

THE BIOLOGY OF THE CONVICT SURGEONFISH
ACANTHURUS TRIOSTEGUS TRIOSTEGUS (LINNAEUS) FROM
MINICOY ATOLL, LAKSHADWEEP

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ABSTRACT

Acanthurus triostegus triostegus is the commonest acanthurid found in shallow intertidal reef flats of Minicoy Atoll and other Lakshadweep Islands. The species exhibits inward and outward movement on the reef flat along with the tides. It is a typical herbivore and feeds on filamentous and segmented algae commonly found on dead and live coral boulders.

A common formula for both male and female of the species to establish the length-weight relationship is derived as follows: $\text{Log } W = -4.105377 + 2.766371 \text{ Log } L$.

At the end of the first year the species attains a total length of 128 mm and by the end of the second year 167 mm. The ratio of males to females in the population for 1981-82 was 1 : 0.99 and for 1982-83 was 1 : 0.93 indicating a more or less equal proportion.

The total number of matured eggs produced by an individual per spawning varies from 32,022 to 164,013. The size at first maturity at 50% level is 87 mm TL. The species has a protracted breeding season extending almost throughout the year. It may spawn more than once in a breeding season. The settlement of postlarvae occurs in tide pools and the size at first settlement is 25 mm. Dispersal of the postlarvae from tide pools takes place after about two weeks of settlement.

INTRODUCTION

THE CONVICT surgeonfish *Acanthurus triostegus triostegus* (Linnaeus) locally called 'Robulu' is the most common among the twelve species of *Acanthurus* known from the reefs of Minicoy (Jones and Kumaran, 1980). The species is caught for food in most of the Lakshadweep Islands, especially during monsoon when tuna fishery is at a low ebb. The species moves very fast between boulders and hide under them. At high tides they are found in large numbers along with many species of *Abudufduf* on the upper littoral reef flats and return to the lower water marks along with the receding

tide. Works on the biology of *Acanthurus triostegus triostegus* from the Indian Ocean is not known. However, Dawson *et al.* (1955) have reported on the gastro-intestinal contents of this species from Line Islands, in the Pacific Ocean, including 40 species of benthic algae and a number of diatoms. Randall (1961) has given a detailed report on the biology of the related subspecies *A. triostegus sandvicensis* from the Hawaiian Islands. In view of its importance as a food fish in Lakshadweep, a detailed study on the biology of this species was undertaken at Minicoy Atoll during 1981 July to 1983 June, the results of which are presented in this paper.

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MATERIAL AND METHODS

Samples of *A. triostegus triostegus* were collected from both the windward and leeward reefs of Minicoy on weekly or biweekly basis depending on the weather conditions. The free-lying boulders on the reef flats were covered with a cast net and the fishes hiding beneath were driven out by lifting the boulders and samples collected. Most of the samples were collected during the incoming tides when the species invade the upper littoral reef flats. The postlarvae or 'acronuri' were collected with the help of a scoop net from the tide pools. The total length and weight of individuals were recorded in mm and gram respectively. A total of 907 specimens of both the sexes within a length range of 25 to 172 mm was

analysed for this study. For the estimation of ova, part of the ovary was weighed and total count of the ova made with the help of a plankton counting chamber and then estimated for the gross weight of the ovary. For the determination of the progression of ova 200 to 300 ova were measured in each stage of the ovary. For all measurements 85 micrometer division is equal to 1 mm.

FOOD AND FEEDING HABITS

A total of 832 specimens was examined during the period of observation for their gut contents. The species is herbivore. It feeds on filamentous and segmented algae commonly found attached to dead and living coral colonics and boulders. Occasionally small calcareous particles and foraminifers were also found along with the algae. Though the species is a strict herbivore in nature, it was observed that in captivity it may opt for carnivorous items like clam meat and crab meat. The species invade in large numbers at high tide on the upper littoral zones and use it as a forage ground. The average for the two years of the percentage occurrence of stomachs in the various degrees of fullness in different months during 1981 to 1983 is presented in Table 1.

TABLE 1. Percentage occurrence of the stomachs of *Acanthurus triostegus triostegus* in various stages of fullness from July 1981 to June 1983 (Pooled)

Month	No. of specimens examined	Degrees of fullness			
		Empty	$\frac{1}{2}$ full	$\frac{1}{2}$ Full	Full
July	23	26.09	—	73.91	—
August	97	10.31	—	56.71	32.98
September	73	10.96	—	46.58	42.46
October	25	16.00	—	40.00	44.00
November	86	1.16	—	45.35	53.49
December	29	31.03	3.45	41.38	24.14
January	39	15.38	—	56.41	28.21
February	80	12.50	—	51.25	36.25
March	90	7.78	1.11	56.67	34.44
April	121	9.09	—	77.69	13.22
May	120	9.17	10.00	47.50	33.33
June	4	10.00	2.50	35.00	52.50

All samples were collected during day time. Most of the fish is fully fed (Half full and full is taken as fully fed and empty and one-fourth full as empty) during day indicating that the fish feeds actively during the day time. Some of the early morning samples (depending on tide) may account for the empty condition of the stomach. No direct correlation between the feeding activity and breeding activity could be established. The species is known to spawn in deeper waters in the tropical waters (Randall, 1961) and all our samples were collected from the reef flats.

not significant. Therefore, a common formula to establish the length-weight relationship of *A. triostegus triostegus* from Minicoy is given as follows :

$$\text{Log } W = -4.105377 + 2.766371 \text{ Log } L.$$

AGE AND GROWTH

Peterson's method of tracing the length frequency progression of modes was applied. Though, many modal sizes occurred during 1981 to 1983 period, only a few modes could

TABLE 2. Test of identity of regression lines for the length-weight relationship of *Acanthurus triostegus triostegus*

Sex	d.f.	Corrected sums			d.f. $\sum Y^2 - (\sum XY)^2 / \sum X^2$	
		$\sum X^2$	$\sum Y^2$	$\sum XY$		
Male	.. 369	4.2545	36.4365	11.9676	368	2.7725
Female	.. 353	3.7495	30.5175	10.1618	352	2.9772
				Total	720	5.7497
Total	.. 723	8.0123	67.1086	22.1651	722	5.7914
		Difference			2	0.0417

ANOVA

Source of variation	d.f.	S.S.	m.s.	f
Between sexes	2	0.0417	0.02085	
Within sexes	720	5.7914	0.00804	2.5932 §

§ Not significant at 1% level.

LENGTH-WEIGHT RELATIONSHIP

To establish the length-weight relationship of the species, a total of 724 specimens were utilised, of which 370 were males and 354 were females. The above relationship for males and females were established separately as follows.

$$\text{Male Log } W = -4.204232 + 2.8129509 \text{ Log } L$$

$$\text{Female Log } W = -3.9865612 + 2.710175 \text{ Log } L$$

Details of basic statistics and analysis of covariance for males and females are presented in Table 2, which indicated that the differences between regression co-efficient at 1% level is

be traced satisfactorily for a reasonable time to determine the growth. As is inferred from Fig. 1 and 2, modes A, B, C and D yielded reasonable data on growth rate. Mode C with an initial TL of 30 mm attained 140 mm in 16 months, while mode D, starting with 35 mm reached 125 mm in 15 months. Mode A registered a growth of 75 mm in 15 months with an initial TL of 75 mm and mode B reached 145 mm in 10 months starting with 100 mm. Yet another mode E, attained a size of 105 mm with an initial length of 60 mm in 6 months. It is also seen that mode C has an average monthly growth of 11.25 mm during the first

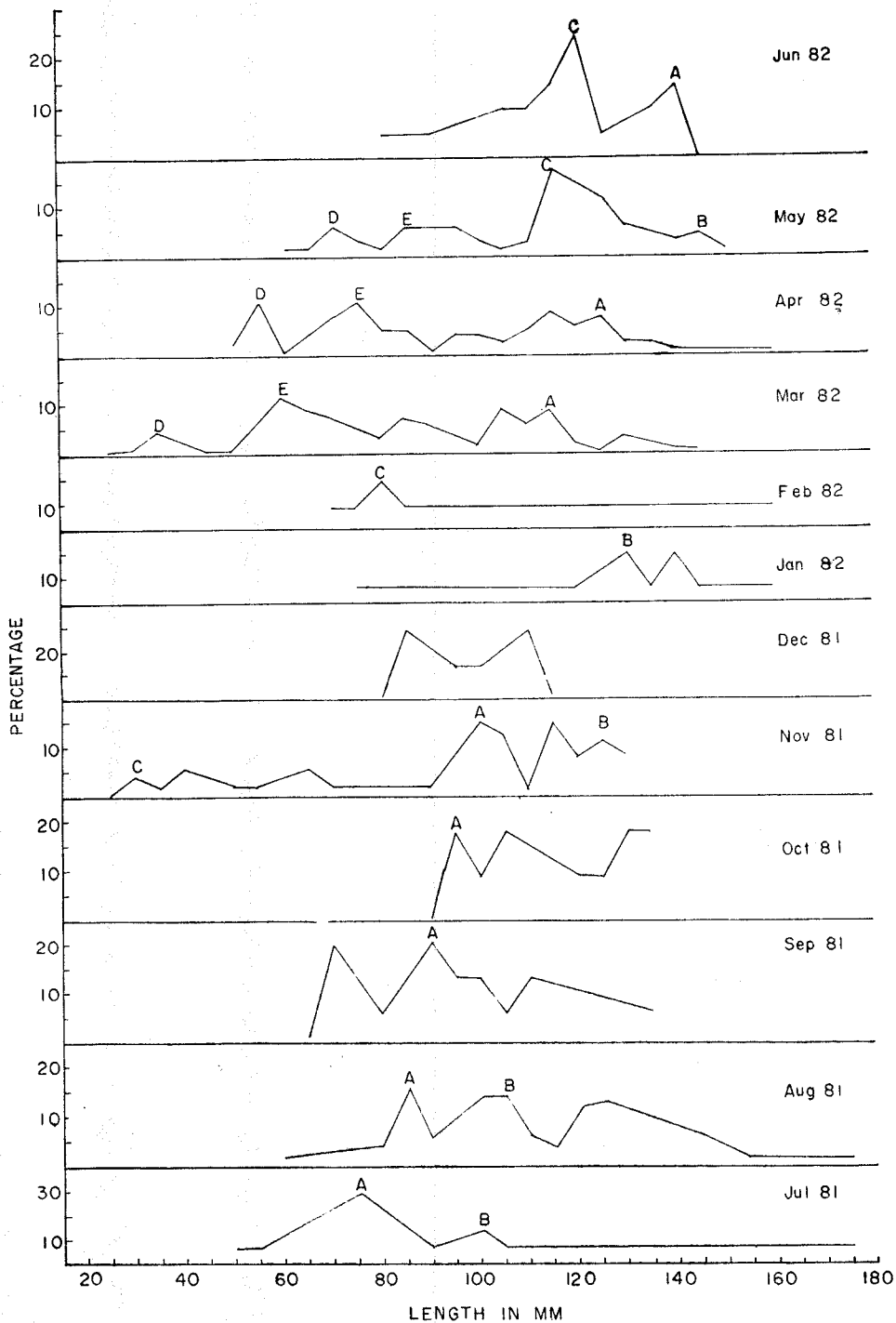


FIG. 1. Length frequency distribution of *Acanthurus triostegus triostegus* from Minicoy Atoll during July 1981 to June 1982.

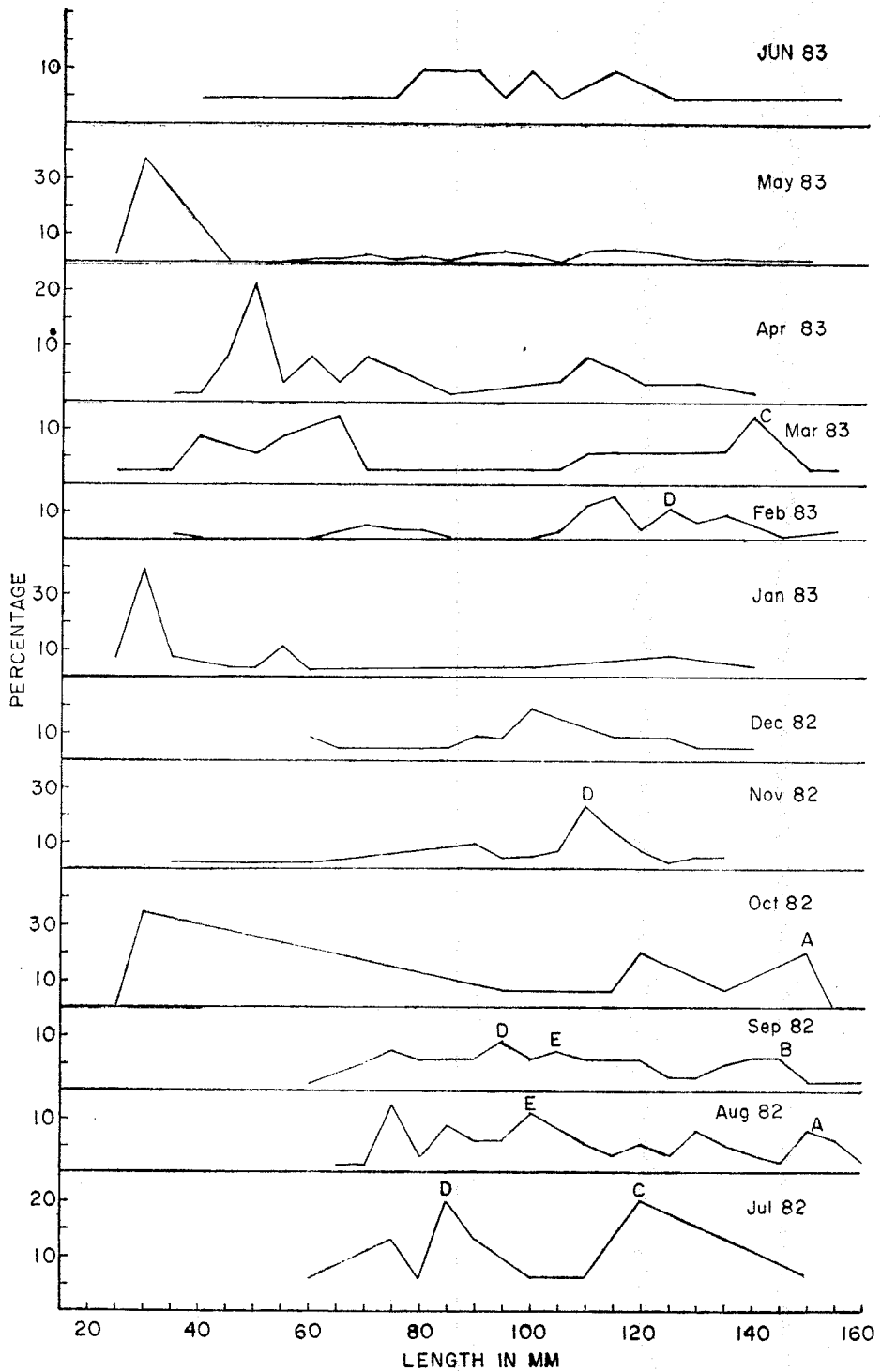


FIG. 2. Length frequency distribution of *Acanthurus triostegus triostegus* from Minicoy Atoll during July 1982 to June 1983.

8 months and mode D has 9.37 mm for the same duration. Both the modes start soon after settlement of the postlarvae. Averages of modes C and D for the first 8 months is 10.31 mm per month. Since the postlarvae at first settlement is about 25 mm in TL with an estimated age of 2 months (Randall, 1961) the annual growth of the species is 128 mm for the first year. The species registers a slower rate of growth after the first year. Mode A progressed from 125 mm to 150 mm in 4 months with an average monthly growth of 4.1 mm and mode B, from 125 mm to 145 mm in 6 months (average monthly growth 3.33 mm) and mode C, grew from 120 mm to 140 mm in 8 months with an average monthly growth of 2.5 mm. Average for modes A, B, and C shows a monthly growth rate of 3.25 mm per month during the second year. A clear retardation of growth from attaining sexual maturity is indicated which further slows down in the second year. From the data it is estimated that, during the second year the fish will increase in size to the tune of 39 mm. Therefore a fish that has completed two years of life should be having a TL of 167 mm. The maximum size recorded from the present samples is 172 mm.

REPRODUCTION

Stages of maturity and ova progression

Gonads are located in the dorso-posterior part of the body cavity. Fully matured ovary is thick, club-shaped, bilobed with subequal lobes. Mature male gonads are slightly compressed. The frequency polygons of ova diameter for the various stages of maturity is given in Fig. 3.

Stage I: Ovary very small and occupies about one-fourth of the length of the body cavity. Eggs are in proliferating stage and range from 1 to 8 md with a mode at 4 md (0.05mm). Testis thin, narrow and white in colour.

Stage II: Includes both immature virgins and spent recovery stages. Ovary occupies about half of the length of the body cavity.

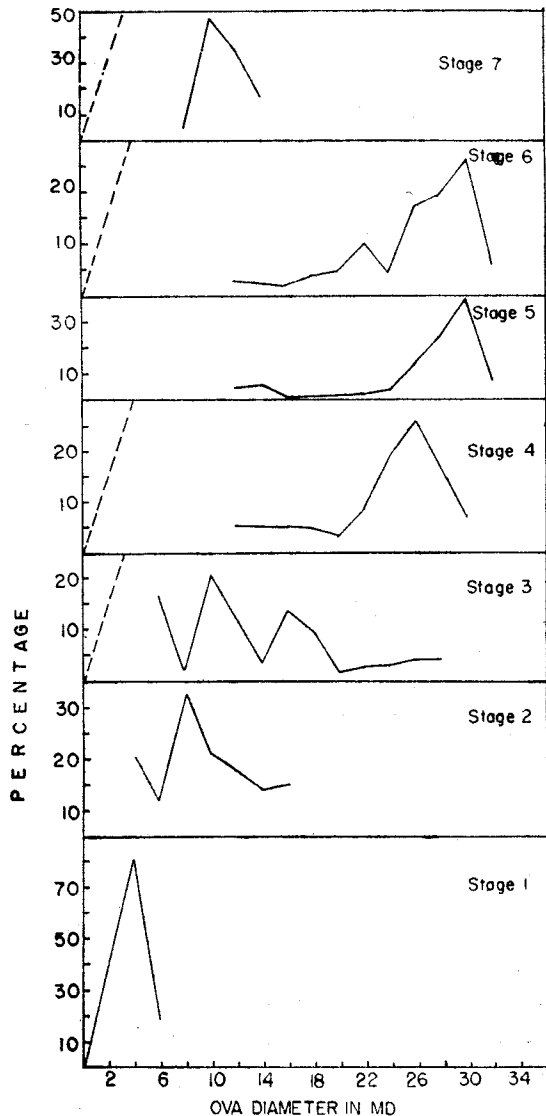


FIG. 3. Ova diameter polygon at different stages of maturity in 4. *triostegus triostegus*.

In the spent and recovery stages a few of the reabsorbing eggs can be detected. A conspicuous mode of ova gets separated from the

proliferating stages with a mode at 8 md (0.09 mm). Testis remains thin and ribbon-shaped.

Stage III (Maturing): Three modes of ova viz. immature, intermediate and maturing are detectable. The largest mode is at 16 md (0.19 mm). Yolk deposition on ova starts. Testis also thicken and extends to half of the length of the body cavity.

Stage IV (Mature): Ovary turns yellow in colour and looks solid. Deposition of yolk on ova increases from previous stage. The larger ova destined to spawn register a fast growth and reach a mode at 26 md (0.31 mm). Testis further thickens and extends to more than half of the body cavity.

Stage V (Ripe): Ovary deep yellow. Occupies about two-thirds of the length of the body cavity. Ripe ova yellow due to deposition of yolk with mode at 30 md (0.35 mm). Testis thick ribbon-shaped.

Stage VI (Spawning): Ovary deep yellow as in stage V. Ovarian wall looks thin and ova visible through them. Most of the ova is free from the follicles. Ova remain the same size as in stage V. Testis a white cream coloured with an oily look.

Stage VII (Spent): Ovary shrunk, with dark spots at the distal part. Ova of the size as in stage II, but a few are at 10 md (0.12 mm). A few deep yellow matured ova are sometimes present which were not spawned out. Testis shrunk.

Sex Ratio: A total of 728 specimens was analysed to determine the ratio of male and female in the population. No significant variation in the percentage occurrence of males and females could be observed in the different months during the period of observation (Table 4). The ratio of males to females during the year 1981 to 1982 is 1:0.99 and for the period 1982 to 1983 is 1:0.93. This indicates a more or less equal proportion for males and females in the natural population for the species.

Size at first maturity

Only females are considered for this study. Stages I and II are treated as immature and stages III to VII are considered to be mature to determine the size at first maturity. The percentage occurrence of various stages as pooled for two years, in different stages of maturity in different size groups (5 mm range) is given in Fig. 4. The minimum stage of III occurred at 65 mm TL and that of the spent stage at 86 mm TL. As indicated in Fig. 4, the size at first maturity at 50% level is 87 mm TL. Above 130 mm all fishes are matured. From the determination of age and growth it is evident that the individual starts spawning when it is 8 to 9 months old.

Fecundity: Fecundity is defined as the total number of eggs produced by an individual in a year and it is possible to ascertain fecundity when the number of eggs produced per spawn and the number of spawning in a year is known. The number of spawning in *A. triostegus triostegus* during the present study was not exactly ascertained and only the total number of ova per ovary in a few individuals was estimated. As presented in Table 5 the total number of matured ova varied from 32,022 to 1,64,013 in different individuals studied. In addition to these there was a set of immature ova ranging from 1170 to 8,840. However, the data presented in Table 5 does not indicate any direct correlation between length or weight of the fish on the total number of eggs produced.

Spawning: As shown in Fig. 3 a dominant mode of ova separates and progress from stage III and gets ready for spawning. Presence of lower modes and immature eggs is an indication that another mode may subsequently reach the spawning stage. The number of spawning that an individual perform in an year is not indicated, though it is likely that the individual will spawn more than once in a breeding season. It is also not clear whether the eggs are shed in batches or in a single

gout. To determine the spawning season a total of 353 females in different stages of maturity in different months were analysed and the data is presented in Table 3.

A high percentage of immature specimens (Stages I and II) is present during August and

Settlement of postlarvae on reefs

The postlarvae of the species get settled at first on tide pools when they are about 25 mm in TL. It was found that the leeward side has a profusion of postlarval settlement than in windward side of Minicoy atoll. Observation on larval settlement was difficult during

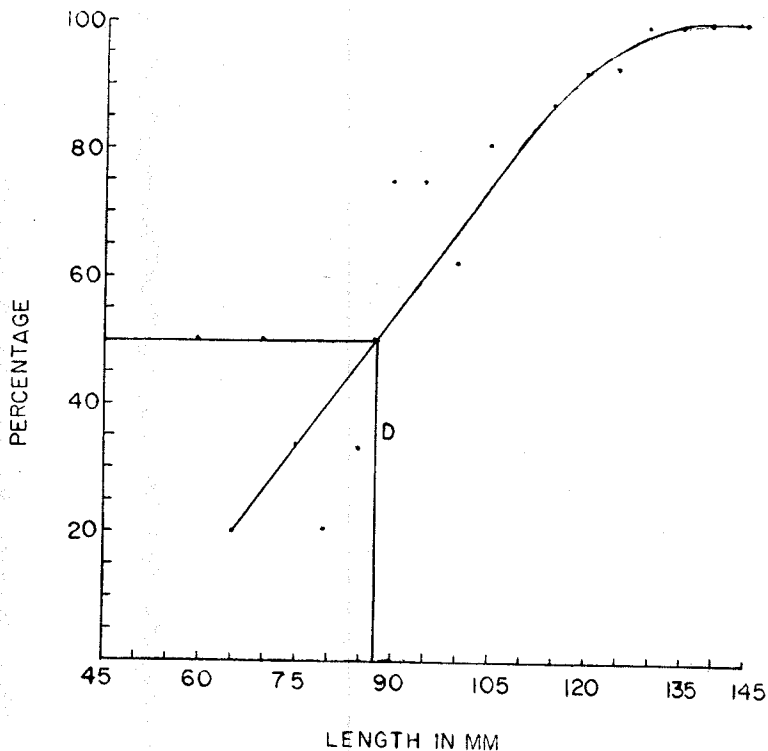


FIG. 4. Length at first sexual maturity at 50% level in *Acanthurus triostegus triostegus* at Minicoy Atoll.

September. Spent fishes are present during July to November indicating active spawning. However, the absence of spent ones during December to March and again in May and June is not an indication of cessation of spawning since stage VI was present in all these months. *A. triostegus triostegus* spawns at Minicoy throughout the year with peak in monsoon periods.

active monsoon due to heavy wave action. However, during December to March settlement of postlarvae in groups on reef flats was observed. The presence of immature specimens in fair numbers in samples during August and September is an indication of new recruits to the population from the postlarvae settled during active monsoon. Wind and water current favour the postlarval settlement from

TABLE 3. Percentages of different stages of maturity of females of *Acanthurus triostegus triostegus* for the various months from July 1981 to June 1983 (Data pooled)

Month	No. of specimens examined	Percentage of maturity stages						
		I	II	III	IV	V	VI	VII
July	6	—	—	83.33	—	—	—	16.67
August	33	6.06	66.67	12.12	—	3.03	6.06	6.06
September	35	—	51.43	14.28	—	17.14	—	5.71
October	12	—	—	25.00	33.33	25.00	8.33	8.33
November	40	2.50	5.00	20.00	10.00	47.50	12.50	2.50
December	12	—	16.67	33.33	8.33	25.00	16.67	—
January	8	—	—	—	—	50.00	50.00	—
February	30	—	16.67	23.33	30.00	26.67	3.33	—
March	38	—	18.42	13.15	13.15	47.37	7.89	—
April	49	12.24	26.53	10.20	14.29	24.49	10.20	2.04
May	74	1.35	9.56	22.97	20.27	25.68	20.27	—
June	19	—	5.26	10.53	10.53	63.16	10.52	—

TABLE 4. Percentage of occurrence of males and females of *Acanthurus triostegus triostegus* in the population from July 1981 to June 1983 at minicoy

Month	No. of fish	1981—1982				1982—1983				
		Male	percentage	female	percentage	No. of fish	Male	Percentage	Female	percentage
July	5	4	80.00	1	20.00	15	10	66.67	5	33.33
August	50	30	60.00	20	40.00	45	32	71.11	13	28.89
September	11	7	63.64	4	36.36	58	27	46.35	31	53.45
October	11	4	36.36	7	63.64	9	4	44.44	5	55.56
November	35	15	42.85	20	57.14	36	16	44.44	20	55.56
December	7	5	71.43	2	28.57	21	11	52.38	10	47.62
January	14	10	71.43	4	28.57	8	4	50.00	4	50.00
February	10	8	80.00	2	20.00	65	37	56.92	28	43.08
March	55	28	50.91	27	49.09	23	12	52.17	11	47.83
April	59	29	49.15	30	50.85	33	14	42.42	19	57.58
May	66	23	34.85	43	65.15	53	22	41.51	31	58.49
June	20	9	45.00	11	55.00	19	11	57.89	8	42.11
Total	343	172	50.15	171	49.85	385	200	51.94	185	48.06

TABLE 5. Estimation of ova in *Acanthurus triostegus triostegus* from Minicoy.

Length of fish (mm)	Weight of fish (gm)	Weight of ovary (mg)	No. of immature ova	No of mature ova	Stage
105	29.5	1460	3439	75930	V
107	34.0	570	1179	34470	V
114	38.5	1122	2316	60269	VI
116	43.0	765	1452	47376	V
128	65.0	730	1834	40960	V
137	60.0	1200	8780	77482	V
138	79.0	1920	7964	95569	V
151	85.0	3315	8840	1,64,013	VI
154	96.5	950	1383	32022	V
155	114.0	2175	8845	81.925	V

pelagic zones during active monsoon at Minicoy (Pillai *et al.*, 1984). Continuous observations on selected tide pools has shown that the dispersal of postlarvae takes place in about two week's time after first settlement.

DISCUSSION

Due to lack of previous work on the biology of this species from tropical warm waters comparison of the present results is not possible. However, a few aspects of the biology of the present species is compared here with that of *A. triostegus sandvicensis* from Hawaii (Randall, 1961). The Hawaiian subspecies is reported to register a monthly growth rate of 12 to 13 mm for the standard length range of 26 to 45 mm during the warmer months of the year. This is in agreement with the early rate of *A. triostegus triostegus* from Minicoy. *A. triostegus sandvicensis* is reported to cease growing during the winter months. No such cessation of growth is evident in warm waters for *A. triostegus*

triostegus and the annual growth of the species is much more than the Hawaiian counterpart.

The present study also indicates that the matured ova of the present species on spawning is much smaller (0.35 mm) than *A. t. sandvicensis* (0.67 mm). The smallest ripe female of *A. triostegus sandvicensis* recorded by Randall (1961) was with a standard length of 101 mm. Since his samples were limited it is not known whether this is the size at which the species reaches maturity at Hawaii. The smallest specimen with stage IV observed at Minicoy has a total length of 85 mm. It is evident that *A. triostegus triostegus* spawns at Minicoy at a lower size range than *A. t. sandvicensis* at Hawaii. Tropical warm waters may accelerate the breeding activities. According to Randall (1961) *A. triostegus triostegus* spawns in small batches in deep waters at tropical areas. The spawning behaviour at Minicoy was not observed since the present sampling area was centred on shallow intertidal reef flats.

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