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POPULATION ESTIMATION OF HORSE-SHOE CRAB *TACHYPLEUS GIGAS* BY CAPTURE-RECAPTURE METHOD AT CHANDIPUR SEA SHORE (ORISSA), INDIA

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ABSTRACT

Population of horse-shoe crab *Tachypleus gigas* (Müller) was estimated at Chandipur sea shore with the help of Jackson's capture-recapture method. Horse-shoe crabs came to breed in high tide zone associated with the full moon tides. The capture marking release data showed that maximum 6,000 animals came to the breeding beach on 9th March. Some sort of sexual selection and dispersal phenomena had also been recognised from this field experiment.

INTRODUCTION

HORSE-SHOE CRABS are very mobile in nature and they prefer a wide range of habitat in the sea ; come to the shore only during the breeding season, mostly with pairs in Indian coastal region (Debnath, 1985). So their population size was measured only by capture-recapture method and it was quite impossible to estimate the population size by quadrate method or by using any other fixed sampling units.

Lincoln (1930) first used the formula to estimate the duck population in North America which is sometimes called as 'Lincoln Index' (Bailey, 1952). The formula is : $N = \frac{a.n}{r}$. Where, N = Total population, n = Total second sample, a = Total no. marked and r = Total recaptures.

Jackson (1933) independently used the same method for estimating the density of Tsetse flies. The present authors used Jackson's 'Negative' and 'Positive' methods (Jackson, 1937, 1939) to estimate the population size of adult horse-shoe crabs that came to breed at Chandipur sea shore (Orissa) from 6th March to 13th march, 1985. However, the idea of capture-recapture method is simple enough, but it is very difficult to attribute a precise variance to the estimates (Andrewartha, 1970).

Population size of North American species *Limulus polyphemus* has been estimated with various capture-recapture techniques (Baptist *et al.*, 1957 ; Sokoloff, 1978 ; Rudole, 1980 ; Botton and Haskin, 1984). But so far no such records on Asian Horse-shoe crabs were established. We used the Jackson's simple method because it easily fits with our field data.

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MATERIAL AND METHODS

Based on fears of tagging loss (Gray, 1964) we used steel needle to mark on the dorso-lateral surface of the hard-carapace. The marks were very distinct like, 7/3-1, 7/3-2,

..... 8/3-40, 8/3-55 etc. A number of horse-shoe crabs *Tachypleus gigas*, those came in pairs, the large female carrying her male partner on her back were captured. A few solitary (lone) males were caught on the beach during low tide. Partners of the same mating couple were marked with similar number. After quick marking operation, the pairs were released mostly at the same spot of capture. Day work continued upto 8 hours in average, while at night average 2 hours spent for the method in the restricted place only. 15 strong pairs were segregated and the males and females were released quite apart from each other. However, these isolated partners bore the same mark.

Quick capture, marking and release were performed for obtaining better result. Special

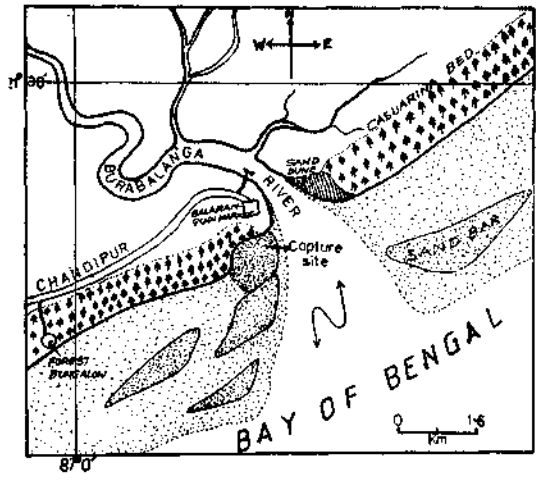

FIG. 1. The capture-recapture site of horse-shoe crabs *T. gigas* at Chandipur sea beach, Balasore (Orissa).

care was taken during marking so that the animals felt minimum disturbance.

The main capture site was on the western front of the Burabalanga River mouth where the wave action was minimum and the standing water was calm having huge populations of gastropods and polychaetes on the muddy bottom (Fig. 1). On and after 15 minutes of optimal tide the crabs came in pair which displayed some sort of fascinating courtship along the water margin.

RESULT

Crude Recaptures : A Trellis diagram is made to place the crude-recaptures (Table 1), in which total 653 individuals of horse-shoe crabs are taken into count. Although 692 individuals were captured, 39 of them had been rejected due either to their moribund condition or physical injury made by the crows *Corvus splendens*, an effective predator. The numbers in each row (horizontal) indicate the numbers of horseshoe crabs (*T. gigas*) marked on the date indicated in the left margin. The vertical columns indicate the numbers recaptured of those that were marked on the dates shown in the left margin.

Corrected Recaptures : In Table 2 each *row* provides the raw material for estimating the size of the population (on the day of release) by Jackson's positive method and each *column* provides the raw data for estimating the size of the population (on the day of recapture) by Jackson's negative method. The values in the body (Table 2) are corrected recaptures which have been calculated by the equation 1.

Population size : The values for 'r' calculated from each *row* and *column* by using equation 2 or 3 (equation 2 for upto 3 entries, while equation 3 for more than 3 entries). Equation 4 is then used to calculate 'a' for each row and column and N (population size) is derived by dividing 10,000 by a_0 (Equation 5). Thus the Table III shows the sum up of the values for r_+, r_-, a_0 and N. The numbers of individuals that came on 7th, 8th and 9th March, respectively were estimated by positive method, while for 10th March it was calculated by negative method.

TABLE 1. *Crude recaptures*

Trellis Diagram

Date marked	Total captured	Total marked and released	Date recaptured						
			7th	8th	9th	10th	11th	12th	13th
March 6th	12	11	1	2	—	—	—	—	—
7th	70	68		4	18	2	—	—	—
8th	193	188			26	12	—	1	—
9th	202	194				2	2	1	—
10th	74	72					1	—	—
11th	63	60						—	1
12th	50	36							—
13th	28	24							
No. Captured	692	11	68	188	194	72	60	36	24
Date captured		6th	7th	8th	9th	10th	11th	12th	13th

TABLE 2. *Corrected recaptures*

Date marked and released	Date recaptured							Posivite Method $N(+)$
	7th	8th	9th	10th	11th	12th	13th	
6th . . .	13,368	9,671	—	—	—	—	—	—
7th . .		3,128	13,644	4,0849	—	—	—	785
8th . .			7,128	8,8652	—	—	—	1,144
9th . .				1,4318	1,718	1,431	—	5,820
10th . .					2,314	—	—	—
11th . .						—	6,944	—
12th . .							—	—
13th . .								—
Negative Method $N(-)$				820				
Date Captured . .	7th	8th	9th	10th	11th	12th	13th	

TABLE 3. *The values for* r_+, r_-, a_0 and N

Date	Positive Method			Negative Method		
	r_+	a_o	N_+	r_-	a_0	N_-
7th ..	1.057	12.7395	785			
8th ..	0.6466	8.7387	1,144			
9th ..	1.00	1.718	5,820			
10th				0.7951	12.2018	820

Equations :

$$y_n = R_n \times \frac{100}{C_m} \times \frac{100}{C_n} \quad \ldots\ldots\ldots (1)$$

$$r_+ = \frac{Y_2 + Y_3 + Y_4 + \ldots Y_n}{Y_1 + Y_2 + Y_3 + \ldots Y_{n-1}} \quad \ldots (2)$$

$$r_+ = \frac{Y_3 + Y_4 + Y_5 + \ldots Y_n}{Y_1 + Y_2 + Y_3 + \ldots Y_{n-2}} \quad \ldots (3)$$

$$a_o = \frac{Y_1 + Y_2 + Y_3 + \ldots Y_{n-1}}{r_+} - (Y_1 + Y_2 + \ldots Y_{n-2} \quad \ldots (4)$$

$$N = \frac{10{,}000}{a_o} \quad \ldots\ldots\ldots\ldots (5)$$

Where,

Y_n = Corrected recaptures.

R_n = No. of recaptures on date n.

C_m = No. of marked on date n.

C_n = Total captured (including recaptures) on date n.

r = The weighted ratio of $\frac{Y_n}{Y_{n1}}$.

a_o = Corrected values for the date of estimation.

DISCUSSION

The breeding horse-shoe crabs (*T. gigas*) at Chandipur (Orissa) showed strong lunar and tidal rhythmicities, with animals appearing at and within a few days of full moon and within 2 hours of the time of high tide. Among several variables only lunar cycle, day of year and wave height correlated significantly with number of crabs on the beach (Rudloe, 1980). A correlation between capture-released animals (total 653) and recaptured animals (total 73) on successive days showed significant negative result ($r = -0.945$, $\rho = 0.01$). Population peaked at 8 to 9th March (Fig. 2). Of 73 recaptures (38 ♂ + 35 ♀), the recovery rate of

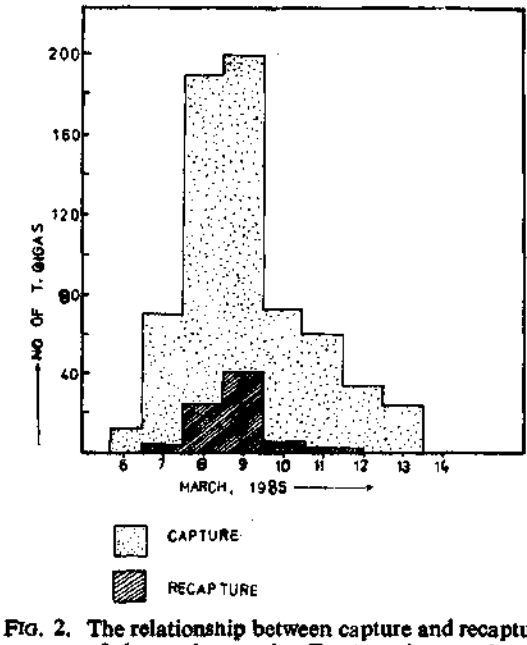

FIG. 2. The relationship between capture and recapture of horse-shoe crabs *T. gigas*, irrespective to their sexes.

males (11.4%) dominates over female (10.93%). This was because the unhurt males, those were alone and partnerless (predatory pressure by *Corvus*), came to the breeding beach again and again to find their chosen females. The capture-recapture data indicates a clear variation of the total number of arriving animals on or near the breeding beach. The maximum numbers occurred at 9th March (5,820 animals). The authors, however, failed to capture horse-shoe crabs on the following new moon tides (15th to 25th March).

One pair of *T. gigas* was recovered from Burabalanga delta, 200 m opposite to the site of release and one from 50 m apart from the site. This findings showed the dispersal habit of the species. Amongst 15 segregated mating pairs, we recovered one pair intact 3 days after the date of release. We confirmed this interesting finding by observing similar marks on carapaces of both the male and the female. The authors can predict from this observation that specific selection between the male and female during breeding occurred. But how they chose themselves and found together and returned to the breeding ground remained a great mystery.

A tagging study of the horse-shoe crab (*Limulus polyphemus*) indicated that males return to breeding beaches more frequently than females and the data reveals a total of 33,300 individuals existing at Mashes sands, Florida (Rudloe, 1980). The horse-shoe crab *Limulus polyphemus*, population was assessed during hydraulic dredge surveys of the surf calm resource in the inshore 5.5 km (3 nautical miles) of the continental shelf off New Jersey (Botton and Haskin, 1984). Off-shore study is, therefore, only can predict the exact population size in the Indian continental shelf.

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