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Pteropods with Two Separate Sexual Openings.

By H. McE. KNOWER.

Having recently had occasion to review the anatomy of *Cavolinia longirostris*, by means of sections of specimens obtained by the U.S. Fish Commission schooner 'Grampus,' I find that the statement in text-books and elsewhere, that all Pteropods have but a single external opening for the hermaphroditic sexual organs, is not correct. *Cavolinia longirostris* (to which species my specimens apparently belong) has two distinct and separate sexual openings.

There is a large hermaphroditic gland, lying posteriorly and dorsally in the visceral sac, which is asymmetrical, being more developed on the left side. In this gland the youngest ova are found in the centre, immediately around the intraglandular portion of the duct, the oldest ova with considerable yolk at the periphery. The male elements arise from lines of cells running from the periphery towards the centre. A single duct leaves the gland from its anterior face, dorsally and far to the left. Receiving the seminal vesicle near this point of origin, the duct runs over to the right towards the median plane. Near the middle line it opens into the anterior face of a large glandular sac, which has much folded walls. This sac is the muciparous gland, and the duct ends on reaching it. Sections do not show a separate albumen-gland described for the genus. They do show that some of the folds of the walls of the single cavity of the gland are lined with non-glandular ciliated cells, while others have distinctly glandular cells. The seminal vesicle is, as described, a long saccular appendage of the duct, with its end dilated and coiled up on the left side of the stomach. The muciparous or, rather, uterine gland is quite large; it lies in the anterior portion of, and occupies most of the left side of, the visceral sac. Quite near the point where the hermaphroditic duct opens into the uterine gland the vas deferens arises from the gland on its anterior right corner, to the left of the median line. This is a *closed* ciliated tube, not a ciliated groove (in which this species differs from all other Pteropods), which curves around on the right to the dorsal surface of the fins, to run anteriorly and open at the sac of the invaginated penis. *On the left side of the uterine gland sections in all planes show a second opening from the reproductive system to the exterior.* This is a slit-like aperture on a slight papilla, on the anterior surface of the visceral sac and to the left. The opening leads directly into a ciliated fold of the uterine gland, the ciliated cells of which turn out at the lips of the aperture and become continuous with the epithelium of the external surface of the body. There can be no doubt that this is a natural opening, and near it is found the seminal receptacle, a thin-walled sac filled with spermatozoa and lying on the left face of the uterine gland. This seminal receptacle opens into a fold of the uterine gland, not far from the external opening just described, which I take to be a vaginal opening.

In the possession of two separate sexual openings *Cavolinia longirostris* differs from all other Pteropods. The opening on the right side leading to the penis is perhaps to be homologized with the single aperture of other species. All that is necessary is the closure of the usual ciliated groove to form a tube to the penis, and this is an evident advantage in ensuring the transference of the male products. Another opening (vagina) becomes a necessity as soon as the more primitive right one is given over entirely to the male products; and this may account for the new aperture on the left side. In other words, the other Pteropods represent the more primitive condition of the hermaphroditic duct, while *Cavolinia longirostris* has become more specialized by the acquisition of a separate opening for each sex. The anatomy of the adult does not, of course, show whether, as Korschelt and Heider ('Lehrbuch der vergleichenden Entwicklungsgeschichte der wirbellosen Thiere,' p. 1088, fig. 644 c) would put it, there has been a splitting of a primitively single opening into two, or whether a new independent opening has been acquired into the left side of the uterine gland. Perhaps the study of the ontogeny of the sexual organs of this species will settle the question.

Contrary to Pelseneer ('Challenger' Report on the Pteropoda, pt. 3, p. 19), the heart of *Cavolinia longirostris* is on the left side, agreeing with Souleyet's figure of *Cavolinia tridentata*, for which see Lang ('Lehrbuch der vergl. Anatomie,' p. 664, fig. 469).

Muscles in the fins are distinctly striated, a condition which Lang states ('Lehrbuch der vergl. Anatomie,' p. 695) is not found in mollusks, but which Kellogg ("A Contribution to our Knowledge of the Morphology of Lamellibranchiate Molluscs," Bull. U.S. Fish Commission, vol. x. 1890) found in the adductors and heart-muscles of Lamellibranchs. Paneth ('Archiv mikr. Anatomie,' Bd. 24), describing a similar appearance in the fins of *Cymbulia* and *Tiedemannia*, decides this is not natural, but artificial striation. I have not been able to study living tissue, but the striation, as I find it, is very distinct, and looks in every way like ordinary striated muscle.—*Johns Hopkins University Circulars*, May 1894, pp. 61, 62.