

PRELIMINARY EXPERIMENTS ON ELECTRICAL FISHING IN FRESH WATER

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INTRODUCTION

Fishing using electricity is a new technique and is still in the experimental stages in many of the advanced countries. While no published records are available in India, considerable work has been done in Germany (Mayer Waarden, 1953, 1954a, 1954b, 1955, 1957; Hattop 1957, 1958a, 1958b; Kreutzer 1951, 1954; Denzer 1954, 1956; Halsband 1955, 1956), United States (Smith 1955a, 1955b, 1955c; Halton *et. al.* 1954; Lennon and Parker 1958; Wathwe *et. al.* 1964), USSR (Shentiakov 1963; Shentiakov *et. al.* 1959; Nikonorov *et. al.* 1959; Nikoronov Ivan 1964; Badamshin *et. al.* 1964), Canada (Smith and Sanders 1954), Newfoundland (Murray 1958), United Kingdom (Mck-Bary 1956; Dickson 1954). These papers mainly deal with the behaviour of the fish in the electrical field, the physiological effects of electrical current on fishes, methods of electrofishing, electric fencing etc.

Electrical fishing in fresh water is easier, less dangerous for the same voltage and requires less power (Lt. Cd. (Sp) B. Mck. Barry 1956) than for that being carried out in sea to cover the same area, as the conductivity of fresh water is too

low compared to sea-water. The effect of an electric field on the fish will depend upon the voltage drop on its body due to the passage of electric current.

The following experiments on electrical fishing were conducted with a view to studying the distribution of electrical field when an alternating current is passed through two fixed electrodes in fresh water and to study the reaction of different fresh water fishes to the field.

MATERIAL AND METHODS

All the experiments were conducted in a fresh water pond of about size 70' × 60' and a maximum depth of 12' at the middle. The main characteristics of the water are given below:

1. Salinity : 0.26 parts/1000
2. Conductivity : 1.38×10^{-3} ohm⁻¹/cm. at 25°C.
3. Bottom of the pond : Sandy mud.

Experiments were carried out using the following fishes available in the pond.

Fishes	Max. length	Max. girth
1. Cat fish	380mm.	121mm.
2. Climbing perch	173mm.	127mm.
3. Murrels	300mm.	135mm.
4. Tilapia	125mm.	120mm.
5. Megalops	270mm.	185mm.

The necessary electrical power was drawn from a 6.5 K. W., 400V, 50 cycles, 3 phase diesel generator set. The electrode used for the experiment is shown in Fig. 1.

The connections to the electrodes were given through 2-core T. R. S. Cables. Two mild steel sheet metal electrodes – Fig. 1 – were used for the measurement of potential distribution and for studying the effect of electric field on fish. Live fishes were kept in a bag net for one day, before being used for the studies.

Experiments to study the potential distribution in water:

The two electrodes were suspended from a sisal rope tied across the pond in such a way that the conducting portion remains completely immersed in water. The distance between the electrodes was adjusted to 5'. The electrodes were connected to the two phases of the generator. Although the rated voltage of the generator was 400V between phases, on load it gave on the terminals of the electrode only 330V between phases. An earthing pipe was fixed near the tank to get a good earth point. An earth lead was taken in the dingy and it was connected to an Avometer. A field measuring probe was connected to the other terminals of the Avometer. The measurements were taken by the measuring probe at different points radially on the surface and at different depths.

Experiments to study the reaction of fishes to an electric field:

The effect of electric field on fish was tried by putting live fishes of different size groups, one at a time in a small bag made of net and hanging the bag at different points in the field from a rope tied radially from the electrode. The voltage at the point and the distance from the electrode were noted. The fishes were exposed to

the field for 30 seconds. If the fish were stunned (turned upside down in certain cases, lying still on their sides in the case of cat fish), within the 30 seconds at a point, that point is taken as the effective point.

RESULTS AND DISCUSSION

Fig. 2 shows the formation of the curves of equipotential lines around the electrodes when they are fixed at 5' apart and a voltage of 330 is applied across them. It is clear from the figure that there exists a minimum potential region in between the two electrodes. The plane of this region is perpendicular to the plane connecting the two electrodes. In a field of alternating current the fish takes a transverse position with respect to the direction of current (Mayer Waarden 1957). This phenomenon is called oscil-lotaxis. It is happening in the minimum potential region mentioned above. In Fig. 2, even though the form of the equipotential curves is the same for both the electrodes they are not equal. This is because the voltage developed in each phase of the generator was not the same. This is clear from Table – 1 which shows the potential measurements taken at different points in the field.

Fig. 3 shows the relationship between voltage and distance from the electrode.

A third degree polynomial of the form $Y = aX^3 + bX^2 + cX + d$ where a, b, c and d are constants were fitted to the observed data by the principle of least squares. The equation obtained by fitting the third degree polynomial for the data was :

$$Y = -0.00077X^3 + 0.12599X^2 - 7.24000X + 149.58030,$$

where Y denotes voltage in direction 240° from AB from earth and X denotes

distances from electrode, B in inches (Table -1). The closeness of fit of this polynomial can be seen from the graph. In the graph the points plotted denote observed data points and the curve drawn represents the graph of fitted third degree polynomial for the data.

Table - II shows the voltage drop on the body for each fish for electronarcosis, the length of fish, the distance from electrode at which it happens, the voltage etc. It has been assumed in the calculations that the voltage per cm multiplied by the fish length is the equivalent of the voltage over the fish, since it was difficult to measure the actual voltage drop over the free swimming fish and since from field measurements the voltage at different points in the field are available.

Fig. 4 shows the relationship between the voltage drop on the body of the fish and the length of fish for the effect of electronarcosis for Cat fish, Murrels and Megalops. The relations are in the form of first degree equation.

For Cat fish, the equation is

$$Y = 0.4707X + 0.0339$$

where Y = voltage drop

X = fish length (cm).

The correlation co-efficient between voltage drop and fish length $r = 0.9977$, which is significant at 10% level, indicating significant correlation between the two.

For murrels, the relation is $Y = 0.4793X - 0.1158$

where Y = the voltage drop on the fish

X = length of the fish (cm).

The correlation co-efficient $r = 0.9984$ which is significant at 10% level indicates significant linear relationship.

For Megalops the relationship is

$$Y = 0.4731X + 0.0317$$

where Y = voltage drop on the fish

X = length of the fish (cm).

The correlation co-efficient between voltage drop and length of fish $r = 0.9997$ which is significant at 10% level, indicates significant linear relationship between the two.

In Fig. 5, the voltage drop on the fish length is plotted against the maximum girth of fish for electronarcosis effect on Cat fish, Murrels and Megalops.

For Cat fish, the relationship is

$$Y = 1.8138X - 3.6842$$

where Y = voltage drop

X = maximum girth of fish (cm).

The correlation co-efficient between voltage drop and maximum girth of fish $r = 0.8764$ which is significant at 10% level indicates correlation between the two.

For Murrels, the relationship is

$$Y = 1.1233X - 1.6223$$

where Y = voltage drop and

X = the maximum girth of the fish (cm).

The correlation co-efficient $r = 0.9093$ which is significant at 10% level indicates significant linear relationship between the two.

For Megalops the relationship is

$$Y = 0.6268X + 1.6814$$

where Y = voltage drop

X = maximum girth of fish.

The correlation co-efficient between voltage drop and girth of fish $r = 0.9856$ which is significant at 10% level indicates significant linear relationship between the two.

In Fig. 6, the voltage drops on fish length is plotted against the weight of fish for the effect of electronarcosis for Cat fish, Murrels and Megalops.

For Cat fish, the relationship is

$$Y = 0.0584X + 4.6675$$

where Y = voltage drop

X = weight of fish (g).

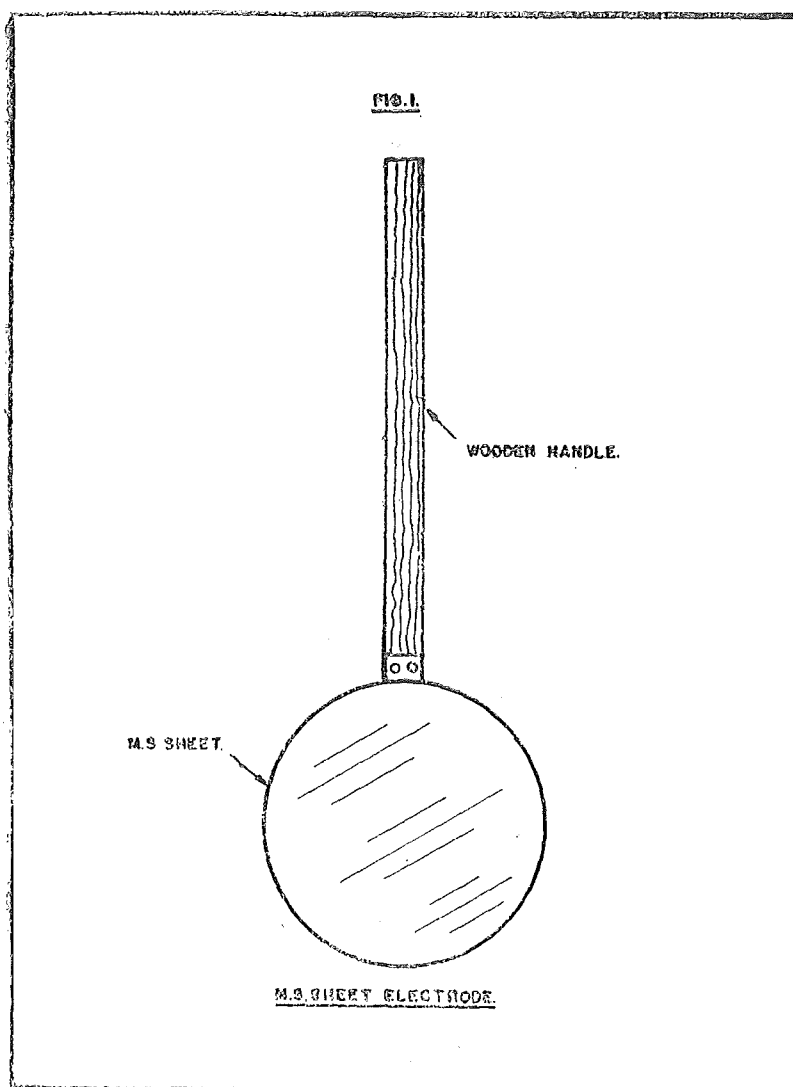


FIG.3.

RELATIONSHIP BETWEEN VOLTAGE IN DIRECTION 240° FROM A B AND DISTANCE FROM ELECTRODE.

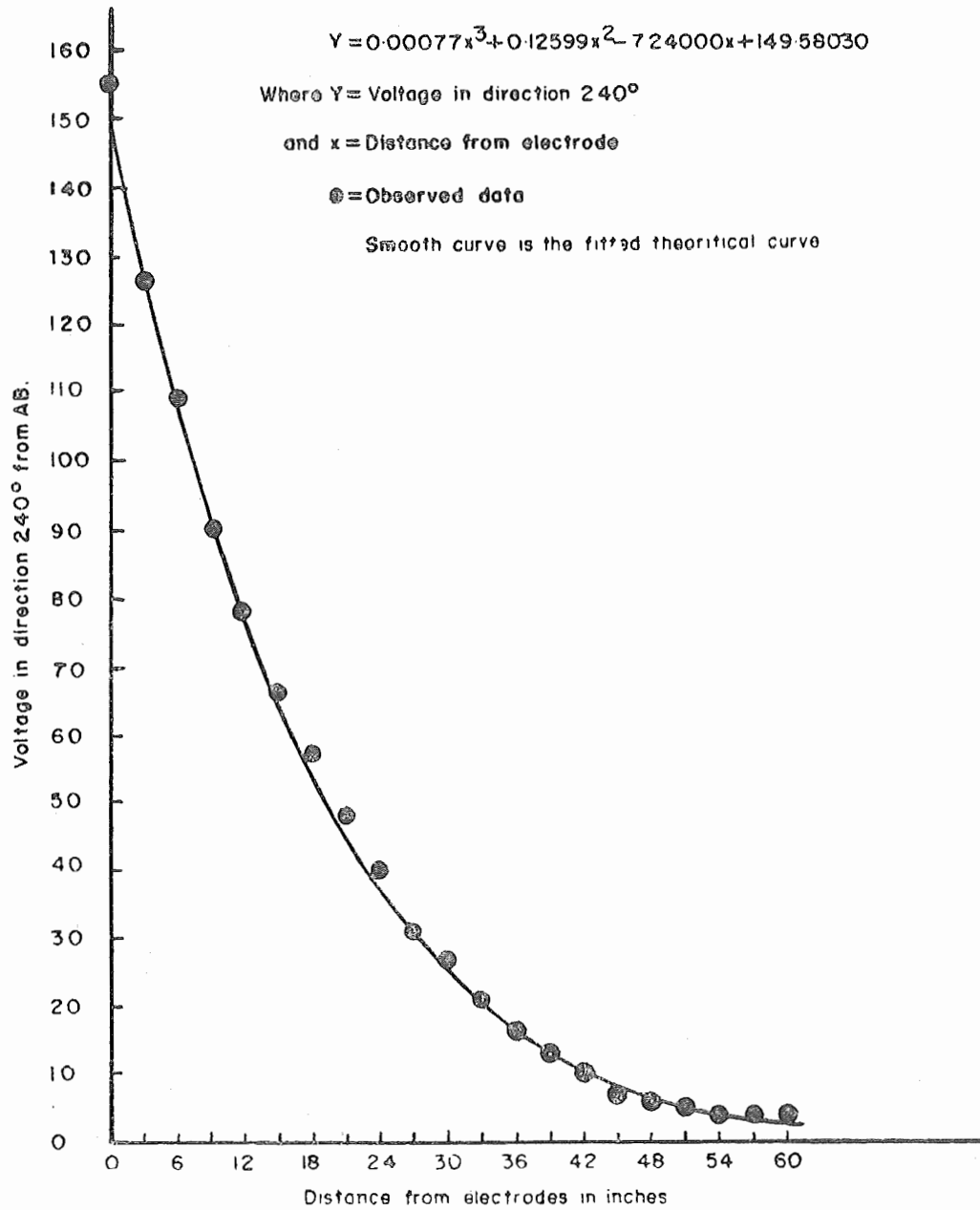


TABLE I

Distance from electrode	Electrode A				Electrode B					
	Voltage at 60° from AB	Voltage at 120° from AB	Voltage in direction 240° from AB	Voltage in direction 300° from AB	Voltage in direction 60° from AB	Voltage in direction 120° from AB	Voltage in direction 180° from AB	Voltage in direction 240° from AB	Voltage in direction 300° from AB	Voltage in direction 0° from AB
0	141	141	141	141	155	150	150	155	150	150
3"	106	106	111	108	143	145	134	126	145	142
6"	93	93	94	89	132	126	115	109	125	132
9"	75	83	84	78	127	120	91	90	100	127
12"	66	71	77	66	112	86	75	78	87	107
15"	51	66	68	56	97	80	59	66	82	90
18"	43	58	63	49	82	78	46	57	68	75
21"	37	52	53	40	67	62	30	48	70	60
24"	30	46	47	33	55	45	19	40	57	57
27"	25	43	43	28	47	38	10	31	48	47
30"	17	40	37	22	40	32	3	27	42	42
33"	17	36	33	19	32	26	10	21	37	37
36"	12	33	30	15	26	19	22	16	32	34
39"	9	30	26	12	24	15	23	13	30	30
42"	6	26	20	9	20	10	57	10	26	27
45"	5	25	20	7	19	7	61	7	23	25
48"	2.5	23	19	6	17	5	67	6	21	22
51"	2.5	22	18	5	15	4	81	5	19	20
54"	2.5	20	16	4	14	4	100	4	17	19
57"	3	19	15	3	12	4	111	4	16	17
60"	5	17.5	13	3	11	4	141	4	15	16

(Electrode E)

TABLE II

Fish	Voltage gradient — 0.475 V/cm.						
	Voltage drop on the fish	Length of the fish	Distance from electrode to the stunning point	Time of exposure	Voltage at the point	Max. girth of fish	Wt. of fish
Cat fish	16.9 V	35.5 cm.	120.4 cm.	30 sec.	15 V	9.65 cm.	170 g.
Cat fish	18.00V	38 cm.	120.4 cm.	30 sec.	15 V	11 cm.	210 g.
Cat fish	14.45V	32.4 cm.	91.4 cm.	30 sec.	22 V	12.2 cm.	175 g.
Cat fish	14.9 V	31 cm.	91.4 cm.	30 sec.	22 V	11 cm.	180 g.
Cat fish	7.82V	16.5 cm.	91.4 cm.	30 sec.	22 V	6.35 cm.	25 g.
Cat fish	17.1 V	36 cm.	120.4 cm.	30 sec.	15 V	11 cm.	210 g.
Cat fish	15.65V	33 cm.	91.4 cm.	30 sec.	22 V	11.4 cm.	180 g.
Cat fish	15.65V	33 cm.	91.4 cm.	30 sec.	22 V	9 cm.	160 g.
Cat fish	4.75V	10 cm.	62 cm.	30 sec.	43 V	6 cm.	20 g.
Cat fish	13.3 V	28 cm.	91.4 cm.	30 sec.	22 V	10 cm.	200 g.
Cat fish	4.04V	8.5 cm.	52 cm.	30 sec.	43 V	5 cm.	10 g.
Cat fish	15.65V	33 cm.	91.4 cm.	30 sec.	22 V	9 cm.	210 g.
Anabus	8.2 V	17.25 cm.	120.4 cm.	30 sec.	15 V	12.7 cm.	100 g.
Murrel	11.3 V	23.8 cm.	152.0 cm.	30 sec.	10 V	11.9 cm.	170 g.
Murrel	12.35V	26 cm.	152. cm.	30 sec.	10 V	12 cm.	175 g.
Murrel	14.25V	30 cm.	152 cm.	30 sec.	10 V	13.5 cm.	225 g.
Murrel	13.3 V	28 cm.	152 cm.	30 sec.	10 V	13 cm.	190 g.
Murrel	10.4 V	22 cm.	120.4 cm.	30 sec.	15 V	11 cm.	140 g.
Murrel	11.9 V	25 cm.	152 cm.	30 sec.	10 V	13 cm.	200 g.
Murrel	9.95V	21 cm.	120.4 cm.	30 sec.	15 V	10 cm.	120 g.
Tilapia	5.95V	12.5 cm.	45.5 cm.	30 sec.	60 V	12 cm.	60 g.
Tilapia	2.85V	6 cm.	38.2 cm.	30 sec.	64 V	5 cm.	5 g.
Megalops	11.9 V	25 cm.	120.4 cm.	30 sec.	15 V	17 cm.	300 g.
Megalops	12.8 V	27 cm.	152 cm.	30 sec.	10 V	18.5 cm.	350 g.
Megalops	12.3 V	26 cm.	120.4 cm.	30 sec.	15 V	17 cm.	350 g.
Megalops	12.8 V	27 cm.	152 cm.	30 sec.	10 V	16 cm.	275 g.
Megalops	4.05V	8.5 cm.	91.4 cm.	30 sec.	22 V	4 cm.	5 g.

FIG. 5

RELATIONSHIP BETWEEN VOLTAGE DROPS AND GIRTH OF FISH (MEGALOPS, MURREL & CAT FISH)

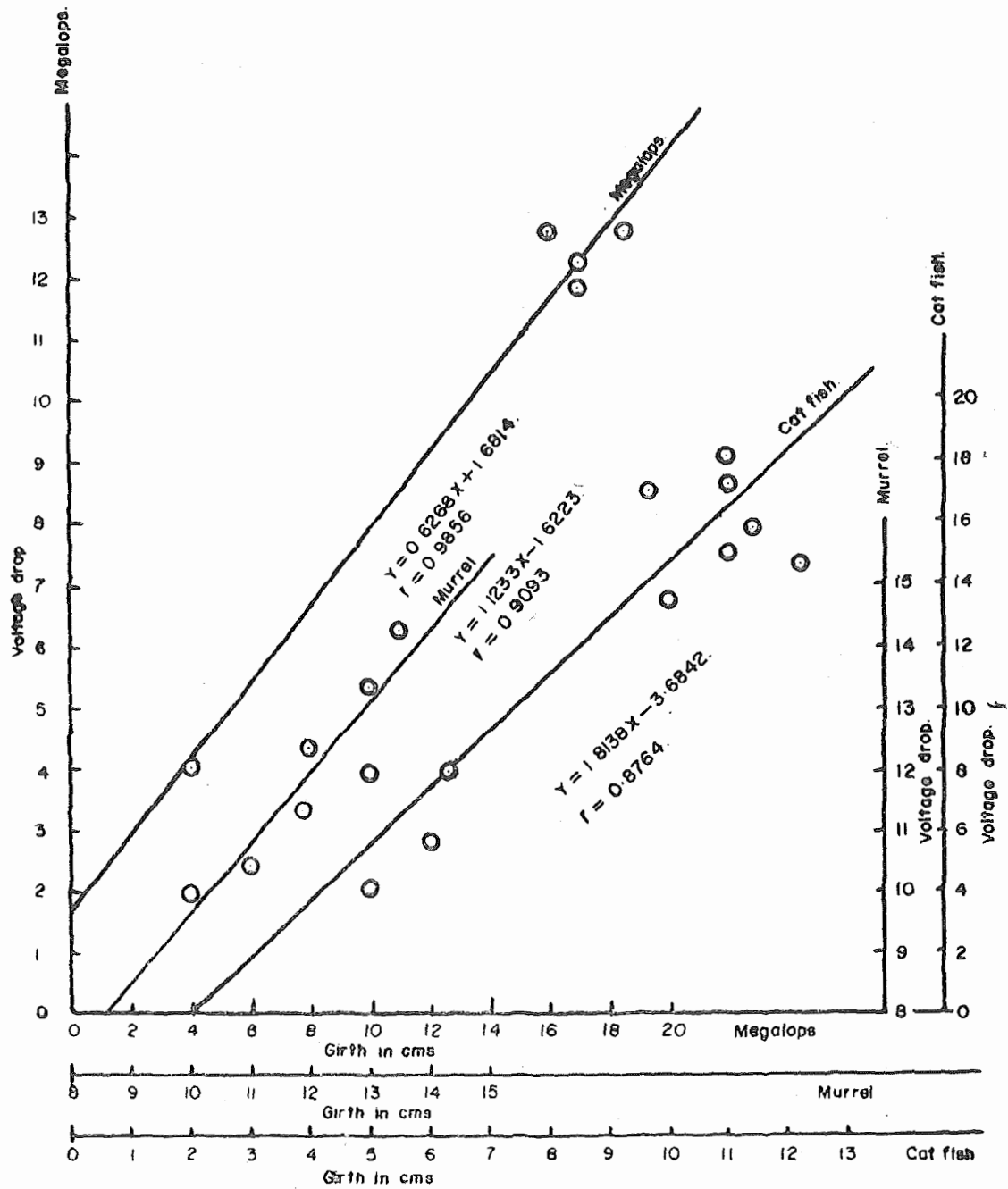
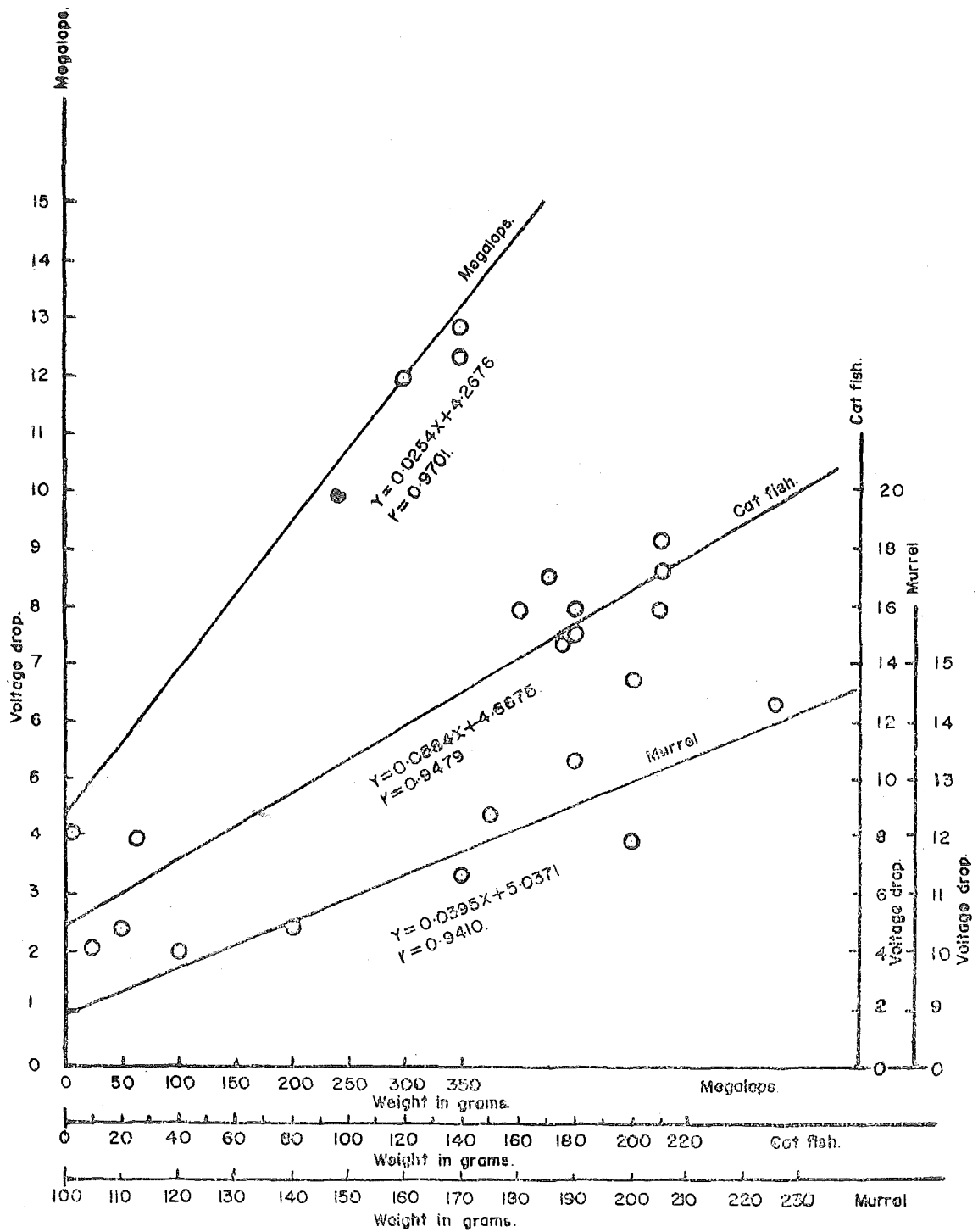


FIG. 6.

RELATIONSHIP BETWEEN VOLTAGE DROPS AND WEIGHTS OF FISH (MEGALOPS, MURREL & CAT FISH)



The correlation co-efficient between voltage drop and weight of fish $r = 0.9479$ which is significant at 10% level, indicates significant linear relationship between the two.

For Murrels, the relationship is expressed as

$$Y = 0.0395X + 5.0371$$

where Y = voltage drop
X = weight of fish (g)

The correlation co-efficient $r = 0.9410$ which is significant at 10% level indicates significant linear relationship.

For Megalops, the relationship is expressed as

$$Y = 0.0254X + 4.2676$$

where Y = voltage drop
X = weight of fish (g).

The correlation co-efficient $r = 0.9701$ which is significant at 10 % level indicates significant linear relationship.

From the figures, it is evident that the threshold values for electronarcosis for fishes depend on the size of the fish.

ACKNOWLEDGEMENT

The author is grateful to Shri M. Velu, Research Officer, Central Institute of Fisheries Technology and to Shri G. K. Kuriyan, Senior Research Officer, Central Institute of Fisheries Technology, for offering valuable suggestions and guidance during the course of the investigation and for kindly going through the manuscript. Grateful thanks are also due to Dr. A. N. Bose, Director, Central Institute of Fisheries Technology for the encouragement in the work. The author is grateful to Shri H. Krishna Iyer for kindly going through the experimental data and for statistical analysis. The author is also thankful to Shri M. D. Verghese for assisting in the execution of the work.

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