Some Observations on the Luminous Organ of the Fish, *Paratrachichthys prosthemius* JORDAN et FOWLER※

By

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Although considerable attention has been directed to deep-sea luminous fish such as *Iniomi* in which luminecence is produced by luciferin-luciferase reaction within the cell, comparatively little is known of certain squid and fish which occasionally or regularly emit light because of symbiotic lumious bacteria harbored in certain gland.

HARVEY (1920) ascertained that certain species of East Indean fish *Photoblepharon* and *Anomalops* have a special subocular luminous organ, in which luminous bacteria are allways present. These bacteria live among a group of special long cylindrical cells which are richly impregnated with blood capillaries. Continous light emission of these bacteria is sometimes shut off by a screening mechanism of melanophores.

Similar finding was made by YASAKI and OKADA through both the bacteriological and histological methods in luminous organ of the nocturnal fish, *Monocentris japonica*. A spceies of *Gadidae, Physiculus japonicus,* as observed by KISHITANI (1930), has black discs, abounding with two kinds of luminous bacteria in a gland imbedded in ventral muscle.

While, HICKLING (1925) called attention to a new type of luminecence in the fish, *Macrocephalus laevis*, viz., light comes out only after luminous material is discharged to the exterior. In 1938 HANEDA disproved HICKLING's theory, by way of showing that source of light of *Macrocephalus laevis* is due to luminous bacteria.

Since then it has become clearer that some luminous fish emit light on account of symbiotic luminous bacteria distributed from deep-seas to shallow waters (e. g., *Macrouridae, Acropoma* and *Leiognathidae*) but it does not exclude that luminous fish aboundantly found in the depths of the ocean turn to their own resources for production of light.

The present paper embodies observations on anatomical and histological structures of the luminous organ appearing in a species of the *Trachichthyidae, Paratrachichthys prosthemius* JORDAN et FOWLER.

The materials dealt with here were obtained by means of the motortrawler from a depth of about 100 fathoms off Aichi and Mie Pref., socalled Kumanonada.

General features of the organ of this fish were first macroscopically studied

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using materials which were made translucent by glycerin. The histological technique employed was essentially the same as that described in previous paper (KUWABARA, 1954).

MARMER (1910) mentioned this fish (*Paratrachichthys*) as being "known to live at present day, mostly at great depth, in these as nearly all over the world" and he continues "vent occupies a more anterior, between the ventrals." He is apparently unaqare of any luminous property in this fish and none of the authors he quotes seems to have suspected it, so far as the author can ascetain, so that the work reported here may be said the first to specifically describe luminous organ of this fish.

Fig. 1 represents lateral and ventral views of the fish in which anus is situated anteriorly just behind ventral fin, and armed with scutes (ST) to form ventral

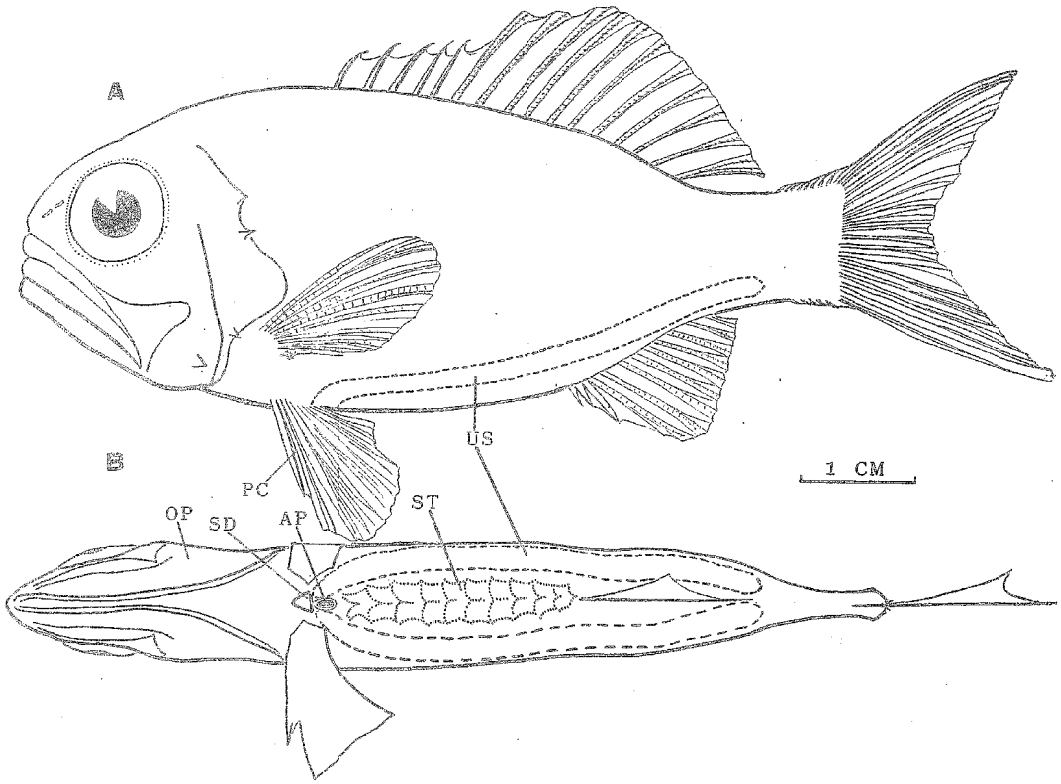

Fig. 1. Lateral and ventral views of *Paratrachthys prosthemius* JORDAN et FOWLER, showing the position of scale-less depression.
AP, papilla in which the rectum terminates; OP, operculum; PC pectoral fin; SD, scale-less depression; ST, scutes; US, unknown structure.

keel. The pectoral fin of one side is indicated by PC, black scale-less depression (SD) lying between and behind bases of pectoral fin. OP is operculum, and AP is papiila in which rectum terminates at its apex, viz., anus. Possibly this papilla was formed by turning inside out the rectum owing to pressure change when brought ashore from depth of ocean.

When base of the anal papilla is examined with a magnifying lens a characteristic disc which has opening of the duct of luminous organ is found just before the papilla.

The skin in this region is remarkablly thickened and heavily loaded with chromatophores. The scale-less depression measures 1.8 mm in width in a specimen with total length 70 mm, its skin apparently much thinner, are quite translucent in middle, but abundantly surrounded by melanophores which are provided with branched and ramifying processes.

Fig. 2 shows longitudinal (A) or transverse (B) section though the middle of gland and rectum. The rectum (P) is seem with quite thick wall and much pleated

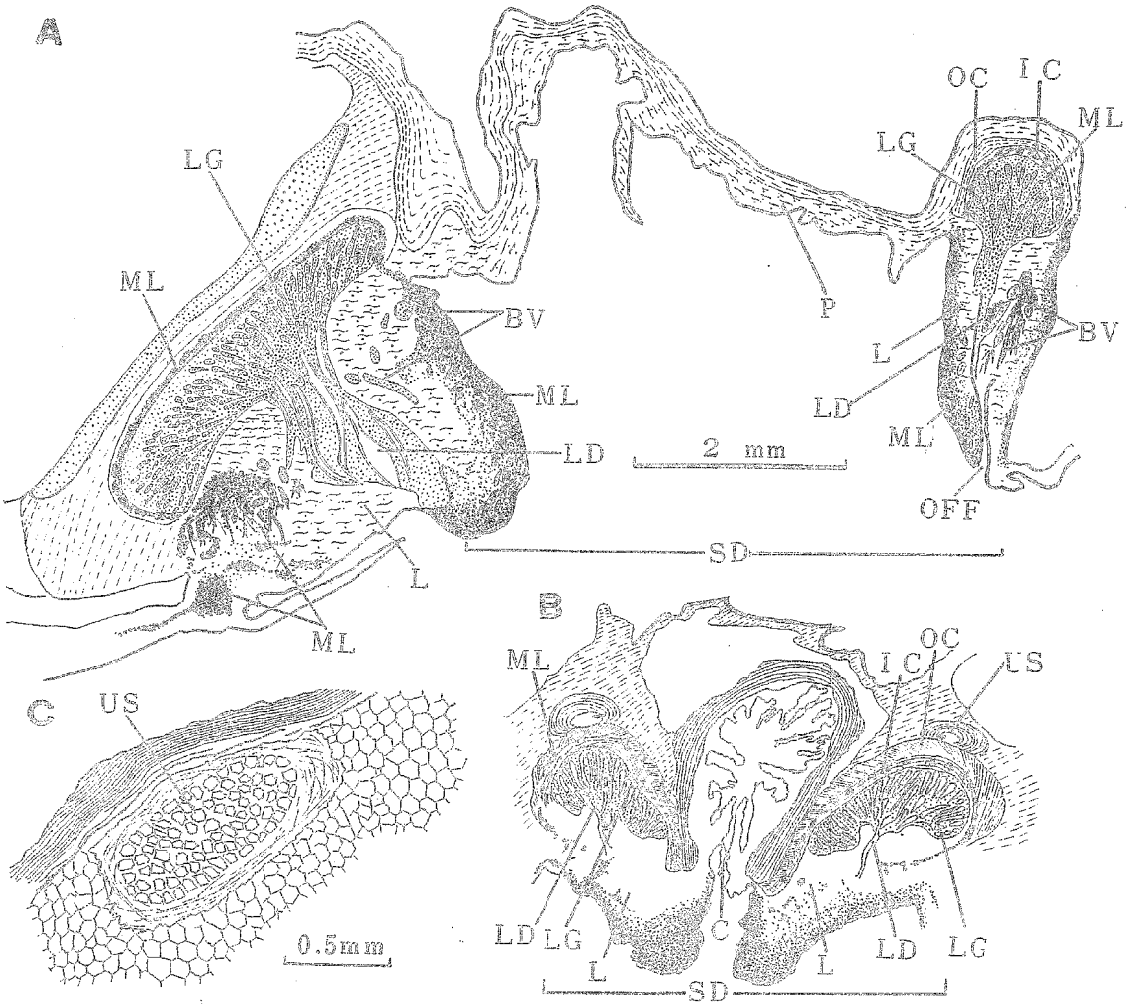

Fig. 2. A and B, Longitudinl and transverse sections of luminous gland; C, transvers section of the unknown structure which starts from scale-less depression and extends backward along the each ventral side of the body. BV, blood vessel; C, coelom; OC, inner capsule; L, lens; LD, duct; LG, luminous gland, ML, chromatophore pigment; OC, outer capsule; OFF, opening; SD, scale-less depression; US, unknown structure.

epithelium. The luminous gland (LG) is furnished with its duct (LD) passing downwards and opening to the exterior. The figure illustrates that the luminous gland here encircles the rectum, a point which will be again referred to. A remakable hyaline lens body (L) lies beneath the gland. ML points to portions of the heavy sheath of black pigments which rectum possesses down from the coelom to body wall.

The luminous gland of this fish essentially consists of ramified tubes, emptying

themselves in a duct and staining well with haemtoxylin and eosin. Along the wall of the tubes granules are found abundantly, so that the cytoplasm stains with eosin.

Granular bodies which look like bacteria are found assembling in groups along the outer wall of the tube and also in the lumen of the gland, they never show up within glandular cells, in which close scrutiny reveals nerve-endings. All these findings suggest identity of the object with the sack of bacteria as described by KISHITANI in the luminous gland of *Physiculus japonicus*, a device for keeping the glandular celle from the bacteria.

The number of the tubes decreases as one approaches its opening which is situated near the anus and in the wall of the rectum. Tne capsule which covers up the luminous gland is composed of two layers: outer and inner. Inner (IC), accompanied by chromatophores, is made of winding fine fibres, whereas outer one (OC) is composed of parallely running fibre bands of crude collagen. They are compactly set and stain well with Delafield's haematoxylin and eosin.

Between the gland and epidermal layer, there is dermal layer which is scale-less, so that it may serve as a lens which condenses the light emitted from the luminous gland. A translucent disc in the capsel is heavily laid with vein and capillaris (V) in close juxtaposition with the chromatophores (ML). Black pigments presumably expand and contact so that they stand in relation with the control of light emssion.

In Fig. 2 a, a long tongue of tissue is seen, viz., rectal papilla (P). It consists chiefly of connective tissue, containing black pigment, and rich in blood sinuses (BV). At this point the luminous duct is seen at LD, with its characteristic feature opening in the wall of the rectum.

Curiously enough, a structure of an unknown nature is visible, starting from the black scale-less depression back-ward along each ventral of the body. As the structure in question (US) in Figs. 1 and 2,C assummes the same appearance as the luminous gland of *Acropoma japonica* Type 2 (HANEDA, 1950), the author first has taken it for the luminous organ of this fish (*P. prosthemis*). But this chracteristic structure is nothing more tnan muscle tissue histologicaly. Its scrutiny is deferred to future.

In viws of the observations given above the luminous gland of this fish essentially consists of simple gland whicn is ramified out, and centering in the duct, opening in the wall of rectum, and covered by both outer and inner capsules.

As regards the lens, the translucent colune which is composed of fine connective tissue layers above the gland fulfills its function.

Since the chromatophores are seen ramified out, it is possible that they serve as a mechnism for screening the lignt emit from tne gland.

The results thus far point to the conclusion that the organ in question is essentially simmlar to the "OPEN TYPE" ones in *Gadidae* (KISHITANI, 1930), *Macrouridae* (HANEDA, 1936) *Monocentridae* (YASAKI, 1928) *Acropomatidae* (YASAKI

& HANEDA, '36) and *Leiognatidae* (HANEDA,'40), which possess opening are capable of direct emission of light by culture of luminous symbiotic bacteria within the luminous organ.

Wide difference is evident from these structure of luminous organ which are the closed type without any external opening such as *Yarella* and *Polyiounus* (HANEDA, 1950) and scopelid fish my previous paper (KUWABARA, '54).

Although the writer has had neither an opportunity of ascertaining actual light emission from the organ nor of undertaking bacteriological studies on living fish, the observations, purely anatomical and histological, clearly demonstrate that the structure of this organ is that of luminous organ which poduces light indirectly.

Concluding the subject the author wisnes to this opportunity of expressing his sincere thanks to Prof. R. ISHIYAMA of the College for his kindness in giving valuable guidance and encouragment throughout the course of this study.

Summary

1) The luminous organ of this fish is situated just before the anus, forming a black scale-less depression, 1.8mm wide in fish 70mm in total length.

2) Around the sclae-less depression the luminous gland is laid down opening in the wall of the rectum throuth a duct.

3) This apparatus which belong to "OPEN TYPE" luminous organ, consists of such elements as black scale-less depression, luminous gland and lens.

4) A structure of an unknown nature starts from the scale-less depression and runs backward along each ventral side of the body. It is imposible to decide now wheather it is an element of the luminous organ or not.

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