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The Biology and Genetics of Electric Organ of Electric Fishes

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Editorial

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Editorial

The electric fish comprises an interesting feature called electric organ (EO) which can generate electricity. In fact, they have an electrogenic system that generates an electric field. This field is used by the fish as a carrier of electric signals for active sensing and communicating with other electric fish [1]. The electric discharge from this organ is used for navigation, communication, and defense and also for capturing prey [2]. The power of electric organ varies from species to species. Some electric fish species can produce strong current (100 to 800 volts), especially electric eel and some torpedo electric rays are highly remarkable [3]. However, the detailed molecular mechanism of electrogenesis is largely unknown.

Electric rays (Torpediniformes) possess large kidney shaped powerful electric organs at the base of pectoral fins that are visible through skin. A single family with 2 genera and 3 species occur in the Bay of Bengal. Among them *Narcine brunnea* and *Narke dipterygia* were reported as generating electricity which is powerful enough to disable human [4].

Bennett, [5] reported in his book that electric organs were found in six groups of fishes. In some cases, the voltages are large enough to stun prey or repel predators. These are strongly electric fishes that include the electric eel (*Electrophorus electricus*) from South America, the electric catfish (*Malapterurus electricus*) from Africa, the family of electric rays, the Torpedinidae, which are cosmopolitan and marine, and possibly the stargazers (*Astroscopus sp.*) of the Western Atlantic.

Bennett, [5] also noted that the weakly electric fishes emit electric organ discharges (EODs) from their tail electric organs and sense feedback signals from their EODs by electroreceptors in the skin. These weak signals can also serve in communication within and between species. But the strongly electric fishes produce remarkably powerful pulses. A large electric eel generates in excess of 500 V. A large Torpedo generates a smaller voltage, about 50 V in air, but the current is larger and the pulse power in each case can exceed I kW [5].

The generating elements of the electric organs are specialized cells termed electrocytes. A large influx of Na^+ ions makes the inside more positive and causes efflux of K^+ ions through the opposite face. But Electrocytes of different species have different arrangements such as in strongly electric fishes, the electrocytes are always flattened [6].

Torpedo electric organ is a prime source of acetylcholine (ACh) receptor protein. Most of the electrocyte response is due to the Na+ mechanism. Zakon, et al. [6] also found that the candidate genes mainly encoding Na^+ and K^+ channels. The genes for two Na^+ channels, Nav1.4a and Nav1.4b, which are orthologs of the mammalian muscle-expressed Na+ channel gene Nav1.4. Both genes are expressed in muscle in non-electric fish. Nav1.4b is expressed in muscle in electric fish, but Nav1.4a expression has been twice lost from muscle and gained in the evolutionarily novel EO in both groups [6].

Jason, et al. [7] confirmed differential expression of genes in EO of mormyrid weakly electric fish (*Brienomyrus brachyistius*) that represent four classes of proteins: (1) ion pumps, including the α- and β-subunits of Na^{+}/K^{+} -ATPase, and a plasma membrane Ca^{2+}-ATPase; (2) Ca^{2+} -binding protein S100, several parvalbumin paralogs, calcyclin-binding protein and neurogranin; (3) sarcomeric proteins troponin I, myosin heavy chain and actin-related protein complex subunit 3 (Arcp3); and (4) the transcription factors enhancer of rudimentary homolog (ERH) and myocyte enhancer factor 2A (MEF2A).

However, there arise many more questions: which other genes are interacting and playing role, how the signaling event works, why there is discrimination between weak and strong volt generation, how the organ was evolved etc. Thus very little is known about the electric organ in the contest of science. For the elucidation of detailed molecular mechanism of electrogenesis, which may provide fruitful information in the field of Biotechnology, it is essential to perform intensive genetic research on electric organ of electric fishes.

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