CHAPTER - VI

TERRITORIAL BEHAVIOUR

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Introduction

Territoriality, i.e., active defence of an area against intruders, occurs in all classes of vertebrates, most frequently among birds and fishes. It has also been reported for a variety of invertebrates. The behavioural aspects of territorial defence have been extensively studied (Nice, 1941; Burt, 1943; Baerends and Baerends-van-Roon, 1950; McNicol and Noakes, 1981; Davies, 1978; Hartmann, 1965; Greenberg, 1947; Keenleyside, 1962; Lecren, 1965; McNicol, 1979; Ross, 1977). The adaptive values of territorial defence have been discussed by many authors. The most widely accepted hypothesis is that territorial behaviour increases the probability of reproductive success by optimal distribution of available space among conspecifics (Albrecht, 1969; Allen, 1972; Moyer and Bowyers, 1973; Fricke, 1974; Ierael ... Van, 1958). Territoriality also regulates density. Aggression increases with density. Density dependent aspects of aggression was reported by Kenyver and Tinbergen (1954), but most investigators were primarily interested in the behavioural aspects and ecological significance of territory.

The present study deals with the territorial behaviour of two catfishes, H.fossilis and C.batrachus.

On the basis of observations in a laboratory pool, behavioural aspects of territory and its ecological significance is also discussed.

Materials and Methods

In order to study the territorial behaviour of H.fossilis and C. batrachus in laboratory, a tank measuring 2.14 m x 0.92 m x 0.60 m was constructed. It was made of bricks. The floor of the tank was covered with a heavy, black plastic sheet, upon which a layer of sand and clay (about 6 cm height) together with small pebbles was placed to make a substrate. The sand layer resembled a natural pond bed common in this locality. Water from a local pond was then poured into the tank. The height of water column of the tank was maintained at 44 cm from the sand bed.

The tank was divided into 14 equal parts of imaginary lines. White stones of uneven shape (4 cm x 4 cm x 2 cm, approx.) were placed at the four corners of each constituent parts of the tank as shown in the figure (Fig. T1). Thus the four stones provided the boundary of each part. The stones of three rows were marked as $A_0 - A_7$, $B_0 - B_7$ and $C_0 - C_7$ respectively for convenience of observations. Each compartment had an area of 1393.54 cm^2 (length - 30.48 cm, breadth 45.72 cm). Eight petri dishes (2 cm

diameter and eight jars (4 cm x 3 cm x 2 cm) were placed at different places in the tank as food containers and as shelters. The positions of the petri dishes are shown in the figure (Fig. T1). The tank was lighted by 6 hundred watt bulbs for a period of 12 hrs daily.

The experiment on Hetropneustes fossilis was conducted for a period of 20 days from 1.9.80 to 20.9.80. Five fishes comprising of three males, namely, P_1, Q_1 and R_1 and two females, namely, S_1 and T_1 were introduced into the tank successively at 1 day interval. The first fish (P_1) was introduced on 1.9.80.

For Clarias batrachus, the experiment was started from 21.9.80 and continued upto 27.10.80, i.e., for a period of 36 days. As in the previous experiment, five fishes, three males, namely, P, Q and R and two females, namely, S and T were introduced into the tank successively on 15th, 16th, 17th, 18th and 19th September, 1980. Observations were made at five different times every day for both H. fossilis and C. batrachus. The total period of observation per day was 150 minutes. Each observation lasted for 30 minutes. The fish used in the experiments were selected with natural individual markings so that each could be easily identified. The position of each fish in the tank was recorded every 3 minutes over the total period of

observation. So during each 30 minutes observation period the position of the fish was identified and recorded 10 times on a map of the tank. Data were recorded after release of all the five fishes, i.e., from the 6th day after the onset of the experiment.

Results and Discussion

The territorial behaviour of H. fossilis and C. batrachus are discussed below:

(a) H. fossilis:

The fishes were introduced into the tank as mentioned in materials and methods section. The first fish after release selected a corner of the tank and settled there. Soon after the release of the 2nd fish, it swam aimlessly for 15 minutes and then joined the first fish. No external manifestation of aggressive behaviour was observed between them. They kept on living together and settled peacefully in the same corner. Similarly, the rest of the fishes also settled in the same corner with the previous two. No aggressive interactions were observed among them. All of them took food together from the nearest food container. When the food of one container was finished they all switched over to the next container. After feeding they again gathered in the same corner of the tank. The experiment was conducted for 15 days, and no change in behaviour

was observed. It was, therefore, concluded that individuals of H. fossilis did not posses individual territory at least during September when the experiment was conducted.

(b) C. batrachus:

Clarias batrachus, on the other hand, was found to maintain individual territory strictly. The territory included shelter as well as grazing or feeding area. Individual fish could be recognised because of their natural characteristics and markings. The five fish released in the tank selected five particular spots as their shelter spots. It was observed that they were almost always within a few meters of their particular shelter spots. It was interesting to note that individual fish always used the same route for their movement to and from their shelter spot. The fishes were introduced into the tank one by one and they accommodated themselves in different areas of the tank as shown in the picture (Fig. T2). The first fish, i.e., P, when introduced, travelled all around the tank, presumably in search of a suitable place to settle. P showed preference for a particular area from the very first day. Like the first fish, the rest also swam initially all around the tank after release for finding a suitable shelter spot. Then they gradually settled and started to

defend actively the particular area of their choice. A lot of territorial aggression occurred among the fish. Aggression increased with increase in number of inhabitants in the tank. Later on, however, frequency of aggression decreased and was seen only during feeding or while a fish accidentally intruded into others territory. Aggressive behaviour included chasing, circling and tail beating motor patterns (described in Chapter III). Occasionally while chasing they were found to cross their own territory. In such situation, sometimes they stayed beyond their own territory for 1-7 seconds. It was also observed that the fish always returned to its shelter spot directly by the shortest route even though the pathway traced during chasing was long and circuitous. When an intruder was seen, the resident fish immediately rushed towards it and in most cases the intruder retreated. In some cases the resident stopped at a distance from the intruder. The intruder retreated as soon as it was challenged without any overt fighting. In most cases where attacks were observed the intruder stayed within the territory of the resident and finally it was chased well beyond the territorial boundary. No attack was initiated outside the territory. Intruders passing over a foreign territory beyond a level of 50 cm above the bottom were not usually attacked. As such

territory in this species appeared to be three dimensional. The fish under observation generally confined their movements within their own territory and did not intrude into neighbouring territories even when the neighbour was not close by. Individual differences in territorial behaviour was observed. Some fish were more vigorous and active in defending their territories. But in general, they had only one shelter spot and fixed escape path to it. While they were less tolerant of intrusions into their territories, they clearly recognised and respected their own boundaries.

Food were given in different fixed spots, close to the territories but not within any territory. When food were placed in the feeding-cups all the fishes immediately rushed towards the food and the dominant fish chased away the subordinate ones. It was noticed that the dominant fish took food from the feeding station close to its territory and then went towards another station for more food. The dominant fish chased the others and swallowed most of the food until satisfied. The fishes were found to search for food before it was supplied. During feeding, the fishes did not maintain territory rigorously. They visited feeding stations at different areas apparently without concern of defending their territories at that time. Aggression also occurred during feeding. But as soon as the food was

finished they returned to their territories.

As has been mentioned earlier (Chapter III) in the chapter on agonistic behaviour, there was a change in colour during aggression. But such colour change was not observed in fishes during territorial fights.

Most studies have shown that territorial aggression increases reproductive success through protection of a nest site or other resources such as food, shelter and space (Abel, 1961; Albrecht, 1969; Ross, 1969; Clarke, 1970; Low, 1971; Myrberg, 1972; Myrberg and Thresher, 1974; Thresher, 1976; Fishelson, 1964; Allen, 1972; Moyer and Sawyers, 1973; Fricke, 1974). The present study, however, was conducted during non-breeding season. So it was obvious that aggression on observed in this study was mostly for shelter and feeding-area. Complex discriminative interactions occurred in some species of cichlid fishes with little or no sexual dimorphism (Baerends and Baerends -van-Roon, 1950). The general ecology in relation to territory and behaviour other than breeding of some fishes were studied by Turner and Ebert, 1962; Helfrich, 1958; Stevenson, 1963; Robert Ross, 1977).

Figure 32 showed the total area covered by individual resident fish. It was observed that the biggest (in terms of length and weight) fish defended the largest area. Size of territory varied directly with the length and weight

of the fish. Table TT 1 showed the length/weight of each fish and the area covered by them. From table TT 1 and figure T2 it was evident that P had the largest and T had the smallest territory. The territories of Q and S, P and R overlapped to some extent. The area of overlapped territory being 60.89 cm^2 and 30.19 cm^2 respectively. It was found that the number of visits of Q to the overlapped area was twice as great as that of the fish S. Whereas, P visited the overlapped zone 1.25 times more than R.

P and Q were recognised as the dominant No. 1 and 2 fishes. The dominant fishes consumed more food. Increase in the amount of food consumption might have some effect on increase in territory size through interference into others territories resulting in overlap and intense competition (Noakes and McNicol, 1980).

Figures T3 - T7 showed the individual territories of fish P, Q, R, S and T respectively. Each cross (X) represents one visit to the particular spot by the fishes. Occasional movements beyond the territories was also shown by X-marks. Territory size was maximum for the most dominant fish (P) and minimum for the most subordinate fish (T). The fish T often trespassed into adjoining territories probably in search of food. It may be mentioned here that T, the most subordinate fish in the tank

did not always get enough food due to competition from dominant ones.

Figure T8 showed the regression analysis of total length and weight on total area defended as territory by Clarias batrachus individually. The lengths and weights are directly proportional to the size of the defended area. The regression equations corresponding to the straight lines are found to be (a) $Y = 0.13X + 172.0$ ($r = 0.98$) and (b) $Y = 0.62X + 34.40$ ($r = 0.99$) for weight and length respectively.

Meeting of two fishes was termed as encounter. Number of encounters among P, Q, R, S, T have been shown against number of days in Table - TT2. Number of encounters of a particular fish with others was different on different days. For all the fishes studied, the encounters was maximum between 10 to 17 days. The number of encounters ultimately dropped either to nil (R, T) or to one per day (P, Q, S). Thus, the number of encounters increased with days initially and then decreased after reaching a maximum. The fishes became reluctant to interact as the days went by and the residual encounters (nil or one) towards the end of the experiment took place only during feeding. These encounters often resulted aggressive behaviour. As mentioned earlier, only three types (chasing,

circling and tail beating) of motor patterns were displayed during territorial aggressive behaviour. The total number of aggression (chasing, circling and tail-beating taken together) for all the fishes (P, Q, R, S, T) individually were counted each day and shown in Table TT3. Here also aggression increased initially, reached the maximum level between 10-13 days and the decreased almost to zero. Thus encounters and as a consequence fearce battles between conspecifics in the initial phase gradually subsided giving rise to stable understanding between them. The reason for decrease in aggression may be as follows: a territory holder could identify its own territory and also the adjacent territory possessed by another individual. It was more a case of familiarisation rather than habituation. After familiarisation high intensity aggression was not necessary for the maintenance of the territory. Low intensity aggression such as threat was sufficient for its maintenance along with mutual avoidance (Marler, 1967) by adjacent territory holders.

A dominant fish was identified by its (i) body weight, (ii) food intake, (iii) vigour and (iv) area covered. Analysis of the above factors suggested that the fish P and Q were dominant among the fishes. The body weights of these two fishes were more than the rest of the

three. During food intake, these fishes separately chased the others away and consumed the maximum amount between them.

In table TT4 and TT5, total number of encounters and total aggressive score received and delivered by each fish have been shown. The ratio, delivered (encounters/aggressions) to received (encounters/aggression) reflected the vigour of the individual fishes. For number of encounters and aggressive scores, the vigour decreased as follows T, S, R, P, Q and T, R, S, P, Q respectively. The territorial area maintained by P was maximum and decreased in the following order : P, Q, S, R, T. Considerations of the above criteria, therefore, indicated P and Q fishes to be the most dominants and T to be the most subordinate.

Table - TT 1

Length, weight and area covered by fishes P,Q,R,S,T.

Sl. No.	Length(cm)	Weight (gms)	Area covered (cm^2)	Correlation Coefficien	
				Length	Weight
1.	19.30	58.00	2363.62		
2.	19.81	59.00	3019.60		
3.	19.05	50.00	2114.93	0.98	0.99
4.	18.29	45.00	1358.82		
5.	17.78	42.00	785.09		

Table - TT2

Scores of encounters per day by individual fish

Days	Number of encounters each day by fish				
	P	Q	R	S	T
6	1	1	0	1	0
7	2	2	0	0	0
8	2	2	1	1	0
9	2	2	2	1	0
10	3	5	2	5	1
11	3	5	2	3	1
12	4	5	3	3	2
13	5	5	3	3	0
14	6	6	3	3	0
15	3	4	1	1	0
16	4	4	1	2	0
17	3	3	0	2	0
18	2	2	0	1	0
19	1	1	0	1	0
20	2	2	0	1	0
21	2	2	0	1	1
22	1	2	0	1	1
23	1	2	0	1	0

Contd..

Table - TT 2

Days	Number of encounters each day by fish				
	P	Q	R	S	T
24	1	2	0	1	0
25	1	2	0	1	0
26	1	1	0	1	0
27	1	1	0	1	0
28	1	1	0	1	0
29	1	1	0	1	0
30	1	1	0	1	0

Table - TT 3
Scores of aggression per day by individual fish

Days	Number of aggressive acts each day by fish				
	P	Q	R	S	T
6	1	2	0	1	0
7	2	3	0	0	0
8	2	3	1	1	0
9	4	3	1	2	0
10	8	8	3	4	1
11	10	7	3	3	1
12	8	8	2	3	1
13	4	4	1	2	2
14	3	4	1	2	0
15	3	4	1	1	0
16	2	3	1	2	0
17	3	3	0	1	0
18	2	2	0	1	0
19	2	2	0	1	0
20	2	3	0	1	0
21	2	2	0	1	0
22	1	1	0	1	0
23	1	1	0	1	0

Contd..

Table - TT 3 (Contd..)

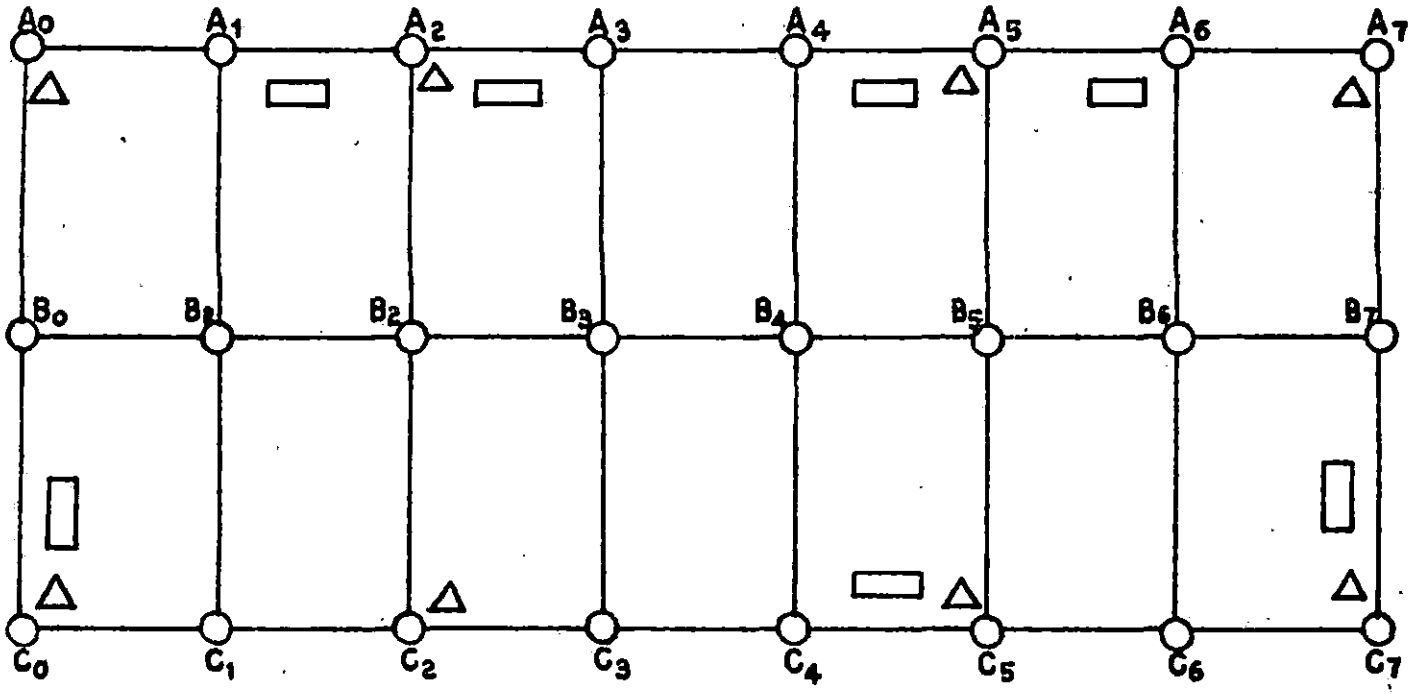
Days	Number of aggressive acts each day by fish				
	P	Q	R	S	T
24	1	2	0	1	0
25	1	2	0	1	0
26	1	1	0	1	0
27	1	1	0	1	0
28	1	1	0	1	0
29	1	1	0	1	0
30	1	1	0	1	0

Table - TT4

Showing total number of encounters received and delivered by P,Q,R,S,T and their delivered to received (D:R) ratios

Resident		Delivered by intruders						
		Q	P	R	S	T	Total	D:R
Received by	Q	-	10	2	17	25	54	4.50
	P	9	-	9	16	11	44	4.93
	R	1	1	-	4	8	14	1.00
	S	-	3	2	-	38	43	1.10
	T	2	1	1	3	-	7	0.03
Total		12	15	14	39	82		

1 Cm = 12 Cm.
Scale



○ Stone, △ Petridish, ▭ Jar

Fig. T1

Fig. T2 Showing the area coverage of the resident fishes P, Q, R, S, T

Fig. T3 Showing the position visited and area covered by fish P

1 cm = 12 cm.
Scale

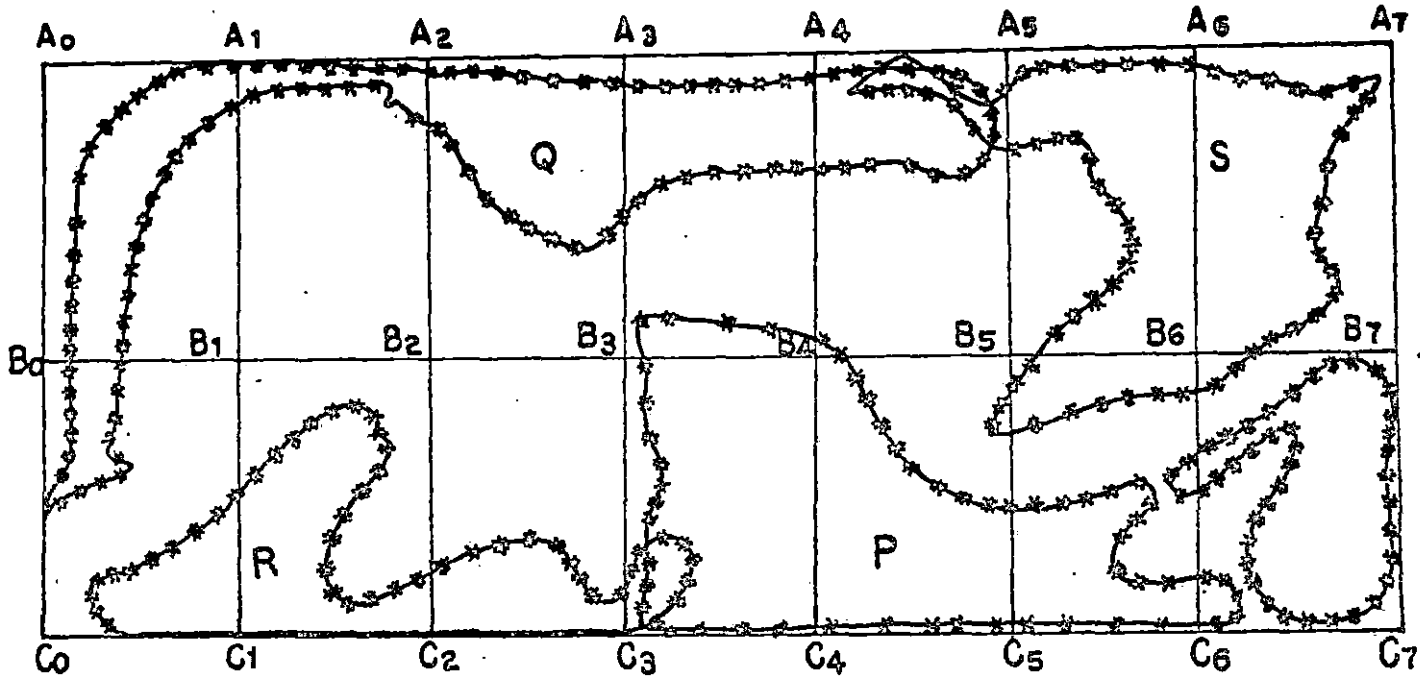


Fig. T2.

1 Cm = 12 Cm.
Scale

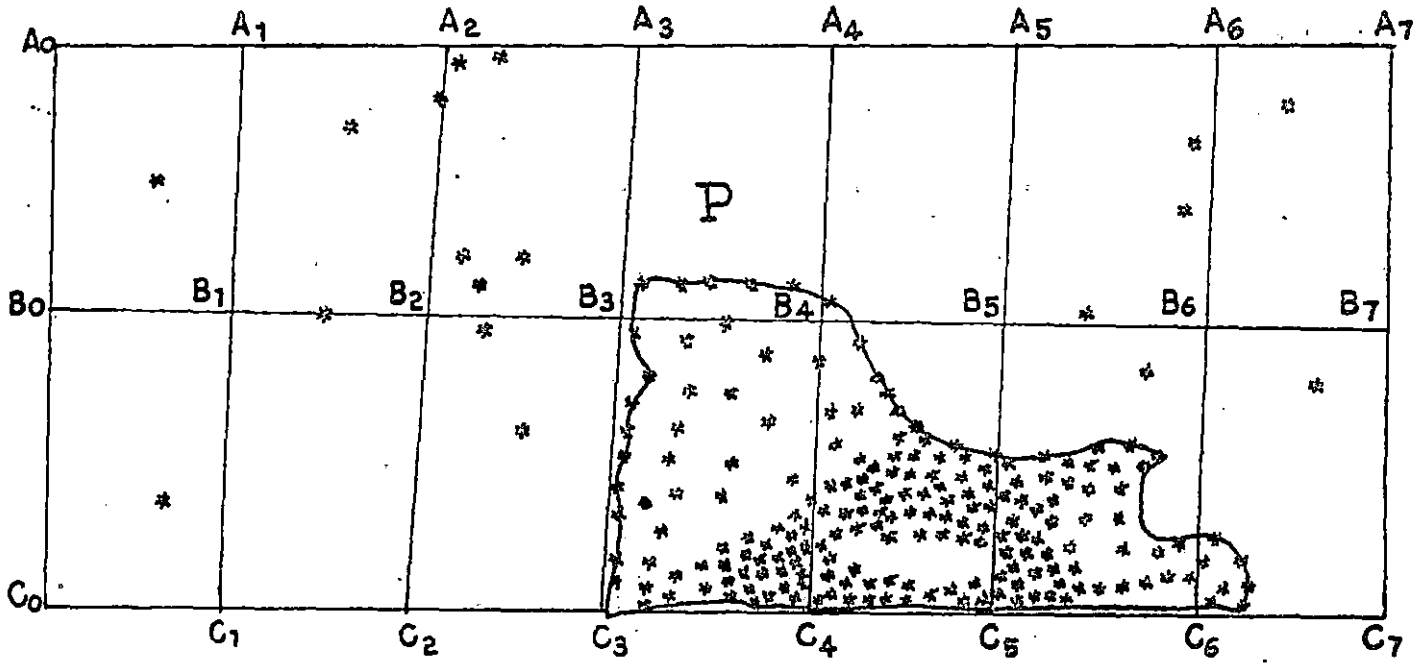


Fig. T 3.

Fig. T4 Showing the position visited and area covered by fish Q

Fig. T5 Showing the position visited and area covered by fish R

1 Cm = 12 Cm
Scale

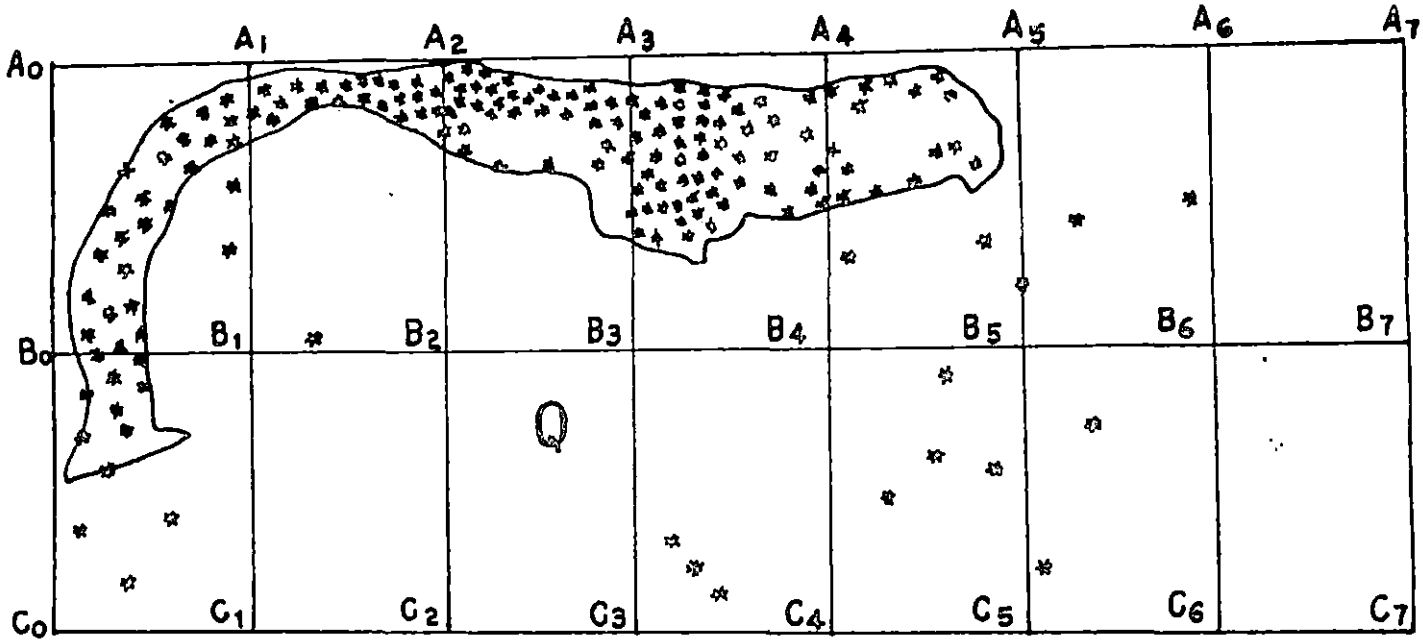


Fig. T4 .

1 Cm = 12 Cm
Scale

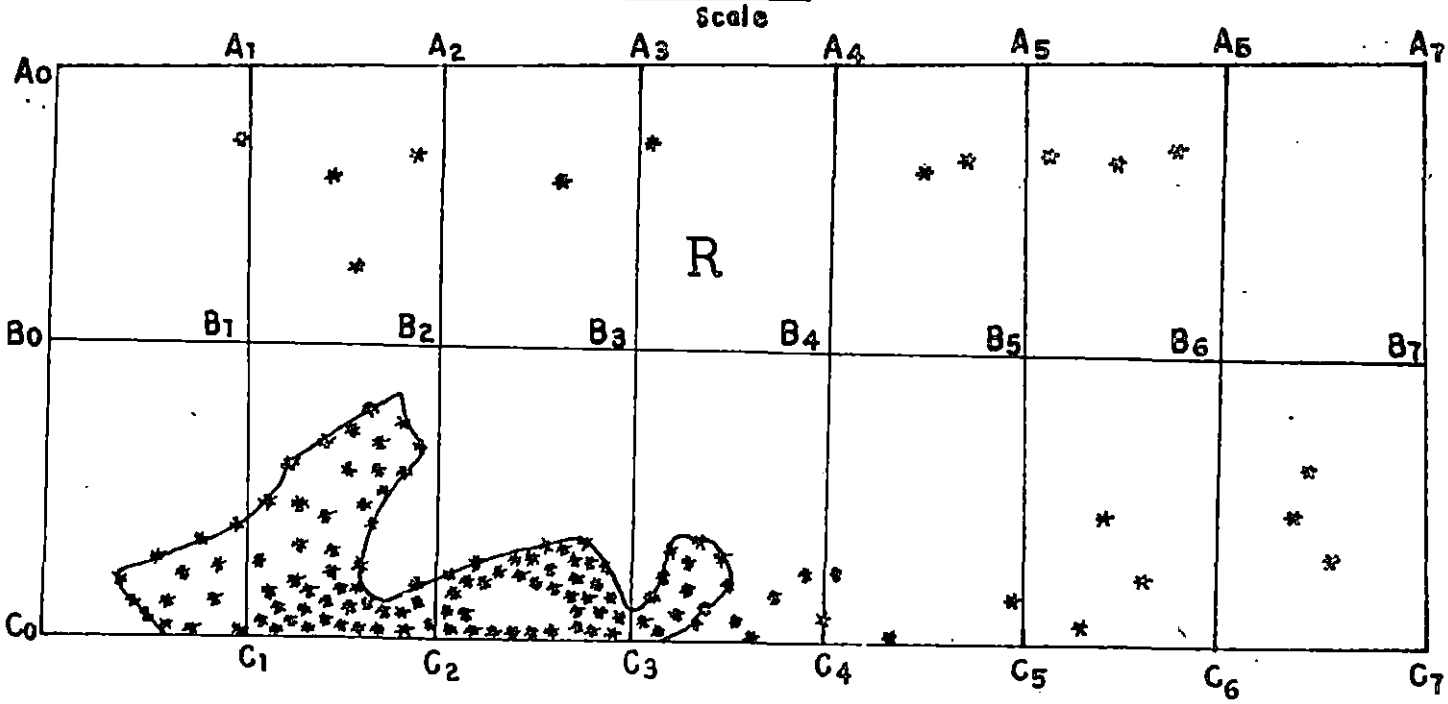


Fig. T5 .

Fig. T6 Showing the position visited and area covered by fish S

Fig. T7 Showing the position visited and area covered by fish T

1 Cm = 12 Cm
Scale

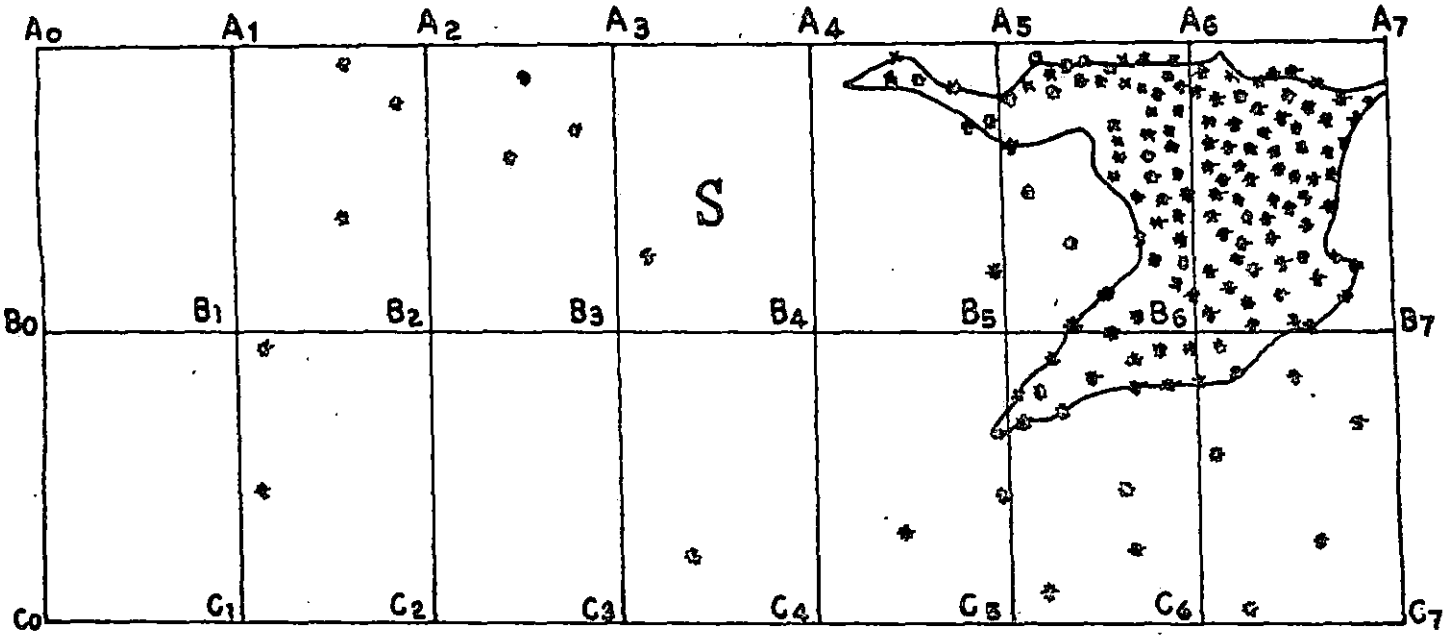


Fig. T6.

1 Cm = 12 Cm
Scale

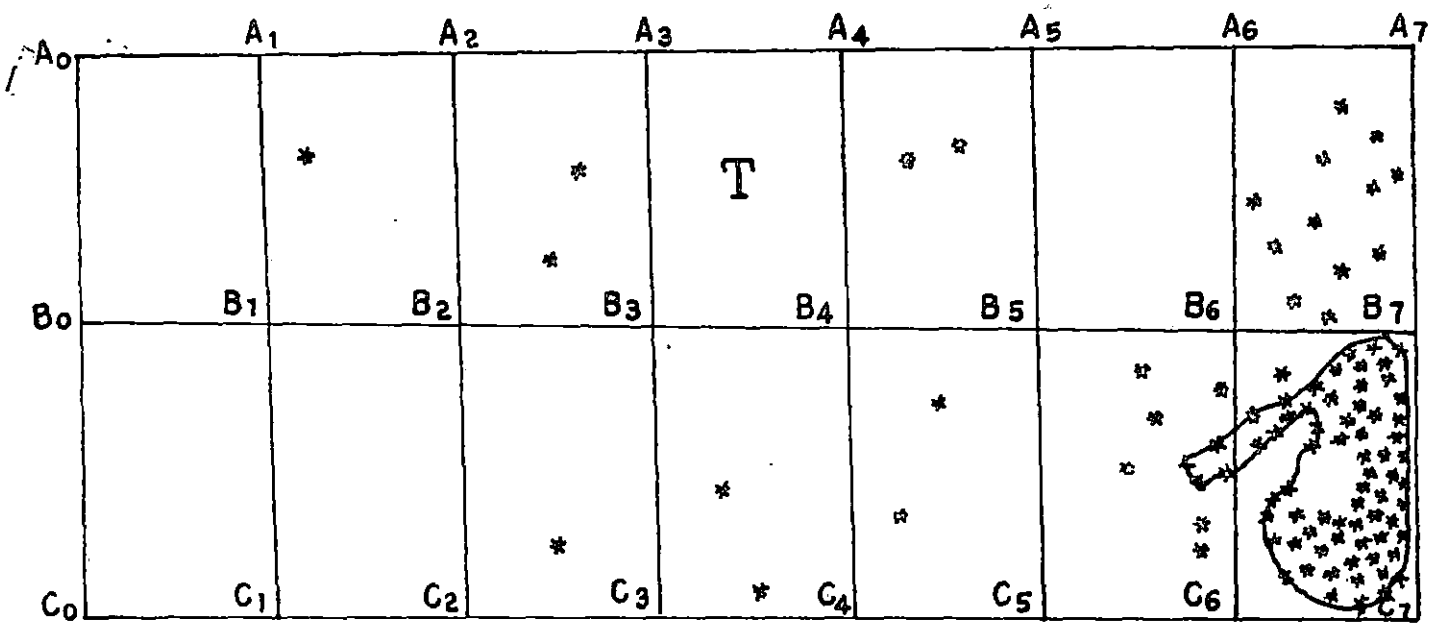


Fig. T7.

Fig. T8 Showing the regression of length and weight on total area covered by fishes P, Q, R, S and T.
Regression equation of area covered and (a) weight, (b) length.

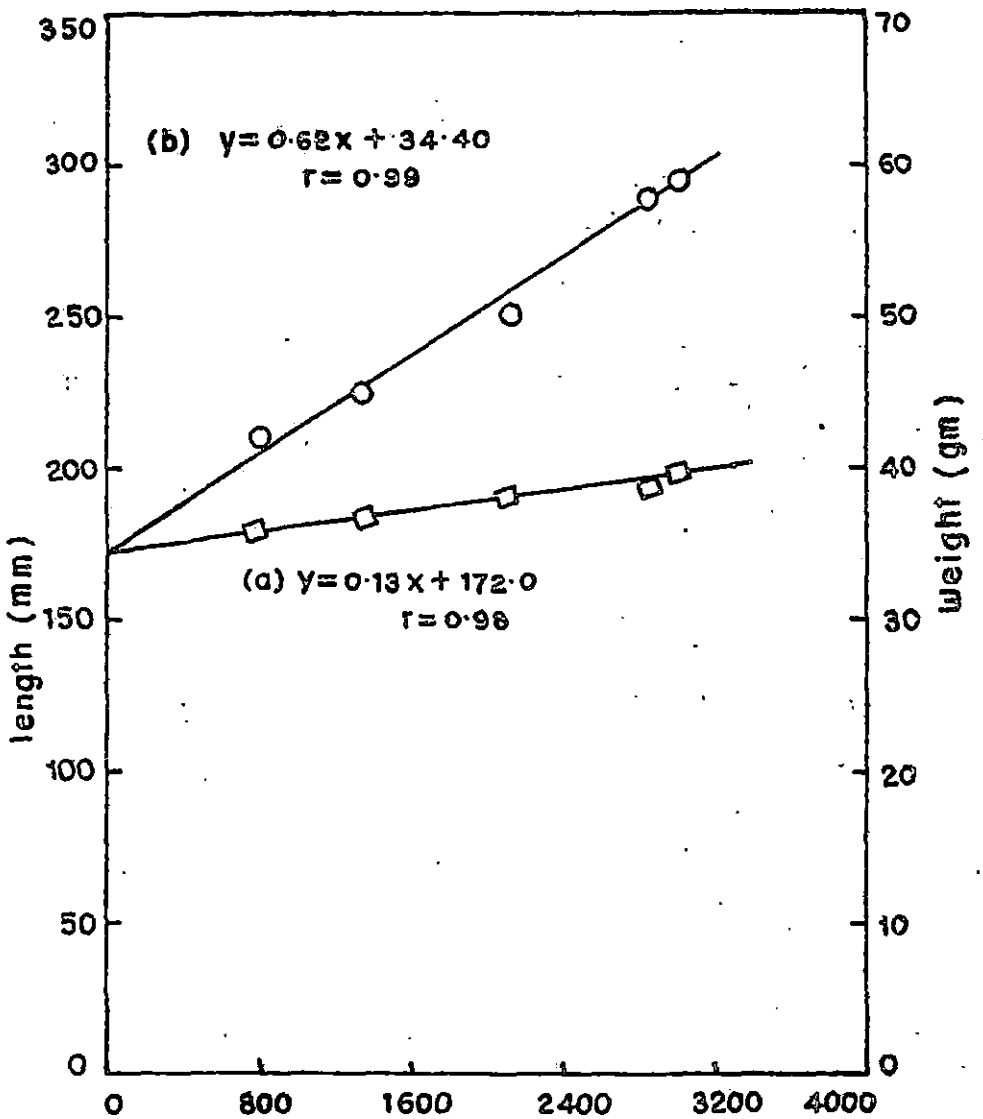

(b) y= 0·62x + 34·40
r= 0·99
(a) y= 0·13x + 172·0
r= 0·98
length (mm)
weight (gm)
350
300
250
200
150
100
50
0
70
60
50
40
30
20
10
0
0
800
1600
2400
3200
4000
Area coverage (cm²)
O — Length , □ — Weight

Fig. T8 .