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Some peculiarities of the consequences of electric current effect on hydrobionts.

by

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The discussion on the consequences of electric fields effect was started when electrical fishing was used for the first time.
Up till now there is no unanimous opinion on this problem. It can be explain by the fact that the effect of electric fields influence on hydrobionts is not studied well enough and also by the contradictoriness of the literary data available.

In connection with this surveys were conducted by the group of scientists of Zoology and parasitology Institute of the Academy of Sciences (Lithuanian SSR) jointly with the Klaipeda department of special experimental design office of commercial fisheries.

The aimes were the follows:

- firstly, it was necessary to determine the doses of electric current and duration of action which is dangerous for the hydrobionts.
- secondly, taking into consideration the fact that current even in dozes lower than dangerous, still causes some changes in the functional condition of the organism, the nature of this changes should be

investigated and also the duration of their action the effect of current is over.

- thirdly, peculiarities of consequences should be studied when electric current was used more than once.

Four species of the Baltic Sea fishes were taken for this experiment: Baltic herring (Clupea harengus membras), cod (Gadus morhua calarias L.), flounder Pleuronectes plattessa L.), smelt (Osmerus eperlanus eperlanus L.), three species of fresh water fish - rainbow trout (Salmo irideus L.), carp (Cyprinus carpio L.), goldfish (Carassius auratus gib.L.) and nine species of water invertibrates.

Impulsive current with frequency 25 - 30 hertz (in some cases 50 - 100 hertz) was used, duration of impulse T= I,6 - 2 mc, the form of impulse - fading half-sinusoid, alternating current f = 50 hertz and continuous current. Duration of influence in the main part of the experiment was 30 sec, in some experiments ϕt was changed in the limits 5 - 60 and sometime several minutes.

To determine dangerous dozes of electric current the famous method was used which goes in the aquatic toxicology under the name of " fish sample ": when groups of fishers (or other animals) undergo the effect of electric current oE different parameters, then after certain time (24 hours) the number of survived animals was determined. To facilitate estimation and comparison of electric current influence on survival of the animals two thresholds were chosen: field tension, causing the death of 5% of the animales (E_{05}), this is the first stage of the danger ; and field tension, causing the death of 50 % of the animales (E_{50}), the threshold of considerable danger.

Eggs during the incubation period, then larvae and fingerlings if fish and crustaceans were subjected to regulary action of electric current, at the same time hematogenesis, embryogenesis, growth and development of the animales were observed. Some other indices were also observed, such as hematological indices, protein fractions of blood, rhythm oh the heart and breath, electrolite, nervous mediators and behaviour reactions, conditioned reflexes after electric current influence.

The results of the experiments showed that survival of fish and aquatic invertibrates while subjected to influence of electric fields depends on the species peculiarities of the animals on the kind of current, its parameters and duration of action.

There are species very steady to electrical fields. Among fishes of the Baltic Sea which were studied was found plaice. This species showed 100% survival under all parameters of impulsive current (f= 25 - 50 hertz, T= I,6mc, E = 0,5 - 6 V/cm, t = 60 sec).

Goldfish also turned out to be of great endurance to the influence of electric current, it did not die under the current f = 25 hertz, T = I,6 mc, E = 8,7 V/ cm, t = 5 min

Baltic herring, cod smelt and rainbow trout are inferior to goldfish and plaice in this respect.

Nevertheless after 5 or I0 seconds of impulsive current influence (parameters used : f = 20 - 50 hertz, T = I,6 mc, E = 0,5 - 6 V/ cm) the first did not die.

When the duration of the electric current influence was prolonged the threshold of the fish death became lower: 5% of the Baltic herring death under impulse current was observed when E_{05} was equal to I,6 - 3,4 V/cm, 50% - E_{05} was equal to 4,5 - 7,5 V/cm, 5% of the cod death was observed when E_{05} was equal to 0,5 V/cm, 50% - E_{50} = 2,2 - 3,0 V/cm.

5% of the trout death was observed when E_{05} was equal to I,I - I,3 V/cm, 50% - E_{50} = 2,5 - 3,7 V/cm.

The threshold of the fish death, while using continuous current is considerably lower than with impulse current: 50% of the Baltic herring and cod death took place when E_{50} was equal to 3 V/cm (t = 30 - 60 sec).

Alternating current is the most dangerous for fish. Even flounder endured it very bad - E_{05} = I,2 - 2,5 V/cm, E_{50} = 3,8 - 6,7 V/cm. The Baltic herring - t = 30 sec, E_{50} = I,6 V/cm for cod - E_{50} = I V/cm.

The thresholds of aquatic invertebrates death are rather high. For invertebrates of the Baltic herring (Artemia salina, Nereis diversicolor, Crangon crangon) - E_{05} = 3 - I3 V/cm, E_{50} = 8 - I6 V/cm (using impulse current).

At the same time for freshwater species of invertebrates E_{05} under impulse current fluctuates in the limits from I0 V/cm (for water-flea and mysid) till 50 V/cm (greissena), E_{50} cosequently from 20 till 80 V/cm.

The influence of electric current on the process of fish reproduction was studied under parameters causing deep electronarcosis (f = 25 hertz, T = I,6 ms, E = 0,5 V/cm, t = 30 cm).

When larvae or fingerlings were regularly influenced

by such dosez of impulsive current (I time every month for a year period) or eggs were fecundated directly in the electric fields, it did not influence the further cause of reproduction and development of fish. The only evidence of the negative influence of electric current was the rise of fish embrio death, when the eggs during the process of development were influenced by current, particularly, during critical periods in their development.

However, as it was seen from the analisys of the date received, the thresholds of the embrio death depend on the eggs size and perhaps on the duration of the development period of the embrio.

Thus, in the experiments with impulse current the increase of embrio death of the trout and brook trout (large eggs and long period of embrio development) began under E I,5 V/cm. At the same time survival of carp embrio (small eggs, short period of embrio development) under analogous influence did not differ from control group.

More early hatching of the larvae in the groups subjected to the influence of electric current did not influence negatively on the following development of the fingerlings.

Impulse and alternating electric current under E = I,5 and 3 V3 cm did not influence essencially on growth and feeding of " broad-clawed crayfish " on the eggs and the results of the incubation.

However, impulse and alternating electric current stimulated considerably the hatching of the larvae and growth of the fingerlings of " broad-clawed crayfish ".

Alternating electric current did not influence much on the terms of moult of crayfish and increased their driving in the period of moulting.

Electrical influence causing the state of deep narcosis among fish, did not exert equal influence on indices of physiological state. Some of them remained comparatively stable (electrolyte K, Na, Ca), others showed medium changes (hematological indices, protein, blood), there were also some indices which showed strong, thuogh temporary changes after electrical current influence. It can be reffered to the respiration and the work of the heart, mediators sympathetic nervous system - " cateholamin" and reactions of behaviour.

Character of the consequences of the electric current influence on the feed coditioned reflexes of the goldfish is determined by the kind and parameters of the current, by duration of the influence and individual peculiarities of behavioural activity of fish. Conditioned reflexes were displayed normally straight after the influence of the electric current was stopped under E = 0,5 - I V/cm (impulse current), (f = 30 and I00 hertz, T= I,6 mc) and t = I0 sec.

Only some increase of latent period was marked.

More strong influence (E = 2 -3 V/cm, t = 30 - 45 sec) were accompanied by slowing-down conditioned reflexes, which went on (altogether with the period of restoration) from several minutes till 5 - 7 hours.

The most hard and long violations of the blood conditioned reflexes of the goldfish were observed when alternating current was used.

On the next day after the action of all parameters of electric current, manifistation of food conditioned reflexes was quit normal. Regular action (5 or 9 times repeated, once a week) for the majority of fishes did not influence food conditioned reflexes. Though some fish had temporary failure of the conditioned reflex activity.

These are the main results of the experiments. However, the results themselves cannot value the gear from the point of view of the electric current action on hydrobionts, they can only be used as initial data for technical calculation, helping calculate the probability of consequences of electric current action on fish while using the gear for electric fishing.

The probability of the consequences depends not only on the sensibility of fish to the action of electric current (E_{05} , E_{50}) , but also on the technical characteristics of the gear and regime of its work. The probability of bad consequences will be very small if the volume of the space is not large with dangerous E_{05} and E_{50} in respect to all between-electrodes space, when the speed of trawling is high and there is practically no possibility for fish to leave the sack (electrotrawl).

Using the principle, mentioned above the calculations for electric trawl were made (its work is described in " Rybnoye khoziaystvo " N I - 1975.

The calculations showed that the probability of the consequences of the electric current action on fish was not high ($3{,}33 \cdot 10^{-4}$), and on aquatic invertebrates

($6{,}9 \cdot 10^{-4}$). It means, that when the catch is 10 tons and average weight of fish is 0,2 kg, only 17 fish of 50 000 will be subjected to the action of electric current.

By this we wanted to underline that any new project of electric gear for marine fish must be calculated to to value it from the point of view of consequences of electric current action on hydrobionts and the gears should be used only in case if there is no bad influence.

In any case electrodes with small squares should not be used because small square is the reason of large tensity of electric field.

Besides, we must take into consediration that the regime of the fishing gear work should provide the best circumstances for fish, so that it did not stay for a long time in the space between the electrodes.

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