

## The Urogenital Papilla of the Tube-snout, *Aulichthys japonicus*

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**Abstract** The structure of the urogenital papilla of the oviparous fish, *Aulichthys japonicus*, was observed and the function of the organ was discussed. The epithelium, corium and layer striated muscle place continuously from the peripheral to central portion of the papilla. Although the origin of the papilla in this species appears to be the same as that of ovoviviparous rockfishes, *Sebastes* and *Sebastiscus*, the internal structure of the former shows marked differences from that of rockfishes.

The function of the urogenital papilla or copulatory apparatus in teleosts has been studied in the viviparous or ovoviviparous fishes such as Poeciliidae (Gordon and Rosen, 1951; Rosen and Bailey, 1963), Brotulidae (Suarez, 1975), Zoarcidae (Nielsen, 1968) and Scorpaenidae (Mizue, 1959; Igarashi, 1968). However, the urogenital papilla is also found in some of the oviparous fishes such as Gobioidae (Egami, 1960; Arai, 1964), Cottidae (Watanabe, 1960) and others.

The oviparous tube-snout, *Aulichthys japonicus* Brevoort has a well developed urogenital papilla in the adult male. In oviparous fishes the urogenital papilla is not presumably used as a copulatory apparatus, but it appears to be closely related to the reproductive behavior of these fishes.

In the present paper the structure of the urogenital papilla of the adult male of *A. japonicus* is described and its function is discussed.

### Material and methods

Eleven specimens of *A. japonicus*, 8 males,

103.5~105.2 mm TL, and 3 females, 116.8~126.0 mm TL, were collected by a seine in the kelp beds at Usujiri near Hakodate on April 26 and May 2, 1975, just spawning period of the fish.

The external feature of the urogenital papilla and the secondary sexual characters were observed under a binocular microscope. For the purposes of determination of sex and examination of maturity, the urogenital papilla and the gonad were cut out and fixed in Bouin's solution. Then the urogenital papilla and gonads were sectioned by the usual paraffin method at 10 $\mu$  and were stained with Delafield's haematoxylin and eosin.

### Results

This species exhibited marked secondary sexual characters during their breeding season. Color of the dorsal ray was light-green in males and bluish-tint in females. The male pectoral fin rays were light greenish-brown in color and those of females were colorless. There is also a tendency of the adult male to be smaller than the adult female (Figs. 1,

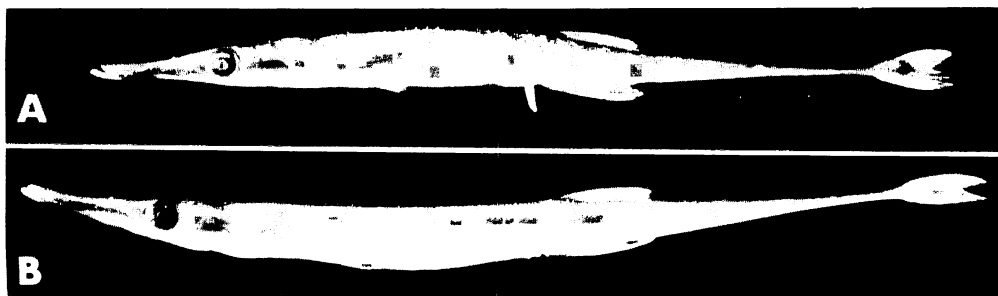


Fig. 1. Adult male (A), 103.5 mm TL and adult female (B), 124.4 mm TL of *A. japonicus*.

A~B).

Sections of the testis and ovary of *A. japonicus* were observed. The testis and sperm duct were filled with a large amount of

spermatozoa and the ovary contained oocytes at yolk globule stage. This suggests that *A. japonicus* was in spawning condition (Figs. 2, A~B).

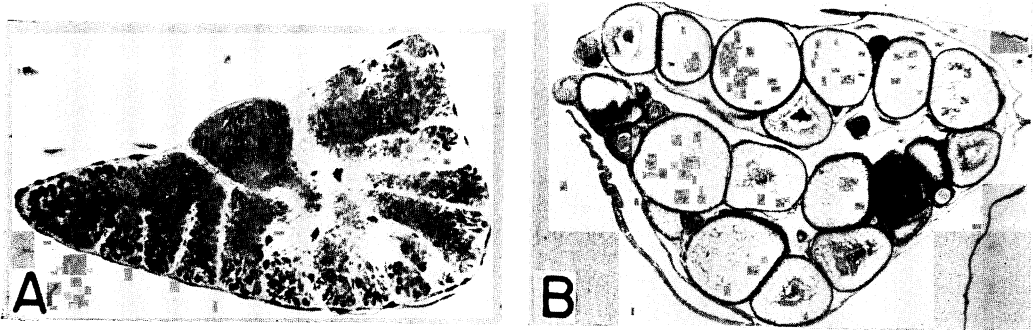


Fig. 2. Cross sections of the testis and the ovary of *A. japonicus*. A, the testis of *A. japonicus*, 103.5 mm TL, collected on April 26, 1975,  $\times 21$ ; B, the ovary of *A. japonicus*, 116.8 mm TL, collected on April 26, 1975,  $\times 21$ .

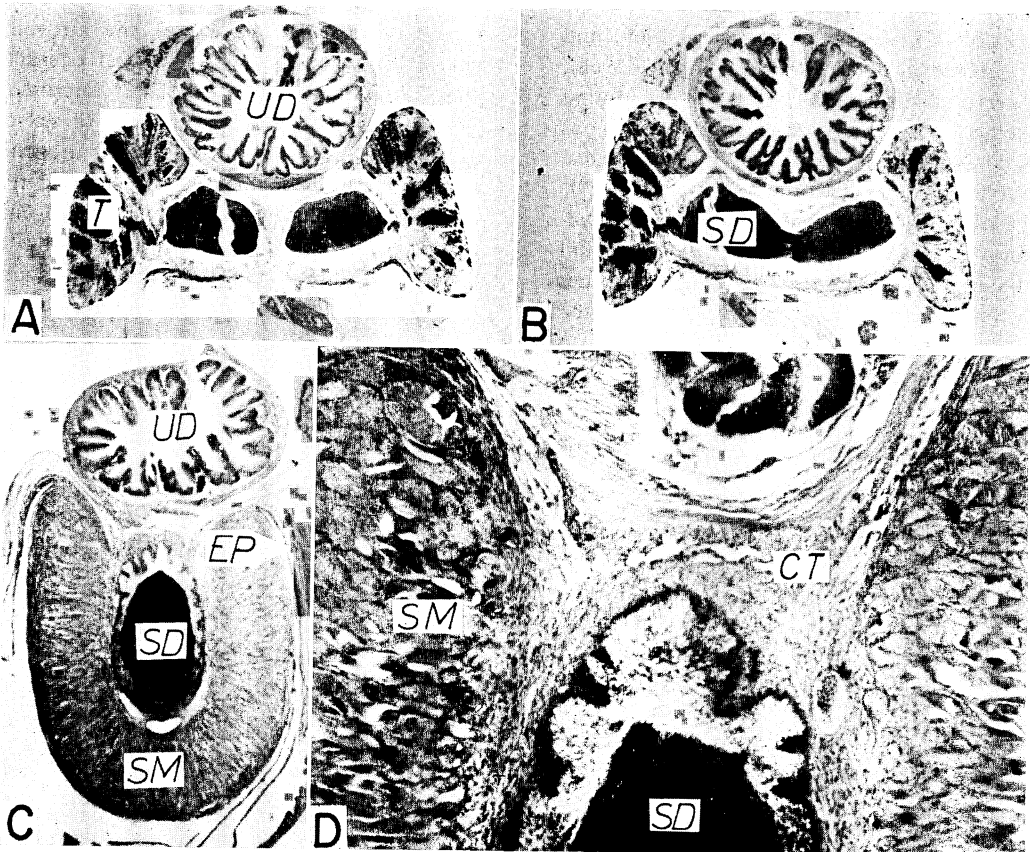


Fig. 3. Cross sections of the urogenital papilla of *A. japonicus*. A, the basal region of the urogenital papilla,  $\times 23$ ; B, a slightly median region of the urogenital papilla,  $\times 23$ ; C, the median region of the urogenital papilla,  $\times 23$ ; D, magnification of Fig. 3C, layer striated muscles lie from central to peripheral portion,  $\times 43$ . CT, connective tissue; EP, epithelium; SD, sperm duct; SM, layer striated muscle; T, testis; UD, urinary duct.

The urogenital papilla of the male is extruded ventrally behind the anus, and is bordered anteriorly by the intestinal tract and posteriorly by the muscles of the anal fin in the peritoneal cavity (Fig. 5, A). As the spawning season approaches, the urogenital papilla was pushed out from the abdomen, with the testis more and more expanded.

A histological study of the urogenital papilla revealed its internal structure. At the basal region (near the testis) of the papilla, a large urinary duct runs along the dorsal part of the urogenital papilla and two divided sperm ducts run below the urinary duct. The layer striated muscles are quite undeveloped

(Fig. 3, A). At a slightly further median region, the two sperm ducts are fused into a single depressed duct (Fig. 3, B).

At the median region, the cross section of the papilla is oval in shape (Fig. 3, C). The large urinary duct surrounded by the intensely folded epithelium runs along the dorsal part of the urogenital papilla. The sperm duct, which is ventrally surrounded by a horse-shoe shaped layer striated muscle, is present in the central connective tissues (Fig. 3, D).

At the terminal region, the cross section of the papilla is almost circular in shape (Fig. 4, A). The epithelium, corium, muscles, and connective tissues lie successively from the

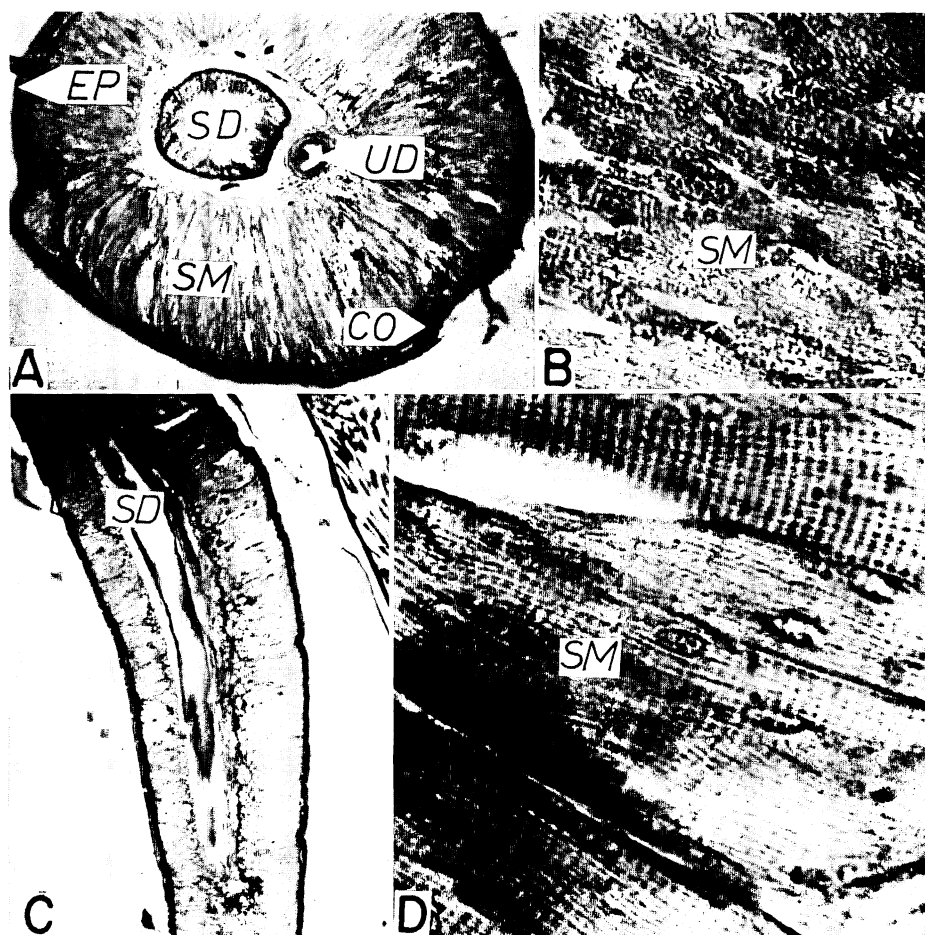


Fig. 4. Cross and midsagittal sections of the urogenital papilla of *A. japonicus*. A, cross section at the terminal region of the urogenital papilla,  $\times 46$ ; B, magnification of Fig. 4A, layer striated muscles are clearly observed,  $\times 161$ ; C, midsagittal section of the urogenital papilla,  $\times 12$ ; D, magnification of Fig. 4C,  $\times 161$ . CO, corium; EP, epithelium; SD, sperm duct; SM, layer striated muscle; UD, urinary duct.

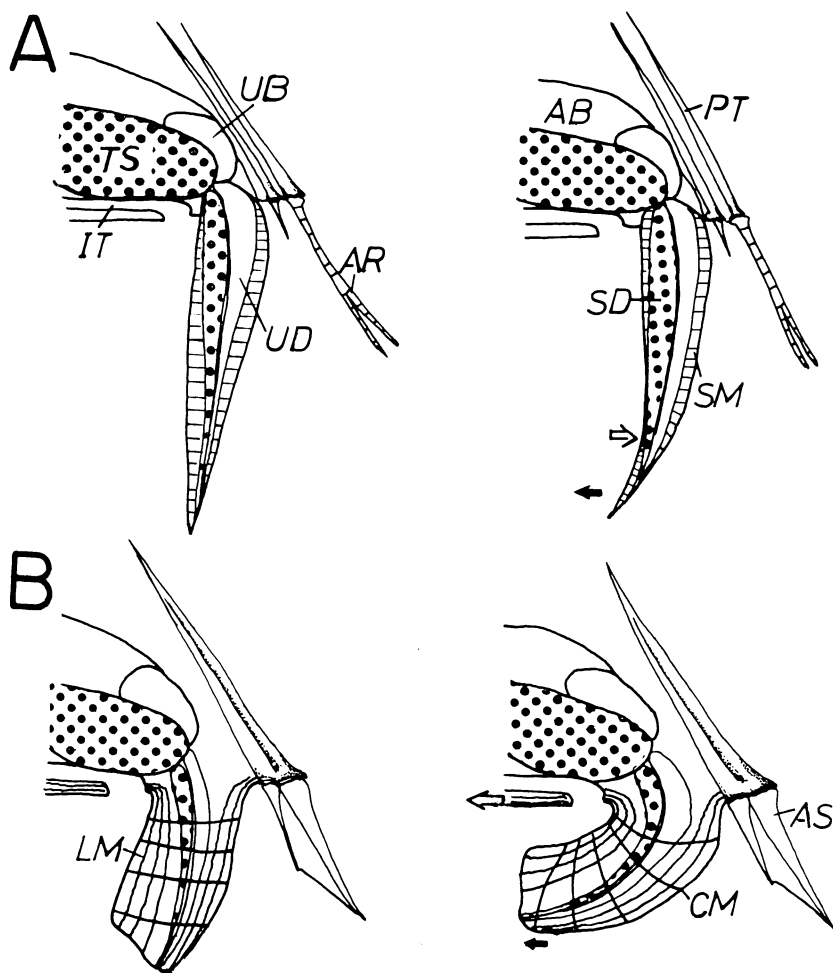


Fig. 5. Diagrammatic figures showing vertical sections through the center of urogenital papilla and its adjacent organs. Muscles of the anal fin are omitted.

A: *Aulichthys japonicus*. Before contraction of the layer striated muscle (left), and a slightly movement of the urogenital papilla from part to part by the contraction of the layer striated muscles (right). B: Rockfish (*Sebastes taczanowskii*). Before contraction of longitudinal and circular muscles (left), and a great movement at basal part of the urogenital papilla by contraction of the longitudinal and circular muscles (right).

White arrows indicate the direction of contraction of muscles, and black arrows indicate the direction of the movement of the urogenital papilla. AB, air bladder; AR, anal fin ray; AS, anal fin spine; CM, circular muscle; IT, intestinal tract; LM, longitudinal muscle; PT, pterigiophore; SD, sperm duct; SM, layer striated muscle; TS, testis; UB, urinary bladder; UD, urinary duct.

peripheral to the central portion. Both the sperm and urinary ducts respectively penetrate the central connective tissues (Fig. 4, A). There is an intensely folded epithelium on the inner surface of the urinary duct, while such epithelium is absent on the inner

surface of the sperm duct. The muscles of the papilla consist of horizontal layers of striated muscles, and the nuclei of layer striated muscles are slightly stained with haematoxylin (Fig. 4, B). With the exception of the layer muscles, the circular and longitu-

dinal muscles are quite undeveloped (Fig. 4, A).

At the midsagittal section of the papilla (Fig. 4, C), the sperm and urinary ducts run from the testis and urinary bladder to the terminal tip through the central portion of the papilla, respectively. Layer striated muscles lie from the basal region of the papilla to the tip (Figs. 4, C~D).

### Discussion

It is well known that there are two origins of the copulatory apparatus in viviparous or ovoviviparous fishes. The gonopodium of Poeciliidae, the clasper of Elasmobranchii, and the penis and pseudoclasper of Brotulidae originate from a part of fin (Leight-Shape, 1920; Gordon and Rosen, 1951; Rosen and Bailey, 1963; Hulley, 1972; Suarez, 1975), while the urogenital papilla in rockfishes originates from the projection of the sperm and urinary ducts (Mizue, 1959; Igarashi, 1968).

In *A. japonicus*, it is clear that the papilla does not originate from the fin because neither skeletal elements nor specialized organs can be observed in the papilla. If the papilla originated from the digestive tract, its muscles would be the smooth muscles, as found in the digestive tract. From the reason described above, the author concludes that the papilla of *A. japonicus* originates from the projection of the sperm and urinary ducts as in the case of rockfishes.

According to Mizue (1959) and Igarashi (1968), the internal structure of the urogenital papilla in the ovoviviparous rockfishes, *Sebastes* and *Sebastes*, consists of epithelium, corium, connective tissues, corpus cavernosum, lymphocyte, and circular and longitudinal muscles, but layer striated muscle is undeveloped. In *A. japonicus*, however, the corpus cavernosum, lymphocyte, and circular and longitudinal muscles do not appear, while abundant layer striated muscles are regularly arranged from the central to the peripheral portion of the papilla.

Although the urogenital papilla of rockfishes and that of *A. japonicus* seem to have the same origin, the internal structure of the rockfishes and *A. japonicus* shows marked

differences. Differences of the structure and the nature of the muscles which characterize the two species may be related to the difference of the movability of the urogenital papilla in the reproductive behavior of these fishes. Thus it may be presumed that the papilla of rockfishes has a multidirectional movability at its basal point by the contraction of the longitudinal muscles, which run from the abdominal margin of the body to the tip of the papilla, as well as the circular muscles surrounding the urinary and sperm ducts (Fig. 5, B).

In the papilla of *A. japonicus*, however, neither circular nor longitudinal muscles are observed, nor are corpus cavernosum and lymphocyte detected, but a regular arrangement of layer striated muscles is found. From these characteristics, the author concludes that the papilla is quite immobile at its basal point, but slightly movable from part to part by the contraction of the layer striated muscle, without possessing much flexibility (Fig. 5, A).

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卵生魚、クダヤガラ *Aulichthys japonicus* の泌尿生殖突起

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クダヤガラの泌尿生殖突起の構造を観察し、その機能を推定した。

突起の内部構造は外側から中心部へ向って表皮、真皮、横紋筋層の順に配列されており、中心部にある結合組織の中に輸精管および輸尿管が別個に貫通している。この突起は筋肉層の配列状態から考え、突起の基部を中心として大きく動くことはなく、層状に配列された横紋筋を個々に動かすことにより、部分的な小さな動きしかしないし、また、海綿体、リンパ球などが存在しないことから可動性に乏しいことが推定される。

この突起の起源はメバル属の魚のそれと同様、泌尿生殖孔部が突出したものと考えられるが、クダヤガラとメバル属の魚との突起の内部構造、特に筋肉層の配列状態には大きな違いが認められる。この違いは生殖行動における泌尿生殖突起の可動性に関係しているものと考えられる。

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