

Remarkable Changes in the Vertebrae of Perciform Fish *Scombrobrax* with Notes on Its Anatomy and Systematics

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Abstract The abdominal vertebrae of the deep-sea perciform fish, *Scombrobrax heterolepis* develop into a strange structure in the adult. Vertebrae 5th through 12th have expanded parapophyses that are bulged dorsolaterally to form a nearly hemispherical pocket on each side, opening ventrally. Delicate bubble-like evaginations of the gas bladder fit into the bullae. Because of the possession of unique features, percoid and scombroid characters, we propose to place the monotypic species in the family Scombrobracidae and suborder Scombrobracoidei in the order Perciformes.

Scombrobrax heterolepis is a deep-sea fish known from the Indo-Pacific and the Atlantic, possibly world-wide (Higgins et al., 1970). Most specimens available to ichthyologists since description of the 22.7 cm holotype (Roule, 1922) have been less than 10 cm long, but the species reaches more than 30 cm. Several specimens exceeding 10 cm have been available to us.

The skeleton of *S. heterolepis* has been studied by Gosline (1968) and by Potthoff, Richards and Ueyanagi (1980), but in both instances the study included juvenile specimens only. Roule (1922) commented on a radiograph of the holotype. We studied additional specimens by means of radiographs, dissection and staining and clearing. The study disclosed ontogenetic modifications of vertebrae unparalleled in other fishes and a gas bladder-skeleton relationship of a unique nature.

Material examined

Material examined is all from the Indo-Pacific and listed in the report by Higgins et al. (1970). All specimens are deposited in the Far Seas Fisheries Research Laboratory at Shimizu-shi, Shizuoka-ken, Japan.

Vertebrae

In small specimens of *Scombrobrax heterolepis*, the vertebrae are similar to young scombroids, but in those from 90 to 100 mm, modifications can be seen (Fig. 1). Vertebrae 1 through 4 are unmodified. Number 5 shows a small flangelike expansion of the parapophyses posterior to the rib articulation. In vertebrae 6, 7, and

8, the parapophyses and the expansion thereof are progressively larger so that each of these vertebrae forms a wide vaulted arch. The structures become narrower in 9, 10 and 11 as the parapophyses become more vertically oriented. Vertebra 12 has broad but nearly vertical parapophyses and a bridge representing the beginning of the haemal canal. The remainder of the vertebrae are unmodified, with the first haemal spine being on vertebra 14.

In a specimen of 135 mm, vertebrae 1 through 4 and 13 through 30 remain unmodified, but 5 through 12 have expanded parapophyses that are bulged dorsolaterally to form a nearly hemispherical pocket on each side, opening ventrally. These pockets are shallow in number 5 but deepen in successive vertebrae until they approach a bullar form in 10, 11 and 12.

The largest specimen dissected, 250 mm, probably represents the full development of the vertebral modifications (Fig. 1). In fact, vertebrae seen in radiographs of specimens in the 140 mm to 170 mm range are essentially the same as those of the largest specimens, except that the bullae of the large specimens are relatively deeper. In the large specimens, vertebrae 1 through 4 are unmodified. Vertebrae 5 through 12 are expanded laterally and dorsally on each side to form thin-walled bullae that have wide openings ventrally. Vertebra 13 has a rudimentary bulla on the left side. Vestiges of parapophyses are present on 4 through 9, and modified parapophyses occur on 10, 11 and 12. Ribs articulate with small notches in the outer rim of the bullar openings, except for vertebra 4, in



Fig. 1. Modified vertebrae of adult *Scombrobrax heterolepis* (250 mm SL): lateral view (above: 8th~16th) and ventral view (below: 5th~13th).



Fig. 2. Lateral view of bullar 9th and 10th vertebrae of *S. heterolepis* (250 mm SL).

which the ribs attach to the anterior edge of the openings.

Dorsally the bullae are flattened. The highest part of each is about even with the floor of the neural canal, and below the level of the zygapophyses (Fig. 1). The diameter of the bullar opening is somewhat less than the greatest diameter of the cavity in all expanded vertebrae, so that the upper part of the vertebra is wider than the lower. That is especially noticeable in 4, 11 and 12. A yellowish fatty substance extends along the dorsal surface of the bullae and

partially fills the spaces between adjacent bullae. Ligaments reach from neural spines to ribs on vertebrae 2, 3, and 4. Large flattened ligaments reach from neural spines to centra.

The openings of the bullae extend below the ventral surface of the centra so that an arch is formed between the openings. This arch is narrow and shallow in 5, but becomes wider and deeper through 8, then narrower and deeper so that the width of the arch on 12 is about one-half that of number 8. The unmodified portions of the bullar vertebrae are about the same size as adjacent vertebrae. The neural spines are laterally flattened in vertebrae 1 through 9, then tend to be flattened front-to-back. Bullae are covered by a thick connective tissue membrane. When this is removed, fine granular striae, oriented generally with the body axis, can be seen on the surface of the bullae.

Roule (1922) noted the thick, higher-than-long characteristics of the anterior vertebrae—"Vertebres anterieures epaisses, aussi hautes que longues;..." but did not comment on them further.

Examination of several other genera, including *Scombrops*, *Promethichthys*, *Rexea*, *Trichiurus* and *Aphanopus* disclosed no such modifications of vertebrae as seen in *Scombrobrax*.

Relationship of gas bladder to vertebrae

The gas bladder begins below vertebra 2 and

extends posteriorly to below vertebra 13. The walls are thin and are covered by a pigmented membrane, usually appearing dark gray. The gas bladder is closely applied to the roof of the body cavity, against the vertebrae. Consequently, the cephalic kidney diverges into two lobes, one on each side of the gas bladder, and the renal kidney is confined to the posterior part of the cavity.

In adult *Scombrolabrax heterolepis*, delicate bubble-like evaginations from the dorsal surface of the gas bladder fit into the bullae. The peritoneal membrane separating the vertebrae from the gas bladder is so thin and elastic that, when the gas bladder pouches are withdrawn from the bullae, the membrane stretches tightly over the bullar opening. Even in specimens preserved for a few years, the membrane remained so elastic that the head of a round-head pin could be inserted into the bullae without rupturing the membrane.

**Notes on gross anatomy of viscera of a male,
154 mm SL**

As viewed from the left side, the left lobe of liver overlies the dorsal aspect of the pyloric caeca and stomach. The latter is a conical bag extending over half the length of the body cavity. The pyloric opening is anterior; the gut runs from the lower part of the stomach to the right, curving upward to make an open loop along the anterior one-third of the right side of the stomach. From the bottom of the loop, just posterior to the pelvic bones, the gut runs straight to the anus, the lumen enlarging posteriorly.

The right lobe of the liver is about one-fourth the size of the left lobe, and lies along the anterior end of the stomach, dorsolaterally, between that organ and the upper part of the intestinal loop. Pyloric caeca are seven in number, two attaching to the gut at the anterior end of the stomach and five along the anterior half of the intestinal loop. All caeca pass under, or in front of, the stomach so that the distal ends are all on the left side. The spleen is between the gut and stomach adjacent to the last pyloric caecum.

The testes are long and flat, each not much more than two mm thick, and stretch the length of the body cavity. They are closely appressed together behind the stomach in the posterior third of the coelom. The gas bladder begins

above the middle third of the stomach, and its anterior end lies between the testes. A small pad of muscle fibers covers the ventral aspect of the anterior end of the gas bladder. The bladder is covered by a pigmented membrane and appears dark gray. The walls are thin and delicate.

The cephalic kidney is at the extreme front of the cavity. It is small and diverges posteriorly into two lobes. The renal kidney is at the posterior end of the body cavity, and invades the enlarged second and third haemal arches.

Systematic position of Scombrolabracidae

Although Roule (1922), noting the mixed characteristics of *Scombrolabrax* that appeared to ally the genus to both Percoidei and Scombroidei, erected the family Scombrolabracidae ("Scombrolabracides") and suborder "Scombropercoides" for it, subsequent authors (see Grey 1960) placed the genus in families representing Percoidei or Scombroidei. Grey tended toward placement in a separate family, a placement adopted by Gosline (1968) and by Potthoff, Richard and Ueyanagi (1980). Lindberg (1974) placed the genus in the Gempylidae, which he put in the suborder Trichiuroidei. Nelson (1976) placed it in the Gempylidae (in Scombroidei) although he noted that the genus was of uncertain position.

The shifting and uncertainty of placement of the family Scombrolabracidae has been a consequence of the mixture of characters noted by Roule (1922) and enlarged upon and added to by subsequent authors. The general appearance of the genus plus some features that Grey (1960) and Gosline (1968) considered to be primitive gempylid characters seem to place the family close to the Gempylidae, whereas the vertebral count of 30, the serrate preopercle and opercle, the protractile premaxillae, and the procurrent spur on the lowermost principal caudal ray (Johnson, 1975) tend to ally the family more to the Percoidei. We believe that the unique character of the vertebrae and gasbladder, coupled with the mixed scombroid and percoid characteristics of the genus warrant its removal from both Scombroidei and Percoidei. As Roule stated in 1922, this unusual fish constitutes a separate suborder. Following the modern practice in deriving the subordinal name, it

becomes Scombrolabracoidei rather than Scombropercoidei as proposed by Roule. The bullar nature of the vertebrae in mature members of this group is as trenchant a character as any separating other perciform suborders from the basal Percoidei.

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ムカシクロタチの特異な脊椎骨の発達と系統上の位置 Carl E. Bond・上野輝弥

深海性スズキ目魚類ムカシクロタチ *Scombrolabrax heterolepis* の腹椎骨が特異な形に成長をとげることが判明した。この変化はすでに標準体長 135 mm の個体においてみられ、249 mm の個体では完成していると思われる。第1~12脊椎骨の椎体が左右に大きく膨脹し中空の構造となる。この一つ一つの脊椎骨の膨らみの中に鰓の背面がくびれて入りこんでいる。この部分において腎臓は鰓の両側に分かれて存在する。

ムカシクロタチの系統上の位置について考察を行った結果サバ亜目とスズキ亜目の形質を種々保持している上、独特な形質も顕著なので、Roule (1922) によって創設されたムカシクロタチ 亜目を認めることとした。本亜目は現在のところ一科一属一種を含む。

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