J. mar. biol. Ass. India, 1985, **27** (1 & 2) : 113-123

ECOLOGY AND BIOLOGY OF THE WHITE-TAILED HUMBUG *DASCYLLUS ARUANUS* (POMACENTRIADE, PISCES) FROM MINICOY ATOLL

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ABSTRACT

The pomacentrid *Dascyllus aruanus* (Linnaeus) lives among the branches of ramose corals throughout the Indo-Pacific along with *Chromis caeruleus*. Though, both the species prefer to be associated with live corals, *D. aruanus* can easily adapt to dead coral colonies when live corals become scarce in nature due to large scale death of corals as is observed at Minicoy. *D. aruanus* is observed to attain a total length of 61 mm at the end of the first year and a total of 97.0 mm by the end of the second year of life. This may be the maximum length the species attains at Minicoy.

The length-weight relationship shows significant difference between the male and female, hence separate formulae has to be used to determine these relationships as follows.

Males .. Log W = —3.676976 + 2.480743 Log L.

Females .. Log W = —4.243749 + 2.807415 Log L.

The sex ratio for the two year periods of observation is Male : Female = 1 : 1.61 and 1 : 1.35 respectively. The size at first maturity at 50% level is estimated to be 38 mm. Fecundity ranged from 2,125 to 7,157eggs in an ovary at a time.

The individual fish spawns more than once in a year. The breeding season almost extent throughout the year with an active period from April to January. The pelagic phase of the larvae seems to last about 2 weeks. The behaviour and biology of the two co-existing species viz. *D. aruanus* and *Chromis caeruleus* display very little difference indicating both species have evolved almost similar adaptations.

INTRODUCTION

THE WHITE-TAILED HUMBUG *Dascyllus aruanus* (Linnaeus) is a small pomacentrid fish that co-exists with the blue puller *Chromis caeruleus* on Indo-Pacific reefs among ramose live corals. Sale (1972, 1980) and Sale *et al.* (1980 ; 1984) have summarised some of the observations on the habitat selection of *D. aruanus* on reefs from the Great Barrier Reef area. Pillai *et al.* (1985) have recently studied the biomass relationship of these two species of fishes with the surface area of the live coral isolates at Minicoy. With a view to examining the similarities and differences in the behaviour and biology, if any, of *C. caeruleus* and *D. aruanus* that co-exist, a concurrent study of their biology was undertaken. The results on *D. aruanus* is presented in this communication. There seems to be no previous study on the biology of this species from any other part of the Indo-Pacific.

The authors express their sincere thanks to M/s. D. Kojan Koya, O. Ismail, N. Pookoya, C. Mohamed Koya and P. I. Koya for the valuable assistance in the field during the collection of samples. Shri K. Sreenath advised on statistical analysis of data and Dr. P. N. Radhakrishnan Nair read through the manuscript

more than once critically and offered valuable suggestions for improvement. Smt. Uma Bhat rendered help in processing field data.

Material and Methods

Samples of *D. aruanus* for the present study was collected from ramose corals inhabiting the lagoon of Minicoy Atoll in Lakshadweep during 1981 July to June 1983. The sampling technique adopted is the same as described by Madan Mohan *et al.* (1986) for *C. caeruleus*. Since *D. aruanus* could not be lured far away from the coral colonies by offering mashed crab meet, most of the specimens was collected from the corals by breaking the coral colony into a scoop net. Total length of fish was recorded in mm and weight in grams. For fecundity studies the entire or part of the ovary was teased out and the counts taken with the help of a plankton counting chamber. For all measurements of ova diameter, 85 micrometer division is equal to 1 mm.

Ecology

D. aruanus is a resident reef fish on ramose corals chiefly on *Acorpora* spp. and *Pocillopora* spp. in Minicoy. A detailed list of common species of these coral genera are already given by Pillai (1971). *Dascyllus* is also found associated with *Porites andrewsi* and *Heliopora caerulea* at Minicoy though rarely found among massive live corals. According to Sale, (1980) the species is invariably found associated with only live ramose corals in Great Barrier Reef area. However, continuous observations in the lagoon of Minicoy has shown that *D. aruanus* can get adapted to dead corals in a short time. Studies during 1981-84 have also shown the presence of all sizes, including newly settled juveniles of 6 to 8 mm T.L. of *D. aruanus* on isolated dead *Acropora* colonies and thickets. However, *C. caeruleus*, was generally confined to the available live corals. It is an indication that, though, *D. aruanus* prefers live corals in nature, it is capable of getting adapted to dead corals when live corals become insufficient due to mass mortality as has happended in Minicoy (Pillai, 1983). This 'I will take almost anything' approach, as in the case of *Pomacentrue wardi* in rubble patches (Sale, *et al.*, 1980) enables this species to survive in a deteriorating environment. It is not fully understood, whether *C. caeruleus* is less successful on dead corals than *D. aruanus*. It is also possible that in a deteriorating environment, when living space become insufficient, interspecific composition drives out the less successful species, though in ideal condition, apparent agressive behaviour is not manifested between members of the co-existing species.

The ready inhabitation of dead ramose corals by *D. aruanus* in the absence of live corals is an example of a high degree of adaptability of some reef fishes to changing conditions in a highly complext ecosystem like coral reefs. It has been shown recently (Pillai *et al.*, 1984) that *Ctenochaetes strigosus* is capable of prolonging its pelagic early life and undergo sexual development, when failed to get settled on reefs due to one or other reason after its normal postlarval pelagic life. The ready accepatnce of any type of animal food by both *D. aruanus* and *C. caeruleus*, in captivity (both are planktivorous in nature) was reported by (Pillai *et al.* 1985). It may be this high degree of adaptability of reef fishes that is the key to their success in the extremely complex reef ecosystems that is often subjected to violent changes.

Biology

Food and feeding habits

The species is diurnal and zoo planktivorous. There is no selective feeding of plankton, and food includes copepods and amphipods. Sometimes filamentous algae and fragments of coralline material are also found which could have entered the stomach along with plankton. The composition of the gut contents is similar

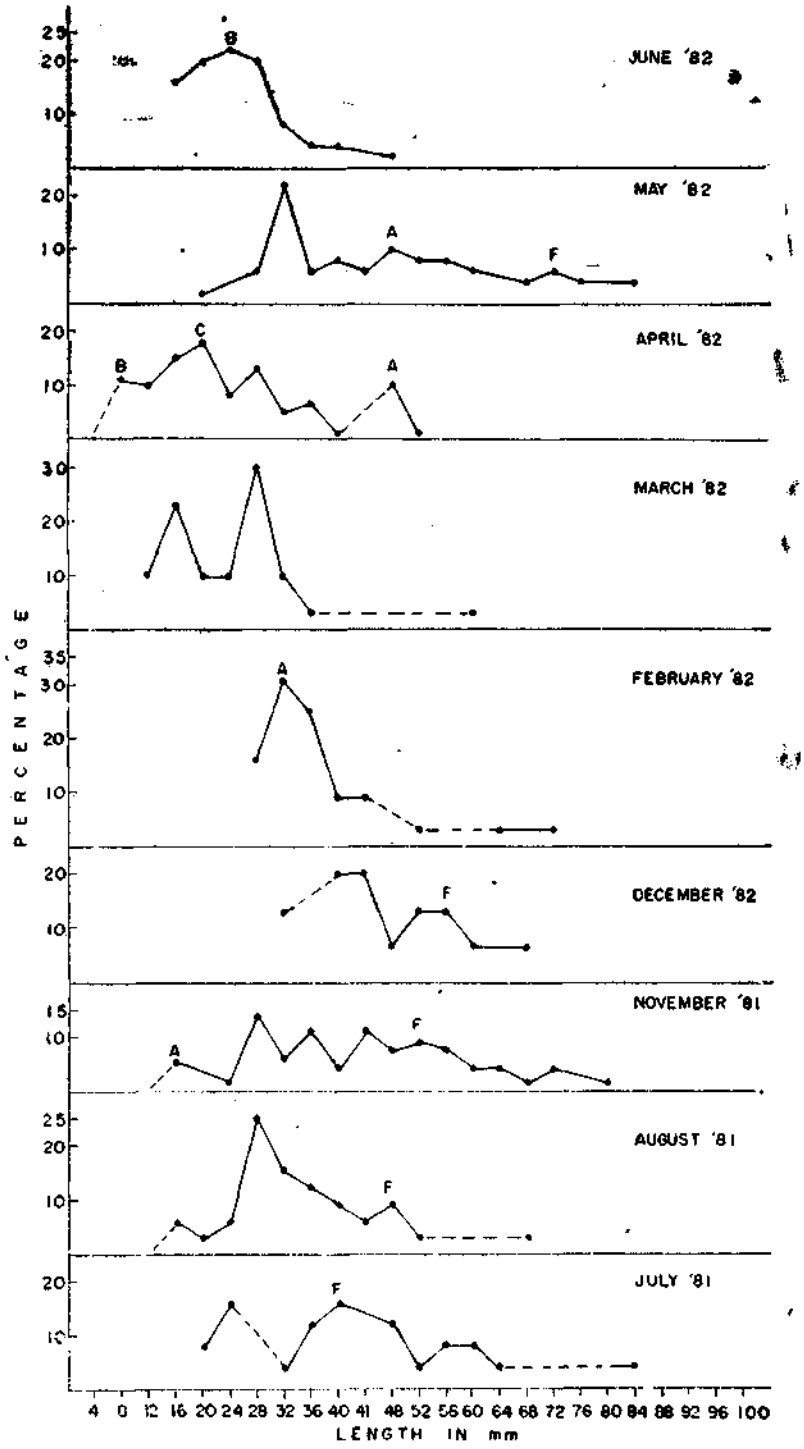

FIG. 1. Length frequency curves of *D. aruanus* during 1981 to 1983 at Minicoy Atoll.

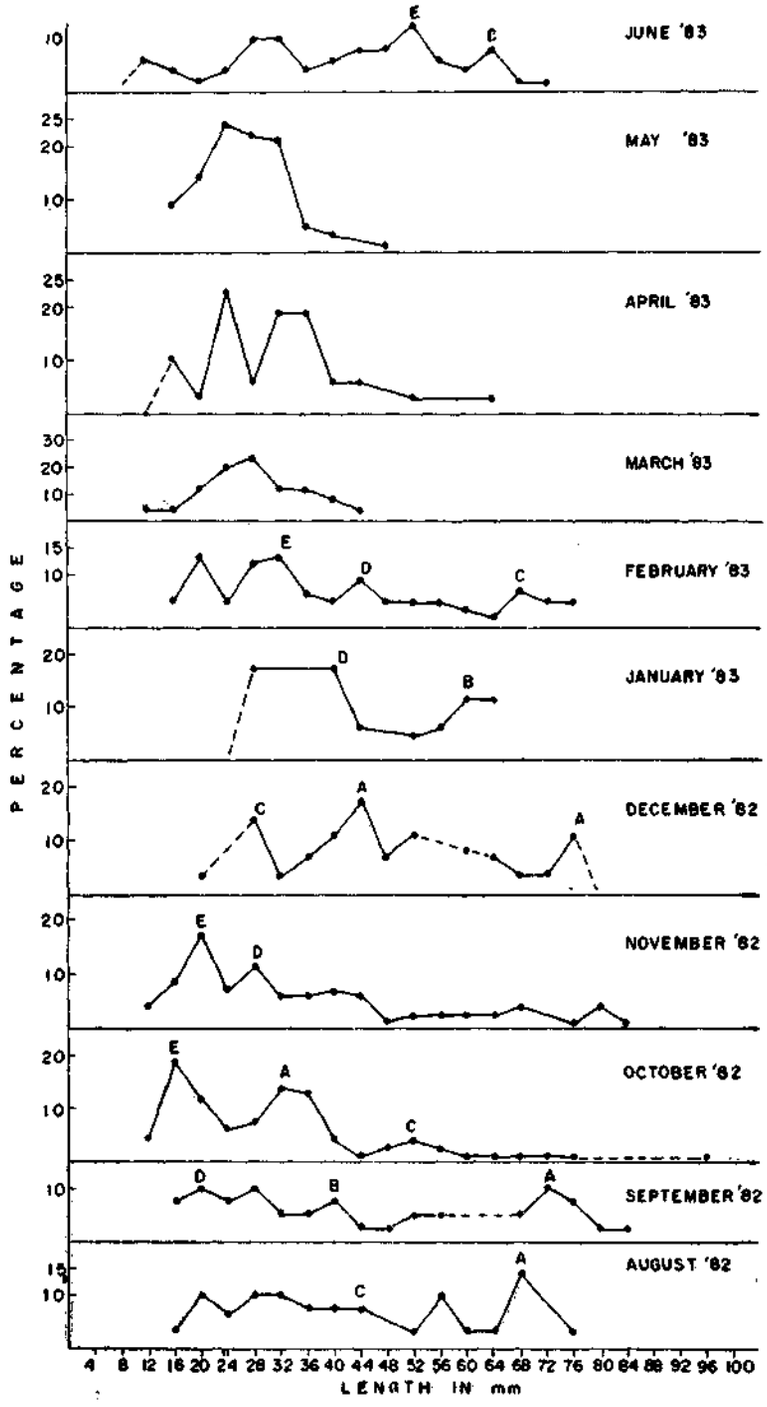

Fig. 2. For explanation, see Fig. 1.

TABLE 1. *Percentage of maturity in* D. aruanus *in different stages. Data for July* 1981 to *June* 1982 *and July* 1982 *June* 1983 *pooled*

Month	Stages I	II	III	IV	V	VI	VII
July ..	—	—	66.64	—	16.67	—	16.67
August ..	—	50.00	50.00				
September ..	8.33	25.00	16.67	—	41.67	8.33	—
October ..	36.36	9.09	—	18.18	9.09	27.27	—
November ..	11.11	27.78	25.00	11.11	—	8.33	16.67
December ..	—	19.23	7.69	11.54	23.08	11.54	26.92
January ..	—	—	11.11	—	33.33	55.55	—
February ..	—	27.59	20.69	24.14	13.79	13.79	—
March ..	6.25	31.25	37.50	25.00	—	—	—
April ..	—	41.67	25.00	8.33	4.17	4.17	16.67
May ..	—	9.09	42.42	24.24	12.12	12.12	—
June ..	3.23	16.13	16.13	12.90	25.81	12.90	12.90

to that already reported by Madan Mohan *et al.* (1986) for *Chromis caeruleus* from Minicoy. Analysis of food contents have revealed that in most fishes stomach contained only digested food in the morning and undigested food in the evening a clear indication of diurnal feeding. During July-August when the lagoon presents turbulant conditions a good many fishes had more or less empty stomach.

Length-Frequency

The population of *D. aruanus* inhabiting a coral colony is of different sizes mainly due to continual recruitment of postlarvae (Pillai *et al.*, 1985). The size frequency presented here is based on 801 specimens collected during July 1981 to June 1983. The total length ranged from 6 mm to 95 mm. The percentage frequency in the various size groups are presented in Fig. 1 and 2.

AGE AND GROWTH

The progression of different modes is presented in Fig. 3. It is evident from tracing mode B alone that the fish after hatching and settlement will reach a total length of 8 mm in the first month. The average monthly rate of growth of all the modes taken together is estimated by applying the methods given by Thomas (1969). This indicates a value of 5.08 mm per month and the fish is estimated to reach a T.L. of 61 mm by the end of the first year. During the second year the fish adds 15 mm during the first five months with an average monthly growth of 3 mm. At this rate by the end of the second year the fish will attain a total length of 61 + 36 = 97 mm.

Length-Weight relationship

The estimation of length-weight relationship of the species is based on a total of 160 males (length range 26 to 95 mm) and 210 females (Length range 27 to 82 mm). The length weight relationship for males and females is as follows :

Male : $\log W = -3.676976 + 2.480743 \log L$.

Female : $\log W = -4.243749 + 2.807415 \log L$.

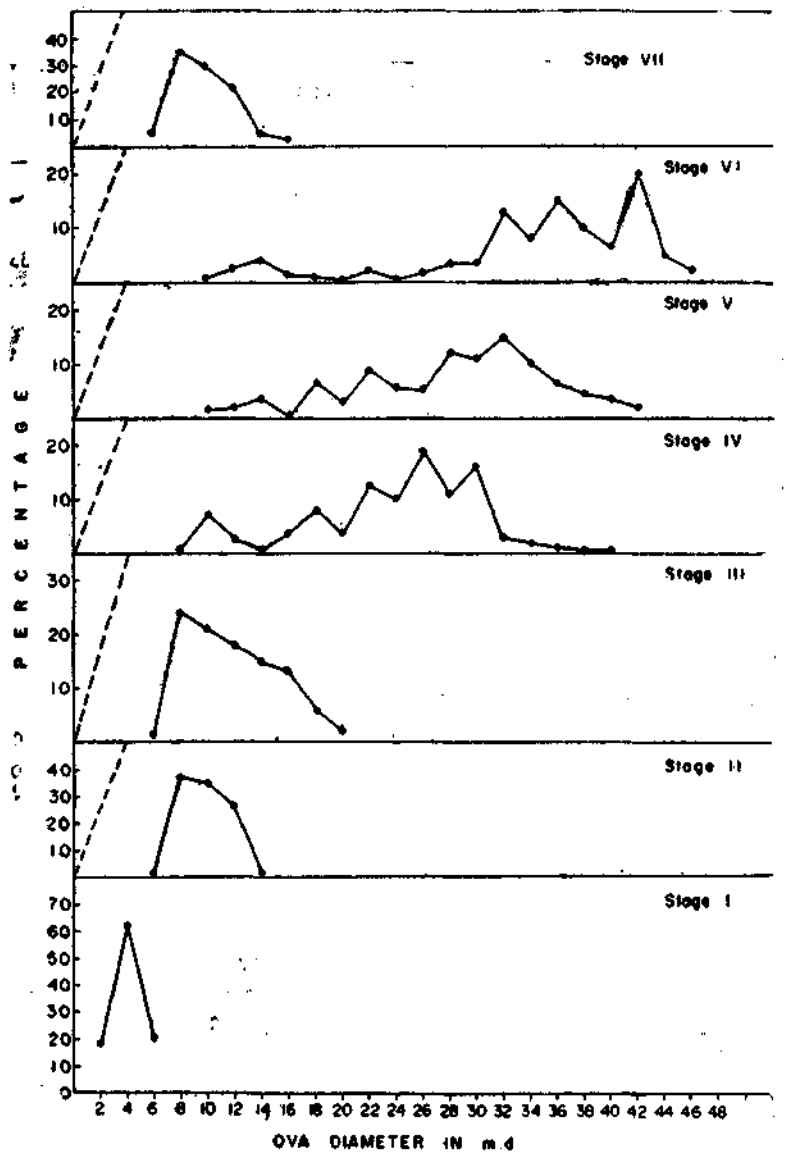

FIG. 3. Progression of length frequency modes in *D. aruanus*.

The significance of difference between the regression coefficients for males and females was tested by analysis of covariance and was found to be significant at 5% level. Therefore, a single equation to express the length-weight relationship in *D. aruanus* is not justified. Separate formulae as above have to be used for males and females.

Sex ratio

The percentage ratio of males and females during the two years of observation are given

separately in Table 3. During 1981-82 period the ratio of male to female is 1 : 1.61 and for 1982 to 83 the ratio of M : F = 1 : 1.35.

TABLE 2. *Percentage of mature and immature fishes in the natural population of* D. aruanus *from Minicoy for various months. Pooled data for July* 1981—*June* 1982 *and July* 1982—*June* 1983 presented

Month	Immature	Mature
July ..	—	100
August ..	50.00	50.00
September ..	33.33	66.67
October ..	45.45	55.55
November ..	38.89	61.11
December ..	26.92	73.08
January ..	—	100
February ..	27.59	72.41
March ..	37.50	62.50
April ..	41.67	58.34
May ..	9.09	90.91
June ..	19.36	80.64

TABLE 3. *Percentage occurrence of Males and Females in* D. aruans *in Minicoy during July* 1981 *to June* 1983

Month	1981-'82 Male	1981-'82 Female	1982-'83 Male	1982-'83 Female
July ..	45.45	55.55	—	—
August ..	100.00	—	86.67	13.33
September ..	—	—	53.85	46.15
October ..	—	—	66.67	33.33
November ..	46.34	53.66	48.15	51.85
December ..	15.38	84.62	34.78	65.22
January ..	—	—	40.00	60.00
February ..	50.00	50.00	26.09	73.91
March ..	45.45	54.55	33.33	66.67
April ..	12.50	87.50	44.44	55.56
May ..	35.48	64.52	27.78	72.22
June ..	20.00	80.00	12.90	87.10

REPRODUCTION

Classification of maturity stages

Based on visual and microscopic examination, the various stages of the developing gonads are given as follows :

Stage I: Ovary bilobed, transparent and occupies one-fourth of the body cavity. Ova elongated or oval, range from 1 to 6 md with a mode at 4 md. Ova of this size is also seen in all stages of the ovary indicating continuous proliferation. Testis small and slender occupying one-fourth of the body cavity.

Stage II: The ovary shows signs of secondary lobes on the main lobes. The distal portion of the ovary starts expanding. Ova range from 1 to 14 md (0.16 mm) with a mode at 8 md. Testis also enlarges extending to one-third of the body cavity.

Stage III: Secondary lobes widen at the distal part of the ovary. Ova with signs of yolk. The ovary slowly starts to darken. Ova with three modes, at 4, 8 and 16 md. Larger ones 20 to 22 md. (0.23 to 0.25 mm) Testis thickens and becomes ribbon-shaped.

Stage IV: Ovary becomes yellow with scattered dark spots allover. Mature ova range from 20 to 40 md with mode at 30 md. Testis becomes creamey white and extend to half the body cavity.

Stage V: Ovary extends to two-thirds of the body cavity. Ovarian wall transluscent. Blood vessels conspicuous. Ripe ova 26 to 42 md with a mode at 32 md (0.37 mm). Testis similar to stage IV but becomes thicker.

Stage VI: Ova slightly more advanced than in stage V with a mode at 42 md. Ovary starts spawning. Testis thick and ribbon shapped as in stage V.

Stage VII: Ovary shrunk and equal to the stage of II. A few ovaries may contain some

ripe large ova left out. The developing ova at this stage is 6 to 16 md. with mode at 8 md. A large number of minute ova are also seen.

Development of Ova to Maturity

Frequency polygons of ova in different stages of the ovary are presented in Fig. 4. In the first stage of development only small ova with a mode at 4 md are seen which advance to a mode of 8 md in Stage II. In the IIIrd stage of ovary two modes are in progression indicating that more than one mode of ova may develop to maturity in quick succession. As the Fourth stage is reached the larger progressing ova enlarge at a faster rate and attain a mode of 30 md and also get deposition of yolk. In the Stage V ova do not increase much in size from Stage IV but there is more deposition of yolk and the ova look more yellowish. By the VIth stage when spawning takes place the ova increase suddenly to a mode of 42 md and get freed from the ovarian follicle.

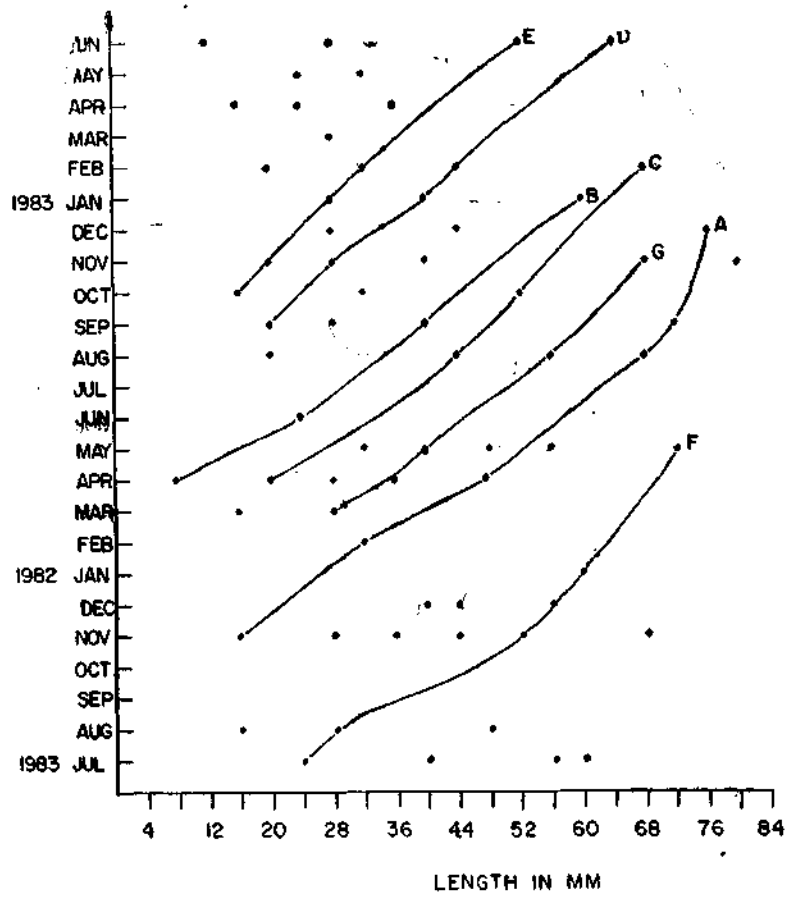

Fig. 4. Ova diameter polygons at different stages of maturity in *D. aruanus*.

Fecundity

Ovaries of stage V and VI were teased and mature ova were counted. The details are presented in Table 4. As is inferred from the Table a relatively larger number of ova per gram weight of the body of the fish is present in stage V than in Stage VI. This is due to

partial shedding of the ova from the ovary at stage VI. This also may indicate that the individual fish spawn in batches.

The fecundity ranged from 2125 to 7,157. But in Table 2, nos 5 and 6 represents only part of the ova and this might have been due to partial loss since the ovary is in stage VI.

Size at first maturity

The percentage of mature fishes (Stages III onwards) at a length frequency of 2 mm size range interval is indicated in Fig. 5. Mature fish (Stages III and IV) started appearing at 30 mm TL and all the fishes at 51 mm TL were mature. However, as indicated in Fig. 5

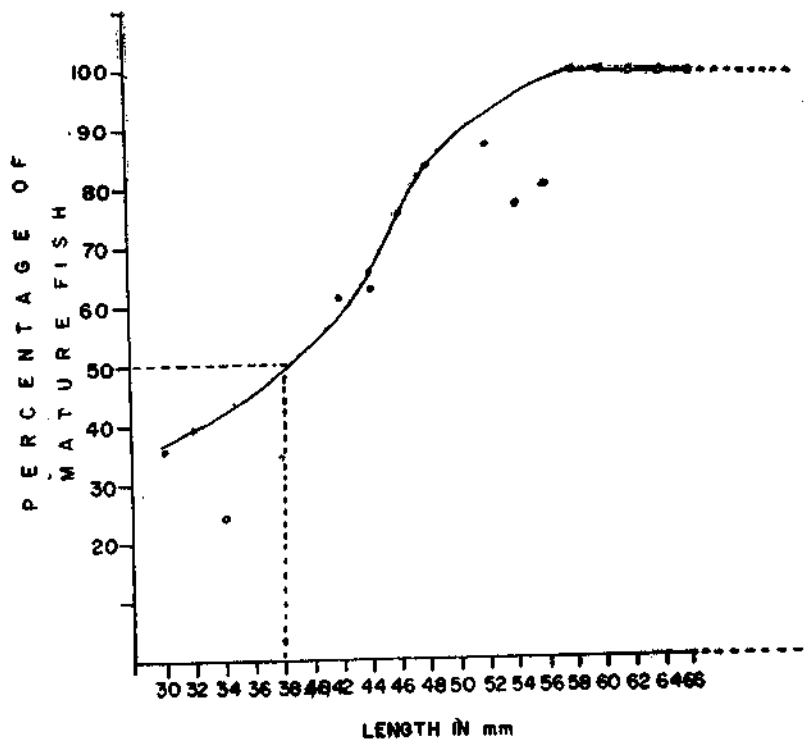

FIG. 5. Length at first sexual maturity at 50% level of *D. aruanus*.

TABLE 4. *Fecundity estimates of* D. aruanus *from Minicoy Atoll*

Length of fish mm	Weight of fish in gm.	Weight of Ovary mgm.	Total Ova (matured)	Ova/gm weight fish	Stage
42 ..	2.5	140	5218	2087	V
52 ..	4.00	120	5266	1316	V
52 ..	4.50	322	7157	1590	V
53 ..	5.00	68	2125	425	VI
58 ..	6.00	107	3512	585	VI

the length at first maturity at 50% level is 38 mm TL.

Spawning

As is inferred from the data presented in Fig. 4 more than one mode of ova is simultaneously progressing in the ovary. This indicates that the individual fish will spawn more than once in a year. Based on a study of 798 specimens (Females only) the percentage of gonads in different stages of maturity in various months as well as the total percentage of immature (Stages I and II) and mature ovaries are indicated in table 1 and 2. The indeterminate and juveniles that were present in all the months are not listed. Matured fishes exceed 50% in all the months and spent ovaries were recorded from April to November but stage VI of the ovary was present during December to February. The absence of spent fishes in the samples during August and September need not reflect any lack of spawning. This indicate that the species breeds in Minicoy all around the year but the peak period is April to January for about 10 months.

Settlement of larvae on corals is recorded in all the months indicating spawning and larval recruitment. However there seems to be a relatively high rate of settlement soon after the monsoon from December to April at Minicoy.

Comparison of the Behavioural and Biological Aspects of *C. Caeruleus* and *D. Aruanus* from Minicoy Atoll

A comparison of the behavioural and biological aspects of *C. caeruleus* and *D. aruanus* that co-exist on the same microhabitat without niche partitioning (Pillai *et al.*, 1985) is of scientific interest. As listed below, it is apparent that these two species show more or less similar adaptations that should have evolved parallel.

Function	*C. caeruleus*	*D. aruanus*
Habitat	Live-ramose coral	Normally live-ramose corals But can adapt easily to dead corals.
Population	Of many size ranges by continual recruitment	Of many size ranges. By continual recruitment.
Movement	Fast, sometimes darting	Slow steady swimming.
Activity	Diurnal	Diurnal
Longivity	2 to 3 years	2 to 3 years.
Maximum size	113 mm	More or less as in *C. caeruleus*.
Growth rate	5 mm or so per month during the first year 2.5 per month during the second year.	5.08 mm per month for in first year 3 mm in second year.
Fecundity	About 8000	About 7,000.
Breeding	Throughout the year individual spawns more than once in a year. Eggs shed in batches.	Throughout the yearspawns more than once in a year. Eggs may be shed in batches.
Larvae	Planktonic. Pelagic phase lasts about 2 weeks	Planktonic. Pelagic phase two weeks possibly.
Size at first settlement on corals	6 to 7 mm.	6 mm.
Size at first maturity at 50% level	38 mm.	38 mm.
Sex ratio	Female dominant.	Female dominant.
Food	Zooplankton.	Zooplankton.
Reaction	Agonistic.	Agonistic.

Note :—Data for *C. caeruleus* is based on Madan Mohan and *et al.* (1986).

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