A REVIEW OF THE AMERICAN MENHADEN, GENUS BREVOORTIA, WITH A DESCRIPTION OF A NEW SPECIES

BY

SAMUEL F. HILDEBRAND

U. S. Fish and Wildlife Service

(Publication 3913)

CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
MARCH 22, 1948
A REVIEW OF THE AMERICAN MENHADEN, GENUS BREVOORTIA, WITH A DESCRIPTION OF A NEW SPECIES

BY

SAMUEL F. HILDEBRAND

U. S. Fish and Wildlife Service

(Publication 3913)
The Lord Baltimore Press
Baltimore, MD., U. S. A.
A REVIEW OF THE AMERICAN MENHADEN, GENUS BREVOORTIA, WITH A DESCRIPTION OF A NEW SPECIES

By SAMUEL F. HILDEBRAND

U. S. Fish and Wildlife Service

INTRODUCTION

The genus Brevoortia, as herein understood, contains seven American species, five of which occur on the Atlantic coast of North America and two on the Atlantic coast of South America. The genus has been reported, also, from the Atlantic coast of Africa. Indeed, Fowler (1936, p. 174) identified the African representative with B. tyrannus of the Atlantic coast of the United States. This record certainly is in need of verification. However, no specimens are available for study, and nothing new on the African menhaden can be added at this time.

The genus, in respect to the American species, was last reviewed by G. Brown Goode in 1878, who did such excellent work that most of his determinations still stand. I have elevated his B. tyrannus var. brevicaudata to full specific rank for reasons stated in the account of that species. I also have recognized B. aurea (Agassiz) as a separate and distinct species which Goode regarded as a geographical variant of B. tyrannus. Furthermore, I have recognized two species among the specimens identified and described, in part, by Goode as B. patronus. One of these apparently is new, and is named and described in these pages.

Brevoortia is not known from the tropical shores of America nor from the West Indies. In North America it ranges from Nova Scotia to the mouth of the Rio Grande, being missing, however, in southern Florida. In South America the genus is known from Bahia, Brazil, to Bahia Blanca, Argentina.

The menhaden fishery.—The success of the menhaden fishery on the Atlantic coast of the United States, and to a lesser extent on the Gulf coast of the United States, affects the economic status of the people of those areas profoundly, as many depend almost wholly on this fishery for a livelihood. This, like other marine fisheries, fluctuates greatly. Periods of great abundance sometimes are followed by
several lean years. However, it does not follow that when a small catch is made in North Carolina, for example, New Jersey also will have a small catch the same year. Indeed, the reverse may be true. The catch in the United States for certain years has exceeded 700,000,000 pounds, valued in recent years at about $11,000,000. A very small part of the catch is utilized as food for man, the bulk of it being used in the manufacture of oil, fish meal, and fish scrap. No fishery for Brevoortia seems to have been developed in South America, though the fish have been reported as abundant, at least at times, in southern Brazil and in Uruguay.

An explanation.—To avoid confusion, the following explanations are offered. The number of fin rays includes both simple and divided rays, and the number of scales is based on the oblique rows that cross the middle of the side between the margin of the opercle and the base of the caudal. It is highly important for conformity with enumerations in the descriptions that the rows are counted at the middle of the side, as in some species the scales become much smaller dorsally and larger ventrally. This enumeration can be made with a considerable degree of accuracy in the species with large scales, at least, if the specimens are held at the proper angle to sight along the rows, magnification generally being unnecessary. The vertical rows usually are more distinct than the oblique ones on the trunk, but become so indistinct on the tail that their enumeration is not practical. The number of modified scales on the back, in front of the dorsal, includes only those that have a free lateral edge. As these scales are not fully developed until a fairly large size is attained, it is advisable to use adult fish only for this enumeration, as explained subsequently. The serrations and pectinations of the scales are flexible (not spiny) in Brevoortia, and they are of unequal length in the different species (see fig. 8); therefore they are often useful in determining species. It is necessary, however, to compare scales from specimens of about equal size, as the pectinations increase in length with age. It is necessary, furthermore, to compare scales from the same part of the body. The scales illustrated in figure 8, for example, were all taken from the middle of the side below the anterior rays of the dorsal.

An attempt was made to count the abdominal and caudal vertebrae separately. However, so much difficulty was met that the separation was abandoned and only the total number of vertebrae is given in the descriptions.
The length of the head was measured from the rim of the snout to the most distant part of the bony margin of the opercle, and its depth is the distance between the slight groove at the occiput and the keel of the first ventral scute. Although the last-mentioned measurement is not an exactly vertical one, it does constitute one between two solid points, and therefore a fairly accurate one. The mandible was measured to its posterior extremity. The length of the pectoral and ventral fins in each instance is the distance between the base of the first ray and the tip of the fin; the lower lobe of the caudal was measured from the middle of the caudal base; and the axillary appendage of the pectoral was measured from the base of the upper ray of the pectoral. The other measurements were made in the usual way, or if there is any deviation, it is so stated in the descriptions.

Acknowledgments.—The writer is indebted to many persons for specimens, data, and other help received. He is particularly grateful to Gordon Gunter, of the University of Texas, for furnishing a very fine series of specimens of the new species herein named for him. The kindness of William C. Schroeder, of the Museum of Comparative Zoology, and of William C. Neville and John C. Pearson, of the United States Fish and Wildlife Service, in furnishing specimens is deeply appreciated. I am indebted, furthermore, to Mr. Schroeder for the loan of specimens from South America, for without them it would not have been possible to give adequate descriptions of those hitherto obscure species. I am grateful, of course, to those officers of the United States National Museum who have provided laboratory space and the use of the specimens in the National Museum collections.

While most of the data used were compiled by me, during the course of about 30 years, I have included some unpublished enumerations and proportions by the late William C. Welsh, and others by Dr. A. B. Hardcastle, now of the United States Bureau of Animal Industry. I am grateful to Dr. Hardcastle for the use of his unpublished manuscript on B. tyrannus based on a study of specimens from Beaufort, N. C. The illustrations were prepared by Mrs. Ann S. Green, biological aid with the United States Fish and Wildlife Service, who also gave valuable assistance in compiling the data and in preparing the bibliography.

Origin and necessity of the review.—This review is primarily a "by-product" of the study of the genus in connection with the preparation of accounts of the species of Clupeidae for the forthcoming general publication on the "Fishes of the Western North Atlantic," by the Sears Foundation, Yale University. As that general work is intended for the use of the general biologist and intelligent layman, taxonomic
reviews are out of place. Therefore, this somewhat technical treatise is offered as preliminary to the more general treatment given the North American species in the general work mentioned. This preliminary study of the American species was necessary because some of the species were imperfectly known. The South American species, indeed, had been identified with *B. tyrannus*, as only subspecifically, or as specifically distinct from it. Under this confusion it was not even possible to state the range of the commonest species of North America.

**Genus BREVOORTIA Gill**

**The Menhaden**

*Brevortia* Gill, 1861, p. 37 (genotype by designation, *Brevortia menhaden* Gill = *B. tyrannus* (Latrobe)).

*Description.*—Body oblong, compressed, median line of chest and abdomen with a sharp edge, bearing bony scutes; mouth large, the maxillary extending to or beyond middle of eye; upper jaw with a distinct median notch; lower jaw included in the upper one, not projecting, its upper margin (within the mouth) nearly straight; teeth wanting in adults; cheek (bone below eye) deeper than long; lower limb of first gill arch with an obtuse angle; gill rakers long, slender, numerous, increasing in number with age, those on upper limb of first arch extending downward and over those on the upper part of the lower limb; scales adherent, exposed parts much deeper than long, the margins serrate or pectinate in adults; a series of modified scales next to median line of back in front of dorsal fin; vertebrae about 42 to 50; dorsal with 17 to 22 rays—the last one not produced—origin of fin about equidistant from margin of snout and base of caudal; anal with 17 to 25 rays; ventral fins small, with 7 rays; intestine very long; peritoneum black.

*Some changes that occur with age and growth.*—Young, under about 70 mm. in total length, have minute teeth on the margin of the maxillary (verified in all the species except *aurea* and *smithi*), which soon disappear with age and growth. In such young the gill rakers are short and those on the upper limb of the first arch do not yet extend downward over those on the upper part of the lower limb. The two series of modified scales, one on each side of the median line of the back in front of the dorsal fin, often do not become fully developed until the young reach a total length of 100 to 125 mm. or more, and the other scales have merely somewhat indented edges in the young, the serrae or pectinations developing with age and growth, being
longer in large specimens than in half-grown ones. This development makes it necessary to compare specimens of the different species of nearly equal size as already indicated, to show actual differences in this respect. It is important, also, to compare scales from the same part of the body, as the serrations are not uniformly developed on all parts. In general, the serrae are larger on the scales from the back than those from the lower part of the side. The illustrations (fig. 8) given are based on scales of adults taken from the middle of the side below the anterior rays of the dorsal.

Relationship of the species.—The seven species of American menhaden roughly fall into two groups on the basis of scales. One group—\textit{tyrannus}, \textit{brevicaudata}, \textit{patronus}, \textit{pectinata}, and \textit{aurea}—has moderately large scales, which are arranged in fairly regular series on the sides of the body, and the other group—\textit{smithi} and \textit{gunteri}—has smaller and more irregularly placed scales. The species may also be divided into two groups on the shape of the ventral fins, \textit{tyrannus}, \textit{brevicaudata}, and \textit{patronus} having rounded fins in which the innermost ray is not much shorter than the outermost one, while \textit{smithi}, \textit{gunteri}, \textit{pectinata}, and \textit{aurea} have fins with nearly straight (somewhat convex in \textit{aurea}) oblique margins in which the innermost ray is much shorter than the outermost one (see fig. 9), giving the fin a pointed appearance when folded. Also the South American species may be separated from the North American ones by the smaller reduction in the size of the scales on the back and on the base of the caudal in comparison with the scales on the middle of the side.

The North American species fall into two closely related pairs, namely, \textit{tyrannus} from the Atlantic and \textit{patronus} from the Gulf, and \textit{smithi} from the Atlantic and \textit{gunteri} from the Gulf, and one odd one, \textit{brevicaudata}, from Noank, Conn., related to \textit{tyrannus}. The close relationship between the species of each pair named is not confined to Brevoortia, as a similar relationship exists between the shad, \textit{Alosa sapidissima}, of the Atlantic, and \textit{A. alabamae} of the Gulf, and also between \textit{Pomolobus mediocris} of the Atlantic and \textit{P. chrysochloris} of the Gulf and Mississippi Valley. Nor is such a relationship limited to the family Clupeidae, as two similarly closely related pairs are known to exist in the family Sciaenidae, namely, \textit{Cynoscion regalis} of the Atlantic and \textit{C. arenarius} of the Gulf (Ginsburg, 1929, p. 83), and the other pair occurs in the genus \textit{Menticirrhhus} (also discovered by Ginsburg, unpublished).

In each pair of the fishes named, the range very probably once was continuous, but became discontinuous when the last passageway for fishes across the Florida peninsula became closed. None of the fish
named occur in southern Florida, indicating that suitable conditions for their welfare do not exist there. Hence, the separation of the Atlantic and Gulf representatives is complete. Under this separation, and under the influence of a different environment, the fishes named seem to have become sufficiently differentiated to constitute distinct species.

KEY TO THE SPECIES

a. Scales relatively large, fairly regularly placed, 35 to 56 oblique series crossing middle of side; body rather elongate, its greatest depth 30 to 40 percent of the standard length.

b. Scales on back and at base of caudal much smaller than those along middle of side; ventral fin with a definitely convex margin; the innermost ray more than two-thirds length of the outermost one, the fin not pointed when folded; upper part of opercle with prominent radiating striae; shoulder spot followed by a variable number of smaller dark spots in adults.

c. Ventral outline of body anteriorly moderately convex; usually only about half the greatest depth below a straight line extending through lower margin of eye to middle of base of caudal; sheath of scales at base of dorsal fin low, composed for the most part of a single row of scales, covering only the basal third of the longest rays when standing erect; pectoral fin rather short, falling far short of reaching base of ventral fin, 3 to 7 vertical series of scales between its tip and base of ventral, the fin with 16 to 18 (rarely 15) rays.

d. Maxillary long, reaching well beyond vertical from posterior margin of pupil, 13 to 16 percent of standard length; mandible long, 16 to 19 percent; pectoral fin moderately long, failing to reach base of ventral fin by less than diameter of eye, 3 or 4 vertical rows of scales between tip of pectoral and base of ventral, its length 17 to 21 percent of standard length; caudal fin moderately long, the lower lobe about as long as head, 25 to 35.5 percent of standard length .................................................. tyrannus, p. 7

dd. Maxillary shorter, reaching only to vertical from posterior margin of pupil, 12 to 13 percent of standard length; mandible short, 15.5 to 16 percent; pectoral fin short failing to reach base of ventral fin by a distance exceeding diameter of eye, 5 to 7 vertical series of scales between its tip and base of ventral, its length 15.5 to 16 percent of standard length; caudal fin very short, the lower lobe shorter than head, 22.5 to 25 percent of standard length .................................................. breviceudata, p. 10

c. Ventral outline of body anteriorly strongly convex; much more than half the greatest depth below a straight line extending through lower margin of eye to middle of base of caudal; sheath of scales at base of dorsal fin much higher, composed for the most part of two rows of scales, covering basal two-thirds of shortest rays when standing erect; pectoral fin longer, often nearly reaching base of ventral fin, seldom more than 1 or 2 vertical series of scales between its tip and base of ventral, the fin with 14 to 17 (usually 15 or 16)
rays; caudal fin long, the lower lobe often longer than head, 31 to 39
(usually 32 to 36.5) percent of standard length........patronus, p. 13

bb. Scales on back and at base of caudal not much smaller than those along
middle of side; ventral fin with a nearly straight to slightly convex
oblique margin, the innermost ray not more than two-thirds length
of the outermost one, the fin pointed when folded; upper part of
opercle with feeble radiating striae if any; shoulder spot not followed
by smaller dark spots.

c. Scales large, 33 to 46 oblique series crossing middle of side, 5
longitudinal rows on side of caudal peduncle; pectoral fin long,
sometimes reaching base of ventral fin, occasionally falling short
of this point by diameter of pupil, its length 17.5 to 21 percent of
standard length, 0 to 3 vertical series of scales between its tip and
base of ventral..........................pectinata, p. 21

dd. Scales smaller, 48 to 56 oblique series crossing middle of side,
7 longitudinal rows on side of caudal peduncle; pectoral fin
shorter, failing to reach base of ventral fin by a space varying
from a half to a full diameter of eye, its length 16.7 to 18
percent of standard length, 3 to 6 vertical series of scales be-
tween its tip and base of ventral.................aurea, p. 25

aa. Scales quite small, irregularly placed, difficult to enumerate, about 60 to
75 oblique series crossing middle of side; body deep, its greatest depth
36 to 45.5 percent of standard length; upper part of opercle with feeble
radiating striae or none; shoulder spot not followed by smaller dark
spots.

f. Head small, its length 29 to 31.5 percent of standard length; maxillary
reaching below middle of eye to posterior margin of pupil, 2.0 to 2.4 in
head; pectoral fin short, generally failing to reach base of ventral fin
by rather more than half diameter of eye, 5 to 8 vertical series of scales
between its tip and base of ventral, its length 18.5 to 21 percent of
standard length; total number of ventral scutes 30 to 32 (usually 30);
vertebrae 45 to 47...............................smithi, p. 28

ff. Head larger, its length 31 to 35.5 (usually 32 to 34) percent of standard
length; maxillary reaching to or a little beyond vertical from posterior
margin of pupil, 1.8 to 2.2 in head; pectoral fin longer, generally fail-
ing to reach base of ventral fin by less than diameter of pupil, 2 to
4 vertical series of scales between its tip and base of ventral, its
length 19 to 23.5 (usually 20 to 22) percent of standard length; total
number of ventral scutes 27 to 30 (usually 28 or 29); vertebrae 42
to 44........................................gunteri, new species, p. 31

BREVOORTIA TYRANNUS (Latrobe)

MENHADEN, MOSSBUNKER, BUNKER, FATBACK, SHAD, POGY, BUGFISH

Figure 1

Clupea tyrannus LATROBE, 1802, p. 77, pl. 1, Chesapeake Bay (name; drawing,
without dorsal fin; no description; notes, which do not seem to apply to
menhaden, but more probably to some species of Pomolobus; an isopod,
Olencira praegustator, removed from the mouth of the fish, and described).
**Clupea menhaden** Mitchill, 1815, p. 453, New York (original description; occurrence in New York).

**Clupea neglecta** Rafinesque, 1818, p. 206, Long Island, N. Y. (original description).

**Alosa menhaden** De Kay, 1842, p. 259, pl. 21, fig. 60 (description; local names; economic importance; occurrence in New York).

**Alosa sadina** De Kay (not of Mitchill), 1842, p. 263, pl. 40, fig. 129 (description; figure clearly shows *B. tyrannus*).

**Clupea carolinensis** Gronow, 1854, p. 140, South Carolina (original description).

**Brevoortia menhaden** Gill, 1873, p. 811 (common names; range).

**Brevoortia tyrannus** Goode, 1878a, p. 5 (a discussion establishing the validity of Latrobe's specific name, *tyrannus*); 1878b, p. 31 (description; compared with "var. aurea," and with "patronus"; "varieties" *menhaden* and *aurea* recognized, and a new variety, *brevicaudata*, named and defined); 1879, p. 19 (a complete history of the American menhaden; species and varieties discussed; common names; industry fully described).—**Jordan and Evermann**, 1896, p. 433, and 1900, fig. 195 (description; range; synonymy).

---

**Fig. 1.**—*Brevoortia tyrannus*, based on a specimen 320 mm. in total length, 247 mm. in standard length (U.S.N.M. No. 120809), from Chesapeake Bay at Kenwood Beach, Md.

**Validity of the specific name tyrannus.**—Although Latrobe did not describe the fish he named *Clupea tyrannus*, and even though the notes he gave probably apply to *Pomolobus pseudoharengus* (Wilson), his figure resembles the menhaden closely. This is true, notwithstanding the fact that it lacks a dorsal fin. The shape certainly is correct for the menhaden, and the dark shoulder spot, constantly present, is correctly indicated. The presence of the isopod, *Olencira praegustator*, in its mouth, which Latrobe did describe and figure, offers further proof that he was dealing with the menhaden, for according to Richardson's "Monograph on the Isopods of North America" (1905, p. 231) this crustacean is known to be parasitic only on the menhaden *Brevoortia*, which apparently still holds true. There seems to be no reason, then, to question the availability of the specific...
name *tyrannus* for this species, even though Latrobe offered no description.

**Relationship.**—*B. tyrannus* of the Atlantic is closely related to *B. patronus* of the Gulf of Mexico. The relationship is shown in a parallel comparison in the account of the last-mentioned species (p. 20).

**Source of the data and their presentation.**—The proportions and enumerations given in the following paragraph are mostly based on 100 or more specimens and some of them on 200 or more examples. In the range of proportions specimens less than 70 mm. in total length were excluded because they were considered juveniles. The material studied was collected at many places, from Massachusetts Bay (vicinity of Boston) to Mayport, Fla. The range in the percentages of the parts measured in the standard length is given first in each instance, and this is followed by the number of times these same parts are contained in the standard length or in the head, as the case may be, enclosed in parentheses.

**Some proportions and enumerations.**—Head 28 to 36 (2.75 to 3.5 in standard length), its depth 25 to 32 (3.1 to 4.0 in standard length); depth of body 30 to 39 (2.5 to 3.3 in standard length); base of anal 14 to 19 (5.25 to 7.1 in standard length); lower lobe of caudal 25 to 35 (2.85 to 4.0 in standard length); caudal peduncle, depth 8.5 to 11 (2.9 to 4.0 in head); eye, difficult to measure because of much adipose tissue, about 5.5 to 8.3 (about 4.4 to 6.2 in head); snout 5.5 to 9 (3.9 to 5.5 in head); interorbital (bone) 6.2 to 8.2 (4.2 to 5.3 in head); maxillary 13.5 to 16.5 (1.9 to 2.7 in head); mandible 16.5 to 20 (1.7 to 2.0 in head); pectoral 17 to 20 (1.6 to 1.9 in head); axillary appendage of pectoral variable, 8.0 to 15 (2.3 to 3.8 in head). Dorsal rays 17 to 22; anal rays 18 to 24; pectoral rays 16 to 18, rarely 15; scales in oblique series crossing middle of side 41 to 55; vertical series between tip of pectoral and base of ventral 3 or 4; modified scales in a series in front of dorsal 31 to 43; ventral scutes 30 to 35; gill rakers on lower limb of first arch increasing in number with age, about 60 in specimens 60 mm. long, about 100 in specimens 100 mm. long, about 140 in examples 200 to 250 mm. long, and 150 to 160 in large adults 330 to 360 mm. long; vertebrae 47 to 49, rarely 45, 46 or 50 (enumerated in 194 specimens).

**Variation.**—The range in many of the proportions and enumerations given in the preceding paragraphs is rather wide. This results in part from the many specimens used, and in part from the differences in examples from the various localities within the range of the species. The proportions also are affected by the large range in size
of the specimens measured. Insufficient specimens even now are available for the definite determination of the races or populations that exist. For example, only four specimens from the entire Gulf of Maine are at hand, and none from South Carolina and Georgia. Furthermore, the material from North Carolina and Florida includes few large adults. Therefore, a definite analysis of the various races or populations must await the receipt of additional specimens for study. It can only be stated that the head tends to become larger toward the southern part of the range, as both its length and depth increase slightly in proportion to the standard length. Similarly, the maxillary, the mandible, the pectoral fin, and the caudal fin are proportionately rather longer in specimens from the southern part of the range than in those from the northern part. There is also a slight average reduction in the number of dorsal rays in southern specimens. The data do not show a decrease in the number of vertebrae in southern examples, which is so common an occurrence in fishes generally that it was expected.

It may be noted also that in general northern fish run larger in size, are fatter, and definitely yield more oil per fish than southern ones. Furthermore, spawning occurs during the summer northward, as at Woods Hole, Mass., whereas southward, as in the Chesapeake Bay area, and on the coast of North Carolina, it definitely occurs in late fall and winter. The evidence, then, indicates that each section of the coast has its own population or race. However, as already indicated, more data are required before the morphological differences can be shown accurately.

**Range.**—Nova Scotia to Florida. Taken commercially from Maine to Mayport, Fla. More or less reliably reported from as far south as off Cape Carnaveral and Mosquito Inlet, Fla. (Goode, 1879, p. 36). This species has been reported from the Gulf of Mexico and from South America by various authors. However, menhaden from the Gulf and from South America are recognized herein as distinct species. It has also been reported from West Africa, a record regarded by the writer as probably incorrect, which he cannot verify, however, as the necessary specimens are not at hand.

**BREVOORTIA BREVICAUDATA** Goode

*Figure 2*

*B. tyrannus* var. *brevicaudata* Goode, 1878b, pp. 34 and 37, Noank, Conn. (descriptive notes; compared with “normal” *tyrannus* and with *aurea*; table of measurements and enumerations).
Brevoortia tyrannus brevicaudata Goode, 1879, p. 22, Noank, Conn. (said to vary from "normal" type of tyrannus in having a shorter maxillary, a shorter mandible, lower anal, and shorter caudal).—Jordan and Evermann, 1896, p. 434 (compared with aurea, after Goode).—Jordan, Evermann, and Clark, 1930, p. 44 (range; synonymy).

Study material.—G. Brown Goode (1878b) in his revision of the genus Brevoortia, reported certain specimens from Noank, Conn., as differing from the local "normal" tyrannus in several respects, and as closely related to aurea, a South American menhaden. He designated the Noank specimens a variety of tyrannus, naming it brevicaudata because of the very short caudal fin. I have examined eight specimens from Noank, Conn. The same ones were studied, at least in part, by Goode, who gave in a table of measurements and enumerations the National Museum number 14846, which one of the two lots still bears. These specimens (U.S.N.M. Nos. 14044 and 14846), collected in 1874, are still the only ones of their kind in the collections (mostly in the National Museum) studied. It is indeed strange that no others like them have been noticed.

Relationship.—B. brevicaudata cannot be a geographical variant, as typical tyrannus also occur in the general vicinity of Noank, Conn. The specimens from Noank, in fact, differ in so many characters from tyrannus, some of which show no intergradation, that it becomes necessary to recognize them as representing a distinct species. The distinguishing characters of brevicaudata and tyrannus are shown in the parallel comparison that follows. To make the comparison a fair one specimens of about equal size and all from the general vicinity of Noank, Conn., were used. The differences would be even greater.
if specimens of *tyrannus* from the southern part of the range, as from Florida, were compared, as they have larger heads and longer fins than northern material.

*A lectotype designated.*—As Goode did not designate a type, I have selected a specimen (U.S.N.M. No. 129797) approximately 180 mm. (caudal imperfect) in total length and 145 mm. in standard length as lectotype. This specimen is from a lot quite certainly examined by Goode, as already stated.

*Source of the data and their presentation.*—The following list of proportions and enumerations are based on the eight specimens already listed, which vary from 165 to 180 mm. in total length, and from 126 to 147 mm. in standard length. The range in the percent of standard length of the parts measured is given first in each instance followed by the proportion based on the lectotype, and then the proportion in the standard length or in the head is enclosed in parentheses. The enumerations are given in the same order.

*Some proportions and enumerations.*—Head 29 to 30, 29 (3.3 to 3.85, 3.45 in standard length), its depth 26 to 27.5, 26 (3.6 to 3.84, 3.8); depth of body 35 to 38, 36 (2.6 to 2.85, 2.8); anal base 17.5 to 19, 17.5 (5.25 to 5.7, 5.7); lower lobe of caudal 22 to 25, 25 (4.0 to 4.4, 4.0); depth of caudal peduncle 9.6 to 10.5, 9.8 (2.8 to 3.0, 2.9 in head); eye 5.4 to 6, 5.4 (4.7 to 5.4, 5.25 in head); snout 6.4 to 7.3, 7.3 (3.9 to 4.6, 3.9 in head); interorbital (bone) 6.2 to 7.0, 7.0 (4.1 to 4.7, 4.1 in head); maxillary 12 to 13, 12 (2.2 to 2.4, 2.4 in head); mandible 15.5 to 16, 15.5 (1.8 to 1.9, 1.85 in head); pectoral fin 13.5 to 16, 14.5 (1.8 to 2.2, 2.0 in head); axillary appendage of pectoral 8.0 to 9.4, 8.9 (3.0 to 3.8, 3.2 in head). Dorsal rays 20 or 21, 21; anal rays 21 or 22, 21; pectoral rays 17; scales, oblique series crossing middle of side, 47 to 53, 48; vertical series between tip of pectoral and base of ventral 5 to 7, 6; modified scales in a series in front of dorsal fin 35 to 39, 39; ventral scutes 31 to 33, 33; gill rakers on lower limb of first arch 112 to 127, 124; vertebrae 48 (enumerated in 1 specimen).

The lectotype (fig. 2) has only the shoulder spot. However, one specimen with it has a rather definite row of smaller dark spots below and behind the shoulder spot, indicating that auxiliary spots, at least sometimes, are present in this species.

*A parallel comparison of* B. *tyrannus and B. brevicaudata.*—The principal differences between *tyrannus* and *brevicaudata* are shown in the following parallel comparison, wherein only specimens of about equal size from the same general vicinity were considered.
**MENHADEN, GENUS BREVOORTIA—HILDEBRAND**

**tyrannus**

Head moderately large, its length 30 to 33 percent, and its depth 27.5 to 31 percent of standard length.

Maxillary long, reaching well beyond vertical from posterior margin of pupil, 13.5 to 16.5 percent of standard length.

Mandible moderately long, 16.5 to 19 percent of standard length.

Eye moderately large, 6.2 to 6.9 percent of standard length.

Origin of dorsal generally a little nearer base of caudal than margin of snout.

Pectoral fin moderately long, failing to reach base of ventral by less than diameter of eye, 3 or 4 vertical rows of scales between its tip and base of ventral, its length 19 to 20 percent of standard length, 1.6 to 1.75 in head.

Axillary process of pectoral variable in length, generally about two-thirds length of fin, 10 to 11.5 percent of standard length.

Caudal fin moderately long, the lower lobe about as long as head, 29 to 34 percent of standard length.

Dorsal fin moderately elevated anteriorly, the longest rays greatly exceeding the depth of the caudal peduncle.

**brevicaudata**

Head small, its length 29 to 30 percent, and its depth 26 to 27.5 percent of standard length.

Maxillary shorter, reaching vertical from posterior margin of pupil, 12 to 13 percent of standard length.

Mandible shorter, 15.5 to 16 percent of standard length.

Eye small, 5.4 to 6.0 percent of standard length.

Origin of dorsal somewhat nearer margin of snout than base of caudal.

Pectoral fin very short, failing to reach base of ventral by a distance greater than diameter of eye, 5 to 7 vertical rows of scales between its tip and base of ventral, its length 13.5 to 16 percent of standard length, 1.8 to 2.2 in head.

Axillary process of pectoral very short and broad, only about half the length of fin, 8.0 to 9.4 percent of standard length.

Caudal fin shorter, the lower lobe much shorter than head, 22 to 25 percent of standard length.

Dorsal fin little elevated anteriorly, the longest rays equal to the depth of the caudal peduncle.

**Range.**—Known only from Noank, Conn.

**BREVOORTIA PATRONUS** Goode

Large-scale Gulf Menhaden

**Figure 3**

*Brevoortia tyrannus* Goode, 1878b, p. 39, Brazos Santiago, Tex. (description based on Brazos Santiago specimens (U.S.N.M. No. 892); diagnosis and table of measurements based in part on specimens from the "Mouth of the Rio Grande" (U.S.N.M. No. 891), which are *B. gunteri* n. sp.); 1879, p. 26, pl. 5 (diagnosis and description copied from original account); 1884, p. 575, pl. 206 (common names; movements; parasites; reproduction; food).—**JORDAN, EVERMANN, and CLARK, 1930, p. 44 (range; synonymy).**

*Brevoortia tyrannus* tyrannus* Jordan and Evermann, 1896, p. 434 (compared with Atlantic menhaden; range and abundance; synonymy).—**EVERMANN**
and Kendall, 1892, p. 105, pl. 21, Galveston, Tex. (differences between Atlantic and Gulf menhaden regarded as slight).

*Brevoortia tyrannus* Gunter (not of Latrobe), 1945, p. 29 (occurrence on coast of Texas; habitat).

**Type material.**—This species was described in Goode's revision of this genus (1878b). The account was based on specimens from Brazos Santiago, Tex., and on specimens from the "Mouth of the Rio Grande." That Goode confused two species is evident from a critical reading of his published data and the examination of his type material. The latter now consists of four lots of specimens. The lot (U.S.N.M. No. 892), containing two specimens, each 98 mm. in standard length (caudal fins broken), from Brazos Santiago, Tex., was designated "types" either by Goode or someone else. This designation seems entirely proper, as Goode stated that his description was based on specimens from Brazos Santiago, and in it he used only proportions and enumerations based on these specimens as given in his "Table of Measurements." Therefore, these types definitely represent *B. patronus*, as herein understood. There is at hand a second lot of five small specimens (U.S.N.M. No. 893) also from Brazos Santiago, which Goode must have seen, even though he did not specifically mention them. These specimens, nevertheless, were recorded as "*Brevoortia patronus*" in the register of the Museum along with the types. This lot now consists of one specimen of *B. patronus*, and four of *B. gunteri* n. sp., as herein understood.

Another lot of nine small specimens (U.S.N.M. No. 891) collected in the mouth of the Rio Grande, designated as paratypes of *B. patronus*, also was examined by Goode, as he gave proportions and enumerations for three of these specimens in his tables. These specimens

---

Fig. 3.—*Brevoortia patronus*, based on a specimen 215 mm. in total length, 164 mm. in standard length (U.S.N.M. No. 129810), taken off Galveston, Tex.
| Species               | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 |
|----------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| B. tyrannus          |    |    |    |    | 1  | 2  | 3  | 8  | 12 | 15 | 16 | 14 | 19 | 6  | 12 | 6  | 3  | 2  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. brevicaudata      |    |    |    |    | 1  | 4  | 2  | 11 | 10 | 19 | 14 | 13 | 9  | 4  | 12 | 8  | 3  | 2  | 1  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. patronus          |    |    |    |    |    | 1  | 3  | 1  | 4  | 3  | 7  | 4  | 2  | 2  | 2  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. pecinata          |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. aurea             |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. smithii           |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. gunteri           |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

Number of modified scales in a series on back in front of dorsal fin

| Species            | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 |
|--------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| B. tyrannus        |    |    |    |    |    | 4  | 7  | 16 | 20 | 26 | 37 | 38 | 41 | 42 | 43 | 44 | 45 | 46 | 47 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. brevicaudata    |    |    |    |    | 1  | 2  | 1  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. patronus        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. pecinata        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. aurea           |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. smithii         |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. gunteri         |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

Table 1.—Number of scales in species of Brevoultia

Number of oblique series crossing middle of side

Number of modified scales in a series on back in front of dorsal fin
| Species          | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 |
|-----------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| B. tyrannus     |    |    |    |    |    |    |    | I  | 2  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. brevicaudata |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. patronus     |    |    |    |    |    |    |    | 1  | 2  | 2  | 11 | 10 | 19 | 14 | 13 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. pectinata    |    |    |    |    |    |    |    | 1  | 3  | 1  | 4  | 3  | 7  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. aurea        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. smithi       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. gunteri      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

|            | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 |
|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| B. tyrannus |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. brevicaudata |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. patronus |    |    |    |    |    |    |    | 2  | 11 | 13 | 10 | 18 | 15 | 17 | 11 | 4  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. pectinata |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. aurea    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. smithi |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| B. gunteri |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
are all of the small-scale species, herein designated *B. gunteri* n. sp. It is evident that Goode included the specimens with the fine scales in his "Diagnosis" of *B. patronus*, because he gave a range of 50 to 70 scales in the "longitudinal rows." This range includes enumerations contained in his tables, based in part on the large-scale species, *B. patronus*, from Brazos Santiago, and in part on the small-scale form, *B. gunteri*, from the mouth of the Rio Grande. Finally, Goode gave proportions and enumerations for three small specimens from a lot now consisting of two specimens (U.S.N.M. No. 5864), for which the place of collection is unknown. The two specimens from this lot at hand are *B. patronus*, while the missing one very probably was *B. gunteri*, as Goode enumerated "about 70" scales in the "lateral line." Goode's type material has now been separated and the two species represented have been registered accordingly in the catalog of the National Museum.

Relationship.—*B. patronus* is closely related to *B. tyrannus*, and generally has been considered as only subspecifically distinct from it, or identical with it, by authors. However, it is evident from a critical study that the two differ in many respects, and to such a degree that they apparently should be treated as distinct species. The principal differences are shown in the parallel comparison presented herewith. The tables (Nos. 1 to 7) show deviations in many ways. Even though there is overlapping in all the proportions and enumerations given, it is evident, at once, that the modes often differ widely.

Although the range of the two species is now discontinuous, it was no doubt once continuous. Menhaden are not known to occur on the shores of southern Florida, "Indian River" on the Atlantic and Tampa on the Gulf apparently being the limits of the range southward, respectively, of *tyrannus* and *patronus.* The differences that now exist between the two are exactly what one would expect after a long separation under the influence of a different environment. It is true, also, and in keeping with expectation, that the large-headed, deep-bodied,

---

1 The writer is aware that Silas Stearns, in Goode (1884, p. 575), implied, at least, that *B. patronus* occurred at Key West, Fla. However, Isaac Ginsburg and I resided at Key West for 1½ to 3 years, collected there rather extensively, but failed to find menhaden. It seems improbable, therefore, that *Brevoortia* occurs there. *Harengula* is common at Key West, and it may be that Stearns confused this genus with *Brevoortia*. Neither did Dr. Charles M. Breder, Jr., of the American Museum of Natural History see any at Palmetto Key, Fla., for he stated in a letter in reply to my inquiry, "In the five years that we spent at Palmetto Key I never saw any menhaden, nor were any taken to the best of my knowledge by others working there." No specimens from farther south than Appalachian, Fla., are at hand, though it was reported from Tampa by Henshall (1894, p. 211).
Table 2.—Total number of vertebrae and ventral scutes in species of Brevoortia

<table>
<thead>
<tr>
<th>Species</th>
<th>Vertebrae</th>
<th>Ventral scutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>27 28 29 30 31 32 33 34 35 36 37</td>
</tr>
<tr>
<td>B. tyrannus</td>
<td></td>
<td>1 2 26 18 45 2 1 8 32 79 83 8 3</td>
</tr>
<tr>
<td>B. brevicaudata</td>
<td></td>
<td>1 2 26 18 45 2 1 8 32 79 83 8 3</td>
</tr>
<tr>
<td>B. patronus</td>
<td></td>
<td>3 3 2 22 58 21 5 12 30 63 29 8 12</td>
</tr>
<tr>
<td>B. pectinata</td>
<td></td>
<td>2 2 2 6 12 12 3 4 5 1 2 3 4 5 1 2</td>
</tr>
<tr>
<td>B. aurea</td>
<td></td>
<td>1 1 4 5 12 12 3 4 5 1 2 3 4 5 1 2</td>
</tr>
<tr>
<td>B. smithi</td>
<td></td>
<td>3 9 1 2 11 5 2 1 2 3 4 5 1 2 3 4 5</td>
</tr>
<tr>
<td>B. gunteri</td>
<td></td>
<td>1 2 9 1 15 27 4 1 2 3 4 5 1 2 3 4 5</td>
</tr>
</tbody>
</table>

Table 3.—Number of dorsal, anal, and pectoral rays in species of Brevoortia

<table>
<thead>
<tr>
<th>Species</th>
<th>Dorsal rays</th>
<th>Anal rays</th>
<th>Pectoral rays</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17 18 19 20 21 22</td>
<td>17 18 19 20 21 22</td>
<td>13 14 15 16 17 18</td>
</tr>
<tr>
<td>B. tyrannus</td>
<td>3 19 79 35 1 2 8 44 87 44 21 2 7 58 123 25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. brevicaudata</td>
<td>3 19 79 35 1 2 8 44 87 44 21 2 7 58 123 25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. patronus</td>
<td>1 14 30 34 3 2 11 13 8 2 13 16 4 8 14 14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. pectinata</td>
<td>3 15 15 1 2 11 13 8 2 13 16 4 8 14 14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. aurea</td>
<td>6 8 1 2 5 1 1 2 7 4 8 14 14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. smithi</td>
<td>6 10 1 2 5 1 1 2 7 4 8 14 14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. gunteri</td>
<td>5 25 15 7 2 4 9 18 13 4 1 21 19 16 16 16 16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 4.—Length and depth of head expressed in percent of standard length in species of Brevoortia

<table>
<thead>
<tr>
<th>Species</th>
<th>Length of head</th>
<th>Depth of head</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28 29 30 31 32 33 34 35 36 37 38</td>
<td></td>
</tr>
<tr>
<td>B. tyrannus</td>
<td>2 4 9 36 54 51 36 8 1</td>
<td>3 13 39 53 41 26 12 2</td>
</tr>
<tr>
<td>B. brevicaudata</td>
<td>4 4</td>
<td>3 1</td>
</tr>
<tr>
<td>B. patronus</td>
<td>2 4 8 4</td>
<td>3 8 6 5 1</td>
</tr>
<tr>
<td>B. pectinata</td>
<td>3 1 2 6</td>
<td>1 3</td>
</tr>
<tr>
<td>B. aurea</td>
<td>3 1 2 6 4</td>
<td>1 3 2 3 6</td>
</tr>
<tr>
<td>B. smithi</td>
<td>2 3 8 4</td>
<td>1 4 6 1 2</td>
</tr>
<tr>
<td>B. gunteri</td>
<td>1 11 24 9 4</td>
<td>2 7 17 14 3 5 2</td>
</tr>
</tbody>
</table>

### Table 5.—Greatest depth of body expressed in percent of standard length in species of Brevoortia

<table>
<thead>
<tr>
<th>Species</th>
<th>Greatest depth of body</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45</td>
</tr>
<tr>
<td>B. tyrannus</td>
<td>5 7 16 38 45 43 34 29 11 4</td>
</tr>
<tr>
<td>B. brevicaudata</td>
<td>1 2 2 3</td>
</tr>
<tr>
<td>B. patronus</td>
<td>2 7 16 17 36 36 29 38 30 24 7 3 3</td>
</tr>
<tr>
<td>B. pectinata</td>
<td>2 2 3 3 10 2 3 4 2</td>
</tr>
<tr>
<td>B. aurea</td>
<td>1 1 3 7 1 1</td>
</tr>
<tr>
<td>B. smithi</td>
<td>2 2 5 5 1 1 1</td>
</tr>
<tr>
<td>B. gunteri</td>
<td>2 10 13 10 8 3 3 2 1</td>
</tr>
</tbody>
</table>
Table 6.—Maxillary and mandible expressed in percent of standard length in species of Brevoortia

<table>
<thead>
<tr>
<th>Species</th>
<th>Maxillary</th>
<th>Mandible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12 12.5</td>
<td>13 13.5</td>
</tr>
<tr>
<td>B. tyrannus</td>
<td></td>
<td>8 19 37</td>
</tr>
<tr>
<td>B. brevicaudata</td>
<td>3 1 5</td>
<td></td>
</tr>
<tr>
<td>B. patagonus</td>
<td></td>
<td>3 6 34</td>
</tr>
<tr>
<td>B. pectinata</td>
<td></td>
<td>3 3 8 3</td>
</tr>
<tr>
<td>B. aurea</td>
<td>1 2 1 4 5 1</td>
<td></td>
</tr>
<tr>
<td>B. smithi</td>
<td>2 4 10 3</td>
<td>1</td>
</tr>
<tr>
<td>B. gunteri</td>
<td>2 3 8 13 17 3</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 7.—Lower lobe of caudal fin and pectoral fin expressed in percent of standard length in species of Brevoortia

<table>
<thead>
<tr>
<th>Species</th>
<th>Lower lobe of caudal fin</th>
<th>Pectoral fin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39</td>
<td>13 14 15 16 17 18 19 20 21 22 23</td>
</tr>
<tr>
<td>B. tyrannus</td>
<td>7 21 28 25 41 34 14 10 6 2</td>
<td>4 32 54 38</td>
</tr>
<tr>
<td>B. brevicaudata</td>
<td>1 2 2</td>
<td></td>
</tr>
<tr>
<td>B. patagonus</td>
<td>2 9 13 13 10 12 5 3 2</td>
<td>7 19 35 20 5</td>
</tr>
<tr>
<td>B. pectinata</td>
<td>2 1 4 4 1</td>
<td></td>
</tr>
<tr>
<td>B. aurea</td>
<td>2 1 5 1</td>
<td></td>
</tr>
<tr>
<td>B. smithi</td>
<td>2 3 3 1 1</td>
<td></td>
</tr>
<tr>
<td>B. gunteri</td>
<td>1 4 3 8 7</td>
<td>6 4 4</td>
</tr>
</tbody>
</table>
and long-finned examples from the Gulf are nearest to specimens of the Atlantic menhaden that occur on the opposite coast of Florida, which have larger heads, rather deeper bodies, and longer fins than specimens of *tyrannus* from northern localities.

**Source of the data and their presentation.**—The following list of proportions and enumerations, unless otherwise stated, are based on about 100 specimens, and some of them on many more. The examples used in determining the proportions range from about 60 to 265 mm. in total length and 45 to 207 mm. in standard length. These examples were collected at many places along the coast of the Gulf from Appalachicola, Fla., to Brazos Santiago, Tex., and they include the type specimens (U.S.N.M. No. 892) from the last-mentioned locality. The range in the percentage of standard length of the different parts measured is given first in each instance, followed by those based on the two "types," and then the proportion in the standard length or in the head is enclosed in parentheses. The enumerations are given in the same order.

**Some proportions and enumerations.**—Head 31 to 38, 37 and 37 (2.6 to 3.2, 2.7 and 2.7 in standard length), its depth 29 to 37, 33.5 and 35.5 (2.7 to 3.4, 2.8 and 2.95 in standard length); depth of body 33 to 45, 42 and 42 (2.2 to 3.0, 2.4 and 2.4 in standard length); anal base 17 to 21, 18.5 and 19.5 (4.75 to 5.9, 5.2 and 5.4 in standard length); lower lobe of caudal 31 to 39, broken (2.55 to 3.2 in standard length); caudal peduncle, depth 8.0 to 12, 10.2 and 10.2 (2.6 to 3.9, 3.6 and 3.65 in head); eye 7.0 to 9.2, 8.5 and 8.5 (3.7 to 5.0, 4.35 and 4.4 in head); snout 6.0 to 9.0, 7.5 and 8.5 (3.9 to 5.0, 4.3 and 5.0 in head); interorbital (bone) 6.5 to 8.0, 7.8 and 8.0 (4.1 to 5.0, 4.5 and 4.7 in head); maxillary 14 to 17.5, 17 and 17 (2.0 to 2.4, 2.1 and 2.1 in head); mandible 18.5 to 20, 18.5 and 20 (1.75 to 1.9, 1.8 and 1.9 in head); pectoral 19 to 23, 19.5 and 21.5 (1.5 to 1.9, 1.75 and 1.9 in head); axillary appendage of pectoral 8.5 to 13, 9.5 and 10.5 (2.5 to 4.0, 3.4 and 3.8 in head). Dorsal rays 17 to 21, 19 and 20; anal rays 20 to 23, 22 and 23; ventral rays 7; pectoral rays 14 to 17, 15 and 16; scales, oblique series crossing middle of side, 36 to 50, 47 and 49; vertical series of scales between tip of pectoral and base of ventral 0 to 3, 1 and 2; modified scales in a series in front of dorsal 24 to 33, 30 and 31; ventral scutes 28 to 32, 29 and 30; gill rakers on lower limb of first arch 40 to 50 in specimens about 25 to 40 mm. in total length, 80 to 85 in examples 45 to 60 mm. long, 125 to 130 in specimens 100 to 130 mm., and 135 to 150 in fish 200 mm. and upward in total length; vertebrae 42 to 48, usually 45 to 47, not counted in types (enumerated in 117 specimens).
A parallel comparison of B. tyrannus and B. patronus.—The principal differences between tyrannus and patronus are shown in the following parallel comparison.

**tyrannus**

Body moderately deep, rather robust, the ventral and dorsal outlines more or less evenly convex; usually only half of greatest depth below a straight line extending through lower margin of eye to middle of base of caudal; greatest depth generally over tip of pectoral fin, about two diameters of eye behind margin of opercle, 30 to 40, usually 32 to 37 percent of standard length, average in 232 specimens 34.2 percent.

Head moderately small, somewhat pointed, its length 28 to 36, usually 31 to 34 percent of standard length, average in 211 specimens 32.2 percent; its depth 25 to 32, usually 26 to 30 percent of standard length, average in 203 specimens 27.8 percent.

Scaly sheath at base of dorsal composed for the most part of a single row of scales, not extending above basal third of the shortest rays, and not completely covering the fin if deflexed.

Scales moderately large, 41 to 55, most frequently 45 to 52, average 48.2 in 135 specimens, if oblique series crossing middle of side are counted.

Modified scales on back in front of dorsal fin rather numerous, with long hairlike pectinations in large examples 31 to 43, most frequently 33 to 39, average 36 in 195 specimens.

Caudal fin moderately short, the lower lobe about as long as head, 25 to 35, usually 26 to 33 percent of standard length, average 29.4 percent in 214 specimens.

**patronus**

Body usually deeper, more strongly compressed, the ventral outline much more strongly convex than the dorsal; notably more than half the greatest depth below a straight line extending through lower margin of eye to middle of base of caudal; greatest depth at or near beginning of posterior third of pectoral fin, only about an eye's diameter behind margin of opercle, 33 to 45, usually 35 to 42 percent of standard length, average in 248 specimens 38.8 percent.

Head generally larger, blunter, its length 31 to 38, usually 32 to 34.5 percent of standard length, average in 274 specimens 33.6 percent; its depth 29 to 37, usually 31 to 36 percent of standard length, average in 158 specimens 33.5 percent.

Scaly sheath at base of dorsal notably higher, composed for the most part of two rows of scales, covering basal two-thirds of shortest rays, and covering the fin, except for the rays extending backward beyond the sheath if deflexed.

Scales somewhat larger, 36 to 50, most frequently 38 to 46, average 41.7 in 116 specimens, if counted as in tyrannus.

Modified scales on back in front of dorsal fin generally fewer, with shorter pectinations in examples of equal size, 24 to 33, most frequently 25 to 31, average 28 in 103 specimens.

Caudal fin rather longer, the lower lobe often longer than head, 31 to 39, usually 32 to 36.5 percent of standard length, average 34.5 percent in 69 specimens.
Pectoral fin rather short, not reaching base of ventral fin, generally leaving 3 or 4 vertical series of scales exposed between its tip and base of ventral; its length 17 to 20 percent of standard length, average 18.7 percent of standard length in 262 specimens; composed of 15 to 18, average 17.5 rays, in 213 specimens. Total number of vertebrae 47 to 49, rarely 45, 46 or 50, average 48 in 194 specimens. Total number of ventral scutes 30 to 35, average 32.5 in 237 specimens.

Range.—Known from the Gulf of Mexico, from Appalachicola (also reported from Tampa), Fla., to Brazos Santiago, Tex.; adults generally taken in outside waters running high in salinity.

BREVOORTIA PECTINATA Jenyns

LACHA, SAVELHA

Figure 4

Alosa pectinata Jenyns, 1842, p. 135, pl. 25, Bahia Blanca, Argentina (original description).

Clupea pectinata Günther, 1868, p. 437, “Northern Patagonia” (description).—Berg, 1895, p. 18, “Mar del Plata.—Montevideo.—Embocadura del Rio de la Plata” (reported abundant in the winter in the Rio de la Plata).—Pozzi and Bordale, 1935, p. 155, Argentina (name only).

Brevoortia pectinata Goode, 1875b, p. 38; 1879, p. 18, pl. 6 (compared with other American forms; description).—Regan, 1917, p. 301 (synonymy; description; range).

Brevoortia tyrannus Evermann and Kendall (not of Latrobe), 1906, p. 74, Rio de la Plata, Argentina (synonymy, partly not this species; a comparison of South American examples, consisting in part of pectinata and probably in part of aurea, with North American specimens; differences noted, but not considered of specific importance).—Thompson (not of Latrobe) 1916, p. 405, Montevideo, Uruguay. (Note: A re-examination of the specimens shows that they are B. pectinata.)—DeVincenzi (not of Latrobe) 1924, p. 187 (references; enumerations; remarks).

B. pectinata imperfectly known.—Although this species is well marked, it has not always been recognized by authors, as shown by the foregoing synonymy. Therefore, it seems desirable to offer a somewhat detailed description, which is possible now that rather adequate material is available.
Description.—Head 29.5 to 33 percent of standard length, its depth 28 to 31.5; depth of body 34 to 42; snout 7.0 to 8.5; eye 5.2 to 7.2; maxillary 13.5 to 16; mandible 15 to 18.5; interorbital (bone) 6.5 to 7.4; caudal peduncle, depth 10.5 to 12.6; ventral fin 8.5 to 10; pectoral fin 17.5 to 21; lower lobe of caudal fin 33 to 37; anal base 17 to 21. Dorsal rays 17 to 20, usually 18 or 19; anal rays 19 to 22; pectoral rays 15 to 17, rarely 13 or 14; scales, oblique series crossing middle of side, 35 to 46, vertical series between tip of pectoral and base of ventral 0 to 3; longitudinal series laterally on caudal peduncle 5; modified scales in a series on back in front of dorsal fin 32 to 47; ventral scutes 29 to 32; vertebrae 45 to 47 (enumerated in 6 specimens).

Fig. 4.—Brevoortia pectinata, based on a specimen 290 mm. in total length, 223 mm. in standard length (M.C.Z. No. 17636), from Rio Grande, Brazil.

Body rather strongly compressed, its greatest thickness usually only about a third of its depth, its greatest depth generally a little in advance of origin of dorsal, 2.4 to 2.9 in standard length; ventral outline scarcely more strongly convex than the dorsal; only about half the greatest depth below a straight line extending through the lower margin of eye to middle of base of caudal; caudal peduncle well compressed, its depth 2.6 to 3.1 in head, 3.2 to 3.55 in greatest depth; head, length 3.0 to 3.4 in standard length, its depth 3.2 to 3.55; snout 3.7 to 4.4 in head; eye 5.5 to 7.0; maxillary rounded, reaching nearly or quite to vertical from posterior margin of eye, 2.1 to 2.3; interorbital (bone) 4.2 to 4.8; upper section of opercle with rather feeble radiating striae or none; mandible well included in upper jaw, its length 1.7 to 1.85 in head; gill rakers long, very numerous, the longest ones in adults nearly as long as the snout and half the eye, increasing in number with age and growth, about 75 on lower limb of first arch in specimens 45 mm. long, about 135 in specimens 160 mm. long, and 200 or more in specimens 300 mm. and upward in length; scales
large, closely imbricated, the exposed part about four times as deep as long, the depth of the scale itself only about 125 percent of its length, the serrae rather short and blunt (see fig. 8, D), the scales much less reduced in size on the back than in North American species, and scarcely reduced at base of caudal, in fairly regular series; 5 longitudinal rows of scales on side of caudal peduncle; a row of enlarged modified scales on each side of median line of back in front of dorsal fin, quite variable in number, not fully developed in specimens under about 125 mm. in total length; ventral scutes moderately developed, rather stronger in small specimens than in large ones, 17 or 18, rarely 16 or 19, in front of ventral fins, and 12 to 14, usually 13 or 14, behind them; dorsal fin moderately high anteriorly, the longest rays nearly as long as snout and eye, the last ray only a little longer than the immediately preceding ones, the margin of fin definitely concave, with a very narrow sheath of scales at base, the origin of the fin equidistant from margin of snout and base of caudal, or a little nearer the latter; caudal rather deeply forked, the lobes long, the lower one a little longer than head, 2.7 to 3.0 in standard length; anal fin lower than the dorsal, its margin scarcely concave, with a very narrow sheath of scales at base, its origin about under tip of last ray of dorsal, its base 5.0 to 5.9 in standard length; ventral fin with an oblique nearly straight margin, the innermost ray generally about two-thirds the length of the outermost one, length of fin 3.0 to 3.7 in head (see fig. 9, D); pectoral fin long, very slightly falcate in large specimens, sometimes nearly or quite reaching base of ventral, occasionally failing to reach ventral by a distance fully as great as diameter of pupil, leaving 0 to 3 scales exposed between its tip and base of ventral, its length 5.0 to 5.7 times in standard length, and 1.55 to 1.8 in head; axillary appendage of pectoral rather long in large examples, very short in young, 2.25 to 3.4 in head in examples 200 mm. and upward in length.

Color of preserved specimens bluish gray above, sides silvery; a large black shoulder spot present in adults, not followed by smaller dark spots, shoulder spot missing in specimens under about 90 mm. in length; fins plain, except for dusky punctulation on the dorsal and caudal.

Study material.—The foregoing description is based on 22 specimens, 160 to 365 mm. in total length, 126 to 292 mm. in standard length. In addition a couple of dozen young, ranging from 43 to 110 mm. in total length, 33 to 87 mm. in standard length, are at hand. Enumerations of fin rays and ventral scutes of 13 of these small specimens are included in the description. The proportions based on these
small individuals were not used as they would distort the picture because of their slender bodies, short fins, large eyes, and other juvenile characters. The specimens are in part in the United States National Museum, Washington, D. C., and in part in the Museum of Comparative Zoology, Cambridge, Mass. The place of collection is not definitely stated for some of the specimens. The data as to localities are quoted from the labels as follows: Rio Grande of Brazil, S. A.; Montevideo; off Montevideo; Uruguay; Uruguay River; Paraguay 2; Rio Plata and sea; and Buenos Aires.

*Relationship.*—This species, like its South American congener *aurea*, differs from the North American species in having the scales on the dorsal part of the body and at the base of the caudal fin much less reduced in size. In the shape of the ventral fin they differ from *tyrannus* and *patronus*, but agree with *smithi* and *gunteri*, the outermost ray being much longer than the innermost one, giving the fin an oblique margin, which is nearly straight. In *tyrannus* and *patronus* on the other hand the outermost ray is not much shorter than the innermost one, and the margin of the fin is definitely convex (see fig. 9). The number of oblique series of scales that cross the middle of the side in the South American species falls within the range of *tyrannus* and *patronus*, and therefore is lower than in *smithi* and *gunteri*. The South American species agree with *smithi* and *gunteri* in having no small spots on the side behind the large black shoulder spot, and disagree in this respect with *tyrannus* and *patronus*. The differences between the two South American species recognized herein are set forth in a parallel comparison in the account of *aurea*.

*Abundance.*—*B. pectinata*, according to Berg (1895, p. 18), is abundant during the winter in the La Plata region, and it penetrates the Rio de la Plata, but seemingly not above brackish water. This author, as well as Pozzi and Bordale (1935, p. 181), used the common name "Lacha" for this species and also for *aurea*, while von Ihering (1940, p. 721) called them "Savelha."

*Range.*—The distribution of this species, so far as known, is shown by the localities given in the foregoing synonymy, and by the localities listed from which specimens were examined in this study. According to these the range extends from the “Rio Grande of Brazil” to Bahia Blanca, Argentina.

---

2 The specimens labeled “Paragua” (U.S.N.M. No. 1709), according to Dr. João de Paiva Carvalho, S. Paulo, Brazil (personal communication), very probably were taken in Paranaguá Bay, situated on the northern part of the coast of the state of Parana, Brazil, where Capt. Paige, aboard the U. S. S. *Waterwitch*, seems to have collected.
Clupanodon aureus Agassiz, in Spix and Agassiz, 1829, p. 52, pl. 21 (in color), Bahia, and elsewhere on the coast of Brazil (original description).

Alasua aurea Cuvier and Valenciennes, 1847, p. 427 (this species compared with Clupea menhaden = B. tyrannus; description).

Clupea aurea Günther, 1868, p. 437 (description).

Brevoortia tyrannus var. aurea Goode, 1878b, p. 33; 1879, p. 17, pl. 3 (regarded as a geographical variety; deviation from typical B. tyrannus stated).—Jordan and Evermann, 1896, p. 434 (compared with typical B. tyrannus).

Brevoortia tyrannus Berg (not of Latrobe), 1895, p. 20, "Mar del Plata.—Montevideo.—Rio de la Plata" (synonymy, largely not this species; appearing in great schools).—Schneider and Ribeiro (not of Latrobe), 1903, p. 92, "Bahia Guanabara," Brazil.—Devincenzi and Barattini, 1928, pl. 17, fig. 3, Uruguay, where B. tyrannus does not occur (figure apparently a somewhat altered copy from Goode, 1879, pl. 1).—Poźni and Bordaie, 1935, p. 155, Argentina (name only).

Brevoortia pectinata Fowler (not of Jenyns), 1940, p. 745, fig. 8, Rio Janeiro, Brazil. (Note: The specimen on which this record is based (U.S.N.M. No. 83151) is at hand and proves to be B. aurea.)

B. aurea imperfectly known.—This species has often been considered identical with tyrannus or only subspecifically distinct from it, as shown by the foregoing synonymy. For the lack of specimens for comparison, the species has not been adequately described. As a fair series of specimens of this and related species is now available, the following somewhat detailed description is offered.

Description.—Head 28.3 to 33.6 percent of standard length, its depth 26.3 to 30; depth of body 34.4 to 39.2; snout 7.0 to 8.5; eye 6.0 to 7.25; maxillary 12.5 to 15.5; mandible 15.5 to 18.5; interorbital (bone) 6.4 to 7.4; caudal peduncle 9.0 to 12.5; ventral fin 7.5 to 9.0; pectoral fin 16.7 to 18; lower lobe of caudal 31 to 35; anal base 16.2 to 19.8. Dorsal rays 18 or 19; anal rays 19 to 24, usually 21 or 22; pectoral rays 15 or 16, occasionally 14; scales, oblique series crossing middle of side, 48 to 55; vertical series between tip of pectoral and base of ventral 3 to 6; longitudinal series laterally on caudal peduncle 7; modified scales in a series on back in front of dorsal fin 35 to 46; ventral scutes 30 to 33; vertebrae 45 or 46 (enumerated in 2 specimens).

Body rather strongly compressed, its greatest thickness about a third of its greatest depth, its greatest depth generally somewhat in advance of insertion of ventral fins, 2.55 to 2.9 in standard length; ventral outline scarcely more convex than the dorsal, about half the
greatest depth below a straight line extending through the lower margin of eye to middle of base of caudal; caudal peduncle well compressed, its depth 2.6 to 3.6 in head, 3.25 to 3.85 in greatest depth; head, length 3.0 to 3.5 in standard length, its depth 3.3 to 3.8; snout 3.9 to 4.4 in head; eye 4.4 to 5.3; maxillary round posteriorly, reaching about under posterior margin of pupil, 2.15 to 2.33 in head; interorbital (bone) 3.05 to 5.0 in head; upper section of opercle with feeble radiating striae or none; mandible fully included in upper jaw, its length 1.8 to 1.9 in head; gill rakers very long and slender, the longest ones in adults somewhat longer than snout, increasing in number with age, about 137 in a specimen 160 mm. in total length, and about 225 in a specimen 285 mm. in total length; scales small, not closely imbricated, exposed part of scale rather less than three times as deep as long, the depth of the scale about 140 percent of its length, the serrae not very long nor sharply pointed (see fig. 8, C; scale from a fish about the same length as that in fig. 8, D), shorter and blunter in smaller fish than in large ones, the scales much less reduced in size on the back than in North American species, and scarcely reduced in size at base of caudal, in fairly regular series; 7 longitudinal rows of scales on side of caudal peduncle; the row of enlarged modified scales on each side of median line on the back in front of dorsal fin rather variable in number; ventral scutes fairly strong, 17 to 20, usually 18, in front of ventral fins and 12 to 15 behind them; dorsal fin moderately elevated anteriorly, the longest rays scarcely as long as snout and eye, the last ray only a little longer than the immediately preceding ones, the margin of the fin definitely concave, with a very narrow sheath of scales at base, the origin of the fin generally about equidistant from margin of snout and base of caudal; caudal moderately forked, rather short, the lower lobe a little longer than head,
2.85 to 3.2 in standard length; and fin low, its margin nearly straight, with a very narrow sheath of scales at base, its origin about under tip of last ray of dorsal, its base 5.25 to 6.1 in standard length; ventral fin with an oblique and somewhat convex margin, the innermost ray about two-thirds the length of the outermost one, the length of fin 3.5 to 4.25 in head (see fig. 9, C); pectoral fin short, not falcate, failing to reach base of ventral by a distance varying from half to a whole diameter of eye, leaving 3 to 6 scales exposed between its tip and base of ventral, its length 5.6 to 6.0 in the standard length, and 1.8 to 2.0 in head; axillary appendage moderately long in large examples, short in small ones, 2.2 to 4.7 in head.

Color of preserved specimens dark grayish on back; sides yellowish to brassy; a large black shoulder spot, not followed by smaller dark spots; fins all plain.

Study material.—The foregoing description is based on 15 specimens 110 to 285 mm. in total length, 87 to 223 mm. in standard length. These specimens are in part in the United States National Museum, Washington, D. C., and in part in the Museum of Comparative Zoology, Cambridge, Mass.; the place of collection is not always definitely stated for some of the specimens. The data as to localities are quoted from the labels as follows: Sambaia,3 Rio Janeiro, and Paraguay.4

Relationship, and a parallel comparison.—The general relationship of this species and the North American members of the genus is shown in the account of pectinata (p. 24). It differs from its South American congener in the notably smaller scales, a difference actually greater than shown, by the enumerations given in the description. If scales from the middle of the side below the origin of the dorsal are compared with those of pectinata from the same part of the body, and in examples of equal size, those of aurea are only about two-thirds as large as those of pectinata. This prominent difference is not fully evident from the enumeration of the oblique series along the middle of the side because the scales are less closely imbricated in

3 These specimens were collected by the Thayer expedition to Brazil. Sambaia could not be found on any map at hand. Accordingly the Brazilian ichthyologist, Dr. João de Paiva Carvalho, was consulted, who replied by letter that there apparently is no Sambaia in Brazil, and suggested that the Sambará River, one of many coastal streams between Bahia and Rio de Janeiro, might be intended. He pointed out that the "r" in Sambará might somehow have been changed to "i"; a very plausible explanation.

4 See footnote 2, under B. pectinata (p. 24) for an explanation of the locality "Paraguay."
aurea. Other differences are shown in the following parallel comparison.

**aurea**

Scales small, 48 to 55 oblique series crossing middle of side, not closely imbricated, the length of the exposed part of each scale on middle of side usually about a third of the depth of that part of the scale, 7 longitudinal rows on side of caudal peduncle, 3 to 6 vertical series between tip of pectoral and base of ventral fin. Fins short, the pectoral failing to reach base of ventral by a distance varying from half to a full diameter of eye, 5.6 to 6.0 in standard length, 1.8 to 2.0 in head; ventral fin 3.5 to 4.25 in head; lower lobe of caudal 2.85 to 3.2 in standard length.

**pectinata**

Scales larger, 35 to 46 oblique series crossing middle of side, notably more closely imbricated, the length of the exposed part of each scale on middle of side about a fourth of the depth of that part of the scale, 5 longitudinal rows of scales on side of caudal peduncle, 0 to 3 vertical series between tip of pectoral and base of ventral fin. Fins longer, the pectoral sometimes reaching base of ventral, occasionally falling short of this point by diameter of pupil, 5.0 to 5.7 in standard length, 1.55 to 1.8 in head; ventral fin 3.0 to 3.7 in head; lower lobe of caudal 2.7 to 3.0 in standard length.

**Range.**—The type locality, as given by Agassiz (Spix and Agassiz, 1829, p. 52), is Bahia and elsewhere on the coast of Brazil. Bahia seems to remain the northernmost known limit of the range, whence it extends at least to the Rio de la Plata, if Berg's (1895, p. 20) determination is correct. There are no specimens at hand from farther south than Rio de Janeiro, Brazil.

**BREVOORTIA SMITHI** Hildebrand

Yellowfin Shad

**Figure 6**

_Brevoortia aureus_ Hildebrand (not of Agassiz), 1919, p. 7, with fig., and pl. 1, fig. 2, Beaufort, N. C. (original description of _B. smithi_ Hildebrand (see next reference); compared with _B. tyrannus_; local occurrence; habits; food).

_Brevoortia smithi_ Hildebrand, 1941, p. 224 (_B. aureus_, Hildebrand (see above) recognized as distinct from _B. aureus_ (Agassiz) and as without a name; _B. smithi_ proposed; reference to original description; specimen bearing U.S.N.M. No. 118723 designated as type).

On the identity of _B. smithi._—The present writer, as shown by the synonymy given, at first considered this menhaden identical with _B. aureus_ (Agassiz) from Brazil, and described specimens from Beaufort, N. C., under that name. However, many years later when the opportunity came to compare the North Carolina material with South American specimens he arrived at the conclusion that the speci-
mens from the two areas represented distinct species. As the one represented by the specimens from North Carolina seemed to be without a name, *B. smithi* was proposed.

*Source of the data and their presentation.*—The following list of proportions and enumerations is based on the 18 specimens in the National Museum collection, which range from 120 to 315 mm. in total length, and from 91 to 240 mm. in standard length. Ten of these specimens (Nos. 84368, 118723 (the type), 125939 to 125947, 125950, 125953, and 125955) are from Beaufort, N. C., one (No. 119236) from Cumberland Sound, Ga., five (No. 18049) from the mouth of the St. Johns River, Fla., and two (No. 7696) from Indian River, Fla. The range in the percentage of the standard length of the

![Figure 6](image)

*Brevoortia smithi,* based on the holotype, 295 mm. in total length, 225 mm. in standard length (U.S.N.M. No. 118723), taken at Beaufort, N. C.

parts measured is given first in each instance, followed by the proportion based on the type, and then the proportion in the standard length or in the head is enclosed in parentheses. The enumerations are given in the same order.

*Some proportions and enumerations.*—Head 29 to 31.5, 30.6 (3.2 to 3.45, 3.25); depth 27.3 to 31, 29 (3.25 to 3.65, 3.45); depth of body 36 to 43, 38 (2.3 to 2.75, 2.6); anal base 19 to 21, 20 (4.75 to 5.25, 5.0); lower lobe of caudal 32 to 37, 33.3 (2.7 to 3.1, 3.0); depth of caudal peduncle 9.5 to 12, 10.2 (2.6 to 3.4, 3.0 in head); eye 6.1 to 7.5, 6.1 (4.2 to 5.2, 5.0 in head); snout 6.8 to 8.0, 8.0 (3.7 to 5.0, 3.85 in head); interorbital (bone) 6.2 to 7.7, 6.2 (4.0 to 4.9, 4.9 in head); maxillary 13.2 to 15, 15 (2.0 to 2.4, 2.0 in head); mandible 16.5 to 18.5, 17.5 (1.7 to 1.9, 1.75 in head); pectoral fin 18.5 to 21.5, 21.5 (1.45 to 1.75, 1.45 in head); axillary appendage of pectoral 8.6 to 12, 11 (2.6 to 4.0, 2.75 in head). Dorsal rays 18 to 20, 18; anal rays 22 to 24, 23; pectoral rays 15 to 17, 16; scales, oblique series
crossing middle of side (too irregular to enumerate accurately), about 60 to 70, 64; vertical series of scales between tip of pectoral and base of ventral 5 to 8, 5; modified scales in a series in front of dorsal fin 39 to 45, 45; ventral scutes 30 to 33, 31; gill rakers on lower limb of first arch about 125 to 149 (enumerated in 6 specimens); vertebrae 45 to 47 (enumerated in 9 specimens).

Relationship.—B. smithi is close to B. gunteri n. sp., which is its counterpart in the Gulf of Mexico. The relationship of these two species is shown in the account of the last-mentioned species. B. smithi differs rather prominently from B. tyrannus, with which it was long confused, as shown in the following comparison. As the proportions and enumerations for tyrannus are based on 200 specimens or more, the “usual” range can be stated, but that is not possible for smithi of which only 18 specimens are at hand.

**tyrannus**

Scales moderately large, arranged in fairly regular series, 41 to 55, usually 45 to 52, oblique series crossing middle of side; scales on middle of side with long, hairlike pectinations in large examples (see fig. 8, B), modified scales on back in front of dorsal fin with long hairlike pectinations in adults, 31 to 43, usually 33 to 39 in a series.

Upper part of opercle with prominent radiating striations.

Head moderately large, 28 to 35, usually 31 to 34, average 32.2 percent of standard length.

Body moderately deep, the ventral outline anteriorly moderately convex, usually only half the greatest depth below a straight line extending through lower margin of eye to middle of base of caudal, its greatest depth 30 to 39, usually 32 to 37, average 34.2 percent of standard length.

Anal base rather short, 14 to 19, usually 15 to 18, average 16.5 percent of standard length.

Caudal fin rather short, the lower lobe about as long as head, 23 to 35, usually 26 to 33, average 29.4 percent of standard length, if measured from middle of base of caudal.

**smithi**

Scales notably smaller and less regularly placed, about 60 to 70 oblique series crossing middle of side; scales on middle of side with notably shorter and blunter pectinations in large examples (see fig. 8, F); modified scales on back in front of dorsal fin with notably shorter and blunter pectinations in adults, 39 to 45 in a series.

Upper part of opercle with very feeble striations, or none.

Head smaller, 29 to 32, average 30.7 percent of standard length.

Body rather deeper, the ventral outline anteriorly more strongly convex, more than half the greatest depth below a straight line extending through lower margin of eye to middle of base of caudal, its greatest depth 36 to 43, average 38.7 percent of standard length.

Anal base longer, 19 to 21, average 19.9 percent of standard length.

Caudal fin longer, the lower lobe longer than head, 32 to 37, average 33.8 percent of standard length, if measured as in tyrannus.
**MENHADEN, GENUS BREVOORTIA—HILDEBRAND**

**tyrannus**

Ventral fin with a gently convex margin, the innermost ray only a little shorter than outermost one (see fig. 9, B).

Color dark green to bluish above, sides generally brassy green; fins pale yellow to brassy; shoulder spot followed by a variable number of smaller dark spots, body sometimes profusely spotted anteriorly in adults.

**smithi**

Ventral fin with an oblique margin, the innermost ray only about half as long as the outermost one (see fig. 9, F).

Color lighter, bluish green above, sides silvery; fins golden yellow; shoulder spot not followed by smaller dark spots, the sides being plain, unsotted.

In addition to the morphological differences between *tyrannus* and *smithi*, indicated in the parallel comparison, it should be stated that the latter is a much more active fish, which when caught in a seine makes a vigorous effort to escape, whereas the former generally strikes the net once and then allows itself to be hauled in without making a further effort to flee. Furthermore, *smithi* is not known to school and it is not known to be numerous anywhere, generally only a few individuals at a time being taken. It differs still further from *tyrannus* in being almost devoid of mucus, whereas *tyrannus* is densely coated with mucus. As a result, fresh specimens may be identified by the touch, as *smithi* is not slippery while *tyrannus* is very slippery.

The fishermen at Beaufort, N. C., recognize *smithi* as different from *tyrannus*, and call it the “yellowfin shad,” whereas the latter is simply called “shad” or “fatback.” They consider its edible qualities superior to that of *tyrannus*, and generally keep the few they catch for their own tables.

**Range.**—Known from Beaufort, N. C., to the “Indian River,” presumably Indian River City, Fla.

**BREVOORTIA GUNTERI** new species

**Fine-scale Gulf Menhaden**

**Figure 7**

*Brevortia patronus* Goode (in part not *patronus*), 1878b, p. 39, Brazos Santiago, and mouth of Rio Grande, Tex. (diagnosis and tables of measurements in part based on specimens from the mouth of the Rio Grande, which are *B. gunteri* n. sp.).

*Brevortia* sp. Gunter, 1945, p. 27, Compano and Aransas Bays, Tex. (recognized as differing from *B. patronus* in having more silvery, less green color, as having a sharper snout, a “differently-shaped head” and much smaller scales).

*On the identity of B. gunteri.*—Specimens of this species, as indicated in the foregoing synonymy, were included in Goode’s type ma-
terial of *B. patronus*, wherein examples of two species were confused. It is fortunate that Goode stated that his description was based on specimens from Brazos Santiago, Tex., which definitely make Goode's name, *B. patronus*, available for the large-scale Gulf menhaden, and leaves the fine-scale one without a name. The situation is explained in more detail in the account of *B. patronus* (p. 14).

Gunter (1945, p. 27) recognized this species as different from *B. patronus*, which he designated *B. tyrannus*. However, he did not recognize it as new and he did not offer a formal description, though he did say, "The writer suddenly became aware after months of work on the Texas coast that 2 species of *Brevoortia* were present. . . . The second species was much more common, lived in waters of lower salinity, was more silvery and had less green color, had a sharper snout and a differently shaped head, had much smaller scales and was not slimy." Gunter thought that this might be the "original *B. patronus* of Goode," but it seemed to him that it was "rather close to or possibly identical with the *B. smithi* of Hildebrand." Mr. Gunter was wrong, as already stated, in believing that his specimens, with small scales, might be *B. patronus*, but he was correct when he said they were close to *B. smithi*, though they are not identical with it.

It affords me pleasure to name this species for Gordon Gunter, in recognition of his good work on the aquatic animals of the Gulf coast, and in appreciation of the very fine series of specimens he has furnished me for this study. A description of this species follows, wherein proportions and enumerations pertaining to the type are enclosed in parentheses.

*Description.*—Head 31 to 35.5, usually 32 to 34 (32) percent of
standard length, its depth 29 to 35.5, usually 30.5 to 32 (31); depth of body 37 to 45, usually 38 to 41 (40.5); snout 7.0 to 10 (9.3); eye 6.6 to 9.5 (6.8); maxillary 14.5 to 17.5, usually 15.5 to 16.5 (16); mandible 17.5 to 20.5, usually 18.5 to 19 (19.5); interorbital (bone) 7.0 to 8.0 (7.3); caudal peduncle, depth 9.5 to 12.2, usually 10 to 11 (11); ventral fin 9.3 to 11 (9.3); pectoral fin 19 to 23.5, usually 20 to 22 (21.5); lower lobe of caudal fin 32 to 39, usually 34 to 37 (35.5); anal base 19 to 23, usually 20.5 to 22.5 (21). Dorsal rays 17 to 20, usually 18 or 19 (18); anal rays 20 to 25, usually 22 to 24 (22); pectoral rays 15 or 16, rarely 14 (15); scales, oblique series crossing middle of side, about 60 to 75 (61); modified scales in a series in advance of dorsal fin, 35 to 45, usually 38 to 42 (42); ventral scutes 27 to 30, usually 28 or 29 (29); vertebrae 43 or 44, rarely 42 (enumerated in 22 paratypes).

Body very strongly compressed (for a menhaden), its greatest thickness only about a third of its depth, its greatest depth a little in advance of origin of dorsal and a little in advance of tip of pectoral, 2.2 to 2.7, usually 2.43 to 2.6 (2.47) in standard length; ventral outline more strongly convex than the dorsal, much more than half the depth below a straight line extending through lower margin of eye to middle of base of caudal; caudal peduncle rather deep, 2.7 to 3.5 (2.85) in head, and 3.6 to 4.0 (3.6) in greatest depth; head 2.7 to 3.2 (3.1) in standard length, its depth 2.75 to 3.4 (3.2); snout compressed, with a sharp median notch, its length 3.4 to 4.4 (3.45) in head; eye 3.6 to 4.8, usually 4.2 to 4.7 (4.6); maxillary broadly rounded, reaching to or a little beyond vertical from posterior margin of pupil, 1.8 to 2.2, usually 2.0 to 2.1 (2.0); interorbital (bone) 4.1 to 4.7 (4.4); upper section of opercle with very feeble radiating striae or none; mandible well included in upper jaw, its length 1.55 to 1.95 (1.65) in head; gill rakers long, the longest ones somewhat exceeding length of snout, 97 on lower limb of first arch in a specimen 70 mm. in total length, 113 to 123 in three specimens respectively 103, 113, and 113 mm. long, and 135 to 150 in four specimens 200 to 300 mm. in total length; teeth missing in all specimens at hand; scales closely adherent, the exposed part three to four times as deep as long, the scale itself about two-thirds as deep as long, with prominent serrae in adults, ending in somewhat blunted points (see fig. 8, E); the scales much reduced in size on back and at base of caudal, in rather irregular series (difficult to enumerate accurately); the row of enlarged, modified scales on each side of median line on back in front of dorsal fin not fully developed in young under about 110 mm. in total length; ventral scutes weaker in large examples than in smaller ones,
17 or 18, usually 17 (17) in front of ventral fins, and 10 to 13, usually 11 or 12 (12) behind them; dorsal fin rather high anteriorly, the longest rays about as long as snout and half the eye, the last ray considerably longer than the immediately preceding ones, the margin of the fin rather deeply concave, the base of fin with a very narrow sheath of scales at base, the origin of the fin generally about equidistant from margin of snout and base of caudal; caudal deeply forked, the middle rays about as long as eye, the lobes long, the lower one the

Fig. 8.—Scales of species of *Brevoortia* from middle of side below anterior rays of dorsal; all equally enlarged. A, *patronus*, from a specimen 215 mm. in total length; B, *tyrannus*, from a specimen 320 mm. in total length; C, *aurae*, from a specimen 280 mm. in total length; D, *pectinata*, from a specimen 290 mm. in total length; E, *gunteri*, from a specimen 270 mm. in total length; F, *smithi*, from a specimen 295 mm. in total length.

longer, exceeding length of head, 2.55 to 3.3, usually 2.8 to 2.9 (2.8) in standard length; anal fin much lower than dorsal, its longest rays only about two-thirds length of those of dorsal, its margin somewhat concave, with a very narrow sheath of scales at base, its origin under or a little in advance of tip of last ray of dorsal, its base 4.45 to 5.25 (4.75) in standard length; ventral fin with an oblique, nearly straight margin, the outermost ray somewhat less than twice the length of the innermost one (see fig. 9, E), the fin inserted a little behind vertical from origin of dorsal, length of fin 2.9 to 3.4 (3.0) in head;
pectoral fin long, slightly falcate, the longest ray fully four times as long as the shortest one, the fin failing to reach base of ventral by a distance equal to or more usually a little less than diameter of pupil, leaving about 2 to 4 vertical series of scales exposed between its tip and base of ventral, its length 4.25 to 5.25 (5.0) in standard length, and 1.4 to 1.9 (1.5) in head; axillary appendage of pectoral variable in length, apparently increasing in length with age, usually about half length of fin in large examples, and only about a third in small examples, 2.5 to 4.6 (2.85) in head.

Color of preserved specimens dark gray above a straight line extending through upper margin of eye to slightly above middle of base of caudal, changing rather abruptly to silvery on side; a large black shoulder spot present in adults, only faintly visible in specimens 110 to 125 mm. long, missing in smaller ones, this spot not followed by smaller ones; dorsal and caudal fins somewhat dusky, the margin of caudal pale; other fins plain translucent. Gunter (1945, p. 27) remarked, in comparing fresh examples of this menhaden which he termed the “second species” with B. patronus, “The second species ... was more silvery and had less green color.”

Study material.—This species is represented in the collection of the National Museum by 55 specimens, 70 to 310 mm. in total length, 53 to 230 mm. in standard length. The proportions and enumerations
are based on all this material unless otherwise stated. One half-grown specimen is from the vicinity of Grand Isle, La. The others are from Texas. Some were taken in the mouth of the Rio Grande, and at Brazos Santiago. These are small specimens and part of Goode's type material of *B. patronus* (1878b, p. 39), but not that species as already explained. The rest of the specimens are from the bays in the vicinity of Corpus Christi, Rockport, and Galveston. A particularly fine series of rather large and well-preserved specimens from Aransas Bay, collected and presented by Gordon Gunter, are included. The type (U.S.N.M. No. 129798), 270 mm. in total length, 205 mm. in standard length, was selected from the lot from Aransas Bay, Rockport, Tex.

**Relationship.**—*B. gunteri* differs prominently from *B. patronus* in having much smaller and more crowded scales, which also are much deeper and shorter, and have much shorter and blunter serrations in adults. It differs further in the much more feebly developed radiating striae or none, on the upper part of the opercle; in the absence of dark spots behind the black shoulder spot; as well as in several other respects. It is close to *B. smithi* of the Atlantic, with which it agrees in having a deep, well-compressed body, which is devoid of slime; in having small crowded scales; in the absence of dark spots on the side behind the black shoulder spot; and in several other respects. The chief differences are shown in the following parallel comparison.

**smithi**

Head small, its length 29 to 31.5 percent of the standard length, and its depth 27.3 to 31 percent.

Maxillary reaching from middle of eye to posterior margin of pupil, 13 to 14.5 percent of standard length.

Mandible rather short, 16.5 to 18, usually 17 percent of standard length.

Pectoral fin short, generally failing to reach base of ventral by a distance somewhat greater than half diameter of eye, 5 to 8 vertical rows of scales between its tip and base of ventral, 18.5 to 21.5 percent of standard length.

Ventral scutes 18 or 19, usually 18, in front of ventral fins, and 12 to 14, usually 13, behind them, total number 30 to 32, usually 31.

Vertebrae 45 to 47.

**gunteri**

Head rather larger, its length 31 to 35.5, usually 32 to 34 percent of standard length, and its depth 29 to 35.5, usually 30.5 to 32 percent.

Maxillary reaching to or a little beyond posterior margin of pupil, 14.5 to 17 percent of standard length.

Mandible somewhat longer 18 to 20, usually 18.5 to 19 percent of standard length.

Pectoral fin longer, generally failing to reach base of ventral by a distance a little less than diameter of pupil, 2 to 4 vertical rows of scales between its tip and base of ventral, 19 to 23.5, usually 20 to 22 percent of standard length.

Ventral scutes 17 or 18, usually 17, in front of ventral fins, and 10 to 13, usually 11 or 12, behind them, total number 27 to 30, usually 28 or 29.

Vertebrae 43 or 44, rarely 42.
Distribution.—*B. gunteri* is the counterpart in the Gulf of *B. smithi* in the Atlantic, just as *B. patronus* in the Gulf is the counterpart of *B. tyrannus* in the Atlantic. In each instance the range in geological times very probably was continuous, but in due course it became discontinuous. At least at present menhaden quite surely do not occur in southern Florida. Therefore, no intermingling can take place. Under separation and under environmental differences minor changes seem to have taken place. Although no specimens of *B. gunteri* from Florida are included in the collections examined, I do not regard that as evidence it does not occur there. For that matter, only a few specimens of *B. patronus* from Florida are at hand. Yet menhaden are numerous enough to supply a reduction plant at Port St. Joe, Fla. Probably because menhaden are common, they have not been considered of much interest to collectors, and even if many examples were taken, few were preserved.

Range.—Known from the Gulf of Mexico, from Grand Isle, I.a., to the mouth of the Rio Grande, Tex. Very probably occurring elsewhere in the Gulf; generally not recognized by collectors. Usually living in bays where the water runs low in salinity.

**LITERATURE CITED**

**Berg, Carlos.**


**Cuvier, Georges, and Valenciennes, Achille.**


**De Kay, James E.**


**Devincenzi, Garibaldi J.**


**Devincenzi, Garibaldi J., and Barattini, Luis P.**


**Evermann, Barton W., and Kendall, William C.**


**Fowler, Henry W.**


Gill, Theodore.

Ginsburg, Isaac.

Goode, G. Brown.

Goode, G. Brown, editor.

Gronow, Laurence T.

Gunter, Gordon.

Günther, Albert.

Henshall, James A.

Hildebrand, Samuel F.
1941. An annotated list of salt and brackish water fishes, with a new name for a menhaden, found in North Carolina since the publication of "The Fishes of North Carolina" by Hugh M. Smith in 1907. Copeia, No. 4, pp. 220-232.

Jenyns, Leonard.
1842. The zoology of the voyage of the H.M.S. Beagle, during the years 1832 to 1836, pt. 4, Fishes, 172 pp., 29 pls. London.

Jordan, David Starr, and Evermann, Barton Warren.
1900. Ibid, pt. 4, 958 figs.
JORDAN, DAVID STARR, EVERMANN, BARTON WARREN, and CLARK, HOWARD WALTON.


LITTLE, BENJAMIN HENRY.


MITCHELL, SAMUEL L.


POZZI, AURELIO J., and BORDALE, LUIS F.


RAFINESQUE, C. S.


REGAN, C. TATE.


RICHARDSON, HARRIET.


SCHREINER, CARLOS, and RIBEIRO, ALIPIO DE MIRANDA.


SPIX, J. B. VON, and AGASSIZ, L.

1829. Selecta genera et species piscium quos in itinere per Brasiliam annis 1817-1820, etc. Monachii, pp. 1-138, 76 pls.

THOMPSON, WILL F.


VON IHERING, RODOLPHO.

1940. Dicionário dos animais do Brasil. 898 pp. Sao Paulo, Brazil.