Note on the Mechanism of Discharge of the Cuvierian Organs of Holothuria nigra.

By

George Ralph Mines, M.A.,

Fellow of Sidney Sussex College, Cambridge.

(From the Laboratory of the Marine Biological Association, Plymouth.)

With Plate 26.

It is well known that when Holothuria nigra (the large sea-cucumber common at Plymouth) is irritated, it responds by emitting a number of white conical bodies. These, the Cuvierian organs, rapidly elongate, shooting through the water while remaining attached at their bases to the animal, to form long, intensely sticky tubes. The phenomenon has been described by Minchin (1), Barthels (2), Herouard (3) and others, but there appears to be much divergence of opinion as to the mechanism by which the elongation of the tubes is brought about. Herouard ascribes it to the forcible injection of the tubes with water, while Minchin denies that water-pressure plays any part in the discharge, and attributes the whole affair to the intrinsic activity of the organs themselves. The latter view is adopted by Sedgwick (4).

The observations on which Minchin's explanation is based are these: If the tubes, when first emitted by the animal, are cut off, they continue to elongate. Undischarged Cuvierian organs can be made to elongate after removal from the body.

With regard to the first of these points, it is evident that cutting a very narrow tube with thin and sticky walls will effectively seal the ends, and that the result of cutting or

ligaturing will be the same. As Barthels remarks, the tubes produced under these conditions are thinner than normal and the elongation takes place more slowly.

I find that if the ligature is tightened around their bases as quickly as possible after the appearance of the Cuvierian organs outside the animal, the organs do not shoot through the water to anything like the normal extent, but fall in coils close to the animal. If the ligature is tied somewhat later, the elongation of the organs continues in a fashion more resembling the normal, but it is still imperfect. As the elongation of the distal part of the tube proceeds, the proximal part, which was distended before the ligature was tied, is seen to shrink. This shrinkage does not occur in a normal uninterrupted discharge.

Fig. 1A shows a normal discharge of five Cuvierian organs. Fig. 1B shows a second discharge from the same animal, where the tubes were ligatured very shortly after ejection, by tightening a loop of silk placed close outside the anus through which the organs passed.

In order to display the Cuvierian organs the specimens were photographed in a black dish filled with sea-water. The animal is not seen, therefore, owing to its deep pigmentation.

Fig. 2 gives a closer view of some Cuvierian organs tied at their bases shortly after discharge; it shows the beaded appearance often presented by the tubes under these conditions.

Fig. 3 represents a group of undischarged Cuvierian organs taken from the body-cavity of Holothuria nigra.

Fig. 4 shows a few of these organs in a shallow dish, some of them being pulled out. Picking up an undischarged organ at its ends, it is easy to pull it out to a great length, but the resulting thread looks wholly unlike the tube as normally discharged, in that it is thin and not transparent. When an organ is thus in part pulled out, the remaining portion often undergoes some elongation, the thin thread produced coiling and lying at the bottom of the vessel. The extent to which this goes on varies considerably in different cases; it seems to depend

largely on whether the undischarged organ is filled with water or not.

By introducing a fine glass cannula or a hypodermic needle into the base of an undischarged organ and injecting fluid, the tube is shot out in precisely the same way as in a normal discharge by the living animal. The elongation can be stopped at any stage by reducing the water-pressure and continued by increasing it. When a coloured liquid is used for injection it is often seen to pass up to the tip of the organ before elongation starts, showing that the lumen is patent throughout the undischarged tube. Examination with a low power of the microscope shows transverse thickenings in the wall of the undischarged tube, suggesting that it is folded together rather like an accordion.

The inset in Fig. 5 shows an undischarged organ with a hypodermic needle inserted into its lumen. The rest of the figure shows the effect of injecting it partially with sea-water. Fig. 6 gives another example more completely injected, in this case with air.

A comparison of the appearance of the tubes discharged normally by the living animal with those artificially injected with sea-water reveals no point of difference, but more striking still is the exact similarity of the movements under the natural and experimental conditions.

The pressure needed to cause elongation of the tubes is about 20 or 30 cm. of water. A pressure of 15 cm. sufficed to cause partial elongation of a tube, but failed to shoot it out completely.

It is easy to observe that during the discharge of tubes by the living animal, the body of the latter is always tense and firmly contracted.

In several experiments I have demonstrated the rise of internal pressure in Holothuria on irritation by the following device: A thin rubber balloon attached to the short limb of a long glass tube bent at right angles was introduced in a collapsed state through the oral aperture, and thrust into the body-cavity with the aid of a blunt instrument. The balloon

was then partially filled with water and the long limb of the tube placed vertically. The water stood in the tube at a level of 2 or 3 cm. above the level of the water surrounding the animal. On stimulating the skin there was a marked rise of pressure, the water in the tube reaching levels of, e. g. 10, 14, and 17·5 cm. in various cases. In many cases Cuvierian organs were extruded; if this happened it was always when the pressure approached its maximum. In those instances where the pressure reached or exceeded about 17 cm., there was partial elongation of the organs extruded. It is probable that the operation of introducing the sound so upset the nervous system as to interfere with the reflex contraction, and thus the pressure reached was insufficient to cause complete elongation of the Cuvierian organs. It is certain, however, that a rise of pressure in the body-cavity precedes and accompanies the discharge of the Cuvierian organs, and that even in the injured animal the magnitude of this pressure approaches that needed to elongate an excised Cuvierian organ.

The experiments recorded in this note seem to me to afford evidence in support of Herouard's view as to the mode of discharge of the Cuvierian organs.

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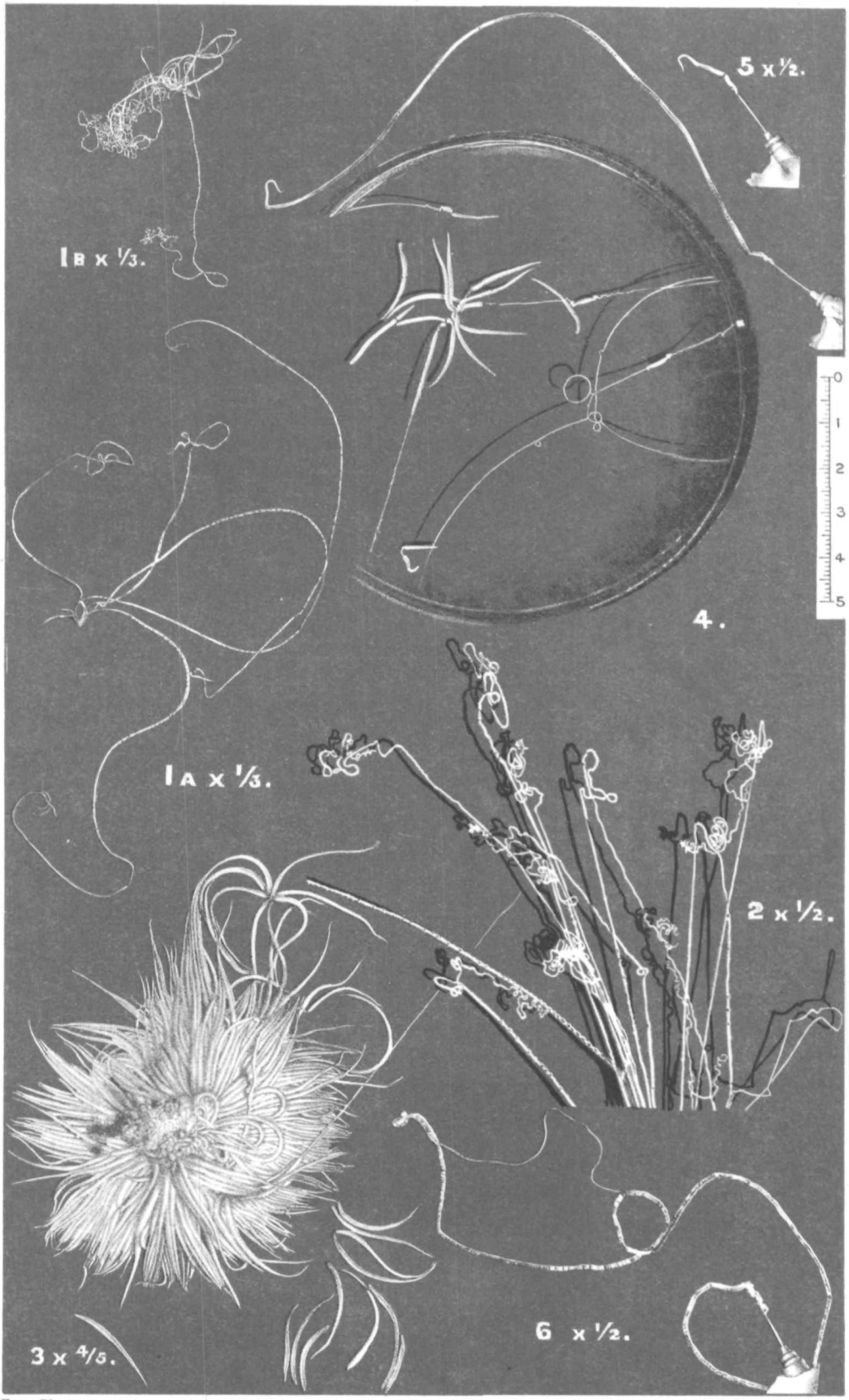

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