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FIRST RECORDS OFF OREGON OF THE PELAGIC FISHES *PARALEPIS ATLANTICA*, *GONOSTOMA ATLANTICUM*, AND *APHANOPUS CARBO*, WITH NOTES ON THE ANATOMY OF *APHANOPUS CARBO*[1]

The species covered in this report are common in parts of the Atlantic Ocean and all are known to occur in the Pacific Ocean. We fill a gap in knowledge of the distribution of two species known formerly only north and south of Oregon, extend the northward range of *Gonostoma atlanticum* Norman, and report inshore occurrences of *Paralepis atlantica* Krøyer. The unusual gross anatomy surrounding the gas bladder of *Aphanopus carbo* Lowe is worthy of description.

Methods

Counts and measurements followed those of Hubbs and Lagler (1958) and all measurements were taken to the nearest 0.1 mm. Specimens are catalogued in the fish collections of the Department of Fisheries and Wildlife (OS) or the School of Oceanography (OSUO), Oregon State University. Anatomical terminology follows that of Lagger et al. (1962) and Romer (1970). Four specimens of *A. carbo* from Oregon were dissected and two were radiographed. Two specimens from the Atlantic Ocean off Madeira were dissected and radiographed. Complete vertebral counts could not be made from the radiographs due to poor resolution of the small posterior caudal vertebrae.

Notes on Distribution and Morphology

Paralepis atlantica has been recorded in the eastern Pacific from Baja California and California (Rofen 1966) and from the vicinity of Willapa Bay, Wash. (Kajimura 1969). Bakkala (1971) reported the species from surface waters of the central Pacific at lat. 48°00′ N, long. 165°00′ W.

Two specimens of *P. atlantica* were found on shore in northwestern Oregon. One (OS 956:456 mm SL) was taken alive on the beach at Netarts, Tillamook County, on 7 October 1963. Another (OS 5160:466 mm SL) was found dead on the beach 29 km north of Seaside, Clatsop County, on 16 May 1960. A specimen of *G. atlanticum* (OSUO 2402:59 mm SL) was captured on 30 July 1977, 65

[1]Technical Paper No. 5082, Oregon Agricultural Experiment Station, Oregon State University, Corvallis, OR 97331.

km west of Newport (lat. 44°38′ N), between 335 and 400 m deep with a small Cobb midwater trawl (10 m mouth opening) with an opening and closing cod end (Pearcy et al. 1977). This female fits the descriptions by Grey (1960, 1961, 1964) and Mukhacheva (1972). Maximum diameter of eggs in the ovary was 0.16 mm. Grey (1964) considered fish of this size to be mature.

Gonostoma atlanticum is usually distributed in warm water of the Atlantic, Pacific, and Indian Oceans. It is found in the eastern and central North Atlantic, and it has usually been recorded from equatorial waters in the Pacific and Indian Oceans. The northernmost previous record (lat. 34°18.6′ N) for its occurrence in the Pacific Ocean was that of Berry and Perkins (1966), who captured several individuals off southern California. The temperature of the water in which the OSUO specimen was captured was 5.37°-5.70° C. Backus et al. (1965) reported the occurrence of *G. atlanticum* in the Atlantic Ocean in waters of 10°-11° C.

Aphanopus carbo was first reported from the Pacific Ocean off Bodega Bay and Fort Bragg, Calif., in 1969 (Fitch and Gotshall 1972). Peden (1974) reported a specimen from off the Strait of Juan de Fuca. Clarke and Wagner (1976) collected larvae and juveniles off Hawaii. Five specimens were taken off Oregon in 1976: OS 5381 (476 mm SL), about 29 km off Cape Meares, at about 183 m; OS 6115 (639 mm SL), about 37 km off Florence, at about 146 m; OSUO 2352 (570 mm SL), 2353 (558 mm SL), 2354 (547 mm SL), 120 km west of Newport, at about 400-480 m, in an opening and closing net.

Our specimens compared with those from Madeira, had slightly smaller horizontal orbit, slightly wider suborbital head width, and slightly shorter anal spines. Otherwise the Atlantic and Pacific Ocean specimens are very similar.

Gas Bladder Anatomy in *Aphanopus carbo*

Although Maul (1954) mentioned that on retrieval to the surface the gas bladder in *A. carbo* expands greatly, causing the skin of the abdomen to split, none of our specimens exhibited this characteristic. Shepel[2] stated that none of the specimens examined by him had their skin split, but that the stomach in most specimens (all from the Atlantic Ocean) were everted. Only one of our specimens had an everted stomach. These differences led us to examine the gas bladder and associated structures in *A. carbo*.

Bone (1971) described the anatomy and histology of the gas bladder of *A. carbo*. Tucker (1953) briefly mentioned the ribs and provided partial radiographs of the ribs and vertebral column in *A. carbo* and *A. schmidti*. However, we found no descriptions of the relationship of the bladder to the vertebral column, ribs, kidneys, and coelom. Our examination of *A. carbo* shows that the gas bladder of this species, and the structures associated with it, has several unusual characteristics. Little variation in anatomy was noted in our specimens.

The position of the gas bladder in *A. carbo* is typical of that in most fishes; it is ventral to the vertebral column and kidneys and dorsal to the peritoneal (abdominal) cavity (i.e., retroperitoneal) (Figure 1). The anterior end of the gas bladder is below the sixth vertebra. From it, two minute extensions proceed anterolaterally at 45°, but the size of the extensions did not allow us to trace them forward more than a few millimeters. Posteriorly, the gas bladder extends to a blunt end between vertebrae 42 and 45, directly dorsal or slightly anterior to the vent. Although the dorsoposteriad portion of the peritoneal cavity narrows and curves ventrally, the gas bladder continues to parallel the vertebral column except for a slight dip near the posterior end. The region between the gas bladder and the peritoneal cavity is filled with hypaxial muscle. The bladder is slightly narrowed at its anterior and posterior ends. It is oval in cross section and slightly smaller than the diameter of vertebral centra in our preserved specimens (Figure 1).

The kidneys extend anteriorly from the region dorsal to the vent to the posterior portion of the skull. They are enlarged in the area above the vent, and between the anterior of the gas bladder and posterior of the skull, and lie ventrolateral to the vertebral column and dorsolateral to the gas bladder. They terminate in a urinary duct that appears to empty into a urogenital sinus.

The ventral ribs are intimately associated with the gas bladder and kidneys. A pair of ventral ribs is present on all trunk vertebrae, but those anterior to the gas bladder are short and thin. These ribs are difficult to find but may be seen readily in radiographs. From immediately anterior to the gas bladder to about the ninth vertebra the ribs become progressively longer and

[2]L. I. Shepel, Fishery Reconnaissance, Murmansk, U.S.S.R., pers. commun. 15 November 1977.

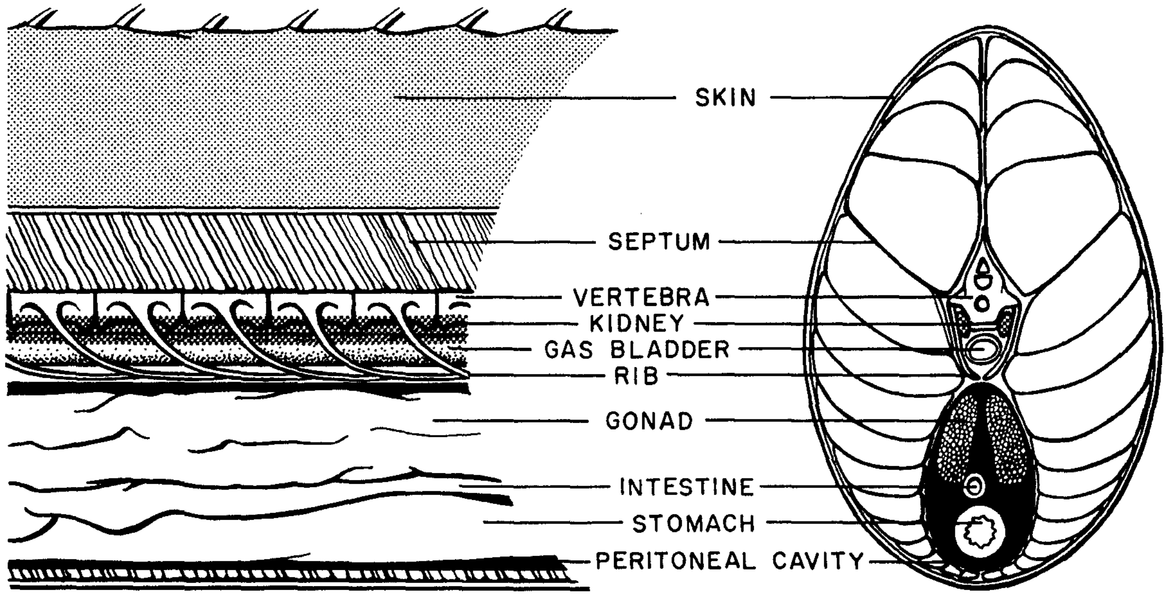

FIGURE 1.—Gross anatomy of the gas bladder and surrounding region in the black scabbardfish, *Aphanopus carbo*. Left: Partial sagittal section in region of the 14th-19th vertebrae. Muscle and other tissue have been removed from the region ventral to the indicated septum. Right: Cross section in the region of the 14th vertebra.

thicker. From that point posteriorly to the first caudal vertebra, all the ribs, except the last two to four, are of the same size, shape, and relative position. All the ribs extend laterally around the kidneys but the last few extend farther ventrally to encage the enlarged posterior portion of the kidneys. Where the ribs contact the gas bladder laterally, they turn abruptly posteriad and almost parallel the bladder while remaining in contact with it. In doing so, they curl beneath the bladder. Each rib extends posteriorly a distance almost equal to two vertebrae (Figure 1). Each rib appears to join a myocomma, then connect to the ventrolateral wall of the bladder. The gas bladder is thus surrounded by a "rib cage."

The hypaxial muscles, in conjunction with the ribs, surround the gas bladder almost completely. The only gap is a narrow medial band of connective tissue to which the ribs attach, present between the peritoneal membrane and the gas bladder (Figure 1).

The unusual anatomy of *A. carbo* invites speculation concerning its significance. The enclosure of the gas bladder in a rib cage apparently reinforces the gas bladder wall, which Bone (1971) has shown is composed of thick connective tissue. The combination of a thick, tough wall reinforced by muscle and bone seems likely to prevent the expansion of the gas bladder when ambient pressure decreases more rapidly than the gas contained in the bladder can be absorbed into the bloodstream. This species is known to feed on cephalopods (Zilanov and Shepel 1975). Possibly the anatomical modifications of its gas bladder and associated structures allow *A. carbo* individuals to pursue prey into significantly shallower water without having to adjust bouyancy and/or absorb gas.

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CHANGES IN RIBONUCLEIC ACID, DEOXYRIBONUCLEIC ACID, AND PROTEIN CONTENT DURING ONTOGENESIS IN WINTER FLOUNDER, *PSEUDOPLEURONECTES AMERICANUS*, AND EFFECT OF STARVATION

Normal development of most embryonic and prolarval (yolk-sac) teleosts depends on material stored in the yolk for a source of both energy and biosynthetic precursers. After hatching there is a transition period when larvae shift from dependence on yolk to an exogenous food supply. The availability of sufficient prey of the proper quality and the ability of larvae to capture and assimilate it are critical to survival during the larval stage. Since differential mortality during the larval stage could be important in determining the year-class size of marine fish, a method for determining the nutritional condition of fish larvae in plankton samples could aid in determining larval survival and prediction of subsequent year-class size. In the past, weight-length relationships (Blaxter 1971), morphometric (Ehrlich et al. 1976), chemical (Ehrlich 1974a, b), and histological (O'Connell 1976; Theilacker 1978) methods have been used with varying degrees of success. All four approaches have limitations and diagnosis of the starving condition in sea-caught larvae is difficult.

Bulow (1970) used RNA-DNA (ribonucleic acid-deoxyribonucleic acid) ratios as indicators