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BIOLOGY

Electrical Sensitivity of the Ampullæ of Lorenzini

ELECTROPHYSIOLOGICAL investigation has shown that the ampullæ of Lorenzini of elasmobranch fishes are sensitive both to slight changes of temperature[1] and also to weak mechanical stimuli[2]. But neither sensory modality is convincing as the biologically adequate stimulus, for the temperature-sensitive regions are buried deep in the body (there being no apparent reason for the great anatomical development of the tube system), and the mechanical sensitivity is quantitatively less than that of the lateral line without being qualitatively very distinct.

There is, however, a third possibility. I have found that in rays the ampullæ are sensitive to slight changes in the electrical potential field surrounding the fish (*Raia clavata*, *R. naevus*, *R. montagui* and *R. brachyura* were used). The impulse discharge from single units in the mandibular group of ampullæ was recorded with the fish submerged about 1 cm. in a large dish of sea water; voltage gradients in the water over the sense organs were established from electrodes near the tail. Under such conditions the threshold d.c. potential gradient (that is, which produced approximately 10 per cent change of impulse frequency at make and break) was 1–2 μV./cm. (8 fish). The gradient had to lie along the line of the tubes, with the opening of the tubes negative to the capsule for an increase in frequency, and the opening positive for decrease. In each case there were opposite after-effects at break. The adaptation was almost complete, with a time-constant of about 5 sec. as is found with direct galvanic polarization of the sensory nerves[3].

With the preparation out of water, the ampullæ could be stimulated by passing a current between a small test probe and the body of the fish. When the probe was placed exactly on the opening of the tube from which the single fibre of the recording ran, a current of 0·005 μamp. (the smallest which could at the time be measured) was considerably greater than threshold; the frequency was increased when the probe was cathodal. But if the probe was displaced slightly from the opening, for example, by 0·5 mm., the threshold became far higher. Thus the stimulating currents would appear to be channelled along the jelly-filled tubes. In this connexion the conductivity of the jelly has been shown (Murray, R. W., and Potts, W. T. W., unpublished work) to be high (85–90 per cent of sea water) compared with that of the body fluids (40–45 per cent of sea water) and presumably the tissues have an even lower conductivity.

There would seem to be at least three possible ways in which this electrical sensitivity could be of direct use to the fish.

(1) It is known that rays have small electric organs derived from part of the tail musculature[4] which produce second-long pulses of up to 4 V. The potential gradients resulting from these would be at least 1,000 times stronger than those which I have found to be threshold for the ampullæ. Lissmann's suggestion[5] is therefore feasible, that this system could act as a navigation device, with the ampullæ detecting the changes in the field produced by the electric organs when an object with a conductivity different from the sea water comes near the fish. The ampullæ could of course act as the receptors for such a navigational system only in elasmobranchs, as they are not found in the teleosts with electric organs.

(2) I have some evidence that the ampullæ are sensitive to changes in the salinity of the sea water at their openings of about 5 per cent. The mechanism for this sensitivity could be electrical, depending on the differences in the diffusion potentials caused by dilution.

(3) When a conductor is moved through the Earth's magnetic field, potential gradients are set up in it. Under certain conditions it is possible to detect by this means the strength and direction of a tidal stream or ocean current. It is, however, theoretically improbable that a fish being carried along by the water movement, and therefore subject to the same influences, could detect these small potentials, although it might be able to determine whether the current was, for example, easterly or westerly by swimming up from a position at rest on the bottom.

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Development of Delayed-type Hypersensitivity in Guinea Pig Embryos

SEVERAL modalities of the immune response of embryos have been previously investigated. These include: (*a*) induction of immunological tolerance[1]; (*b*) antibody formation[2]; (*c*) capacity to reject homografts[3]. There have been no analogous studies of the capacity of the embryo to develop the delayed type of hypersensitivity to protein antigens.

Previous attempts to induce tuberculin skin reactivity in new-born guinea pigs by active sensitization[4] or by passive transfer with leucocytes[5] have been unsuccessful. Weiss[6] injected guinea pig embryos with tubercle bacilli, and elicited tuberculin reactions in some of these animals several weeks after birth.

In the present work, guinea pig embryos were injected *in utero* usually 1–2 weeks before the expected date of their delivery. In early experiments, the injections were made after laparotomy. Afterwards, injections were performed through the intact abdominal wall, using a 23-gauge needle directed at the position of the peritoneal cavity of the embryo, which was held between the fingers of the operator's other hand. In this fashion, 1–10 μgm. of protein