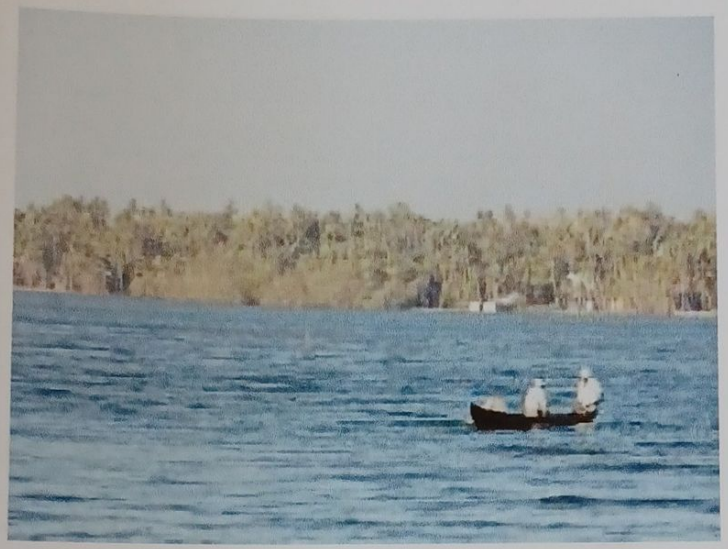

BIOLOGY OF THE SPOTTED CATFISH, *Arius maculatus* (Thunberg, 1972) FROM THE ASHTAMUDI LAKE

Dissertation submitted to the University of Kerala in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF SCIENCE

IN

ZOOLOGY

Submitted by

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DEPARTMENT OF ZOOLOGY
TKM COLLEGE OF ARTS AND SCIENCE
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CERTIFICATE

This is to certify that the dissertation entitled "Biology of Spotted catfish, *Arius maculatus*(Thunberg,1972) from the Ashtamudy Lake" is an authentic record of the work done by.....
under my supervision as partial fulfillment of the requirements for the Degree of ***Bachelor of Science*** in **Zoology** and this report has not been submitted earlier for the award of any degree or diploma or any other similar titles anywhere.

ROHINI KRISHNA M V
(*Supervisor*)
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Certified bona fide:

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EXAMINERS:

1.

2.

DECLARATION

I do hereby declare that this dissertation "Biology of spotted catfish, *Arius maculatus* (Thunberg,1972) from the Ashtamudy Lake"' is a bona fide report of the project work carried out by me, under the supervision and guidance of Rohini Krishna M V, Asst. Professor, Department of Zoology, TKM College of Arts and Science, Kollam as partial fulfillment of the requirements for the award of the Degree of *Bachelor of Science* in Zoology.

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Gokul M S

Sruthy S

Karicode

30.03.2017

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Bijitha B Raj
Sandhya MS
Sasath R
Athira SR
Bismiya AR
Gokul MS
Sruthy S

CONTENTS

INTRODUCTION

Ashtamudi Lake, which flows through Kollam district of Kerala, is one of the largest and deepest wetland ecosystems. Ashtamudi Wetland was included in the list of wetlands of international importance, as defined by the Ramsar Convention for the conservation and sustainable utilisation of wetlands. The lake is the source of livelihood for the people living close to it and they use it for fishing, coconut husk retting for coir production and inland navigation services.

Ashtamudy lake is endowed with a variety of ichthyofauna. 97 species of fish (42 are typically marine, 3 estuarine, 9 estuarine-riverine, 15 marine-estuarine. It is also a congenial habitat for species of Penaeid and Palaemonid Prawns, edible crabs and *Paphia malabarica* (Short neck Clam).The lake contains a variety of food fishes such as *Etroplus surantensis* (Pearl spot cichild), *Channa striata* (Snakehead murrel), *Anabas testudineus* (Climbing perch), *Awaous grammepomus* (Scribbled goby), *Oreochromis mossambicus* (Tilapia), *Brachiurus orientalis* (Oriental sole), *Stolephorus indicus* (Indian anchovy), *Arius maculates* (Spotted catfish), *Gerres abbrevatius* (Short silver belly), *Pseudoetroplus maculates* (Orange chromid) *Scathophagus argus* (Spotted scat), *Parambassis thomassi* (Western Ghat glassy perchlet), *Hyporhamphus xanthopternus* (Red tipped half-beak), *Heteropneustes fossilis* (Asian stinging catfish), *Anguilla bicolar* (Short fineel), *Chanos chanos* (Milk fish), *Dayella malabarica* (Day's herring fish), *Caranx ignobilis* (Giant trevally), *Terapon jarbua* (Target fish), *Mugil cephalus* (Flat head grey mullet), *Clarias batrachus* (Walking cat fish), *Megalops cyprinoides* (Bony mullet), *Ephinephlus malabaricus* (Malabar group), *Mystus gulio* (Long whiskers catfish), *Siganus javus* (Streaked spine foot) and *Nematalos anasus* (Bloch's gizzard shad).

Clams found in the estuary are exported. The estuary is the source of livelihood for thousands of fishermen and is stated to be the second biggest after the Vembanad estuary. The lake has many branches such as Kandachira, Kureepuzha, Thekumbhagam, Kallada, Perumon, Vellimon and Chavara.

Perumon sector is an important part of Ashtamudi estuary and much studies haven't been conducted here. During a preliminary investigation conducted at the landing centre, it was understood that *Arius maculatus* dominated the catch this was one of the reasons for selecting *Arius maculatus* for study.

The present study focuses on the biology of catfish *Arius maculates*, with an emphasis on reproductive biology and food and feeding. *A. maculatus* is also known as the spotted catfish, the sea barbel. *Arius is* a genus of catfish belonging to Order Siluriformes of the family Ariidae. Order Siluriformes are mostly freshwater fishes but two families of Catfishes are found in marine habitats. Of this, the Family Aridae are distributed in marine and brackish waters (Moyle & CechJr, 2004). The Genus Arius shows wide distribution in the Ashtamudy Lake. Vimal Raj *et al*., (2014) recorded the presence of *Arius maculatus* and *A. subrostrus* from Ashtamudy Lake. Studies conducted by Raghunathan (2007) recorded the presence of *Arius maculatus*, *A. thalassimus*, *A. subrostratus*, and *A. dussumieri* from the Lake.

Arius species have three pairs of barbels, including the fleshy and cylindrical maxillary barbels and two pairs of mental barbels. The base of the adipose fin is moderately long, about half the length of the base of the anal fin. The eggs are incubated in the mouth of the male. The fish is of commercial interest to fisheries. It is primarily marketed fresh. *Arius maculatus* or other catfish species that are commonly found in the mangrove waters are benthic feeders. They can locate

their prey efficiently in the muddy waters through their well-developed sense of smell and vision. The presence of maxillary barbels serves as an important sensory organ in search for embedded prey in the muddy sediment of the mangrove area.

Arius maculatus is dioecious. The mature female and male gonads develop in separate individuals and fertilisation of the gametes take place externally. *Arius maculatus* is a common mouth brooding fish. Mouth brooding, also known as oral incubation or buccal incubation, is the care given by some groups of animals to their offspring by holding them in the mouth of the parent for extended periods of time. Mouth brooding has evolved independently in several different families of fish. In the case of *Arius maculatus*, the ova are large and yolky or small and non-yolky, this non-functional ova are also extruded at the time of spawning. After retaining the large functional ova in the mouth, the non-functional ova are probably eaten by the male parent to maintain basal metabolism.

Efficiency in fertilisation and transfer of eggs was brought about by enlarged pelvic fins of the female. The oral cavity of the incubating male gets enlarged to receive a large number of eggs and the oral epithelium secretes large quantity of mucus for the safe carrying of eggs or embryos in the mouth. Early hatching embryos commence feeding on inhaled particles when still in possession of large yolk. The hatchlings develop into fingerlings which normally swim in small schooling in the shallow coastal waters and mangrove creeks.

Catfish are a good source of various minerals. This catfish are edible and have a significant role in the trade industry particularly in the aquarium industry. Many catfishes are well known to produce sounds.

Research has been conducted regarding the reproductive biology of food fishes. Even though Arius is an important species of food fish studies on the reproductive biology of Arius is very sparse. Studies on the reproductive status of food fishes are very essential. Different aspects of reproductive biology studied may include spawning season and fecundity. Studies on this aspects require prior knowledge of the stage of gonad development. The most common method of studying the Gonadal development is through visual observation of the Gonads which can be accomplished easily in fishes such as Arius due to the large size of testis, ovaries and ova which can be observed macroscopically. This technique can easily be accomplished but for detailed study histological investigation of Gonads are essential (West 1990).

Investigations on the ovarian cycle and fecundity of fishes were made by Fischer *et al* .,(1970).Gracia and Lozano (1980) conducted studies on the food and feeding of *A.platypogon* in the coastal lagoon systems of Mexico.Victor *et al.,* (2000) also studied the trophic biology contributions of the slender catfish, *A.platypogon* in Saga Ignacio Lagoon, Baja California, Mexico. The reproductive biology of Loricariid catfishes has been studied in their native habitats using analytical tools as the gonadosomatic index (GSI) and the maturation patterns of ovaries and oocytes (Duarte and Araújo 2002; Duarte et al. 2007; Mazzoni and Caramaschi 1997a,b) Study on length -weight relationship of catfishes along the southwestern coast were made by Chu *et al*., 2012. Mishima and Tanji (1983) described the reproductive status of several species of *Aridae* in Cananéia lagoon-estuarine system. Gomes *et al*., (1999) analyzed the reproductive biology of two Arid catfishes *Genidens genidens* and *Cathorops spixii* from na Baía de Sepetiba, Rio de Janeiro, Brasil.

Mazlan *et al*., 2008 conducted studies on the growth and food habitat of *Arius maculatus*. Ingles *et al.,* 1987 conducted studies on the aquatic management of *Arius maculatus*. In 1998

Jayaseelan studied about the larvae and egg development of *Arius*. Despite this studies on the biology of *Arius maculatus* is scanty. The present study will shed light on some of the important aspects of the reproductive biology of *Arius maculatus* from Perumon sector of Ashtamudy Lake.

MATERIALS AND METHODS

The site selected for study was the Perumon sector of Ashtamudy Lake. It is situated between **$8^0$57'27.85"N** latitude and **76^0.37'05.37"E** longitude (Fig 1and 2). The collection station is in the eastern part of the Ashtamudy Lake. Specimens were collected from the part of the lake near the railway bridge. The water in this area is influenced by tidal currents. This part of the lake is far away from the sea so the migrant fish species are found in fewer numbers. The sampling was carried out monthly; during the months of January, February and March. The collection was carried out during the early morning hours.15 specimens were collected each month.

The specimens were obtained using cast nets.(Fig 3).A **cast net** also called a **throw net**, is a net used for fishing. It is a circular net with small weights distributed around its edge. The net is cast or thrown by hand in such a manner that it spreads out on the water and sinks. This technique is called **net casting** or **net throwing**. Fish are caught as the net is hauled back in.

Contemporary cast nets have a radius which ranges from 4 to 12 feet (1.2 to 3.6 metres). Only strong people can lift the larger nets once they are filled with fish. Standard nets for recreational fishing have a four-foot hoop. Weights are usually distributed around the edge at about one pound per foot (1.5 kilogrammes per metre). Attached to the net is a **handline**, one end of which is held in the hand as the net is thrown. Cast nets work best in water no deeper than their radius. Casting is best done in waters free of obstructions. Reeds cause tangles and branches can rip nets. The netcaster may choose to stand with one hand holding the handline, and with the net draped over the other arm so that the weights dangle, or, with most of the net being held in one hand and only a part of the lead line held in the other hand so the weights dangle in a

staggered fashion (approximately half of the weights in the throwing hand being held higher than the rest of the weights). The line is then thrown out into the water, using both hands, in a circular motion rather as in hammer throwing. The net can be cast from a boat, or from the shore, or by wading. There are also optional **net throwers** that can make casting easier. These look like a lid from a trash can, including the handle on top. The outside circumference has a deep gutter. The net is loaded along the gutter and the weights are placed inside the gutter. The net is then tossed into the water using the thrower.

Various physicochemical parameters such as temperature (Air and water), depth, salinity, pH, dissolved oxygen were checked during the sampling days using standard techniques. Salinity was measured using Master Refractometer (ATAGO), pH (Compact pH meter), dissolved oxygen (Winkler,1888).

The specimens were brought to the college laboratory and the morphometric measurements were recorded. For analysing the food and feeding the stomach contents were examined in fresh condition. The stomachs were visually classified as gorged, full, ¾ full, ½full, ¼ full, trace and empty depending upon the degree of fullness and the amount of food contained in them (Philip,1994). The stomachs were dissected out and the food was preserved in 5% formaldehyde for further study. The individual items of the stomach contents were identified, depending on the stage of digestion.

In addition to this studies on the reproductive biology were also carried out. For this examination of ovaries were carried out and they were classified into 5 stages

For the analysis of gonadal maturity and to calculate the GSI (Gonadosomatic Index) the Gonads were weighed.

The GSI can be calculated according to the following equation.

$$\textbf{Gonado somatic index(GSI)} = \frac{\textbf{Gonad weight}}{\textbf{Total weight}} \times 100$$

The gonads were photographed the ova was measured up to the nearest millimetre. In order to calculate the fecundity the number of mature ova in each ovary was counted.

For length-weight relationship studies, total length and body weight for each sex were recorded. The relationship was calculated by correlating Ln TL to Ln Wt for both male and female specimens and were compared by the equation;

$$W = q \times L^b \quad \text{(Sparre, 1998)}$$

The W= Total weight of Fish in grammes, L= Length of fish in cm, q = Rate of change of weight with length (regression intercept), b = weight at unit length (regression slope).The equation can be transformed into logarithmic scale by taking logarithms on both sides.

$$\text{Ln}W = \text{Ln}\, q + b \times \text{Ln}\, L$$

Fig:1 Map showing the position of the station in Ashtamudy Lake

Fig 2: Students at the study site

RESULTS

Physicochemical parameters.

During the study period, physicochemical parameters such as temperature (Air and water), depth, salinity, pH, and dissolved oxygen were measured and presented in Table1.

Table 1

Parameters/month	January	February	March
Depth (cm)	90	75	95
Air temperature ^{0}C	29	31	32
Water temperature ^{0}C	28	28.5	29.1
Salinity (ppt.)	34	35	35
pH	7.9	8.0	8.0
Dissolved oxygen (mg/lit)	4.2	4.5	4.0

During the period under report, the air temperature varied between 29 to 32 whereas the water temperature varied between 28 to 29.1 ^{0}C. The value of pH did not change significantly during the study period and showed an average value of 8.0.Salinity showed an increase from 34 ppt. in January to 27 ppt. in February and December and the dissolved oxygen values were between 4.0 to 4.5 mg/lit.

Arius maculatus (Thunberg, 1792), Spotted catfish

Kingdom: Animalia

Phylum: Chordata

Class: Actinopterygii

Order: Siluriformes

Family: Ariidae

Subfamily: Ariane

Genus: Arius

Species: *maculatus*

Fig(5): *Arius maculatus*

Arius maculatus can be distinguished from the other members of this genus by the presence of a single dorsal spine, 7 soft dorsal rays, 16 – 30 soft anal rays, rugose head shield and deep and long median fontanelle groove. They can reach a maximum length of about 80cm. (Fig 5). The

fish inhabits Marine, freshwater and brackish water habitat. It is demersal exhibiting potamodromous migration and usually occurs at a depth of about depth range 50 - 100 m.

The fish has a Tropical distribution and is present India, Sri Lanka, Pakistan, Bangladesh, Myanmar and the Indo-Australian Archipelago (excluding Australia).

Biology of *Arius maculates*

The catfish *Arius maculates* was observed throughout the period of study from January 2017 to March 2017. The fishes were caught along with other species such as *Etroplus suratensis*, *Siganus javus*, *Carangx ignobilis, Stolephorus indicus*, *Valamugil cunnesius, Arius subrostrus* and *Gerres abbrevatius A. maculates* formed about 50% of the catch.(Fig 4) Details of the samples collected such as total length, standard length, weight, the condition of the stomach, the weight of stomach, sex, stage of maturity, the weight of gonad and ova diameter for the month of January, February and March are presented table 2,3 and 4.

Table 2: Details of Sample analysed -January

Serial Number	Total length	Standard length	weight	Stomach	Stomach weight	Sex	Stage	Gonad weight	Ova diameter
1	23.7	19.4	150.75	3\4	2.74	male	V	0.210	_
2	20.7	16.5	96.62	3\4	2.5	male	III	0.070	_
3	21.5	16.7	91.73	1\4	0.89	male	III	0.090	_
4	19.3	14.8	67.4	1\2	1.35	female	II	0.180	0.1
5	21.1	16.3	82.68	Trace	0.18	female	IV	2.520	0.4
6	21.2	17.2	100.79	1\2	1.71	Male	I	0.030	_
7	24.7	19.3	164.07	3\4	2.28	female	V	28.070	1.1
8	21.3	16.3	106.03	3\4	2.26	female	III	0.910	0.3
9	23.7	19.1	119.6	1\2	1.97	female	V	12.760	0.7
10	21.2	18	109.67	3\4	2.35	male	II	0.050	_
11	22.4	17.2	95.34	Full	4.6	female	III	1.630	0.3
12	21.7	16.5	92.69	3\4	2.02	female	II	0.460	0.2
13	20.6	17	100.54	1\2	2	female	V	9.950	0.8
14	19.5	14	88.45	1\2	1.82	female	II	0.620	0.3
15	21.7	18.4	94.15	3\4	2.11	female	IV	4.60	0.6

Table 3: Details of Sample analysed –February

Serial number	Total length	Standard length	weight	Stomach	Stomach weight	Sex	Stage	Gonad weight	Ova diameter
1	20.7	16.9	86.34	1\2	1.76	male	III	0.08	_
2	21.6	16.4	91.43	1\2	1.85	female	IV	3.32	0.4
3	23.7	18.2	110.01	Full	3.49	female	IV	4.35	0.4
4	20.2	15.1	87.9	3\4	2.54	male	II	0.04	_
5	21	16.1	81.35	Gorged	6.16	male	V	0.20	_
6	22.1	17.1	100.92	Full	4.33	Male	V	0.201	_
7	21.2	17.2	94.25	3\4	2.86	male	II	0.05	_
8	20.2	15	69.7	3\4	2.2	female	III	0.78	0.3
9	21	15.3	52.31	1\4	0.84	female	I	0.11	0.1
10	20.9	17	86.58	Gorged	6.15	female	IV	2.18	0.5
11	19.2	14.6	62.98	1\2	1.54	male	IV	0.11	_
12	21.1	15.7	87.9	3\4	2.18	female	IV	2.16	0.5
13	20	16.5	87.2	3\4	2.16	male	III	0.083	_
14	18.7	15.5	51.17	1\2	1.84	Male	III	0.081	_
15	18.9	13.5	54.54	1\2	1.56	male	II	0.04	_
16	18	13.2	55.54	1\4	0.89	male	I	0.02	_

Table 4: Details of Sample analysed –March

Serial number	Total length	Standard length	weight	Stomach	Stomach weight	Sex	Stage	Gonad weight	Ova diameter
1	29	23.2	195.24	Gorged	7.9	female	V	11.1	0.6
2	20.2	15.7	87.16	Full	4.62	female	I	0.4	0.1
3	21	17.3	101.81	3\4	2.14	female	V	9.3	0.6
4	22.3	17.9	108.78	3\4	2.16	female	V	13.4	0.7
5	22.5	17	107.75	Full	3.61	female	V	11.0	0.9
6	23.1	17.8	122.89	Full	4.61	female	V	7.4	0.7
7	22	17.2	108.95	3\4	2.26	male	III	0.09	–
8	20.5	16.3	98.32	3\4	2.7	male	V	0.12	–
9	20.8	17.2	92.02	Gorged	7.97	Male	III	0.91	–
10	22.5	17.2	114.6	3\4	2.95	female	IV	3.8	0.4
11	21.1	17.1	79.37	1\2	1.54	female	III	1.9	0.3
12	20	16	89.9	Gorged	6.6	female	III	1.1	0.3
13	22.4	18.6	19.69	3\4	2.75	female	IV	3.9	0.4
14	18.5	14.9	61.22	Full	4.7	Male	II	0.04	–
15	19	16	72.54	Full	3.67	female	III	1.3	0.3

Food and feeding

The feeding behaviour of *Arius maculatus* was observed for a period of 3 months and based on the fullness of the stomach contents the Stomach was classified into Gorged, Full,3/4,1/2,1/4, trace and empty. During the analysis, it was revealed that none of the fishes had empty stomachs and the stomach contents ranged from Gorged to ½ full. The analysis of the stomach contents revealed that the food preference of the fish during the 3 months remained more or less the same. The fish preferred a carnivorous diet with the stomach contents consisting of Fishes (Fig 6) crabs(Fig7) prawns (Fig 8) and crabs(Fig 9 and 10)

Fig:6 Partially digested fish remains

Fig:7 Crustacean remains obtained from the stomach

Fig:8 Crab pincers obtained from the stomach

Fig:9 Crab obtained from the stomach

REPRODUCTIVE BIOLOGY

Description of Gonads:

Ovary

Stage I (Immature):(Fig:10)

- Ovaries are narrow, small
- Transparent or slightly reddish in colour and occupying 1/4th of the body cavity
- Ova are extremely small and are extremely difficult to observe with the naked eye
- Ova diameter is 0.1cm

Stage II (Maturing / Developing) (Fig:11)

- Ovary is small
- Yellowish white in colour
- Ova is small, transparent and spherical in shape
- Diameter of the ova range from 0.1-0.2 cm(Fig:15)

Stage III (Maturing) (Fig:12)

- The ovary is slightly larger than the previous stage. The ovary is yellowish in colour and has started maturing which is evident by the appearance of blood vessels.
- Ova are slight yellowish in colour
- Ovary containing ova with a diameter about 0.3cm(Fig:16)
- It also contains Stage I and II ova

Stage IV (Maturing) (Fig:13)

- Ovary is larger than stage III
- Ovary is yellowish orange in colour and ova are visible from outside
- Ovary consists ova of different sizes
- Stage IV ova are yellowish in colour
- The ova present in both Stage II and Stage III are found in this stage
- Stage 4 ova have diameter of ranging from 0.4 to 0.6cm(Fig:17)

Stage V (Mature) (Fig:14)

- Ovary is greatly enlarged
- Dark yellowish in colour and the ova is highly developed and starts to protrude from the ovary walls
- Ova is larger than other stages
- Ova is yellowish and spherical
- Blood vessels are clearly visible
- The ovary contains ova of different stages. Ova diameter ranges from 0.6-1.1cm(Fig:18)

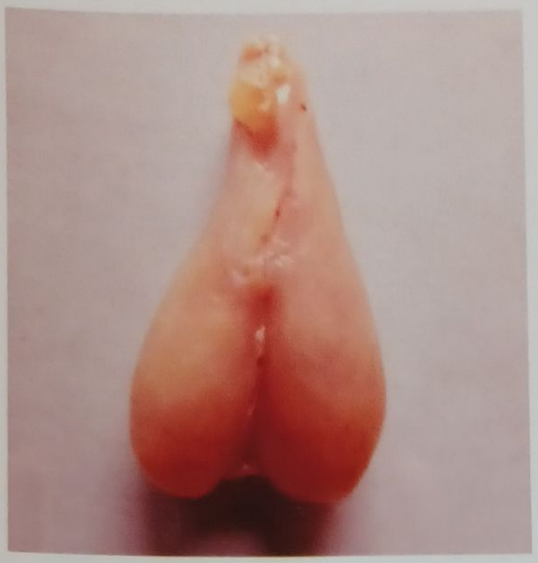

Fig:10 Stage I Ovary

Fig:11: Stage II Ovary

Fig:12 : Stage III Ovary

Fig:13 : Stage IV Ovary

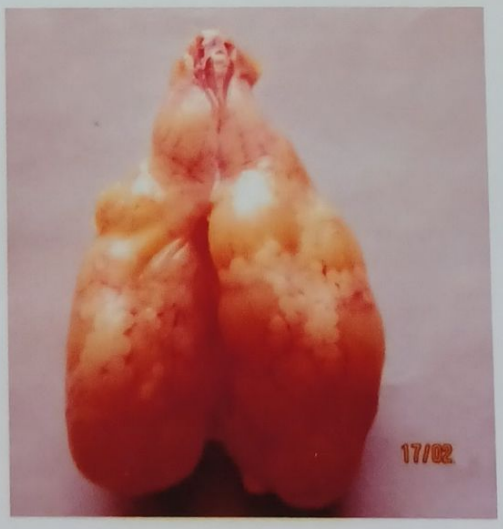

Fig:14 :stage v Ovary

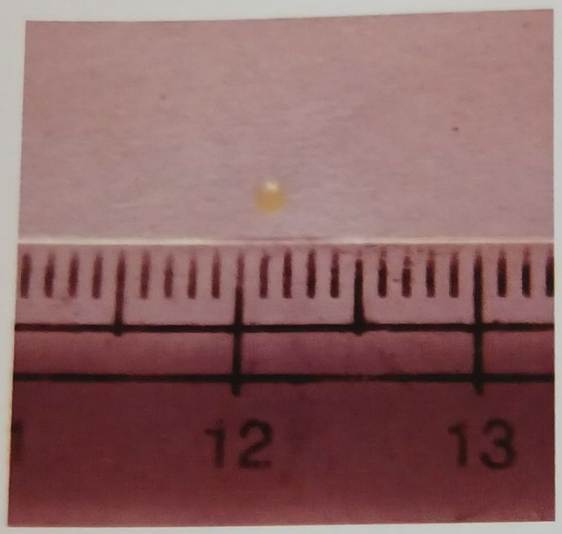

Fig 15 :Stage II ova

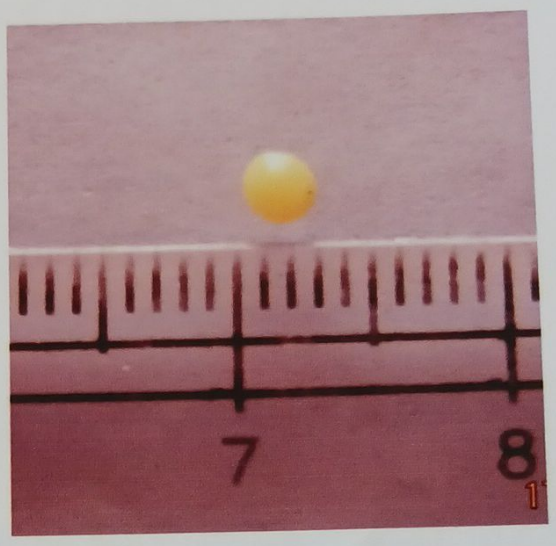

Fig 16: Stage III ova

Fig:17 Stage IV Ova

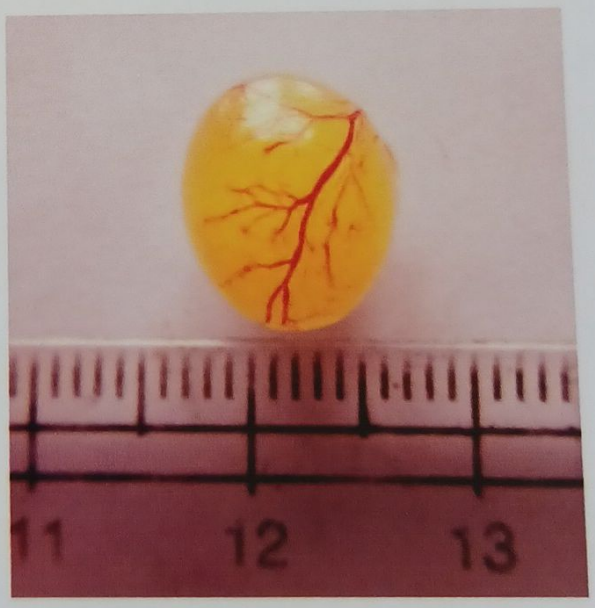

Fig:18 Stage V Ova

TESTIS

Stage I (immature)

Testis thread like and occupying less than a quarter of the body cavity. They are difficult to differentiate. The testis is reddish in colour, elongated and slender. (Fig:19)

Stage II (maturing)

Testis increased in size and translucent, occupies about quarter of body cavity with developing white colour. (Fig:20)

Stage III (maturing)

Testis whitish, enlarged in size, occupies about half of body cavity. Thicker and softer than those of the previous stages. (Fig:21)

Stage IV (mature)

Testis white or creamy in colour occupies more than half and less than three - fourth of the length of the body cavity. (Fig:22)

Stage V (mature)

Testis greatly enlarged in size, convoluted in appearance and milky white, occupying about three-fourth of the length of the body cavity. (Fig:23)

Five gonadal maturity stages were recognised. Stage I (Immature), Stage II (Maturing/Developing), Stage III (Maturing), Stage IV (Maturing), Stage V (Mature). Characteristic features of ovary and testis are given below. During the 3 months of study, Fully mature females were present in more numbers during the month of March whereas February showed predominance in the occurrence of Stage IV gonads. Although the gonads were classified based on physical appearance for a more detailed understanding histological analysis is required.

Fig:19 Stage I testis

Fig:20 Stage II testis

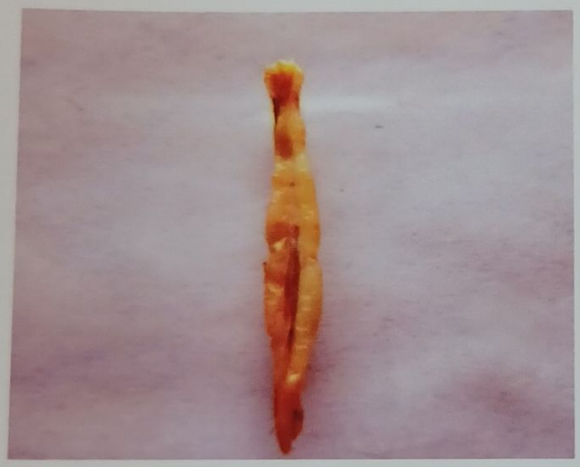

Fig:21 Stage III testis

Fig:22 Stage IV testis

Fig:23 Stage 5 testis

Parental care

Arius maculatus is unique due to the fact that the male fish shows parental care and mouth brooding (Fig23). During the time of mouth incubation, the male fish forgoes feeding. Eggs and embryos were obtained from the oral cavities of fishes. (Fig24). This embryos hatch into juvenile fishes and commence feeding while they are still in the oral cavities.

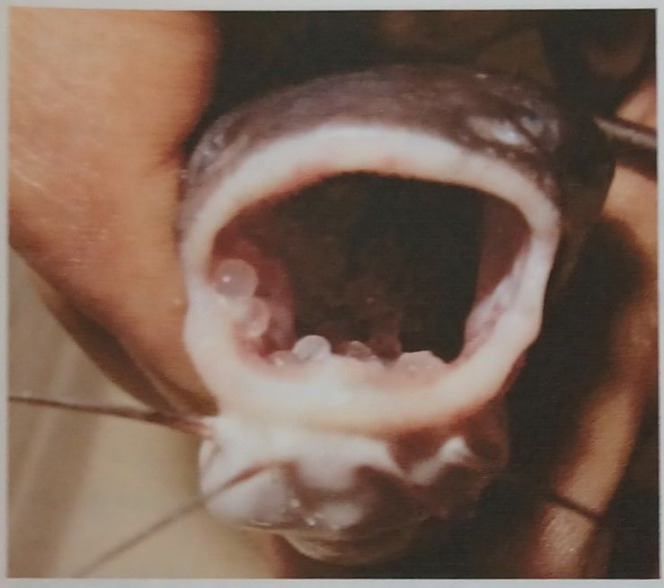

Fig:23: Male fish incubating the eggs

Fig:24 :Embryos obtained from the mouth

Length-weight relationship

The length and weight of 46 specimens were measured and based on that value the length-weigh relationship was calculated. Graphs showing length weight relationship of *Arius maculates* are shown in (Fig 25) and(Fig 26)

. *A.maculatus* underwent allometric growth ($b \neq 3$). Females shown to undergo negative allometric growth with 'b' value of 2.4385 ($b<3$) (Fig) and males underwent positive allometric growth with 'b' value of 3.8018 ($b>3$)(Fig). Regression on both male and female were significant ($P<$ 0.01) and the coefficient of determination of male was higher than that of female ($R^2= 0.825$, female; $R^2= 0.8802$, male).

Negative allometric growth implies the fish becomes more slender as it becomes longer and is indicated by a $p < 3$. Positive allometric growth implies the fish becomes relatively stouter or deeper-bodied as it increases in length and is indicated by a $p > 3$.

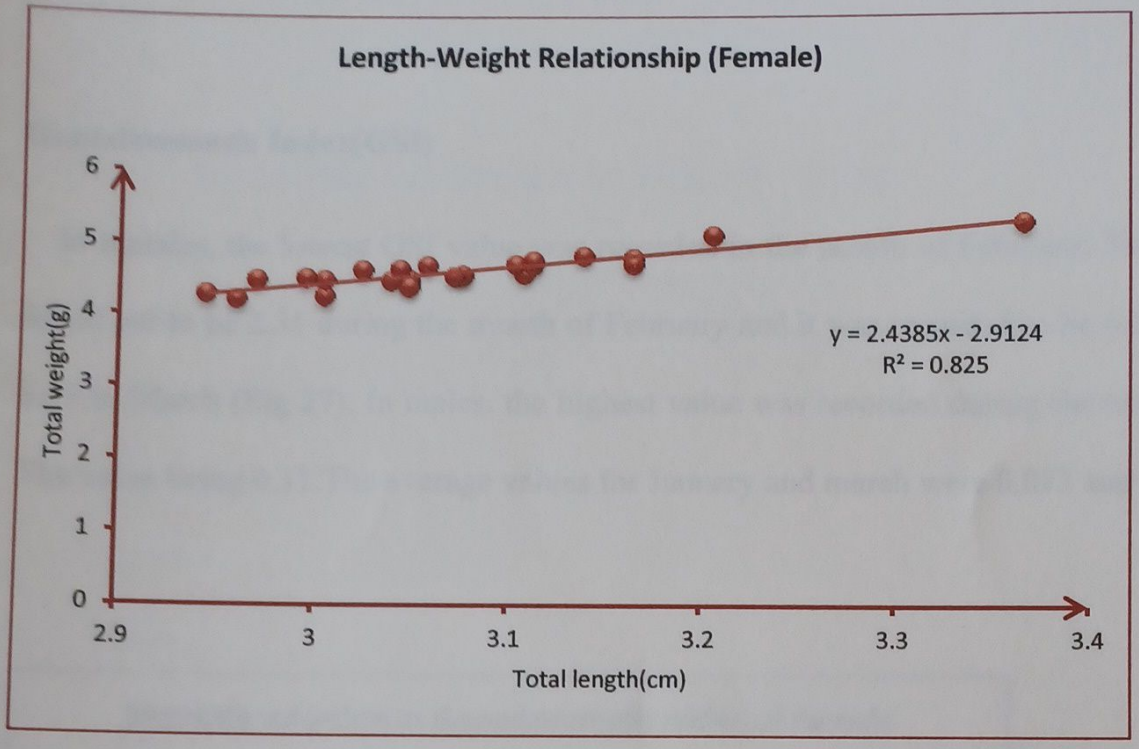

Fig:25 Graph showing length-weight relationship *Arius maculates* female

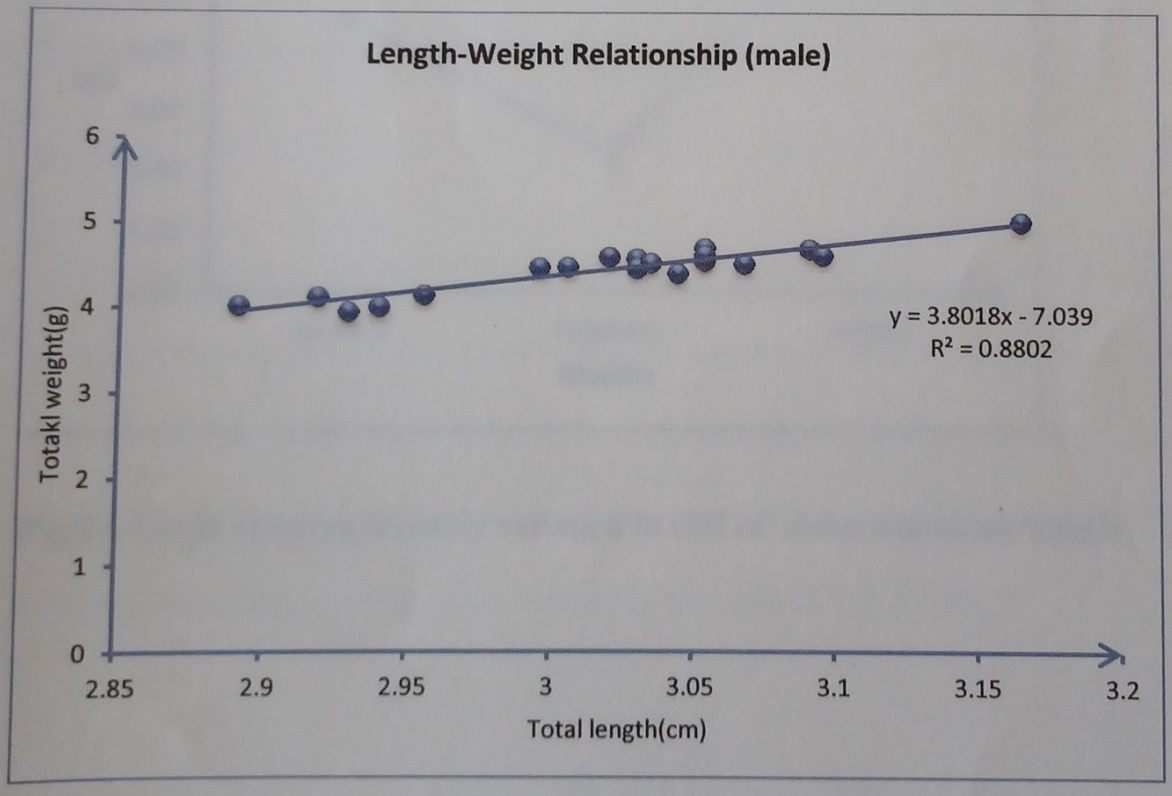

Fig:26 Graph showing length-weight relationship *Arius maculates* male

Gonadosomatic Index(GSI)

In females, the lowest GSI value was recorded in the month of February. The GSI value was found out to be 2.31 during the month of February and it was recorded to be 4.52 in January and 6.59 in March (Fig 27). In males, the highest value was recorded during the month of February. The value being 0.11.The average values for January and march were 0.073 and 0.088 (Fig 28).

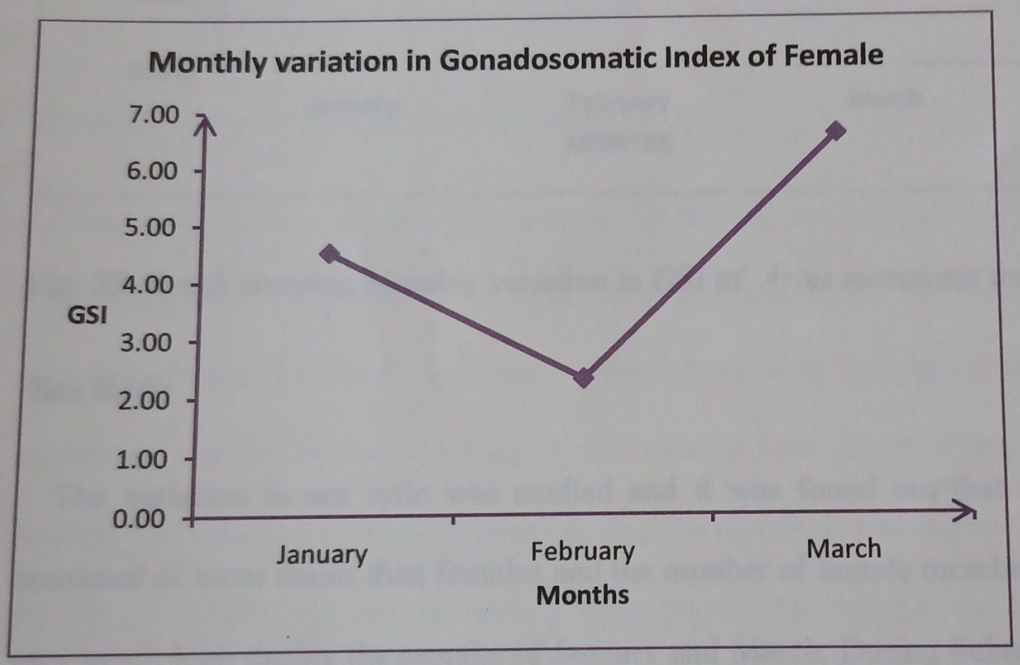

Fig:27 Graph showing Monthly variation in GSI of *Arius maculates* female

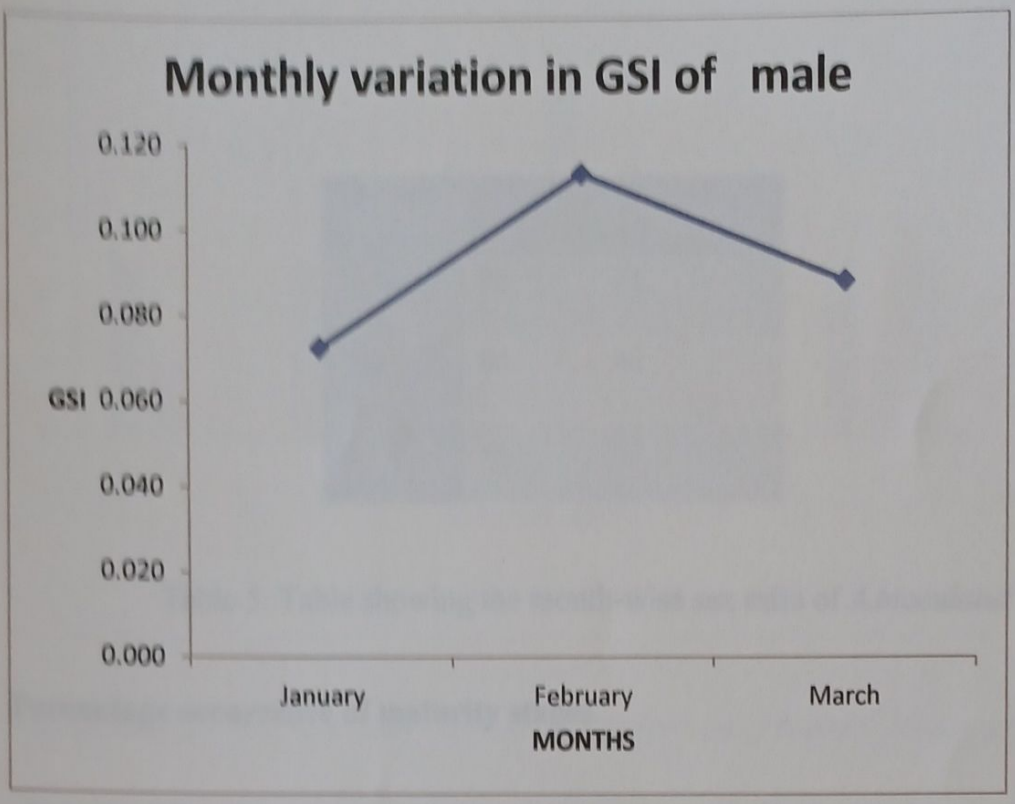

Fig: 28 Graph showing Monthly variation in GSI of *Arius maculates* male.

Sex Ratio

The variation in sex ratio was studied and it was found out that the population generally consisted of more males than females and the number of female members of the population were very much high during the months of January and March. During February males dominated the population but then also the difference was not well pronounced as in the other 2 months the male and female individuals were present in the ratio of 1:2. (Table 5)

Month	% Male	% Female
January	29	71
February	60	40
March	27	73

Table 5: Table showing the month-wise sex ratio of *A.maculatus*

Percentage occurrence of maturity stages

It was evident from the data that in males all the maturity stages were visible in the population during the month of February while no immature individuals were observed in the population during the month of March. A Large number of maturing individuals were observed during this month. In case of females, the Stage II individuals were observed during the month of January and the individuals had Stage V ovary during the month of march so it is safe to assume that the month of March can be associated with maximum fertility in *A.maculatus* female. The percentage occurrence of different maturity stages of Male and female is represented in the graph shown below(Fig 29 and 30)

Fecundity

Fecundity (Absolute fecundity) was found out by counting the total number of spawnable eggs in the female ovaries. In *Arius maculatus* the fecundity was found out to be 18 per fish.

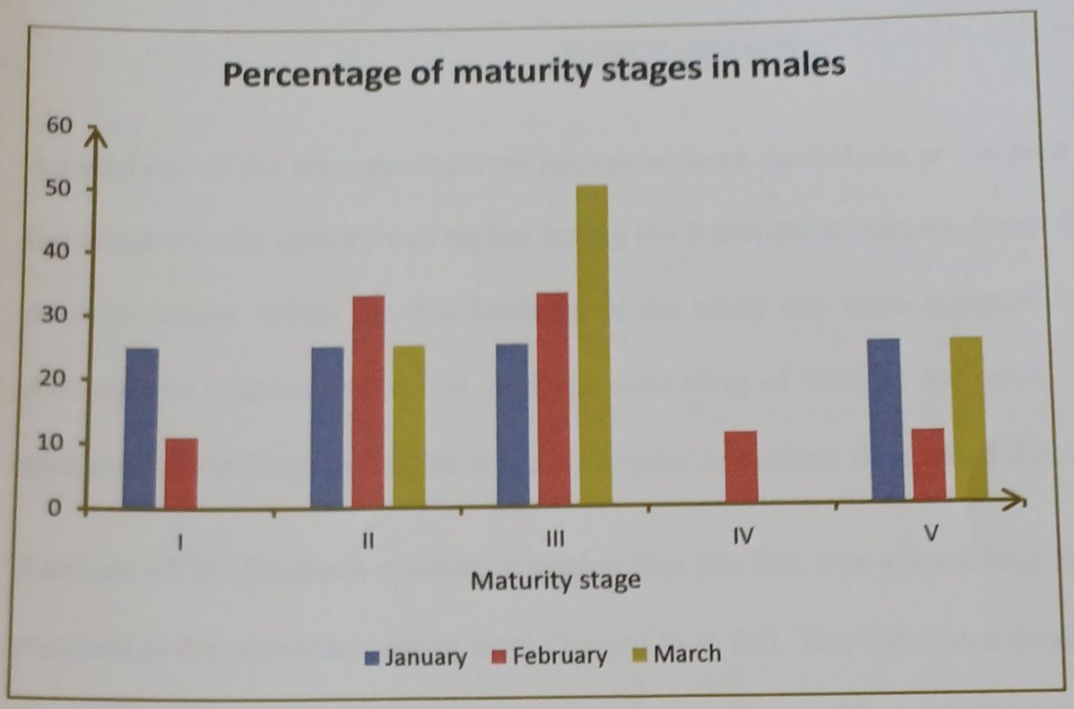

Fig: 29: Graph showing the monthly abundance of different maturity stages of *Arius maculates* male

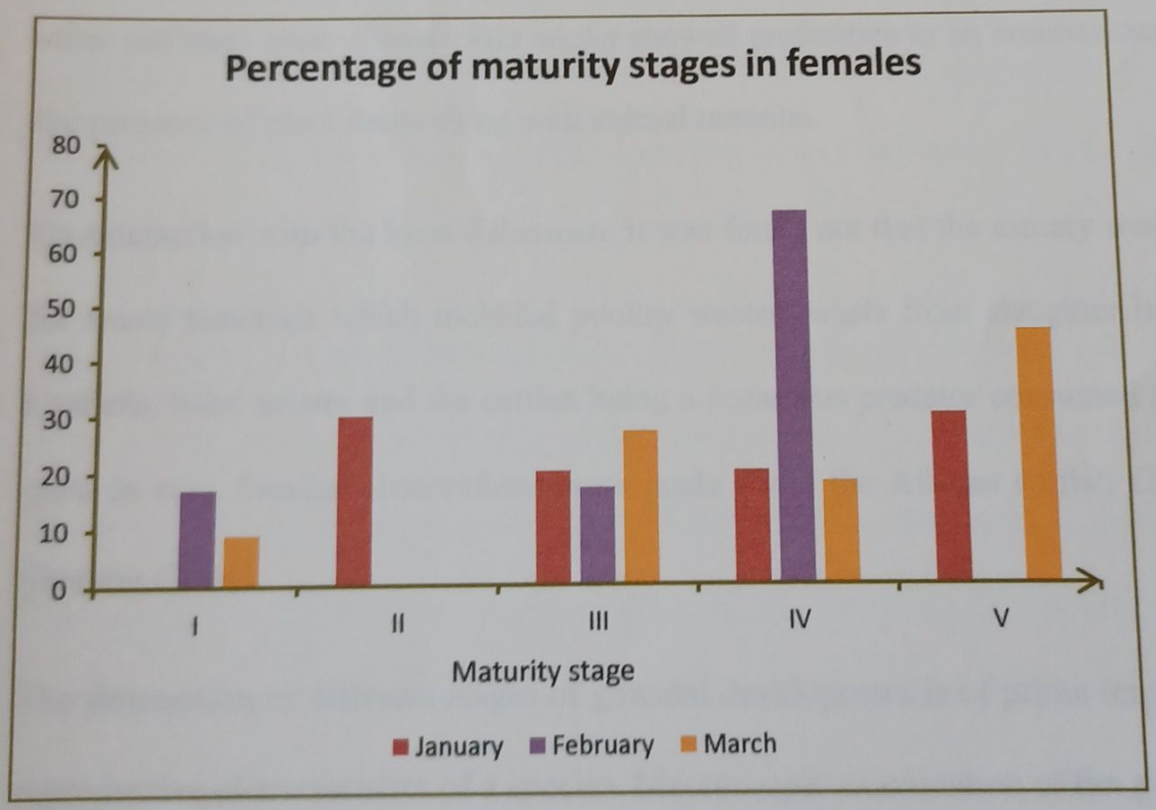

Fig:30 Graph showing the monthly abundance of different maturity stages of *Arius maculates* female

DISCUSSION

An analysis of the physico-chemical parameter were carried out at the area of study and it was found out that the salinity was higher during the 3 months it may be due to the lack of rain in the summer season. When the fish landings of the study site were analysed it was found out that *A.maculatus* dominated the fish landings consisting of 50% of the catch. This was in contrast with the fish landings of Vellimon were *Etroplus suratensis* dominated the catch.

Analysis of the Stomach contents revealed that the fish was a voracious feeder with amount of contents in the stomach ranging from Gorged to ½ full. The fish was a carnivore actively feeding on crabs, crustaceans and other small fishes. The fishes did not feed on any insect parts unlike the other catfishes such as *Mytus bleekeri* and *M.vitatus*. *Arius maculatus* was a strict carnivore other catfishes such *Etropiichtys vacha* showed preference to an omnivorous diet, indicated by the presence of plant items along with animal remains.

On interaction with the local fishermen, it was found out that the estuary was a dumping ground for waste materials which included poultry wastes, waste from slaughter houses, fish markets, kitchens, hotel wastes and the catfish being a voracious predator consumed all of the wastes and grew in size. Similar observations were made about the African catfish *Clarias gariepinus* by Shambu (2004).

The description of different stages of gonadal development is of prime importance in evaluating reproductive characteristics of a species. Macroscopic examination of the gonads of *A.maculatus*. revealed that during the maturation stages the gonads underwent gradual but notable changes in size and form which are more evident in the ovaries than the testis. In general, the ovarian development process in teleost can be divided into two phases (Wallace and Selman 1981); the

previtellogenic phase, when growth is comparatively slow, with few cytoplasmic changes, and the vitellogenic phase, characterised by faster growth and the deposition of large amounts of yolk in the ooplasm. The mature stage is the one occupying the biggest size, which is due to increase in the number of mature ova. Variations can be observed in both colour and size in which the immature gonads are reddish and small and start losing their reddish nature as they develop. In the case of the male gonads, it progresses from slight off-white to milky white. While in females it progresses from light yellow to yellowish orange. The ovaries become lobular as they become fully mature. The diameter of the mature ova was found ranged from 6 to 1.1cm.

There is a drastic change in the ova too in which the ova change from small and transparent to yellowish after vitellogenesis with blood vessels clearly visible supplying food for the developing embryo.One notable difference which sets *Arius maculatus* apart from other catfishes of Family Aridae like *Sciadeichthys luniscutis* and *Genidens genidens* is the absence of Stage VI and VII (the spend and recovering stage) indicating that the fish is a continuous spawner.

Adults occur in inshore waters and estuaries they occasionally form schools. Males incubate eggs in the mouth. Males incubate eggs in the buccal cavity. This period of oral incubation helps in the good development of sense organs. (Rimmer, 1985; Menon et al., 1989; Arockiaraj et al., 2003; Osman et al., 2008).During incubation, males starve which sometimes make them resort to swallowing one or two eggs probably to maintain basal metabolism. Early hatching embryos commence feeding on inhaled particles by the female when still in possession of large yolk.

On the calculation of the length-weight relationship, it was found out that females were shown to undergo negative allometric growth with and males underwent positive allometric growth.

GSI in the least in the month of February is least for females and highest for males. And the studies on the sex ratio revealed with the exemption of the month of February males predominated the catch. The analysis of the percentage occurrence of maturity stages in males revealed that in February gonads of all maturity stages could be observed. And fully mature specimens were present during the month of march. The fecundity was found out to be 18 which was obtained by counting the number of mature eggs in the ovary. Strong venomous dorsal and pectoral spines provide protection for the fish. The status of the species has not been evaluated yet.

So the present study revealed information regarding size composition, food and feeding, maturity stages and availability of mature specimens during summer months. This information will be important in evaluating the status of the species, aquaculture prospects and its need for conservation.

CONCLUSION

The high occurrence of *Arius maculatus* in Perumon shows that the region is an ideal habitat for carnivorous fish species. The barbels of *Arius maculatus* enables them to forage in the area. The large body size of the females also make it a highly favoured catch and thus make them highly susceptible to fishing and it might be difficult for them to bounce back from catastrophe such as over fishing due to the low fecundity. The calculation of the number of mouth brooding specimens may be biased as in most cases the catfish are found to eject eggs from the mouth when they are caught. The analysis of the stomach contents revealed that *Arius maculatus* occupies a high trophic level status. And since it voraciously feeds on crustaceans, the occurrence of these organisms in the estuary are of utmost importance in sustaining the food chain.

Analysis of the gonads revealed that *Arius maculatus* is a continuous spawner thereby making it difficult to abstain from fishing during the spawning period. The ova of *A.maculatus* is a priced delicacy which is cooked along with the fish. It is also a rich source of protein due to the presence high amount of deutoplasm. Fecundity studies were also conducted and it was found out that there were 18 mature ova per fish. Fecundity is also a measure of the vulnerability of the fish. Low fecundity makes the species vulnerable but parental care takes care of this low fecundity.

Arius maculatus is a promising candidate for aquaculture as it can also cultured by using animal and fish wastes like *C. gariepinus* other than that the stomach content analysis had revealed the presence of prawns and fishes like *Stolophorous indicus* which is widely found in the estuary. Since catfishes have great economic importance as a food fish their culture may be economically

feasible. An adult fish will fetch about Rs 50/-from the market. So culturing the fish in a cage in the inland brackish water areas of the estuary and feeding them with trash fishes and prawn waste will be a boost to the aquaculture industry.

The fish eggs are also a highly priced delicacy. So if we can find a way to culture them and extract the eggs from its mouth, this eggs can either be used for consumption or can be hatched with the help of suitable settings in order to produce seed. So it can be stated in a nutshell that *Arius maculatus* is a promising candidate for the aquaculture industry.

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