S. S. College, Jehanabad

Department: Zoology

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Subject: Zoology

Topic: Electric organs in fishes

Mode of teaching: Google classroom & WhatsApp

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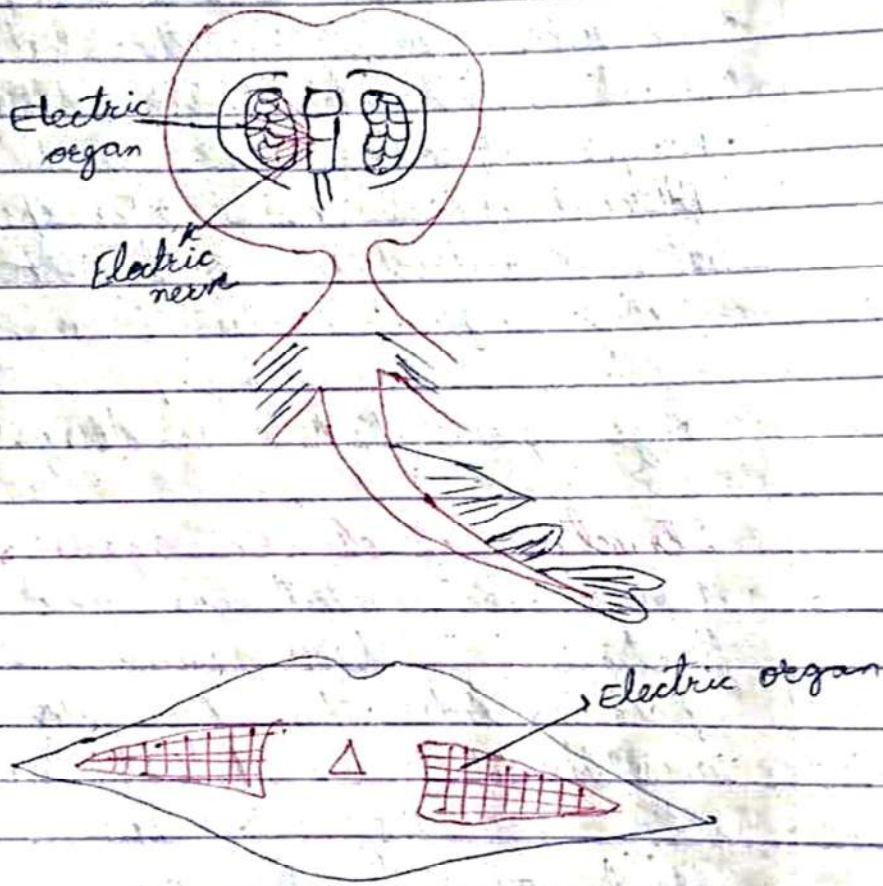
(12) Electric organs in fishes → Imp

Electric organs in fishes are specialised organs for the production of electric field outside the body. They are found only in the fishes and have evolved independently in the different groups of fishes to meet certain fissine needs about 250 sps of fishes both Chondrichthys and Osteichthys are reported, produce electric organs. The discharge of strongly electric fish is large painful to handling.

Structure of electric organs:→ The electric organs are gelatinous and a large fraction of their volume is extracellular space, Besides this, they also contain a considerable amount of connective and other accessory tissues as well as blood vessels & nerves which controls the organs of discharge. In the electric fish the cells which generate electric discharge in commonly called as electrocyte or electroplexus. The connective tissues of electric organs is quite important which because it helps in generating current. The cell which

generate electric current. Electrocytes work on the same general principle as ordinary nerve and muscle cells work.



T.S. Torpedo

Fig. Showing electric organs in Torpedo

Chart of electric generality group of electric fish (Bennett 1970)

Common name	Electric discharge	Distribution
Electric ray	60 volts aff:	Marine
Torpedo		
Mormyrids	Weak	(Africa) Fresh water
Electric eels	500 volts	S. America "
Electric cat fish	300 volts	Africa & Asia
Star gazer	5 volts	W. Atlantic Marine

The type and pattern of the electric organs can be divided into several categories. The strongly electric organs produces monophagic pulses, while the weaker one produce diphagic pulses. The organs are normally discharged in response to external stimuli. The external stimuli may either be tactile, chemical, electric or even the visual pulses.

(1) Electric organs in skates: In Skates, the electric organs are located in the tail region, and specially in the The organ

are spindle shaped and runs rest of the length of the tail. They are much greater than the diameter. The electrocytes originated posteriorly and innervated by nerve-fibres. In Skates the electrocytes are two types :—

(i) Cup shaped → The cup shaped electrocytes lies in the anterior margin of the connective tissue chamber ; often they are convex posteriorly. Both faces are relatively smooth when observed under light microscope.

(ii) Disc shaped → These cells lie near the posterior of the connective tissue chambers.

The response property of these two kinds of cells are some what different. The disc shaped cells are physiologically similar to those of the other marine electric fishes. The organ discharge which are found in Skates is monophasic and head negative. The fish can be provoked for discharge by mechanical stimulation. The organ discharge is variable in size & duration.

(2) Torpinidae (Torpedo) :→ Eg. Narcin, Astroscopus

In torpedo the electric organ is made up of about 500 to 1000

closely packed & roughly circular columns of the electrocytes or electroplates. The electrocytes are 10 to 30 μ in diameter. The electrocytes are mainly confined on the dorsal aspect of the head, where the nerves emerge out from the mid-brain invades. The electric discharge of the large torpedo is monophagic positive on the dorsal surface and negative on the ventral surface. The impulses on the dorsal surface is about 50 to 60 volts.

In Narcin which is a smaller relatives of torpedo has the main bilateral organ which resembles that of torpedo. The Narcin has also an accessory electric organ which lie on the dorsal aspect of the head. The electric impulses which are usually excilled by the electric organ of Narcin is very low. It produces electric about 37 volts.

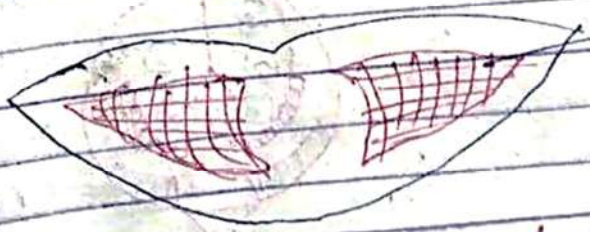


Fig. T.S. of Torpedo

(3) Mormyrids → Eg Gnathonemus
Here the electric organ lies just anterior to the caudal fin and in the posterior part of the trunk region. The electrocyte are arranged in column one after another. In each column there is about 100 to 200 electrocytes in series. The organ discharge in mormyrids are of brief pulse which are emitted regularly at a per second. The mormyrus usually discharge electric impulse of 4 to 15 volts.

(4) Electrophoridae → In electrophorus the electric organ is present in the trunk region

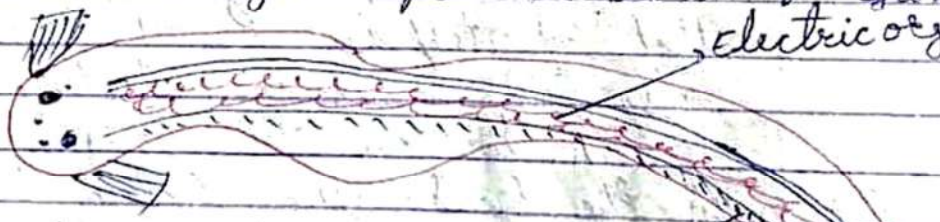
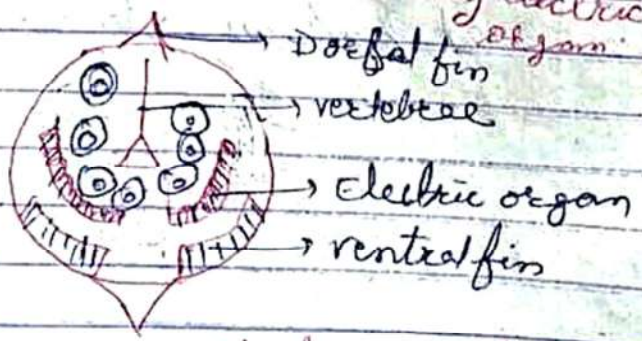


fig: Electrophorus electricus showing electric organ



T.S. of Electrophorus electricus

and occupy about 3/4 of the body. The electric is divided into three bilateral organs. The Hunter's organ are mainly responsible for the generating of electric current. Two classes of pulses have been reported in E. electricus, first one is small pulse which is of 10 volts and the second one is large pulse which is about 500 volts or more.

(5) Gymnarchidae ⇒ Eg. Gymnarchus niloticus

Here the electric organ consists of four columns of electrocytes on each side of the body and one above the other. each columns runs to the tip of the caudal filaments. The electrocytes are flattened, cylindrical and innervated on the posterior faces by spinal nerves. The electric pulses are emitted at a frequency of about 250 seconds.

Biological significance of Electric organs ⇒

(i) In strongly electric fish it function as the organ of offen

Aman

(13) Electroreception :-

→ Electroreception is the biological ability to perceive natural electrical stimuli. It has been observed only in aquatic or amphibians, since water is a much better conductor than air, electroreception is used in electrolocation & for electrocommunication.

Electroreception is known only in vertebrates. It is found in lamprey, cartilaginous fishes (sharks, rays, chimaeras), lung fishes, catfishes, monotremes etc. The electroreceptor organs in all these groups are derived embryologically from a ~~me~~ mechanosensory system. In fishes they are developed from the lateral lines. In most groups electroreception is passive, where it is used predominantly is predation. Two groups of teleost fishes are weakly electric & engage in active electroception; ~~the~~ Gymnotiformes & Notopteroidei.

Electrolocation → ~~Electrop~~ Electroreceptive animals use this ense to locate objects around them. This is important in ecological niches where the animal

cannot depend on vision. Ex - In caves, in murky water & at night.

Passive electrolocation :- In passive electrolocation, the animals senses the weak bioelectric fields generated by other animals & uses it to locate them. These eletric fields are generated by activity of their nerves & muscles. A second source of electric fields in fish is the ion pumps associated with osmoregulation at the gill membrane.

Pasive electroreception is carried out solely by ampullary electroreceptors in fish. It is tuned to low frequency signals.

Fish use passive electroreception to supplemen or replace their other senses whe detecting prey & predators.

Active electrolocation :- In active electrolocation, the animal senses its surroundin environment by generating electric fields & detecting distortions in these field using electroreceptors. This electric field is generated by means of a specialised electric eg organ consisting of modified muscle or nerve. Animals that use active

and defence.

(ii) In weakly ~~elec~~ electric fish the electric organs are mainly responsible for finding out the direction in water.

(iii) The electric organs are used to recognise the opposite sex or inter-specific communication.

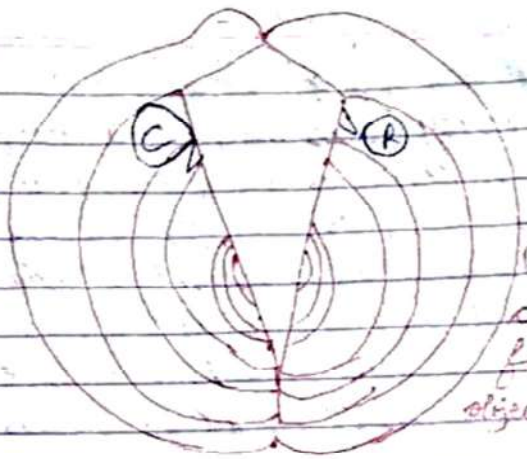


Fig. Active Electrolocation. Conductive objects concentrate the field & resistant objects spread the field.

electroreception include the weakly electric fish, which generate fish can discriminate between objects with different resistance & capacitance values, which may help in identifying the object.

Electrocommunication :→ weakly electric fish can also communicate by modulating the electrical waveform they generate an ability known as electrocommunication. They may use this for mate attraction & territorial displays. Some species of catfish use their elatric discharges only in agonistic displays.

In one species of Brachyhypopomus the electric discharge is similar to the low voltage electrolocative discharge of the

electric eel

Sensory mechanism → Active electroreception relies upon tuberous electroreceptors which are sensitive to high frequency (20-20,000 Hz) stimuli. These receptors have a loose plug of epithelial cells which capacitively couples the sensory receptor cells to external environment. Passive electroreception however relies upon ampullary receptors which are sensitive to low frequency stimuli (below 50 Hz).

Occurrence →

Elasmobranchii → Sharks & rays rely heavily on electrolocation in the final stages of their

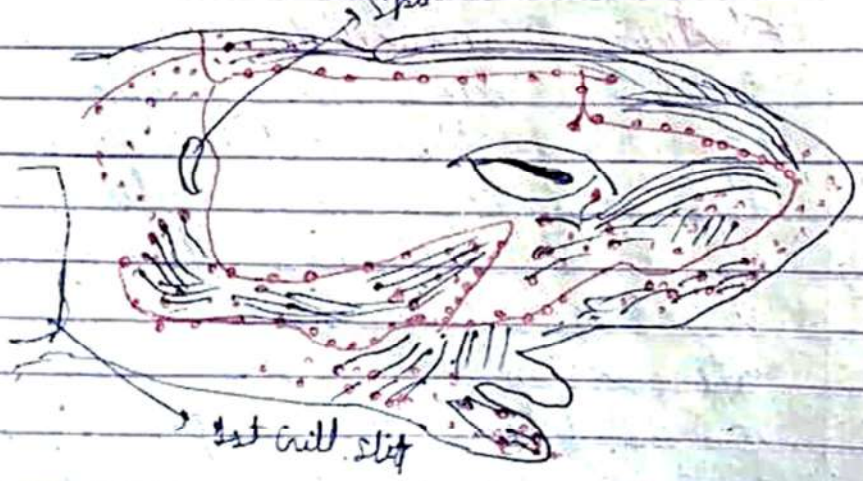


Fig. Electroreceptors (Ampullae of Lorenzini) & lateral line canals in the head of shark

attacks, as can be demonstrated by the robust feeding response elicited by electric fields similar to those of their prey. Sharks are the most electrically sensitive animals known, responding to DC fields as low as 5 nV/cm.

The electric field sensors of sharks are called the ampullae of Lorenzini. They consist of electroreceptor cells connected to the seawater by pores on their snouts & other zones of the head.

Bony fish → The electric eel, besides its ability to generate high voltage electric shocks, uses lower voltage pulses for navigation & prey detection in its turbid habitat.

Monotremes → The electroreceptors of monotremes consist of free nerve endings unlike the specialised receptor cells of fish & amphibians. They are located in the mucous gland of the snout. Among the monotremes the platypus has the most acute electric sense. The electroreceptive capabilities of the two species of echidna are much more simple.

Dolphins → The vibrissal crypts of the

Guiana dolphin were shown to be capable of electroreception sufficient to detect small fish, as low as 4.8 nV/cm.