingobranchiale |
| Phi | pharingealia inferiora |
| Prm | praemaxillare |
| Pr | prooticum |
| Prp | praeoperculum |
| Ps | parasphenoideum |
| Pt | posttemporale |
| Pto | pteroticum |
| Qu | quadratum |
| Rb | radii branchiostegii |
| Rd | radialia |
| Sbo | suboperculum |
| Sc | scapulare |
| Scl | supraclavicula |
| Sh | stylohyale |
| So | supraoccipitale |
| Sp | sphenoticum |
| Sy | symplecticum |
| V | vomer |



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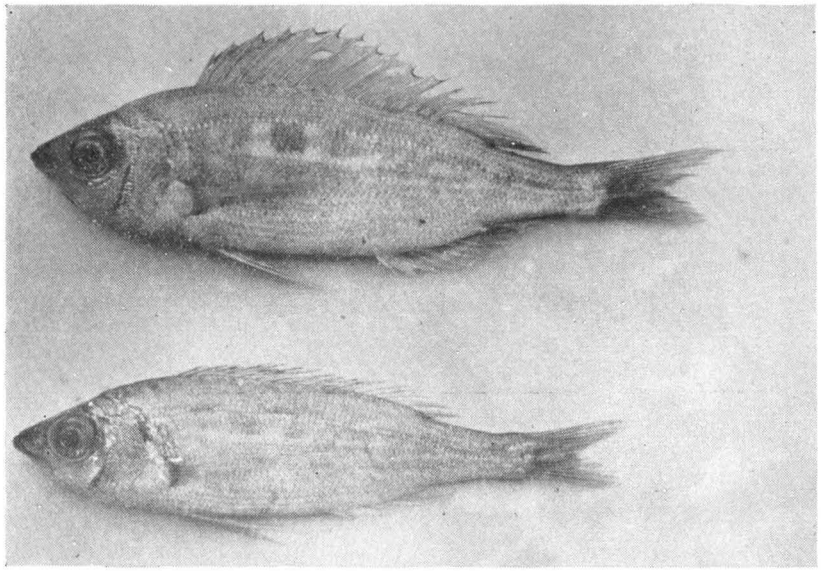

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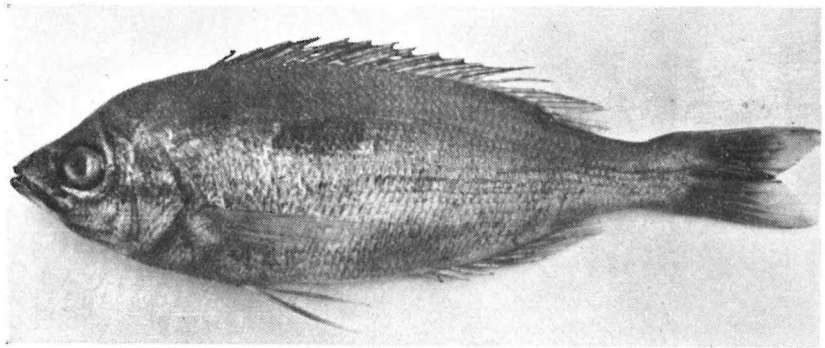

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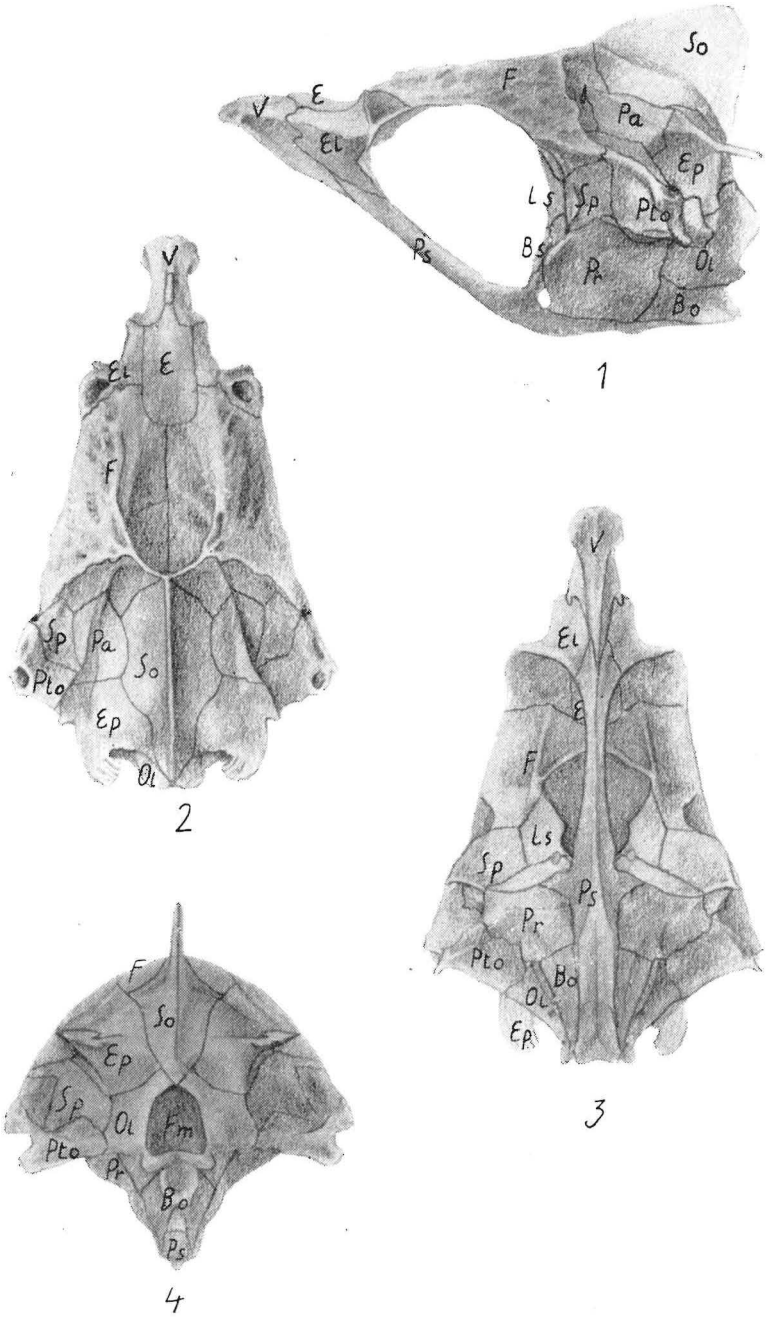
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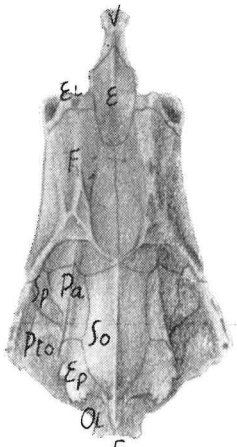
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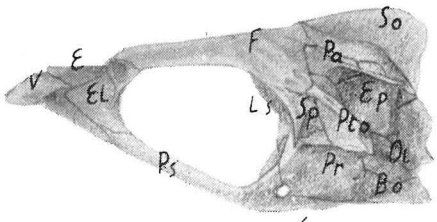
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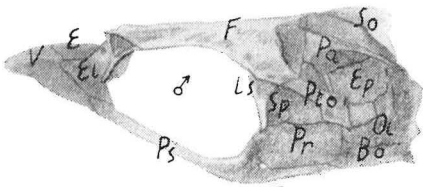
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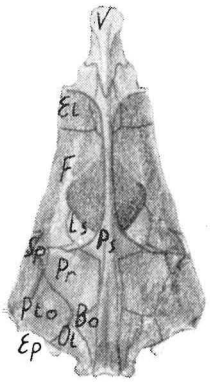
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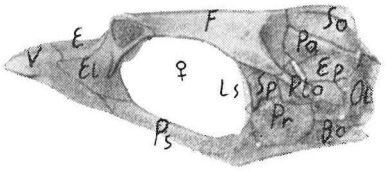
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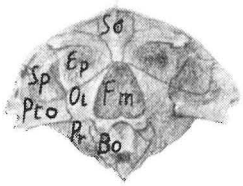
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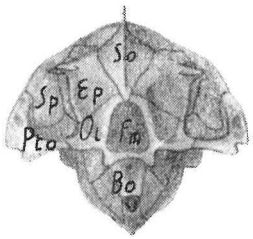
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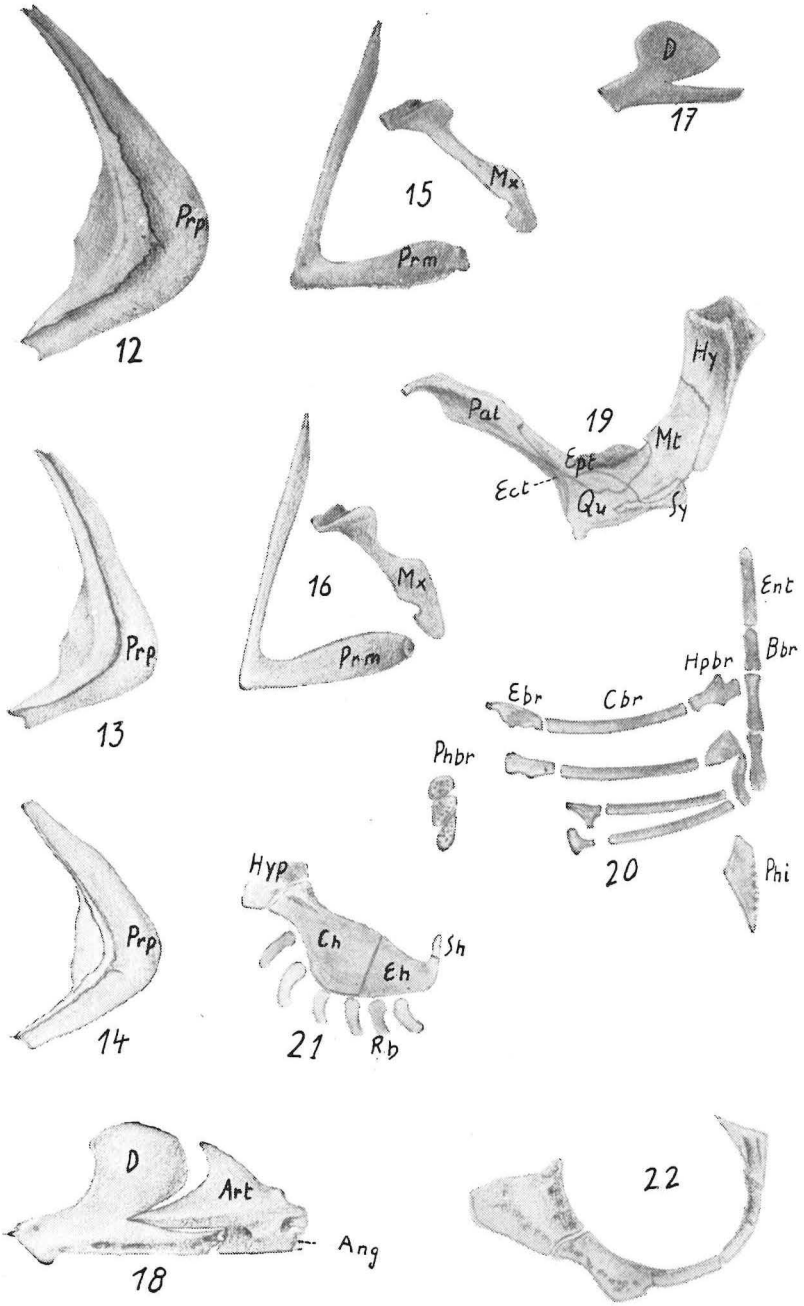
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