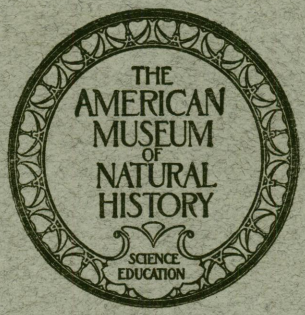
BULLETIN

OF

THE AMERICAN MUSEUM OF NATURAL HISTORY

VOLUME LXI, 1931



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1931

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OF

THE AMERICAN MUSEUM OF NATURAL HISTORY

VOLUME LXI, 1931

ALEXANDER POPE
BOONE VAN DUZEE
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GUDGER WHITE

NEW YORK
PUBLISHED BY ORDER OF THE TRUSTEES
1931

EDITED BY ETHEL J. TIMONIER

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DATES OF PUBLICATION OF SEPARATES[1]

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Art. I,	March 31, 1930.	Art. VI,	April 16, 1931.
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" V,	April 11, 1931.		

[1]The title-page, Table of Contents, and Index to this volume (LXI) published Nov. 15, 1933.

LIST OF ILLUSTRATIONS

PLATES

Text Figures

MAP

LIST OF NEW TAXONOMIC NAMES IN THIS VOLUME

New Genera

New Species

ERRATA

Plate III, captions: Fig. 5 should read Fig. 3; Fig. 3 should read 4: Fig. 4 should read 5.

Page 22, line 17 from bottom, right-hand column: for *argentia* read *argentea.*
" 22, line 10 from bottom, right-hand column: for *arcuatus* read *arcuata.*
" 65, line 2 from top: for *cærulescens* read *cærulescens.*
" 73, line 2 from top: for *balyrus* read *balyras.*
" 96, line 5 from top, for *Gymnosoma* read *Gymnosoma.*
" 98, line 1 from bottom: for *Hypostenia* read *Hypostena.*
" 152, line 13 from bottom: for *Scyliorhinus* read *Scylliorhinus.*
" 153, line 7 from top: for *Scyliorhinus* read *Scylliorhinus.*

Page 181, line 5 from top: for *ovatus* read *ovata.*
" 185, line 3 from bottom, for *albinotatus* read *albonotatus.*
" 192, line 4 from bottom, for *obscura* read *obscurus.*
" 435, lines 23 and 24 from bottom: transpose the word **Railway** on line 23 after Eastern on line 24.
" 455, footnote: for 1912 read 1921.
" 476, line 7 from top: for below read on page 475.
" 480, footnote, line 2 from bottom: for Kuhll read Kuhl.
" 551, line 14 from top: for Lingping read Linping.
" 561, line 16 from top: for *Pachytrion* read *Pachytriton.*

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Article I.—PUG-HEADEDNESS IN THE STRIPED SEA BASS, *ROCCUS LINEATUS*, AND IN OTHER RELATED FISHES

BY E. W. GUDGER

PLATES I–III; TEXT FIGURES 1 TO 7

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MATERIAL

In December, 1928, I was at work on pug-headedness in salmonid fishes, particularly in the brown trout, *Salmo fario*, when Professor E. A. Andrews of Johns Hopkins University paid me a visit, saw my material, and told me that there was in the zoölogical collections of the university a pug-headed fish of some kind. This he kindly loaned me and, on examination, it proved to be a *Roccus lineatus*. Professor Andrews writes that this head bears no label, that he knows nothing of its source, but that it has been in the zoölogical laboratory for nearly twenty-five years. It is much shrunken from long immersion in alcohol, but is otherwise in good condition. It is referred to in this article as fish No. 3.

Mr. C. M. Breder, Jr., of the New York Aquarium, saw this specimen and informed me that, in the winter of 1919–20, he had seen, in the United States Bureau of Fisheries at Washington, another such specimen of this fish. Correspondence with the Bureau brought out the fact that this specimen had disappeared but that another was on hand. This was kindly presented to the Museum by the Bureau of Fisheries. It bears the following label: "Submitted to the Bureau by C. P. Lansburgh, stall 18, Municipal Fish Wharf, Washington, D. C., 7–27–'29. Locality of capture unknown." It will be referred to herein as fish No. 2.

The third fish, referred to herein as No. 1, is a normal, fresh specimen obtained from a local fish dealer near the Museum. In size, it is, as near as could be found, a duplicate of the Washington fish, and hence it will be used as a standard of comparison.

FIRST-HAND DATA ON PUG-HEADEDNESS IN *ROCCUS LINEATUS*

In order to get a numerical basis for comparison of the fishes under consideration, and especially of their head-parts, there is subjoined a table of identical measurements for fish No. 1, the normal specimen; No. 2, the perfect Washington fish; and No. 3, the much shrunken head from Johns Hopkins University.

The table shows that, allowing for normal individual variations, fishes Nos. 1 and 2 are closely comparable, there being in No. 2 no appreciable differences, save in its pug-headedness. In case of No. 3, it must be noted that, despite its long years in alcohol, it measured up well with the others, save in girth. This is understandable since it lacks both gills and throat-parts. Comparison of the measurements of the head of No. 3 with the others indicates that this fish was about equal in size to the others.

Figures will now be set forth and comparisons made of the three fishes seen from the side, from above, and in front, in order that the abnormalities may be studied from every point of view.

Comparison of Normal and Pug-headed Sea Basses in Lateral View

Instead of having fish No. 1 photographed, I am using herein (Fig. 1) a reproduction of Jordan and Evermann's drawing of the striped sea bass (1900). It is an accurate representation of fish No. 1, barring the over-full abdomen. Note the gentle curves on the dorsal and ventral surfaces of the head. If the mouth were closed (fortunately it is open,

Line		No. 1	No. 2	No. 3
1	Length, tip of snout to tip of caudal	425 (16.75)	418 (16.5)	
2	Length, tip of snout to base of caudal (standard)	367 (14.4)	350 (13.75)	
3	Girth in front of spinous dorsal	232 (9.10)	165 (6.50)	
4	Length of head,snout to tip of operculum	108 (4.25)	113 (4.30)	100 (3.90)
5	Length of head, snout to hinder edge of eye	45 (1.75)	48 (1.90)	45 (1.75)
6	Girth of head at hinder edge of eyes	170 (6.60)	193 (7.60)	161 (6.25)
7	Width of head between inner edges of eyes	35 (1.40)	28 (1.10)	25 (1.00)
8	Length of lower jaw, snout to line joining corners of mouth	18 (0.63)	23 (0.90)	20 (0.75)
9	Outside width of lower jaw between points of maxillaries	30 (1.30)	50 (2.00)	32(1.25)
10	Inside width of lower jaw at corners of mouth	21 (0.75)	29 (1.10)	20 (0.75)
11	Projection of lower jaw beyond upper	3 (0.12)	16 (0.63)	20 (0.75)
12	Projection of upper jaw over line joining corners of mouth	16 (0.63)	9 (0.30)	3 (0.12)
13	Weight in grams and ounces	850 (30)	772 (25.75)	

Comparative measurements in mm. and inches.

permitting more direct comparison with the mouths of the other fishes), the head would end in a blunt snout with the lower jaw projecting slightly beyond the upper (3 mm. in my fresh specimen).

As may be seen in Pl. I, fig. 1, made from a photograph taken in lateral view, fish No. 2 (the Washington specimen) is well grown and in fine condition. In short, the only abnormality is in the front of the head: the lack of a snout and of most of the upper jaw. Despite its two years in preservative, the abdominal region only shows any perceptible shrinking; even the mouth remains open. Leaving aside the smaller abdomen,

the great difference between this fish and the normal one is in the head structures, as may be seen by comparing the heads of the two fishes. In No. 2 the same gentle curve on the lower surface is found, but the head in the region of the eyes has been tremendously upraised, has apparently been thickened, and its dorsal surface has become nearly horizontal. As is shown in the table (line 6), its girth at the hinder edge of the eyes is 193 mm., as compared with 70 mm. for the normal fish of about the same length, and 161 mm. for the Johns Hopkins head.

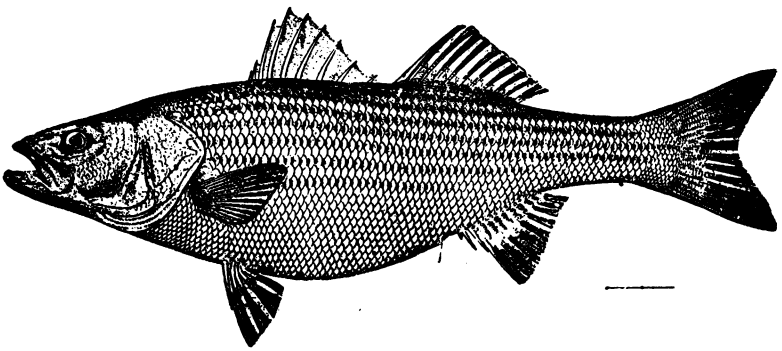

Fig. 1. A normal specimen of *Roccus lineatus* with rather full abdomen. Note the gentle curves of the head and blunt snout. A similar fish is seen from above in Pl. I, fig. 3.

After Jordan and Evermann, 1900.

In the vertical of the hinder edge of the iris, this head begins to fall away steeply and in front of the eyes is found a nearly vertical "forehead." Furthermore, there is present a much-reduced upper jaw, having all the bones (premaxillaries and maxillaries) present but, as that part of the skull in front of the eyes is entirely lacking, the upper jaw has been retracted and brought to lie almost squarely across the open buccal cavity and the lower jaw, over which it projects by 9 mm. Moreover, the hinder (here lower) part of the maxillary and premaxillary extends markedly below the lower jaw (15 mm. below its upper margin)—like the heavy drooping mustaches of some men—while the lower jaw preserves its normal position and length, as may be seen in Pl. I, fig. 1. Attention is also called to the marked bulging of the eyes, to which reference will be made later.

In Pl. II, fig. 1 is shown a lateral view of the much shrunken head from Johns Hopkins. Here the head is not so horizontal above, but there is the same steep forehead falling away even more abruptly to the

remnant of the upper jaw which extends squarely across the buccal cavity, the outer ends of both maxillary and premaxillary hanging markedly below the level of the lower jaw. The projection of the lower jaw beyond the upper is greater here (20 mm. against 16), because of the shrinkage, and because of the straight bar-like structure of the upper jaw. These points will be made clearer in the next section. The girth of this head, with all the throat and gill-parts removed, and after twenty-five years in alcohol, is 161 mm.—but 9 mm. short of that for No. 1, the normal fish, and but 32 mm. (slightly over one inch) less than for the entire head of No. 2. The other measurements, as given in lines 4, 5, and 8 of the table, show that, in general, this head occupies a position between the heads of fishes Nos. 1 and 2, the slight variations being due, generally speaking, to shrinkage.

Comparison of Normal and Pug-headed Striped Basses in Dorsal View

Looking at fish No. 2, from above (Pl. I, fig. 2), one is struck by the bluntness of the head and by its protruding eyes. These eyes are apparently closer together than those of the normal fish (Pl. I, fig. 3), but a glance at line 7 of the table shows that the line joining their inner edges is 7 mm. shorter than the same measurement in the normal head. Below the eyes and the "bulging forehead" is the abbreviated upper jaw, somewhat shaped like a Turkish bow due to its projecting central part composed of the premaxillaries and to the outer ends of these and of the maxillaries overhanging the lower jaw. The shovel-shaped lower jaw, while slightly longer than the normal, is very blunt and very wide in front, as may be seen in Pl. I, fig. 2, and is also very much wider behind, as the figures of line 10 of the table show. In the cavity of this lower jaw lies the wide tongue. Note the dark coloration of the tongue, which is even more pigmented than the lips. This pigmentation has presumably come about because of exposure to the light through having no protecting upper jaw. As will be noted later, this has been observed before (by Sutton, 1913).

In comparison with figure 2 of plate I, showing the pug-headed fish from above, let us study figure 3 of plate I, which portrays the normal fish (No. 1) seen from above. Here we have the narrower, bluntly pointed head of a normal fish whose dorsal parts, as seen in lateral view in Fig. 1, slope gently and smoothly to form a blunt snout. Beyond calling attention to the slightly projecting lower jaw and the widely separated eyes

set flush with the surface of the head, there is nothing to be said. This fish is entirely normal and is used merely as a standard to check the variations.

In Pl. I, fig. 4 is seen the head from Johns Hopkins, viewed from above. Here the head falls away steeply to the nearly straight, bar-like and much retracted upper jaw. The lower jaw (see lines 8, 9, and 10 of the table) is entirely normal in size and shape. The tongue is normal in shape and if once pigmented, as in fish No. 2, the pigment has long since been dissolved. The eyes do not protrude as do those of fish No. 2, but this may be due to the great shrinkage they have undergone.

Comparison of the Three Heads in Frontal View

In Pl. II, fig. 2, is portrayed a frontal view of the normal fish. Could this mouth have been opened slightly (it is stiffened by the preservative), it would have been better for comparison's sake. Of this head there is little to note: the curve of the mouth, the eyes flush with the surface, the gently ascending slope of the head, being the chief points for comparison. It, too, serves merely as a standard of comparison for the bizarre figures now to be considered.

Very different is the Washington fish seen in front view in Pl. II, fig. 3. Note the enormous size of the mouth, or rather buccal cavity, framed by the horizontal lower jaw and the bow-shaped upper jaw which has been retracted and lies almost squarely across it. Particularly noticeable are the bulging eyes and the (apparently) great width of the head. Neither of the other figures of this head so clearly show its bizarre characters as does this one. This is the more apparent when one compares it with figure 2 of plate II, a head-on view of the normal fish. These frontal figures are taken at about the same angle, as the position of the dorsal fin in each figure shows. Imagine the mouth of the fish in text figure 1 closed, then the level of the lower jaw in relation to the upper in Pl. II, fig. 2, becomes more understandable.

Even more weird, in large part due to shrinkage from its long sojourn in preservative, is a frontal view (Pl. II, fig. 4) of the Baltimore specimen. Here we see clearly the reduced bar-like upper jaw. Comparison of figures 3 and 4 of plate II will emphasize the greater differences (certainly in some part due to contraction) between the anterior head structures of these two fish.

The only other head-on photograph of a pug-head fish is Forsyth's (1926), made of such a deformed trout. This figure is, for comparison's sake, reproduced herein as figure 5 of plate II. Here is the same blunt

head with premaxillaries and maxillaries present, and the same long under jaw. The wide head, the protruding eyes, and the far-down hanging outer ends of the upper jaw, seen especially in the Baltimore fish, are lacking.

It should be emphasized that, in the heads of both the Washington and Baltimore specimens, that part of the skull anterior to the eyes is lacking, and there has been a tremendous upraising of the bones in the orbital region. This has brought the eyes closer together and hence it may be conjectured that these fish could see dead ahead much more clearly than the normal fish. So far as I know, this matter has been observed but once before, and that by Sutton, whose work will be noted later.

Another notable thing is the form and position common to both upper jaws, the bar-like structures extending straight across the buccal cavity, with the outer ends drooping over the corners of the mouth. This is in contrast to what was found in the pug-headed salmonids previously referred to. Here, in twelve specimens, six had the premaxillaries pushed back onto the roof of the buccal cavity and invisible from the exterior, while the other six had them present and visible, but all very much reduced, some being scarcely recognizable. In all twelve salmonids, the maxillaries were reduced in size, some markedly so, and were standing at angles from 45° to the plane of the lower jaw to the vertical. In two cases only did the reduced maxillary hang noticeably below the upper level of the lower jaw. This point will be returned to later when the salmonid pug-heads are briefly referred to.

To RECAPITULATE.—In the long-preserved head from Johns Hopkins, as in the head of the fresher Washington fish, there are the same general features (see Pl. I, figs. 1, 2, and 4; and Pl. II, figs. 1, 3, and 4): the flat top to the head, the steep (nearly vertical) forehead, the bones of the upper jaw extending across the buccal cavity, the downward hanging outer ends of the premaxillaries and maxillaries, the long projecting lower jaw, and the somewhat bulging eyes. These are the similarities: the differences need now to be pointed out. The Johns Hopkins specimen has a higher forehead, due to the fact that it lacks the bow-shaped remnant of an upper jaw and snout found in the Washington fish. In the Johns Hopkins head the mouth is closed and the remnant of the upper jaw forms a thin bar extending squarely across it. While the outer ends of this do not hang so far below the level of the upper jaw as those of the whole fish, they apparently do so, due to the fact that they stand nearly vertical, and that, due to the shrinking, they stand out some

distance from the edges of the lower jaw. In front view, the head of the whole fish is much wider than that of the preserved head. This is undoubtedly due to the fact that the cut-off head (which has had the gills removed) has undergone much more contraction. However, the distance between the inner edges of the orbits of the eyes of the two fishes is but 3 mm. greater in fish No. 2 than in the much-shrunken head.

Note has been made of the protrusion of the eyes in the Washington specimen. The eyes of the Johns Hopkins specimen are, of course, much dehydrated and shrunken, and the lens has sunk much more into the cavity of the eyeball than is the case in the first fish. However, the sclerotics in the dehydrated specimen have the same relative proportion, position, and general appearance as in the more recent specimen. From a study of this fish, one must draw the conclusion that when fresh, the eyes of this specimen also protruded.

This protrusion of the eyeballs must have some connection with the changes in the skull. This has been noted before and the explanation found, as will be shown presently when reviewing Sutton's work (1913) on another pug-headed *Roccus lineatus*.

A brief comparison of the data for the three heads shows that, if measurements (lines 4 and 5 of the table) are made from the tip of the snout, the heads vary little from the normal. The girths of the three heads (line 6) show variations from the normal, the head of No. 2 being much enlarged in the region of the eyes, while that of No. 3 is below standard by reason of the collapsing, due to removal of the soft parts. The width between the eyes (line 7) is notably less in the pug-heads than in the normal fish, thus possibly bringing about an approach to binocular vision. Judging by the measurements in line 8, the lower jaws of all three fish show little variation in length beyond the normal. However, the widths of these jaws (lines 9 and 10) show a close correspondence of fish No. 3 to the normal, and a wide divergence of the outside width of the lower jaw in fish No. 2 (Washington). Lastly, the lower jaw of No. 3 projects more beyond the upper jaw (20 mm.) than we find in No. 2, because the upper jaw of No. 3 lacks the projection at the center of the bow, and because its lower jaw is more pointed. However, it projects less than No. 2 beyond a line joining the corners of the mouth of No. 1, because of the differences in the structure of the upper jaws in the two fishes. Comparison in both cases should be made with the same measurements in the normal fish, as shown in lines 11 and 12.

HISTORICAL NOTES ON PUG-HEADEDNESS IN *ROCCUS LINEATUS*

For the earliest reference, known to me, to pug-headedness attributable to the striped sea bass, one must go back eighty-one years, and then, indeed, but to a brief mention.

In 1849, at a meeting of the Boston Society of Natural History, "W. O. Ayres exhibited a skull of a fish, showing a curious malformation. The anterior sphenoid bone was disarticulated, and turned up into the orbit of the eye, causing a displacement of the temporal and maxillary bones." No figure is given and one cannot be sure of just what had happened, but I suspect that his specimen was very like that figured by Sutton (1913). Ayres added that the only two instances he had seen of this malformation were in *Labrax lineatus* and *L. mucronatus*. The first of these fishes is, according to Jordan and Evermann (1896, I, p. 1133), synonymous with *Roccus lineatus*, and the second with the closely related *Morone americana*.

One other indefinite account may be referred to. In the 'New York Sun' for Dec. 21, 1919, appeared a figure of a pug-headed striped sea bass with a brief note of its capture. The cut was made from a photograph sent in by Commodore E. C. Benedict of Indian Harbor, Greenwich, Connecticut, where the fish had been caught some time previously. It weighed 2.5 lbs., from which one may judge that it was about the same size as the fishes under consideration. An effort has been made to locate the original photograph, but it cannot be found in the files of the 'Sun.' Commodore Benedict died some years ago and his personal possessions have been scattered, so there is no chance of locating it.

In the little article in the 'Sun,' the fish is shown in lateral view, but the reproduction is so indistinct that no details can be made out. There is, however, the same level upper head, the same steep forehead, the same projecting lower jaw. The upper jaw apparently is of the same type as that found in the Johns Hopkins specimen. The eyes seem to bulge, but the reproduction is too indistinct for one to insist on this point. Unfortunately, the brief text gives no description of this fish.

Fortunately, however, a fine specimen of a striped bass pug-head has been studied scientifically. In 1913, Alan C. Sutton of Johns Hopkins University published an article on such an abnormal specimen, limiting himself almost entirely to the structures of the skull and to the cause of the marked protrusion of the eyes. The photographic figure of the side view of the head only of his fish is markedly like that of the present Johns Hopkins specimen, as may be seen in Pl. III, fig. 1.

At first I thought that this head was my specimen, but Sutton macerated the head of his fish and published figures of the skull, as will be seen presently. Furthermore, he has written me that he never knew of the present specimen.

Sutton does not give the size of his fish, but notes that it weighed 2.75 lbs., hence, it was probably slightly larger than the Washington specimen. Inspection of his figure of the head (Pl. III, fig. 1) shows the same flat head, steep forehead, short and squarely cut-off upper jaw with the outer ends overhanging the long-projecting lower jaw, and the bulging eyes that are found in the two malformed specimens previously considered. The upper jaw apparently lacks the "bow" in the upper jaw of fish No. 2 (Pl. I, fig. 2), and is probably like that of the other Johns Hopkins head (Pl. I, fig. 4, and Pl. II, fig. 1). Certainly this head in lateral view is remarkably like the other Johns Hopkins specimen.

Sutton called particular attention to the remarkable protrusion of the eyes of his fish, noting that "They seemed to be literally popping out of the head." This is very marked also in the Washington specimen, was evidently true in my Johns Hopkins fish, was indicated in the note on Ayres' fish in 1849, and seems probable from the figure of Commodore Benedict's fish of 1919. Sutton's explanation of the bulging of the eyes is that it is caused by the "buckling" upward into the eye-orbit region of the parasphenoid bone. This will be gone into fully in the next section.

Sutton further called attention to two other points of marked interest in his fish. He says:

> The tongue, however, protrudes to its usual length, lying exposed on the floor of the mouth. As a result of this position it had undergone some modifications, for it was slightly pigmented over its exposed portion and its upper surface was covered with fine scales set similarly to the regular scales which cover the skin, that is, so as to offer no resistance to a body moving from the anterior toward the posterior end of the body. They were not of the nature of true cycloid scales but merely a horny development of the papilla. They did not correspond, however, to teeth such as are normally present on the tip of the tongue of salmon and some other teleosts. Both the pigment and the scales, no doubt, were secondary protective adaptations, being absent normally.

Comment has already been made on the similar pigmentation of the tongue of the Washington fish, which may be seen on inspection of Pl. I, fig. 2. However, I have not been able to find any scales on the tongue of this fish or on that of the head of the specimen from Johns Hopkins. Before the article by Sutton had been seen, I had cleared a lot of coagulated mucus from the tongue of the Washington fish, but

this scraping would hardly have cleared away all the scales if such had been present. However, I do find minute backwardly pointing teeth on the middle and hinder sections of the tongue.

PUG-HEADEDNESS IN THE CLOSELY RELATED EUROPEAN GENUS *LABRAX* OF THE FAMILY SERRANIDÆ

The European sea bass of the family Serranidæ, *Labrax lupus*, is so closely related to the American striped sea bass, *Roccus lineatus*, that the former is sometimes given the generic name *Roccus* and the latter *Labrax* (as by Ayres above). And now, before describing and discussing Sutton's beautiful figures of the skulls of his normal and abnormal specimens, in which are to be found the explanation of all the phenomena under investigation, it will be well to review the accounts of pug-headedness in two specimens of the European *Labrax lupus*. One of these certainly helps to an understanding of this deformity in our American fish.

Mazza, in 1893, figured and described a pug-headed *Labrax lupus*. His photograph shows a fish with an abnormally short snout (the lower jaw being very little longer than the upper) and with a forehead rising at an angle of about 45° to a flat head. This specimen presents the mildest form of pug-headedness that I have yet seen. Perhaps it would be better designated as short-snoutedness, since both jaws are present and practically equal in length, as in the normal fish. It so little resembles the forms under consideration, that it does not seem necessary to describe it further nor to reproduce the figure.

However, in the same journal for 1904, Fasciolo figured and described a marked case of this deformity in *Labrax lupus*. His specimen was 380 mm. (15 in.) long and normal in every respect, save the head. As may be seen in his figure (Pl. III, fig. 2, herein), his fish had a head flat on top, like the American forms, with the upraised skull, the forwardly placed bulging eyes (so interpreted from his photograph), the steep forehead, and the brief retracted upper jaw with the projecting lower one, as found in our specimens. Specifically, the lower jaw projected 12 mm. (0.5 in.) only, being much shorter than ours.

The head of Fasciolo's fish was asymmetrical, the right side being twisted and more deformed than the left. The left maxillary was normal. It was 25 mm. long and stood at an angle of about 45°. The twisted right one was only 15 mm. long and stood nearly vertical, the lower end projecting much below the level of the lower jaw (see Pl. III, fig. 2). The right side of this head, then, was more like that found in American specimens.

To determine the conditions in the skull, Fasciolo made a preparation of the head and found the frontals bent sharply downward; the parasphenoid and vomer were incompletely ossified, were bent upward and twisted to the right. These facts explain why the two sides of this pug-headed fish are unsymmetrical, and probably explain the presumed bulging of the eyes. This is not referred to in his text, but one must so interpret his figures made from photographs. Fasciolo figures both the normal and these deformed maxillary bones, but unfortunately does not portray this deformed skull.

There is one other brief and unsatisfactory reference to an Italian pug-headed *Labrax lupus*. Paolo Panceri (Catalogo Sistematico del Gabinetto Anatomia Comparata nella Regia Università degli Studi di Napoli, Supplemento Primero, Napoli, 1872, p. 63) lists a *Labrax lupus*, "Individuo mopso," apparently received in 1872. He neither figures nor describes it, nor does he even indicate its size. All that can be said is that it is the third known Italian specimen of a pug-headed *L. lupus*.

COMPARISON OF NORMAL AND ABNORMAL SKULLS OF *ROCCUS LINEATUS*

The fish presented to the Museum is too valuable for exhibition purposes to permit its being skeletonized. However, just when there seemed to be no means of getting at the skull structure, save by having an X-ray photograph made, as has been done for the trout (Forsyth, 1926), I found Sutton's paper (1913), previously referred to, and in it excellent photographs of both a normal and the deformed skull. Having his kind permission to do so, these beautiful illustrations are reproduced herein as figures 3 and 4 of plate III.

Figure 3 of plate III shows a lateral view of a normal skull of *Roccus lineatus*. Note the huge orbital region roofed over by the frontals, having below it the parasphenoid, in front the nasals, ethmoid, and vomer, and behind the body of the cranium proper. It is in all essentials a typical teleost skull, and Sutton says that it came from "a fish of the same size and species" as the deformed fish.

Not so, however, the abnormal skull shown in Pl. III, fig. 4, the skull obtained by macerating the head of the deformed fish portrayed in Pl. III, fig. 1. If the two fish were of the same size (see end of preceding paragraph), their skulls should be directly comparable; and if the skulls were photographed at the same distance from the front lens of the camera, as appears to have been the case, then we have a direct basis of comparison. The normal skull measures 64 mm. between perpendiculars;

the abnormal one 51 mm. Then the deformed skull is 13 mm. shorter than the normal, having lost 20 per cent (one-fifth) of the normal length, and that in the region anterior to the eyes.

In the abnormal skull there has been a great upraising of the median portion of the cranium, and especially of that part in the vertical of the hinder edge of the orbit (from 23 to 29 mm., an increase of 6 mm. or 25 per cent). The anterior ends of the frontals have been bent almost vertically downward, the parasphenoid has been buckled up almost vertically, and the nasals, ethmoid, and vomer have been bent backward, inward, and upward until they have come to fill quite half the orbital cavity. This, then, gives rise to the marked exopthalmia noted by Sutton, found on my two specimens, indicated or inferred in the figure in the 'Sun,' in Fasciolo's figure, and in Ayres' description. Comparison of the two figures will make clear the tremendous changes involved. Thus, Sutton's beautiful figures and careful observations clear up the matter of the changes in the skull in all these serranids and the marked bulging of the eyes.

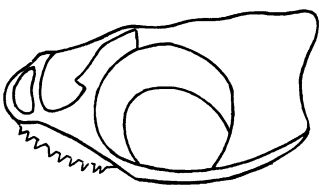

Fig. 2

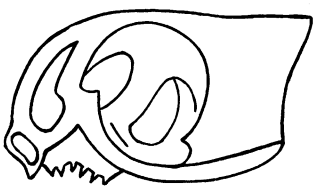

Fig. 3

Fig. 2. Semi-diagrammatic drawing of a normal salmon skull.
After Tornier, 1908.

Fig. 3. Semi-diagrammatic drawing of the skull of a pug-headed salmon.
After Tornier, 1908.

The only other figures known to me comparing the structures of normal and pug-headed skulls are Tornier's (1908) semi-diagrammatic drawings of such skulls in the salmon. Figure 2 shows his sketch of the normal salmon skull and Fig. 3 that of his pug-headed specimen. Here the parasphenoid and the tooth-bearing vomer are bent up at the same time that the anterior part of the skull is bent downward and backward. The anterior part of the head is upraised, shortened, and abruptly rounded as in the sea bass. The eye-cavity has been changed in shape and position (brought nearer to the front and top of the head), but it does not seem to have lost materially in size and volume. Certainly there seems no cause for any exopthalmia, and none was noted.

The only other figures of the skull are Forsyth's beautiful radiographs (1926) reproduced in my paper on pug-headedness in the Salmonidæ (Gudger, 1929). His lateral view is reproduced herein as figure 5 of plate III. Inspection of this figure will show the same normal lower jaw, the same shortened and abruptly rounded head with the anterior parts of the skull bent back onto the roof of the mouth and with a slight upbending of what I take to be the parasphenoid. The figures of the whole head, however, show no exopthalmia whatever.

PUG-HEADEDNESS IN OTHER PERCOIDS, IN SALMONIDS, AND IN CARPS

A few general references will now be brought together for the sake of completeness, so that brief comparison of the upper jaws of these fishes may be made with those of the sea basses studied herein.

Percoids

Marine Forms.—My colleague, Mr. John T. Nichols, tells me that some years ago he saw a pug-headed silver perch, *Bairdiella chrysura*, taken in Florida. This salt-water member of the family Sciænidæ is a perciform fish, distantly related to the fishes under consideration. Unfortunately, it could not be preserved and, as no notes were recorded, only mere mention of the deformity can be made.

Fresh-water Percoid Forms.—I have been able to find in the literature but two references to pug-headedness. In 1885, Herrick described such an abnormal black bass, *Micropterus salmoides*, from a lake in New Hampshire. This specimen was small, weighing only about half a pound. The lower jaw projected 7 mm. beyond the upper. The forehead was somewhat steeper than usual and the head noticeably flatter, according to the figure. The premaxillary was present and normal in position, the maxillary, likewise present, seemed normal, especially in the slight overhang of the lower jaw—i.e., the anterior part of the skull only is lacking. In all other points the fish was normal and in good condition. It does not seem necessary to reproduce Herrick's figure, since it bears no marked relation to these given herein.

In 1908, Pellegrin gave a verbal report before the Société Zoologique de France on a race of pug-headed perches. The first of these were taken in the Seine near Port-Villez. Certain of these monsters were placed in a pond of a nearby piscicultural establishment. Here they multiplied greatly and, at the time of Pellegrin's report, numbered from 300 to 400. They were very markedly different, however, in the degree of deformation of the head. No description of them is given.

Salmonids

The figures from my previous paper on these fishes (Gudger, 1929) being at hand, three of them will be introduced herein for comparison, together with such brief explanations as are necessary to bring out the contrasts.

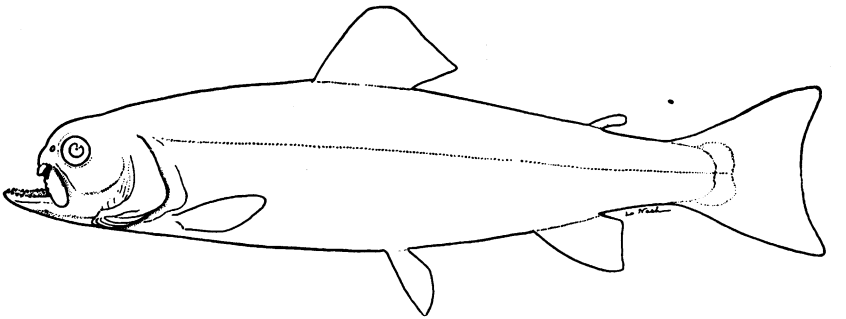

Fig. 4. Full-length sketch of a pug-headed brown trout. Contrast with figure 1 of Plate II.

After Gudger, 1929.

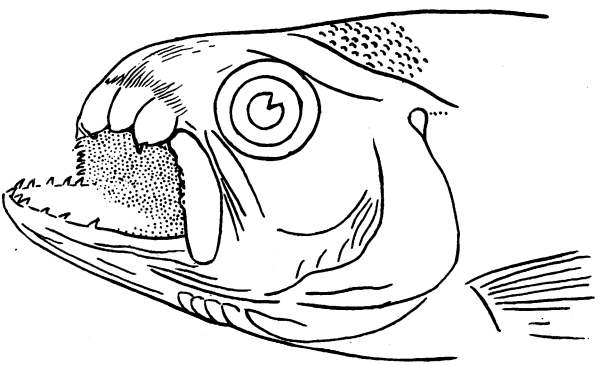

Fig. 5. Quartering view of the open mouth of the fish shown in Fig. 4. Remnants of the premaxillaries and also one much reduced maxillary are shown.

After Gudger, 1929.

Figure 4 is made from an outline drawing of a mounted 13.5–inch brown trout (*Salmo fario*) caught with a fly near Cairo, N. Y., in 1928. It is, so far as I know, the only hitherto published figure of an entire pug-headed fish. If compared with figure 1 of plate I, the differences in the structure of the front of the head and upper jaw are striking. Figure 5 is a quartering view of the head of the same fish drawn to show the remnants of the premaxillaries and the almost vertical position of the

maxillary. Six, or half of the salmonids, discussed in my paper had remnants of the premaxillaries in the front of the mouth or, better, roof of the buccal cavity, very much as shown in Fig. 5. The others dealt with had the premaxillaries pushed back into the buccal cavity and the teeth pressed against the roof of the mouth, and hence were invisible from the exterior. Figure 6 shows this, as it does the very much reduced maxillary standing vertically. This condition I described as the "round-headed" type of pug-heads among salmonids. In some of these the maxillaries are reduced to mere fragments. In this study one or two forms were found intermediate between the two types above noted.

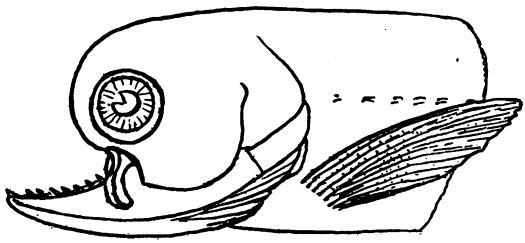

Fig. 6. Head of a "truite mopse" in which no trace of premaxillaries can be seen while the much reduced maxillary stands vertically. Type of the "round-headed" pug-head in salmonids.

After Carlet, 1879.

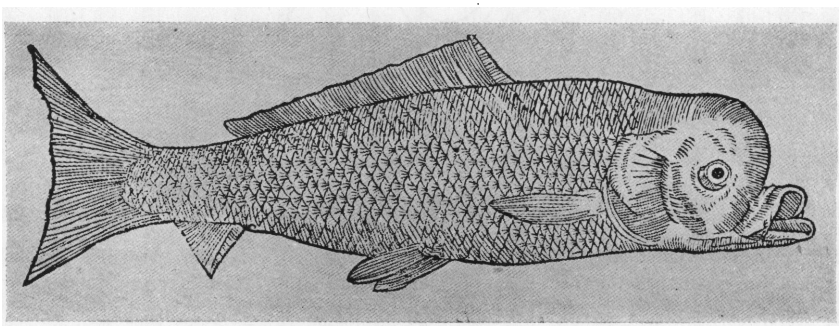

Fig. 7. A pug-headed carp. The oldest figure of such a known deformity, but closely comparable with present-day figures.

After Rondelet, 1555.

Carps

The only figure available of a pug-headed carp is that shown herein as Fig. 7. Furthermore, it is the first figure of a pug-headed fish ever published (from Guillaume Rondelet's 'Universæ Aquatilium Historiæ

Pars Altera,' Lugduni [Lyons], 1555).[1] This figure is included, not merely for its historical interest, but also since it is a fair drawing of a present-day pug-headed carp and interesting for comparison with the sea basses.

Compare Fig. 7 with figure 1 of plate I and note the steep forehead falling abruptly to the transversely placed remnant of an upper jaw. The lower jaw, unlike that in our fish, is but little longer than the upper. The mouth, however, is open. Of three other figures of pug-headed carps before me, two have mouths closely comparable with that in Rondelet's fish, and all have a distinct upper jaw standing at a steep angle to the lower. Also, all have the steep forehead with a marked overhang at the junction of the upper jaw with it. In short, there is more in common as to the general shape of forehead and upper jaw between the sea basses and the carps than between either fish and any other kind of pug-headed fish known to me.

THE CAUSE OF PUG-HEADEDNESS IN FISHES

This was briefly discussed in my paper previously referred to (Gudger, 1929)—briefly because little is known, certainly nothing from experiments on fishes. It has been conjectured that pug-headedness is due to an excessive intake of water through the egg-shell before hatching, whereby pressure is exerted on the developing embryo, resulting in deformity of the snout. This view, however, is now discredited. Sutton, by dissection, has shown the proximate cause in his specimen of *Roccus lineatus*. Here the "buckling" of the parasphenoid and displacement of the nasals, ethmoids, and preorbitals backward into the orbital cavity has produced the very marked exopthalmia. The Washington fish and the much-shrunken head of the Johns Hopkins specimen of *Roccus lineatus* both show the same marked protrusion of the eyeballs. So do Fasciolo's photographs of the closely related *Labrax lupus* of European waters. From this we may conclude that Sutton's discovery of the displaced bones as the causative factor may be extended to these other fish.

Apparently, the "buckling" of the parasphenoid has drawn in with it the other bones. Now it is known that pituitary disturbances bring about achondroplasia in mammals, including man himself. This failure of the bones to harden (noted by Fasciolo in his specimen), or properly develop, results in all sorts of facial abnormalities. Possibly

[1] I have elsewhere erroneously dated this figure, 1554, but the 'Pars Altera' of Rondelet's work was published one year later than the first section. Both parts are bound in one volume, hence the error.

this deformity in these fishes results from such an endocrine disturbance, but since pug-headedness begins in the embryo (see figures of embryos in my 1929 paper), it must arise as a germinal defect. Possibly the defect arises in the germ and is perfected by endocrine disturbances. There has been no experimental work in fishes along this line. The field is still open.

IS PUG-HEADEDNESS IN FISHES TRANSMISSIBLE?

Here again the available data has been given in a brief synopsis in my preceding paper on this abnormality (Gudger, 1929). Pug-headedness, since it arises in the embryo, certainly results from some genetic disturbance. Pug-headed dogs reproduce their kind, though they are not good breeders. Pug-headedness in fishes has apparently been transmitted. Knauthe (1893), in a series of interbreedings of normal descendants of pug-headed forms of *Leucaspius delineatus*, always got a fairly large percentage of pug-heads, showing that the factors for pug-headedness were transmitted from generation to generation.

The only person who seems to have made any observations on the interbreeding of actual pug-headed fishes is Pellegrin, as noted above. But his data were obtained from mere observation and not from any breeding experiments under strict control. It would seem that at Port-Villez the transmission of this abnormality has been shown in a general way, but in varying degrees of completeness of the defect.

From the observations and experiments referred to, it would seem that this teratological condition is transmissible. However, to prove it, pug-headed fish will have to be interbred generation after generation under conditions of strict control and constant observation.

HOW DO PUG-HEADED SEA BASSES FEED?

To this the answer is that no one knows. However, that they do readily feed is attested by the fact that the Washington specimen is 16.4 inches long and weighs 1 lb., 9.75 oz., that the Johns Hopkins specimen was approximately of the same size, that Sutton's fish weighed 2.75 lbs. (probable size, about 18 in.), that Commodore Benedict's fish tipped the scales at 2.5 lbs., and that Fasciolo's related *Labrax lupus* was 15 in. (380 mm.) long. In my paper previously quoted, I discussed the matter of feeding in pug-headed salmonids and expressed great doubts as to whether they could feed on flies at the surface of the water. Two correspondents, to whom I owed data, Mr. J. A. C. Forsyth of London and Mr. Arthur Wood of Glassel, Aberdeenshire, have since

written me that they have repeatedly had pug-headed trout and salmon take artificial flies without the least trouble. Furthermore, Mr. Forsyth has repeatedly seen such trout feeding on natural flies. They take in both kind by "suction"—i. e., by opening the mouth widely and suddenly and then expelling the water through the gills. How they take in minnows is not known. Perhaps the sea basses also take in food by "suction." It would certainly be very interesting to study the feeding habits of such a pug-head in an aquarium. Dissection of a 16.5-inch fresh, normal specimen with a greatly distended abdomen revealed a stomach filled with 300 cc. of partly digested small fishes. It is pretty clear that these must be started down the œsophagus head first, and just how a pug-headed sea bass can bring this about would be very interesting to observe.

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PLATES I TO III

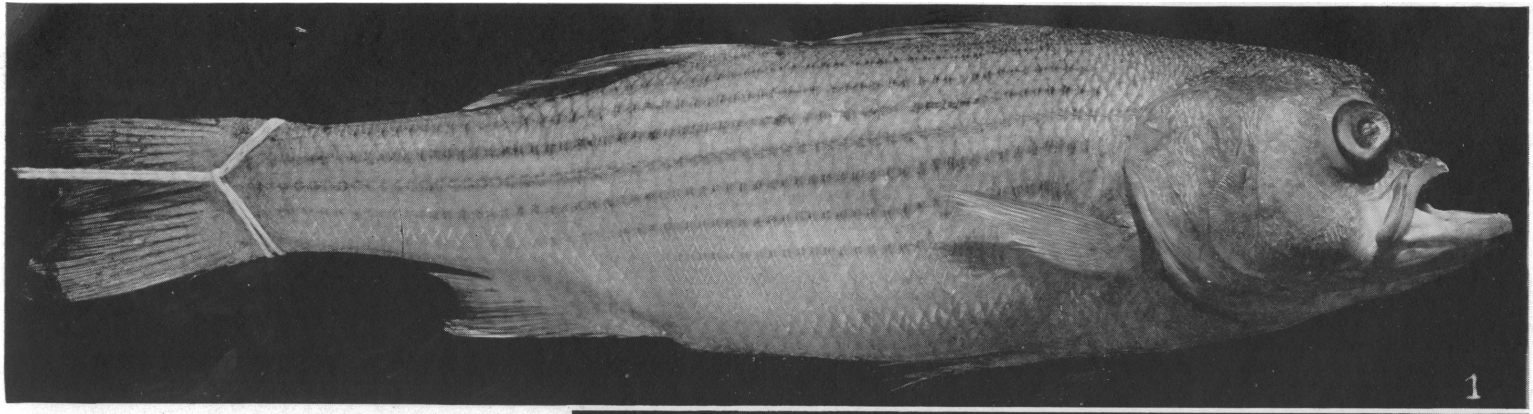
PLATE I

Fig. 1. Lateral view of 16.75-inch pug-headed sea bass, *Roccus lineatus*. Note the steep forehead, protruding eyes, short upper and long lower jaw.

Fig. 2. The head of the same fish seen from above. The protrusion of the eyes is more apparent, as is their closeness to each other. Note the bow-shaped upper jaw and the very wide lower one with the pigmented tongue lying in its cavity.

Fig. 3. The head of a 16.5-inch normal striped bass seen from above. Contrast this head with that portrayed in figure. 2.

Fig. 4. The head of the Johns Hopkins sea bass in dorsal view. Note protruding eyes, square-cut upper jaw and entirely normal lower one.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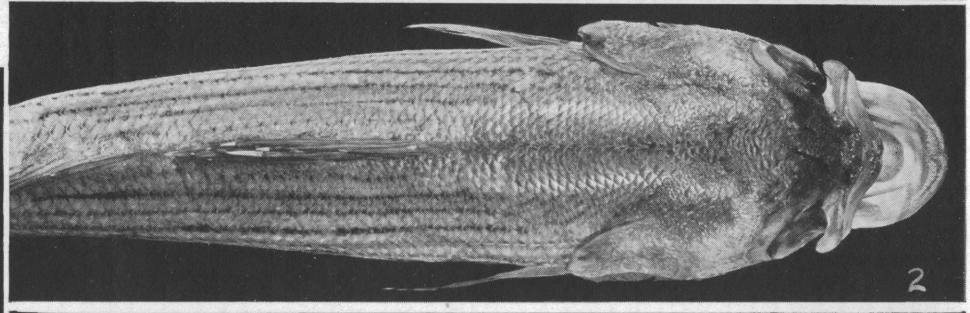
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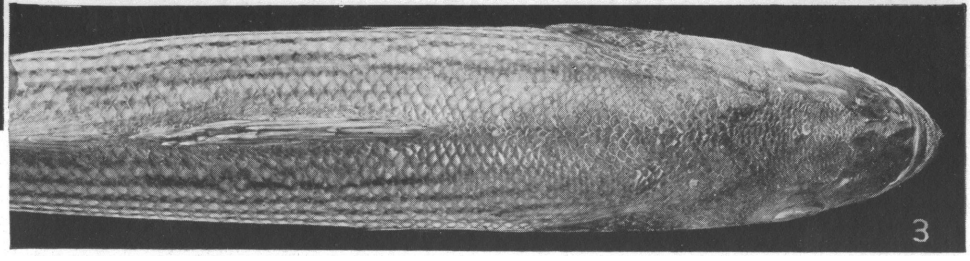
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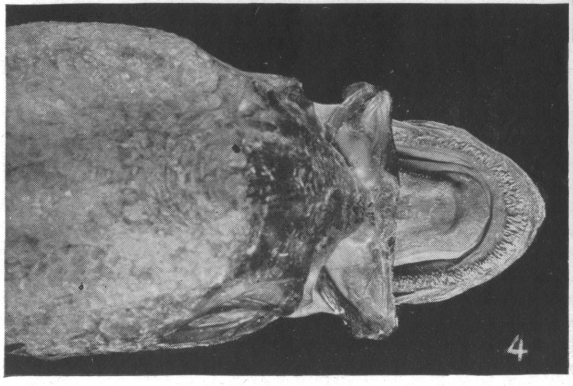
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PLATE II

Fig. 1. Lateral view of the head from Johns Hopkins. Note the configuration of the head and the upper jaw with its outer ends projecting below the level of the long lower jaw.

Fig. 2. "Head-on" view of the normal fish (seen from the side in Pl. I, fig. 3). This head and mouth will serve as a basis of comparison for those to follow.

Fig. 3. Frontal view of the pug-headed fish portrayed in Pl. I, figs. 1 and 2. Contrast the eyes with those in the preceding figure.

Fig. 4. Front view of the head of the Johns Hopkins specimen shown in Pl. I, fig. 4.

Fig. 5. Looking into the open mouth of a pug-headed brown trout (*Salmo fario*). The eyes here do not protrude.

After Forsyth, 1926.


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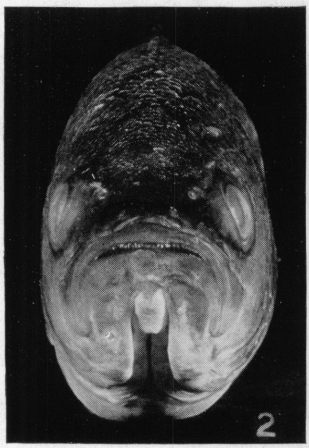
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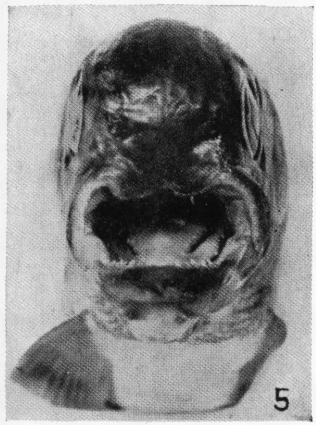
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PLATE III

Fig. 1. Lateral view of the head of another Baltimore pug headed sea bass. Compare with Pl. II, fig. 1.

After Sutton, 1913.

Fig. 2. Lateral view of a head of a pug-headed *Labrax lupus*, a closely related European sea bass. Compare with other heads in lateral view.

After Fasciolo, 1904.

Fig. 3. Radiograph of the pug-headed trout seen in Pl. II, fig. 5. Note the great curve of the frontals, also the nasals, ethmoid, and vomer pushed into the mouth, and what is apparently the up-buckled parasphenoid.

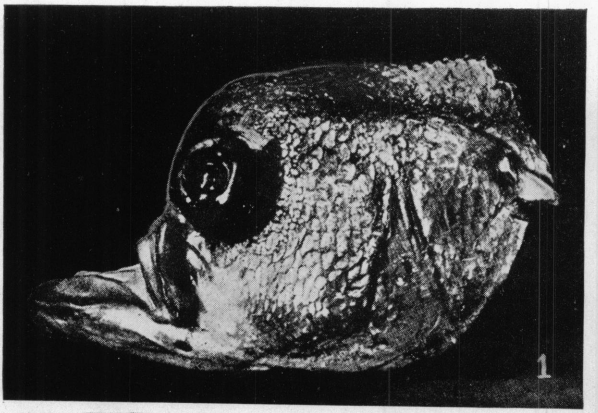
After Forsyth, 1926.

Fig. 4. The skull of a normal-headed sea bass. Note the large orbital cavity.

After Sutton, 1913.

Fig. 5. The skull of a pug-headed *Roccus lineatus*. Noteworthy are the sharply bent down frontals, and the nasals, ethmoid, and up-buckled parasphenoid occupying more than half of the orbital cavity.

After Sutton, 1913.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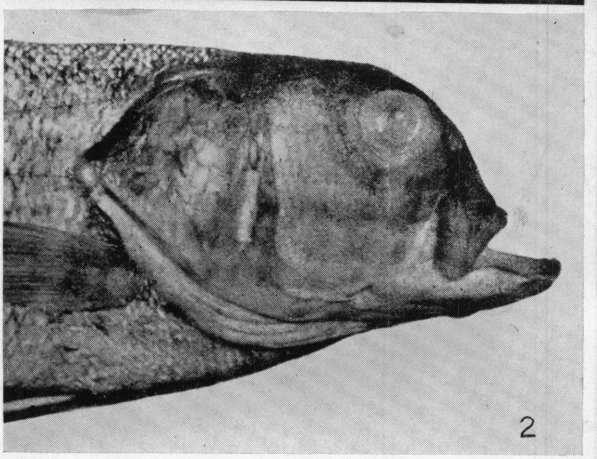
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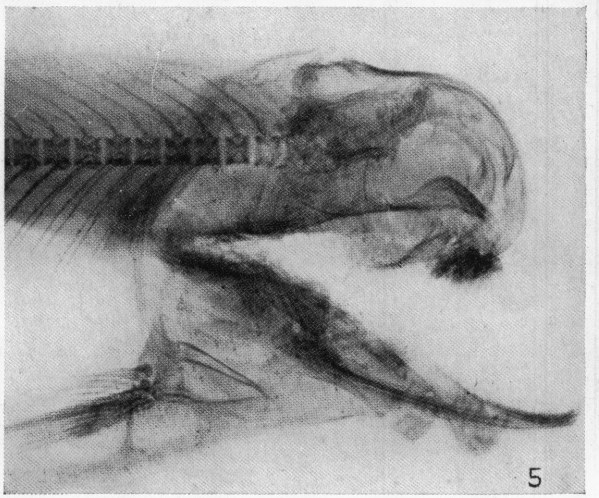
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