

A Study of the Luminous Organs of the Lantern Fish,

Tarletonbeania taylori MEAD

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(With 1 Plate and 2 Text-figures)

Since MEAD (1953) originally described a new lantern fish, *Tarletonbeania taylori* based upon six specimens obtained off Japan, many additional collections of this species have to date been recorded from both western and eastern regions of the North Pacific (e. g., MEAD and TAYLOR, 1953; RASS, 1955; and WISNER, 1959). WISNER (1959), in his extensive studies on the distribution of this species, pointed out that the highly significant differences, especially in meristic characters, exemplified between northeastern and northwestern populations.

In the majority of lantern fishes, no extraordinary intraspecific variation or sexual dimorphism can be detected in the number and placement of the luminous organs, and these serve as a taxonomic character of the species. *T. taylori* is a remarkable species in displaying a pronounced sexual dimorphism in placement of luminous organs, the supra- and infracaudal glands being present only in male. This constitutes a key specific diagnosis. The structural evidence of these luminous glands and photophores on the body is by no means clear. The present report is an attempt to give an account in some detail of the luminous organs of *T. taylori*.

Grateful acknowledgment is made to Prof. K. MATSUBARA, under whose direction this work was carried out. To the entire staff of the Kushiro Branch of Hokkaido Fisheries Experiment Station, the authors are indebted for supplying the material. Special credit is due to Mr. M. SAKURAI, chief of the Branch. Dr. Y. HANEDA of the Yokosuka City Museum was kind enough to extend valuable suggestions.

Material and Method.

The materials upon which the present study is based were captured by the staff of the Kushiro Branch of Hokkaido Fisheries Experiment Station with following data: Station No. 4, 41°55' N., 144°42' E., April 21, 1955, at surface. They comprise 5 specimens measuring 34.5-58.0 mm. in standard length. The methods used in microscopic examination of luminous organs were paraffin embedding and sectioning at a standard thickness of 8 μ . The serial sections were stained with hematoxylin and eosin.

All abbreviations of luminous organs in the description follow those presented by BOLIN (1939).

Results.

Arrangement of photophores and luminous glands (Fig. 1): As usual in general lantern fishes, the photophores of *T. taylori* are arranged on the both sides of the body,

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branchiostegal membrane, circum-orbital region and opercle. The following description is based on the examination of 5 specimens aforementioned. Dn, Vn and Suo, though rather small as compared with the other photophores, are apparently present on the settled position. Of the series Op, 2 in number, the posterior one is set near the ventro-posterior angle of the preopercle. There are 3 Br.

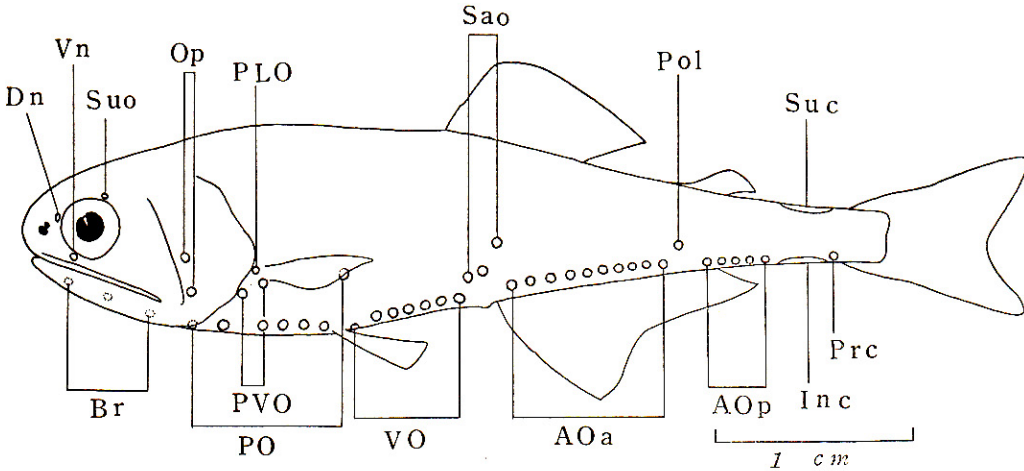


Fig. 1. Arrangement of photophores and luminous glands in male of *Tarletonbeania taylori*.

A small PLO, about half of its neighbors in diameter, is present at the upper end of the pectoral base. PVO 2. The anterior one is located below the opercular margin and the posterior one is situated at the lower portion of the pectoral base. PO, 6-7 in number, are situated along the ventral contour of the body except for the last one which is extremely elevated to the level of the pectoral fin. The first PO is set slightly behind a vertical through Op2. VO 6-7. The first pair, lying just behind the insertion of ventral fin, sit closer to the mid ventral line than successive pairs. The series SaO comprises three organs arranged in elevated sheet above the anus. The third one, locating above the origin of anal fin, is much elevated. AOA, 10-12 in number, form a straight line along the base of anal fin. The first organ originates above the 3rd or 4th anal ray and the rear one lies above 14th, 15th or 16th anal ray. Pol single. It is considerably elevated as compared with the series AOA and AOp, and situated below the origin of adipose fin. AOp 5. They are arranged in a single row along the ventral contour of the body. In male, the last AOp sits immediately before the Inc. Proc, 1 in number, lies in the ventro-posterior corner of the caudal peduncle.

The male specimens bear apparent Suc and Inc on the dorsal and ventral surfaces of the caudal peduncle. But the females lack both glands.

Histology of the photophores: The following descriptions deal with the microscopic features of photophores referred to the PO group, since no fundamental differences were recognized among the organs situated on the body.

Each photophore is a small hemispheroid in shape and is set beneath the stratum of epidermis. Like most other photophores of lantern fishes, it consists of four main elements, (1) photogenic cells forming a luminous body, (2) pigment layer, (3) a reflector, and (4) a lens.

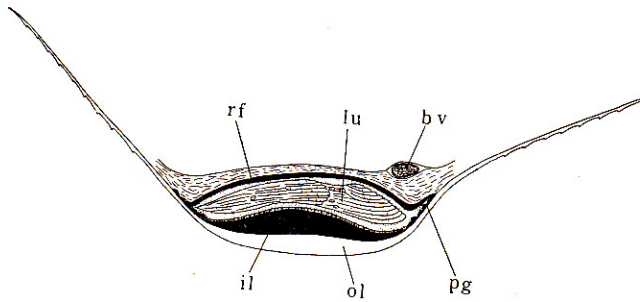


Fig. 2. Diagrammatic aspect of the transverse section of photophore. bv. blood vessel; il. inner layer of lens; lu. luminous body; ol. outer layer of lens differentiated from the scale; pg. pigment cells; rf. reflector.

The proximal bounding layer which embraces the inner end of the organ is represented by connective tissue covered by an extremely thin chitinous lamella that may serve as a reflector of light emitted from the luminous body. (Fig. 2. rf. and Pl. 1. Fig. 2.). It is relatively thin, the thickness being $2.2-2.5\mu$ in connective tissue layer and $0.5-0.7\mu$ in chitinous layer. The latter stratum is called by BEAUER (1908) as "tief Schuppe." The total thickness of this layer is approximately 3μ .

The successive layer of the reflector is a luminous body, composed of stratified columnar cells (Fig. 2. lu). It is a disk-like mass in shape and the proximal surface is somewhat convex to fit the concave surface of the reflector. Each photogenic cell is long, thin glandular cell containing eosinophilic cytoplasm. The nuclei are small. Photogenesis seems to be intracellular.

A considerable amount of erythrocytes can be recognized in the intercellular space. The possibilities of blood supplies within the luminous body thus are evident.

Outside of the luminous body is a thin layer of connective tissue which is tightly bound with the lens.

The scale overlying the luminous body is translucent and abruptly thickened on the organ. It is modified into a lens (Fig. 2, il, ol, and Pl. 1. Fig. 2). Furthermore it is composed of two convex strata at the center, the inner layer being more deeply stained by eosin than outer layer. The inner layer measures $3.0-5.5\mu$ in thickness and the outer one measures $2.5-4.0\mu$. This is rather remarkable for its compound nature which is made up of two different structures. Such an exquisite biconvex lens probably would act, as a whole, very efficiently.

Near the peripheral region of the photophore, there extends a black pigment along the inner side of the reflector and lens (Pl. 1. Fig. 1. pg). In consequence, this pigment flange forms a black ring around the organ in external view.

Histology of caudal glands: In male specimens, the supracaudal gland arises immediately behind a vertical through the last AOp and extends backward to a vertical through Prc. The infracaudal gland sits opposite to the supracaudal gland in dorso-ventral direction. Both glands are virtually the same in microscopic structure. The main structure of the gland consists of luminous glandular tissue backed by the collagenic connective tissue (Pl. 1, Figs. 3 and 4). This luminous body resembles that of caudal gland of *Lampadena nitida* described by ANADON (1957), and differs from that of photo-

phores of body aforementioned. Along the proximal border of the collagenic tissue layer the black pigment cells are scattered. A profuse blood supply is evidently connected with the glandular tissue. The scales overlying the both glands are not thickened. Therefore, these caudal glands lack the structure of a lens.

Remarks and Conclusion.

Observations of microscopic structure of *Tarletonbeania* photophores show that they should be roughly referred to the type represented by photophores of *Myctophum benoiti*, *M. (Lamppanyctus) alatum*, *M. (L.) macropterum*, *M. (L.) lacerta*, and *M. (L.) longipes*. Those were illustrated in detail by BRAUER (1908). One of the most striking aspects of the photophores of *T. taylori* is the fact that the modified scale into a lens is composed of two layers which may enable the organ to act efficiently. It is plausible to consider that such organ is considerably specialized.

In his extensive studies on luminous organs of various fishes, BRAUER (1908) stated that in the luminous caudal glands of *Myctophum valdiviae* the photogenic cells which are homologous to those found in photophores of the body are present at the posterior portion. So far as our observations go, however, both the supra- and infra-caudal glands of *T. taylori* are not provided with such cells, but are composed of luminous glandular tissue.

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Explanation of Plate 1.

- Fig. 1. Photomicrograph of transverse section through peripheral portion of right VO. 4. $\times 470$.
- Fig. 2. Photomicrograph of transverse section through central portion of left VO. 4. $\times 470$.
- Fig. 3. Photomicrograph of transverse section through anterior portion of Suc. $\times 470$.
- Fig. 4. Photomicrograph of transverse section through central portion of Suc. $\times 470$.
- bv. blood vessel; il. inner layer of lens; lg. luminous gland; ol. outer layer of lens; pg. pigment cell; ph. photogenic cells; rf. reflector; s. scale.

抄 録

ホクヨウハダカ(新称)の発光器

岩井 保・岡村 収

ホクヨウハダカは現在までのところ、北太平洋海域からのみ知られている発光魚で、第二次性徴として、雄だけが、体の発光器のほかに尾柄発光腺をそなえている。

体の発光器の構造は、多くのハダカイワシのそれと似て、内側から外側へ向かって、順に、反射層、発光細胞が集まった発光体、レンズの各部分からできており、器官の周辺部には黒い色素が密布する。したがって、外見的には発光器の周囲に黒色輪があるように見える。

ホクヨウハダカの発光器で、とくに興味深いのはレンズで、これは発光器の上に位置する鱗の中央部が肥厚して凸レンズ状に変形したものである。さらに断面をよく観察すると、染色性の異なる内・外二層の部分からできていて、ちょうど組合わせレンズのようになっている。

雄の尾柄発光腺は、体の発光器とは異なる腺細胞からなり、レンズも前述の発光器のように発達していない。

