greatest rise was observed between the 13th and 16th day (3.77 mm^3). Thereafter the increase in volume gradually slowed down, so that in the period from day 16 through 19 the volume increased for 2.45 mm^3 and from day 20 through 22 for 2.33 mm^3.

Normal development of the placenta ensures its adequate exchange function and is a condition for normal growth and development of the fetus. By comparing the findings of my earlier study[7] concerning the quantitative analysis of fetal growth with those of the present study, it becomes evident that the intensive increase of absolute volume of the placenta in the course of its development precedes the period of the greatest fetal weight gain. In the labyrinth the fetal blood vessels intertwined with maternal sinuses form the morphological base of the placenta as an exchange organ. The constant increase of volume density of the labyrinth, and its greatest share in the volume of the completely developed placenta, is a quantitative morphological manifestation of intensive feto-maternal exchange function.

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Anatomical identification of the presumed electroreceptors of two air breathing catfishes, *Clarias batrachus* and *Heteropneustes fossilis*[1]

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Summary. Histological preparations for light microscopy have revealed for the first time the structure of the electroreceptor of *Clarias batrachus* and *Heteropneustes fossilis*, the 2 Indian air-breathing catfishes. These sensory organs are found to resemble the ampullary organs of many weakly electric and nonelectric electroreceptive teleost.

Histological studies of the skin of *Clarias batrachus* and that of *Heteropneustes fossilis* reveal the presence of a category of cutaneous receptors which are different from either the taste buds or the ordinary lateral line organs so far reported for these fishes[2,3]. These receptors present a number of morphological features which are similar to those of the ampullary organs of certain teleosts[4,5], on the basis of which these receptors will henceforth be called the ampullary organs. The description of the ampullary organ given below applies to both *Clarias batrachus* and *Heteropneustes fossilis*, unless stated otherwise.

Material and method. *Clarias batrachus* and *Heteropneustes fossilis* are locally available in plenty all the year round. They are also sold alive in the market, as these catfishes are airbreathing and hardy to keep. The fishes were kept in aquaria when necessary for long periods in good health; they are fed on minced liver.

Ampullary organs are easily detectable in the skin of the back under a binocular. Pieces of the skin containing ampullary organs were removed and fixed in Bouin's fluid. Paraffin sections were cut 6 to 8 µm thick and stained with iron haematoxylin and delafield haematoxylin eosin. Likewise pieces of proximal part of nerve dorsal ramus were prepared to locate the ganglion cells. Ampullary organs were also denervated by transectioning the nerve a few mm away from its ganglion, and removed after varying periods ranging from 15 days to 45 days post operative and prepared as above.

For central connection of this nerve, the nerve was transected in region lying between its ganglion and brain stem, in fish anesthetized with MS 222 (Sandoz). Brain was removed after 1-2 months post operative and processed according to Fink and Heimer technique.

Results and discussion. Each ampullary organ consists of a single ampulla or a group of 2 or 3 ampullae, bearing receptor cells in the epithelium (figure 1). The ampulla or the group of ampullae opens to the exterior by means of a single duct, having a well-defined wall of its own (figure 3). The duct is short and intraepidermal, whereas the ampulla bulges into the dermis though separated from it by the basement membrane. The receptor cells are large, ovoid and hypertrophied. An appreciable apical part of the receptor cells is exposed to the lumen of the ampulla (figure 4).

The ampullary organs are easily contrasted from taste buds or ordinary lateral line organs by surface examination. They appear in the dark pigmented skin as white spots which are largest in diameter and show a central opening. The ampullary organs are distributed over the dorsal surface of the body, occurring singly in rows or in groups of a few. Those on the hinder part of the head and on the trunk and tail are innervated by a special nerve, one on each side of the body (figure 5). This nerve - ramus dorsalis, a branch of VIIth cranial nerve - reaches the hind brain just where the anterior, cranial branches of the VIIth nerve enter. However, the ramus dorsalis is found to retain its individuality inside the brain by way of its specific central pathways, as revealed by degeneration studies on this nerve according to Fink and Heimer technique, and outside the brain by the presence of its ganglion. Transection of this nerve leads, in course of 18 days, to degeneration of the ampullary organs in general and receptor cells in particular (figure 2).

The skin around the ampullary organs is the same as elsewhere. The epidermis appears ordinary, though thick and rich in club cells (Bhatti[6], quoting Rauther 1907). The dermis, however, presents a specialized, thick, subepidermal layer composed of closely set bundles of collagen fibres.

The ampullary organs of the electric and nonelectric teleosts, so far investigated, are held to be electroreceptors[5] involved in their well-demonstrated electroreception mechanism. *Clarias* and *Heteropneustes* are known to respond to moving magnets[7], and *Clarias* is one of the few fishes in which electrosensitivity was early demonstrated[7]. However, so far no anatomical identification of the likely electroreceptors was forthcoming for these 2 fishes. The ampullary organs of these fishes, here described for the first

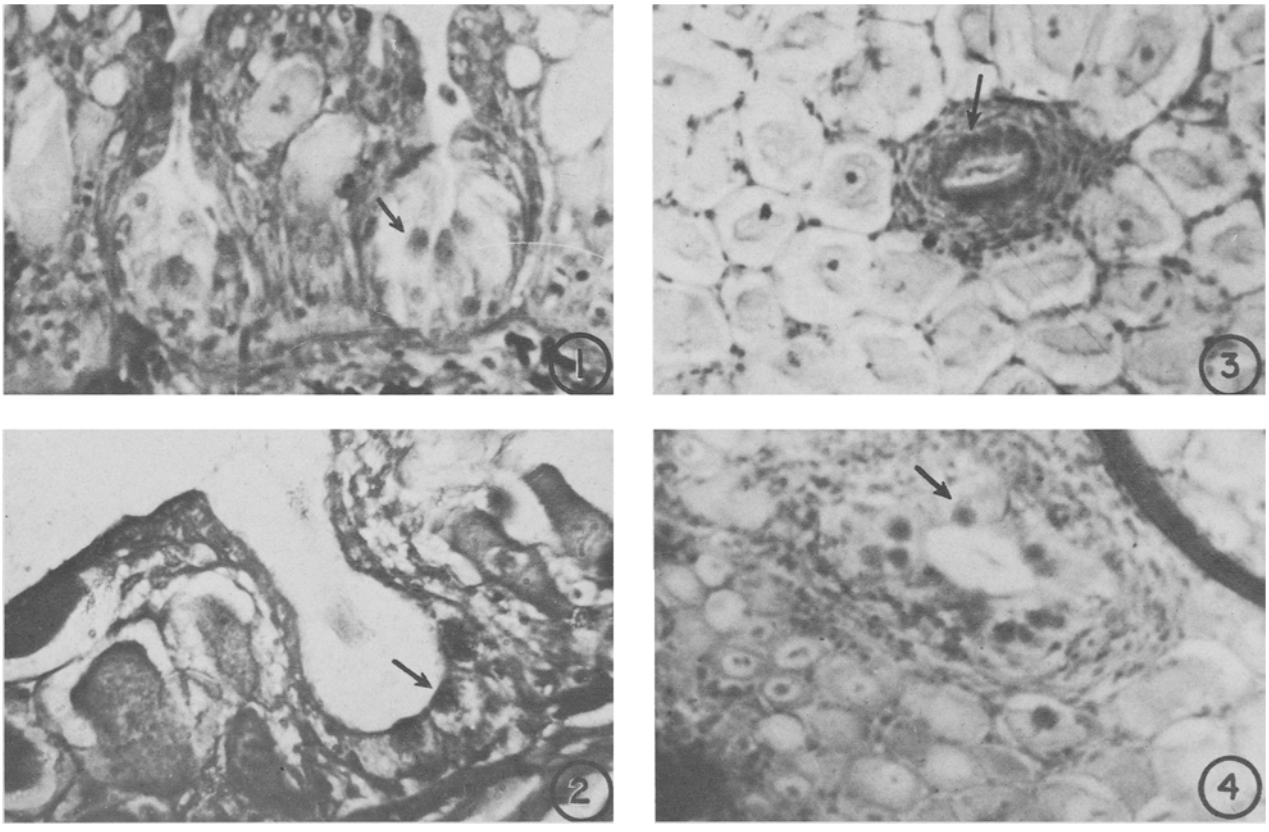

Fig. 1. Ampullary organ of *Clarias batrachus,* as seen in cross section of the epidermis. × 500. Fig. 2. Denervated ampullary organ of *Clarias batrachus,* at 18 days postoperative of the nerve transection. × 500. Fig. 3. Ampullary organ of *Heteropneustes fossilis* as seen in a tangential section of the epidermis showing canal wall. × 700. Fig. 4. Ampullary organ of *Heteropneustes fossilis* as seen in a tangential section of the epidermis showing ampulla with receptor cells. × 700.

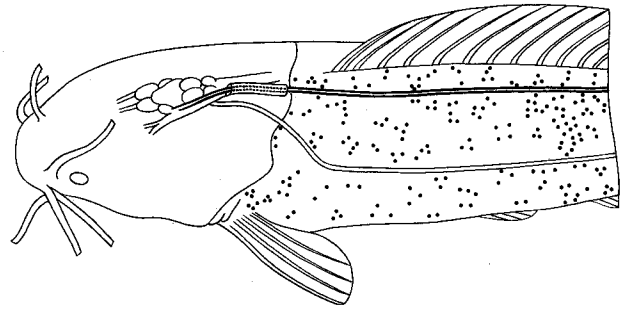

Fig. 5. Schematic drawing showing the distribution and innervation of the ampullary organs of *Clarias batrachus.* Note the ramus dorsalis nerve (thick lined) which innervates the ampullary organs (dots) of trunk and tail regions.

time, essentially resemble the ampullary organs of other freshwater nonelectric catfishes, such as *Amiurus*[8], *Kryptopterus*[9] and *Parasilurus*[10], but differ from that of the marine catfish, *Plotosus*[11] in lacking a long canal. *Clarias* and *Heteropneustes* are air-breathing fishes with an ecology and bionomics[12] not different from that of other electroreceptive fishes[13]. It is therefore suggested that the ampullary organs of *Clarias* and *Heteropneustes* may also be presumed to function as electroreceptors accounting for the electrodetection of the passive type[14] for these fishes. Indeed, these organs are specialized lateral line organs belonging to the type C pit-organs of Srivastava and Srivastava[15], and coexist at least in *Clarias* with the type D pit-organs. These organs are thus additions to the already known ones from other nonelectric fishes, as possible links between the ordinary pit-organs (type D) and the ampullary organs of the weakly electric teleosts[16].

It is hoped that the present report will stimulate prolific physiological probes into the properties of electroreceptors, because *Clarias* and *Heteropneustes* are relatively more plentiful and more hardy owing to their air-breathing habits.

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