SOME ASPECTS ON REPRODUCTIVE BIOLOGY OF *GERRES FILAMENTOSUS* CUVIER

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IN THE NAME OF ALLAH,
THE MOST MERCIFUL AND
COMPASSIONATE

DECLARATION

I hereby declare that this thesis entitled **"Some Aspects on reproductive biology of *Gerres Filamentosus* Cuvier"** is based on my research and has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles or recognition.

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CERTIFICATE

Certified that the dissertation entitled **"Some Aspects on reproductive biology of *Gerres Filamentosus* Cuvier"** is a bonafide record of work done by **Kum. RAIHANATHU BEEVI A.** under our guidance at the Central Marine Fisheries Research Institute during the tenure of her M.Fsc (Mariculture) programme of 1996-98 and that it has not previously formed the basis for the award of any other degree, deploma or other similar titles or for any publication.

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ABSTRACT

STUDIES ON SOME ASPECTS OF REPRODUCTIVE BIOLOGY OF *GERRES FILAMENTOSUS* CUVIER IN COCHIN

The reproductive biology of *Gerres filamentosus* cuvier was investigated in cochin from the samples collected from the trawl landings. Analysis of reproductive organs, maturity condition, fecundity and sex ratio was done during March - June 1998. Oocyte diameter was measured and histological characteristics of ovary were studied. This species remains in the estuarine environment and undergo migration to nearby coastal areas for the purpose of breeding. Final stage of maturity is attained in the sea. The spawning occurs on the sea and the young ones migrate to estuarine area. The process of maturation is a continuous process and spawning take place within a prolonged period. The observed maturity stages of females were (i) immature (ii) inactive / resting (iii) Developing (active) iv mature (v) ripe and running (vi) spent and of males were (I) immature (ii) maturing and (iii) spent.

सारांश

कोचीन में ट्राल अवतरण से संग्रहित नमूनों में से जेरस फिलमेन्टस के पुनरूत्पादी जीवविज्ञान का अध्ययन किया गया । मार्च - जून, 1998 के दौरान इस के जननांग, प्रौढावस्था, जननक्षमता और लिंग अनुपात का विश्लेषण किया गया । अंडक व्यास का मापन औश्र अंडाश्य की ऊतकीय विशेषताओं का अध्ययन किया गया । ज्वारनदमूखी परिस्थिति में यह जाति दिखाई पडती है और प्रजनन के लिए आस पास के तटीय क्षेत्रों में प्रवास करती है । प्रौढ़ता की अंतिम अवस्था ये समुद्र में प्राप्त करती है । समुद्र में अंडजनन संपन्न होता है और फिर से छोटे वाले ज्वारनदमुखी क्षेत्र में प्रवास करते हैं । अंडजनन और परिपक्वन की ये निरंतर प्रक्रियाएं निश्चित अवधियों में चलते रहते हैं । मादा जाति की प्रौढ़ावस्थाएं (i) अप्रौढ़ (ii) निष्क्रिय / सूप्त (iii) विकासशील (iv) सक्रिय ((v) परिपक्व और गतिशील (vi) अंडारिक्त हैं । नर जाति की प्रौढ़ावस्थाएँ ((i) अपरिपक्व (ii) परिपक्व होने वाली और (iii) अंडारिक्त हैं ।

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INTRODUCTION

The gerreidae, which comprise of eight genera and approximatly 40 species commonly known as majorras, silver biddies or purse mouths, is found is most warm seas, most of them are seen is tropical region, a few are temperate species. They are small to medium sized fishes living is sandy shallows of tidal creeks, lagoons, coral reefs and some enter into freshwaters. *Gerres filamentosus* cuvier is commonly called whipfin silver biddy. It is widely distributed in all warm seas of Indopacific, from the east coast of Africa through Indomalayan Archipelago, South China sea, Northern Australia and west Pacific islands.

In the estuaries and back waters of India it constitute an important fishery. They live in shallow coastal waters to a depths of atleast 50m, on sandy bottoms including coralline areas. Caught mainly by beach seines and bottom trawls, castnets, gillnets and seines. This species is a bottom feeder, with the protrusible mouth adapted for browsing on epiphytic animals like amphipods, apart from this it picks up other benthic organisms like polychaets bivalves, gastropods etc. This species grows to a maximum size of 25cm, 15cm is most common.

Gerres filamentosus cuvier remain is the estuarine enviornment until attainment of sexual maturity, fully ripe fishes undergo migration to near by coastal areas for the purpose of spawning, final stage of maturity was attained only in the sea. They probabily spawn at sea, the young ones migrate to estuarine area.

Because of absence of any external character to distinguish the two sexes, the sex were determined after examining the gonads. Sex ratio was found to be 1:1 (female to male). But during the peak spawning season females were more compared to males.

Five maturity stages were determined on the basis of colour, shape, size and microscopic structure of gonad.

I. Immature:

Ovary occupying less than half of body cavity, pinkish jelly like translucent, very small irregular eggs.

II. Maturing Virgin (Recovering spent)

Ovary occupying half of body cavity, light yellowish, eggs not rounded, granular and yellowish white with yolk.

III. Ripening:

Ovary occupy ¾ or more of body cavity, yellowish, egg opaque and not well rounded with yolk.

IV. Ripe :

Ovary occupy the entire body cavity, deep yellow with conspicuous blood vessels most of eggs are transparent with few opaque eggs. Some ova are visible to exterior vacuoles present in yolk.

V. Spent :

Ovary occupy slightly more than half of body cavity, dark pinkish, flaccid, translusent and shrunken with prominent blood vessels.

A knowledge of reproductive biology is essential in understanding the several features of reproduction in fishes. The present investigation was undertaken to elucidate the spawning activities, maturity stages and fecundity of *G. filamentosus* in the Cochin estuary.

Significance of the study

Investigations on maturation and spawning in fishes are of great importance. The fertility of a fish is of great significance in the reprodution of the stock of a species. Information regarding the reproduction, reproductive behaviour forms the basis of the management of broodstock in the aquaculture operations. Efficient management of brood stck depends upon accurate prediction of ripening tissue to facilitate the production of high quality seeds for culture. Reliable collection of high quality gametes requires a precise knowledge of maturation, ovulations and spawning of the candidate species. Accurate estimates of fecundity will enhance the efficiency of brood stock management and larval rearing programmes.

The information gathered from maturation and spawning studies can be used in ascertaining the age and size at which fish attains sexual maturity as well as spawning time and location of spawning sites. Together with fecundity estimate this information can be used to calculate the size of the stock and reproductive potential.

REVIEW OF LITERATURE

Gerreidae is a family of marine Fishes living in coastal waters of tropical areas. Some species migrate to mangrove swamps, lagoons, estuaries and sometimes lower rivers (Bauchot, 1992). They are closely related to leognathidae, some of the earlier taxonomists (Bergh, 1940: Weber and Beaufort, 1931) have treated both the groups under one family leognathidae. But later after considering the characters of gerreidac. Such as, moderate sized scales on head and body, gill membrane free from isthmus; nuchal spines absent, and number of branchiostegial rays six, as against five in leognathidae. It was recognised as a separate family from leognathidae (Smith 1953; Munro, 1955). A systematic key was established to help identification of species of gerreidae through its otoliths (Lemos et al., 1993). Actually 40 gerreid species in seven genera are recognised (Nelson, 1994)

Several workers studied the distribution of different species of gerreidae. Day, 1878 reported that *Gerres setifer* is common in river Hooghly, attaining a length of 100mm, From Chilka lake it was first reported by Chaudhuri, 1923. It has a wide distribution in the sea and coast of India including estuaries. Some information on their landings and distribution was given by Devasundaram (1954), Jones and Sujansingani (1954) and Roy and Sahoo (1962), Jhingran and Natarajan (1966 ; 1969) have briefly described the fishery and Biology of this species. *Gerres lucidus* is a fish of east coast of India (Day, 1878; Nair, 1952; Hamsa and

Kutty,1972) and Minicoy island (Jones and Kumaran, 1980). Distribution of which in pulicat lake was studied by Kaliyamurthy, 1986.

Although various species of gerreidae are found usually in subtropical or tropical waters (Austin, 1971; Cyrus and Blaber, 1984b; Smith and Heemstra, 1986). One of the Australian species, namely southern silver belly *Parequula melbournensis* is confined to the marine waters of Temperate southern part of this continent (Hutchins and Swainston, 1986; Gomon *et al.*, 1994). Indeed this was the most abundant fish species collected during extensive trawl netting of lower west coast of Australia in seven consecutive seasons (Laurenson *et al.*, 1993a). Different species of gerreidae utilize different habitat and have different degree of specificity in habitat preference. (Mathewson *et al.*, 1995).

Studies on maturation and spawning of teleostean fishes have been made by various workers from all over the world. An attempt to study maturity by measurements of ova diameter was first made by Clark (1934). Later Hickling and Ruthenberg, 1936 studied ovary as an indicator of spawning periods in hake, haddock, pilchard and herring. Dejong, 1940 investigated the spawning habits of thirteen species of teleostean fishes from Java sea. Hickling, 1940 estimated fecundity of Atlantic herring of Southern North sea by counting the eggs of mature ovaries. Clark (1950) observed the spawning habit of northern pike in North Western China. The investigation carried out on the teleosts like *Melanogrammus aeglefinus* (Robb, 1982) *Scomberomorus cavalla* (Funucane *et al.*, 1986);

Euthynnus lineatus (Schaefer, 1987); *Lutjanus griseus* (Domeier *et al.*, 1996); *Sillago burrus* and *S. Vittata* (Hyndus *et al.*, 1996) revealed the reproduction biology of the species.

The relationship between attainment of first maturity and body size together with estimates of age composition and growth rates have been determined for populations of *Diapterus rhombeus* using a combinations of gonadal and length frequency data (Austin, 1971, Etchevers, 1978). *Gerres setifer* grows to a size of 110mm when one year old and 175mm when two year old (Patnaik S 1971). The maximum length attained by *G. filamentosus* cuvier is 175mm similar to that of gerreids *Gerres nigri, Diapterus rhombeus, Paraquuila melbournnsis*, but is less than that of *Gerres oyena* (300mm) (Austin, 1971, Albert and Desfossez, 1988, Kurup and Samuel, 1991, Sarre *et al* 1997). The use of scales to age *Gerres oyena* (Forskal) showed that this species which grows to a total length of 300mm lives for up to 7 years (El - Agamy, 1988). Age and growth rate of *Gerres setifer* was determined based on length - Frequency analysis (Anantha and Santha Joseph, 1995). Sarre *et al* 1997 used length frequency data scales and otolith for age determination of *Paraequila melbournesis*.

Reproductive system is a fundamental element in understanding fish stock variability. Early biological observations on the spanish Mackeral were made by Earil (1883) in Chesapeake bay and by Hildebrand and Cable (1938) along the south Atlantic coast. Reports on reproduction and other aspects of their biology were made for waters of Florida (Klima, 1959,) and of veracruz, Mexico (Medoza 1968).

Mojarras (gerreidae) are omnivorus and euriphagous fishes eating a wide spectrum of items mainly small invertebrates. Job (1940) gave an account of food of *Gerres punctatus* (*G. filamentosus*) along with food of other perches from Madras coast. Chacko (1949) furnished an account of food and feeding habit of *Gerres filamentosus, G. oyena and G. abbreviatus* from gulf of Mannar. Observations done on food and feeding habit of *Gerres Oyena* (Forskal) and *Gerres filamentosus* cuvier from pulicat lake by Rao, 1968. Concluded that both Species have identical food habit with similar construction of mouth. Both are bottom feeder with its protrusible mouth adapted for browsing on epiphytic animals like amphipods and also picks up other bethic organisms like polychaetes, bivalves, gastropods etc. (Arenas - G *et al* 1992)

Alves and Tom (1967) described the ouarian histology and size at first maturity of king mackeral *Scomberomorus cavalla* from Florida. Funucane *et al.*, (1986) studied the reproductive biology of *S. cavalla* from south eastern united states. Reproductive biology of Spanish mackeral *Scomberomorus maculatus* was also studied from this area by Funucane and Collins, (1986). Robb (1982) studied histological changes occur in the ovary of haddock *Melanogrammus aeglefinus* (L)

Histomorphology of ovarian changes during the reproductive cycle of *Trachurus mediterraneas* (Teleosti, Carangidae) was observed by Elgharabavi - *et al.*, (1988). Grimes *et al.*, (1988) investigated the reproductive biology of Tilefish *Lopholatilus chamaeleonticeps* Reproductive biological study of the pony fish *Gazza minuta* (Bloch) from PortoNovo east coast of India was done by Jayabalan (1988). An important component of many studies of fish reproductive biology is the assessment of stage of gonad development of individual fish. The methods in use vary from highly detailed to cursery, but there are few reviews of their reliability or usefulness. West, 1990 reviews the methods of assessing ovarian development in fishes. This review examines histology, measurement of oocyte size, staging based on appearance of the ovary, and gonad indices. Sexual maturation of blue spotted mud hopper, *Boleophthalmus pectinirostris* was investigated histologically regarding gonad development and studied by G. S. I, egg diameter, composition etc. by Chung *et al.*, 1991. Lopes *et al.*, 1991 described the oocyte development in Piranha *Pygocentrus nattereri* knerr 1860 (Pisces, Characidae)

Ovarian germinative tissue of a South American teleost fish, the "Pacu" *Piaractus mesopotamicus* (Holmberg) has been studied through histological techniques, for germinative cellular type identification and maturity cycles charecterization of the fish species. (Lima *et al.*, 1991).

The reproduction biology of serranid fish *Plectropomus maculatus* sampled from inshore waters of the central great barrier reef was studied based on histological analysis of gonad material (Ferreira, 1993) and red drum *Sciaenops ocellatus* from nertic waters of the northern gulf of Mexico (Wilson *et al.*, 1994).

A histological study was carried out on the gonads of amberjack, *Seriola dermerili* to provide a basic knowledge of its reproductive biology with a view to a possible control of reproduction in captivity (Micale, *et al.*, 1993), spawning in anchovy *Engraulis lapensis* (Meloy *et al.*, 1994), spawning period of Pacefic Mackeral *Scomber japonicus* is estimated based on the changes in gonad index and ovarian histology (Murayama 1995); the ovarian morphology, annual reproductive cycle and spawning characteristics of kichipi rockfish *Sebastolobus macrochir* collected from the Pacific coast of south eastern Hokkaido, was examined on the basis of histological observation (Koya *et al.*, 1995). Histological sections of European horse mackeral *Trachurus trachurus* (L) ovaries were used to follow oogenesis and to describe the atretic states (Karlous and economidis, 1996)

Prabhu (1956) studied maturation and spawning periodicities of seven species from Madras coast. Later studies on the reproductive biological aspects of *Chanos chanos* (Tampi, 1957); *Sardinella longiceps* (Nair, 1959); *Trichiurus lepturus* (James, 1967); *Trachysurus dussumeriri* (Vasudevappa and James, 1978); *Liza parsia* (Muthukaruppan, 1993); *Sillago sihama* (Jayasankar, 1989); *Mugil* *cephalus* (Goplakrishnan, 1991) have described maturation, spawning, fecundity of teleosts of Indian coast.

Little information is available on the reproductive cycles of gerreidae, Although Austin (1971) and Etchevers (1978) studied the breeding of *Diapterus rhombeus* in the offshore waters of Puerto rico and Venezuela, Charles (1978) investigated the reproductive cycles of *Eucinostomus gula* in Biscayne Bay, Florida, U.S.A Reproductive biological study of Gerres in Natal estuaries by Cyrus and Blaber, 1984, similar studies on *Diapterus rhombeus* (cuvier) and *Gerres nigri* (Gunther) have been done in tropical esturies (Etchevers, 1978; Alberet and Desfossez, 1988). Despite their very high numbers in many areas and commercial importance is some regions (El-Agamy, 1988; Kurup and Samuel, 1991). There have been few detailed studies on the biology of species comprising this family. (Castro and Cowen, 1991, Conover, 1992). Several species of gerreidae spent part of their life in estuaries (Cyrus and Blaber, 1982; Kershner *et al* 1985; Blaber *et al*, 1989; Nelson, 1994).

The only study on reproductive biology of gerreids which has incorporated type of histological examination of gonads, that is usually required to determine the precise duration of spawning period and whether spawning occures more than once in a breeding season is that carried out by Cyrus and Blaber (1984), on three species of gerres in estuaries of tropical Southern Africa. Of all methods determining reproductive state of female fish, histology is the most accurate (Hunter and Macewicz, 1985b) and depends upon the nature of study may be the only satisfactory method. Experimental induced spawning of patao *Eugerres brasilianus* (Pisces, Gerreidae) was done by Alvarez *et al.*, 1991. Nivon *et al* 1990 assessed the aquaculture potential of eight marine species from Maxican Pacific which include Silver biddies *Gerres cinerus* and *Eugerres auxillaris.* Sarre *et al* (1997) carried out investigations on the reproductive biology of a temperate gerreid in Australian waters.

A persual of Literature shows that the reproductive biology of gerreids of Indian waters have been reported by several workers (Jones and Sujansingari, 1954; Jhingran and Natarajan, 1969; Patnaik, 1971) Kurup and Samuel, 1991).

DESCRIPTION OF SPECIES

Gerres filamentosus cuvier

Vernacular name: whipfin Silver biddy

Distinctive Characters

Body compressed, elevated, its depth contained 2 to 2.5 times in standard length in larger specimens upto 3 times in smaller specimens. Anterodorsal profile ascending steeply at an angle of about 4^{0}c to horizondal axis. Second dorsal spine laterally compressed, produced into a filament, whose tip extends past level of first anal spine. Third dorsal spine laterally compressed as long as distance from tip of snout to pre opercular margin., pectoral fin long, tip of depressed fin reaching to level of origin of first anal spine, third dorsal spine laterally compressed as long as distance from tip of snout to pre opercular margin; second anal fin spine much shorter than anal fin base; caudal tin deeply forked, its longest rays three times the length of median rays, (Fig 1)

Colour :

Silvery with 7 to 10 columns of ovoid spots on upper portion of sides, coalescing as bars in small specimens. Pectoral, Pelvic, Caudual and anal fins dusty hyaline, tips of pelvics, anal and lower lobe of caudal, white, dorsal fin hyaline except for the end of filamentous spine, which is black, It is silvery with a dark ovoid patch in the anterio dorsal quarter

Geographical distribution

Widespread in all warm seas of Indopacefic, from the east coast of Africa through Indo Malayan archipelago, South china sea, Northern Australia and the west Pacific islands

Fig. 1 (a)

Fig 1 (b)

Fig. 1 (a) *G. Filamentosus* cuvier female

(b) *G. Filamentosus* cuvier female showing ovary

MATERIALS AND METHODS

Collection of Specimen

Samples of *Gerres filamentosous* were collected from Cochin Fisheries harbour at weekly intervals for a period of three Months (From March 1988 to June 1988). They are caught by trawl nets. The specimens collected had a length range of 120mm to 190 mm

The fish after collection were carried to the laboratory and kept in freezer. The Morphometric measurements like total length, standard length, fork length, head length, depth were measured. The body weight were taken accurately in a sensitive balance. Then the sexes of specimen are identified by cutting open the belly.

Maturity stages of females were identified based on microscopic examination of ovary shape and size in relation to body cavity, colour, extend of yolk formation and microscopic structure such as ova diameter measurement (Clark, 1934).

The ovaries were taken out from body cavity and kept in 10% formalin for preservation. It is used for Fecundity study and ova diameter measurement. A small part of formalin preserved ovary tissue is taken and spread on a microslide. The oocyte were carefully separated with fine needle as evenly as possible to spread out on the slide, Diameter measurements of atleast 100 oocyte from each ovary was carried out under the microscope with an ocular micrometer at a magnification (10x) Ovaries from 30 number of specimens were taken for fecundity estimation.

1. Sex Ratio

A total of 246 fishes collected from commercial catches were examined for determining sex ratio. It was not possible to detect any external characters such as body proportions, meristic charecters or colour which could be useful for sex determination. Sex is determined only by gonadal examination. Total number of individuals belong to each sex were counted. A knowledge of sex composition of catch helps in understanding whether any differential fishing exists between males and females and if so, its possible bearing on the fishable stocks.

2. Size at first Maturity

The fish specimen with gonads undergoing active gametogenesis were considered as mature. The length at which 50% of total individuals are nature was considered as size at first maturity (Beverton and Holt, 1957)

3. Fecundity

Fecundity was estimated by counting the number of mature ova in a weighed portion of ovary and computed for the whole. The regression equation logy = a+b log x was fitted to the data to determine the relationship between fecundity and body weight (grams) as well as total length (mm) here,

4. Oocyte diameter

Size of ova is a good indicater of maturation and gonadal cycle (Davis, 1985). Oocyte diameter was measured along its horizontal axis using ocular micrometer pre caliberated with stage micrometer. Oocytes were measured at random till the count reaches 100 oocyte. The data obtained was used to work out largest size frequency profile.

5. Length frequency analysis

This method is based on the assumption that length of individuals of same age group in a population of fish are approximately normally distributed.

6. Histology

Histological characteristics of ovary at different stages of maturity were studied. Sample pieces of ovary 15mm thick were taken from freshly collected specimens and fixed in Bouins fixative for 12-24 hrs. The tissue was then thoroughly washed with running water for 4 -5 hrs and then stored in 70% ethyl alcohol until further processing. The tissue were dehydrated in graded alcohol series by following standard procedure. This tissues were then cleared with chloroform for 3-4 hrs impregnated with and embedded in paraffin wax . The material was then sectioned at 6-8 μm in a rotary microtome. The sections were spread over slides on which a thin layer of Mayors glycerol albumen adhesive was applied earlier, This adhesive is a combination of egg white and glycerol in 1:1 ratio. The sections were deparaffinised, hydrated and stained with haematoxylin and 1 % aques eosin as counterstain. DPX was used as mounting medium for all slides.

RESULTS

1. Maturity Stages

Male

The male gonads were classified into four stages, immature, maturing, mature and spent. The testes were small and occupied very little portion amounting to about 1/10th of the body cavity in the immature condition. Maturing testes were thick and little flattened whitish in colour and occupied half of the body cavity. In Mature condition there were white in appearance and occupies 3/4th of the body cavity. Spent testes some what whitish red in colour and shrunken.

Females :

The following stages of sexual maturity were observed in the case of females (Fig. 2a).

Stage I (Immature)

Ovaries appears thick, short, transparent tubes occupies small portion of the body cavity. There were present throughout the study period but is less in number as compared to other stages. Oogonia (Mean size: 10 µm) were found in the ovaries. Diametr of the Oogonia ranged forms 2 to 15µm in this state.

Fig. 2 (a)

Fig 2 (b)

Fig. 2 (c)

Fig. 2 (a) *G. Filamentosus* cuvier female maturity stage 1-V

(b) Stage II

(c) Stage V

Stage II Inactive/Resting (Recovering spent)

Ovaries were yellowish, occupies one third of the body cavity : Ova visible to naked eye. Large number of pre-vitellogenetic oocytes were present in immatures and inactive ovaries which showed no evidence of development towards IIIrd type Oocytes. Diameter of the oocytes showed range of 10 μm to20μm (Fig. 2b).

. *Stage III Developing (Active)*

Ovaries occupies about half of the body cavity and yellowish in colour. (Fig. 2a). As the development begins the oocytes increase in size, developing into yolk precursor stage. The nuclei showed irregular cuticle. (Fig 3a). Diameter of the oocytes showed range . 15 μm to 30μm.

Stage IV - Mature :

Ovaries occupies about three forth of the body cavity and deep yellow colour. At this stage non cellular membrane begins to form between follicular layer and developing oocyte. Fig. 3 b illustrates an early non staining yolk stage oocyte. In stage IV development oocyte contains numerous yolk granules and a well developed chorion (Fig. 4 a).

The ova diameter showed a range of 20 μm to 35μm. The ovary contains batches of vocoulated oocytes, some of which contains developing yolk granules.

Stage V (Ripe and Running) :

The mature Oocytes (Fig 2c) in stage V are all in various stages of yolk accumulation. (Fig 4b). Fig.5 (a-b) shows early and peripheral development of the secondary yolk componant appears as stained granuels. The cytoplasom is completely fiilled with secondary yolk granules. During this stage ripe Oocytes undergo hydration, resulting in transparency and considerable increase in volume. This leads to the rupture of the follicle and the eggs passed out though the oviduct.

Stage VI - Spent:

Ovaries small occupies less than 1/3rd of body cavity.

2. Fecundity

The fecundity of specimens ranging 142 to 161 mm, 141 to 172 mm and 141 to 180 mm corresponding to the maturity stages III, IV and V are given in the table 1, 2 and 3.

In the stage III fecundity showed a range of 5460, to 88695 eggs for the fish ranging in length from 142 to 157 mm The number of eggs produced by the fish of different length groups shows that the fecundity of this fish more or less increases with length (Fig 6). The fecundity in the length range 140-145mm is below 10,0000 and increases upto 80,000 in the length range and shows slight decline in the higher length groups.

In the stage IV fecundity showed a range of 17400 to 89,560 for fish ranging from 141 to 195 mm. The fecundity in the length range 140 to 145 is below 25,000 and thus shows an increase upto 50,000 eggs in the length group 150-155 and finally to 70,000 eggs in the range 170 to 175 mm group (Fig 7).

In the stage V fecundity showed a range of 21990 to 41750 eggs for the fish ranging in length from 141 to 180mm in this stages. (Fig 8).

3. Maturity condition

Female

Maturity percentage of fishes is given in the **Table 4** It is observed that in the length range 100-115 all the fishes were immature condition. From 115 mm onwards number of immature fishes decreases and is 165-170 mm range the immature percentage is zero. Mature females were observed in the 115-120 mm length range (25%) and progressively increases and in the 125-130mm range 50% females were mature. In the length range 145-150mm 80% females were mature. The sample shows that the fishes above 165mm sizes were all in mature condition. A total of 150 samples were analysed and it is found that 73 belongs to immature and 77 belongs to mature condition of fish. Size at first maturity was calculated as 125 mm (Fig 9)

Male

Maturity percentage of male fish were given in the **Table 5.** It is observed that in the length range 100-105 all the fishes were in immature condition. As the length increases the percentage of maturity also shows increasing trend and in the 110-115 length range 50% fishes were mature. In the size range 140-145 almost 80% of fishes were in the mature conditions and is 150-155, the maturity is 100%.

4. Sex Ratio

A total of 246 fishes were studied and it is observed that 150 are female fishes and 96 are male ones (**Table No:6**). Sex ratio was found to be female dominated throughout the period of study (IM :1.5F). During the month of march the sex ratio was 1:1.3 (male : female) and showed increase in the female number during the April (IM:2.6F). During June the sex ratio was IM : 1.1 F.

5. Length - Frequency

Length frequency distribution of G. Filamentosus during the period of study is shwon in the Fig 10 to Fig 16.

6. Ova-diameter

The Oocyte - diameter frequency of mature ovary are shown in the Fig. 17 to Fig. 20.

Table No:1 Fecundiity of *G. filamentosus*

Maturity Stage III

Sl. No.	Total length	No. of Ova
1.	142	5460
2.	147	35640
3.	150	43700
4.	151	26200
5.	155	26150
6.	157	88695
7.	160	50820
8.	161	28250

Table No :2 Fecundity of G. filamentosus.
Maturity Stage IV

SI. No.	Total length	No. of Ova
1.	141	17400
2.	144	23700
3.	149	24920
4.	150	43740
5.	155	20160
6.	156	20880
7.	157	53100
8.	160	21680
9.	164	25640
10.	171	65696
11.	172	78560
12.	195	89560

Table No : 3 Fecundity of *G. filamentosus*.

Maturity Stage V

Sl. No.	Total length	No. of Ova
1.	141	21990
2.	144	26295
3.	149	43380
4.	150	36480
5.	155	32120
6.	159	40960
7.	164	39180
8.	165	35250
9.	169	43850
10.	180	41750

Table No: 4 Maturty Percentage of Female *G. filamentosus*

Length (mm)	Immature	Mature	Total
100-105	4 (100)	-	4
105-110	6 (100)	-	6
110-115	8 (100)	-	8
115-120	12 (75)	4 (25)	16
120-125	16 (77)	5 (23)	21
125-130	2 (50)	2 (50)	4
130-135	2 (33)	4 (66)	6
135-140	2 (25)	6 (75)	8
140-145	3 (28)	8 (72)	11
145-150	3 (17)	15 (83)	18
150-155	8 (44)	10 (54)	18
155-160	5 (36.8)	9 (64)	14
160-165	2 (28.6)	5 (71.4)	7
165-170	-	2 (100)	2
170-175	-	2 (100)	2
175-180	-	2 (100)	2
180-185	-	1 (100)	1
185-190	-	1 (100)	1
190-195	-	1 (100)	1
	73	77	150

Table No: 5 Maturty Percentage of Male *G. filamentosus*

Length (mm)	Immature	Mature	Total
100-105	3 (100)	-	3
105-110	2 (66)	1 (33)	3
110-115	1 (50)	1 (50)	2
115-120	2 (40)	3 (60)	5
120-125	1 (33)	2 (66)	3
125-130	1 (33)	2 (66)	3
130-135	2 (17)	10 (83)	12
135-140	5 (25)	15 (75)	20
140-145	2 (16)	11 (84)	13
145-150	1 (12)	8 (88)	9
150-155	-	9 (100)	9
155-160	-	5 (100)	5
160-165	-	2 (100)	2
165-170	-	2 (100)	2
170-175	-	1 (100)	1
175-180	-	1 (100)	1
180-185	-	1 (100)	1
185-190	-	2 (100)	2
190-195	-	-	-
	20	**76**	**96**

Table No : 6 Sex ratio of *G. filamentosus*

	Female	Male	Total	Male : Female
March	52 (57%)	38 (43%)	90	1:1.3
April	58 (65%)	22 (35%)	80	1:2.6
May	40 (55%)	36 (45%)	76	1:1.1
Total	150 (60%)	96 (40%)	246	1:1.5

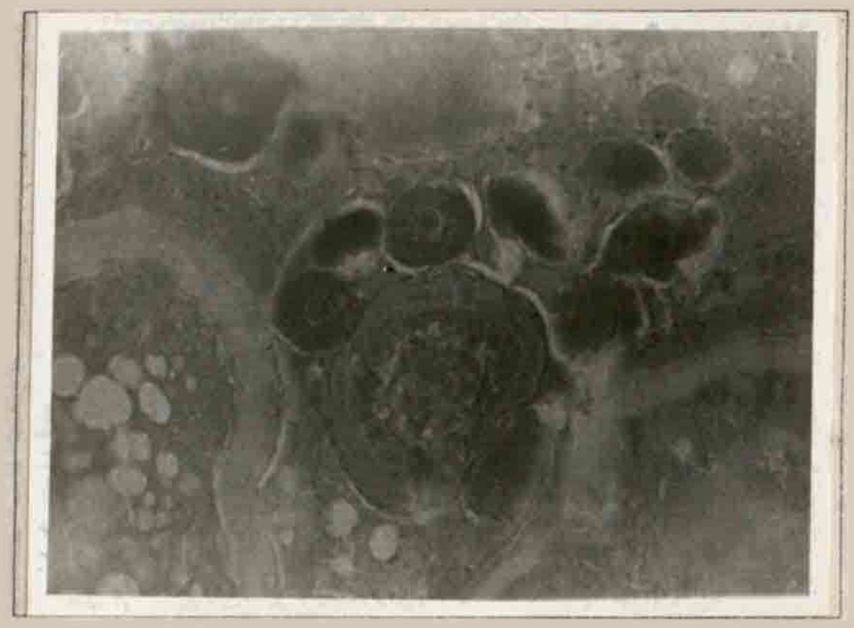


Fig. 3 (a) Stage III Oocytes at yolk precursor stage

Fig. 3 (b) Stage IV Early non staining yolk stage

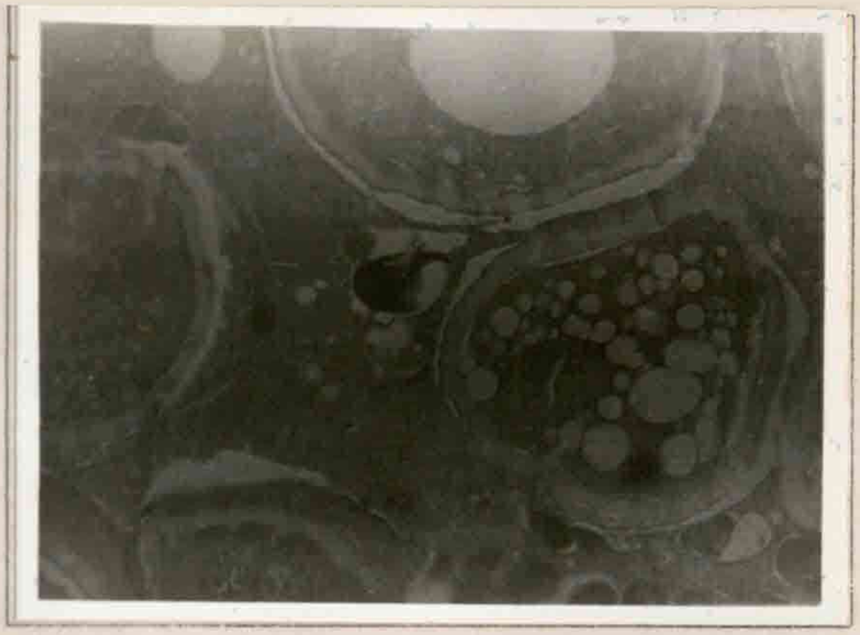


Fig. 4 (a) Stage IV Chorion development

Fig. 4 (b) Stage V Early yolk staining stage

Fig. 5 (a) StageV Early yolk stage - Single oocyte

Fig. 5 (b) Stage V

Fig.8. Fecundity of *G.filamentosus* in relation to length (Stage III)

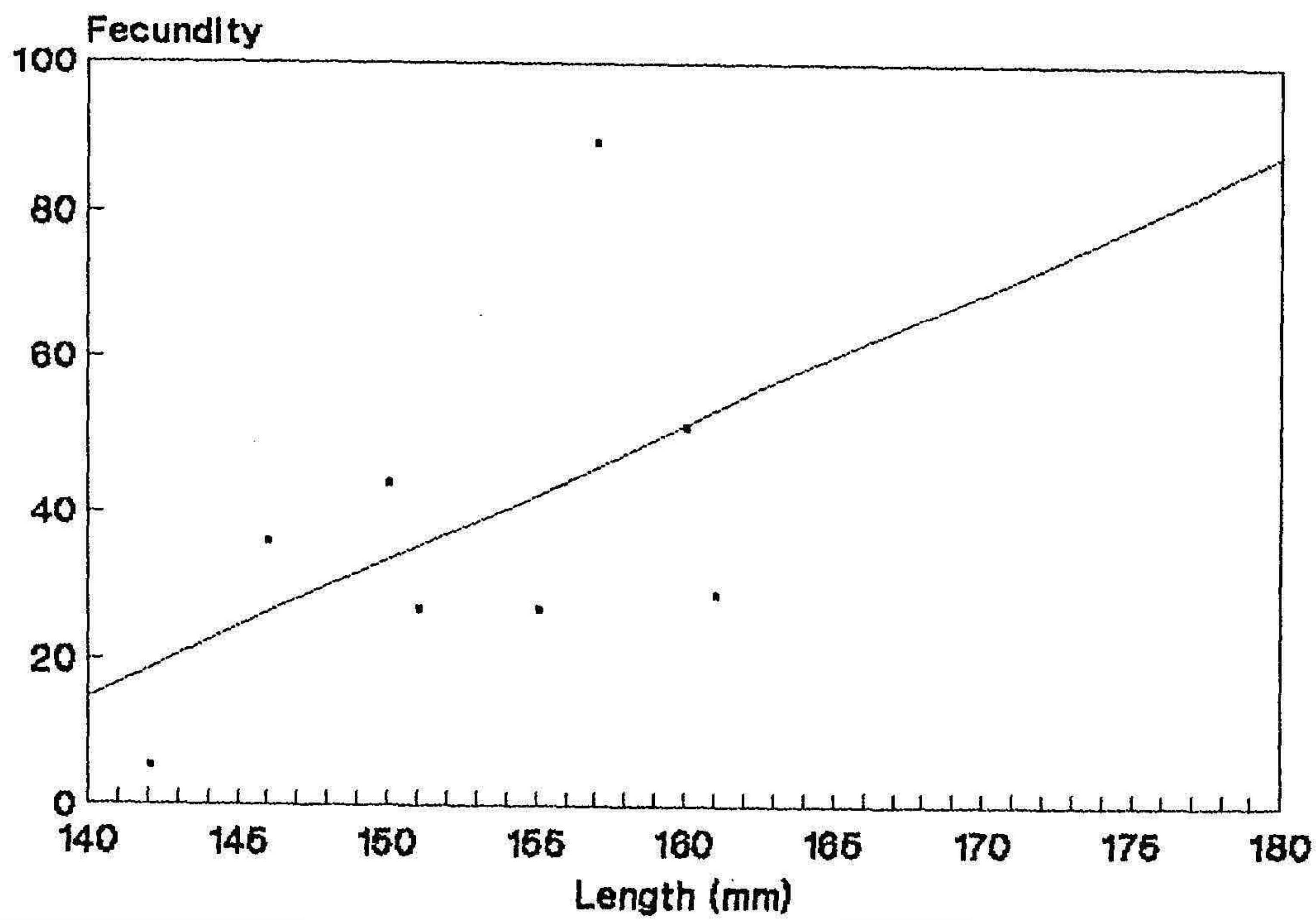


Fig. 7. Fecundity of *G.filamentosus* in relation to length (Stage IV)

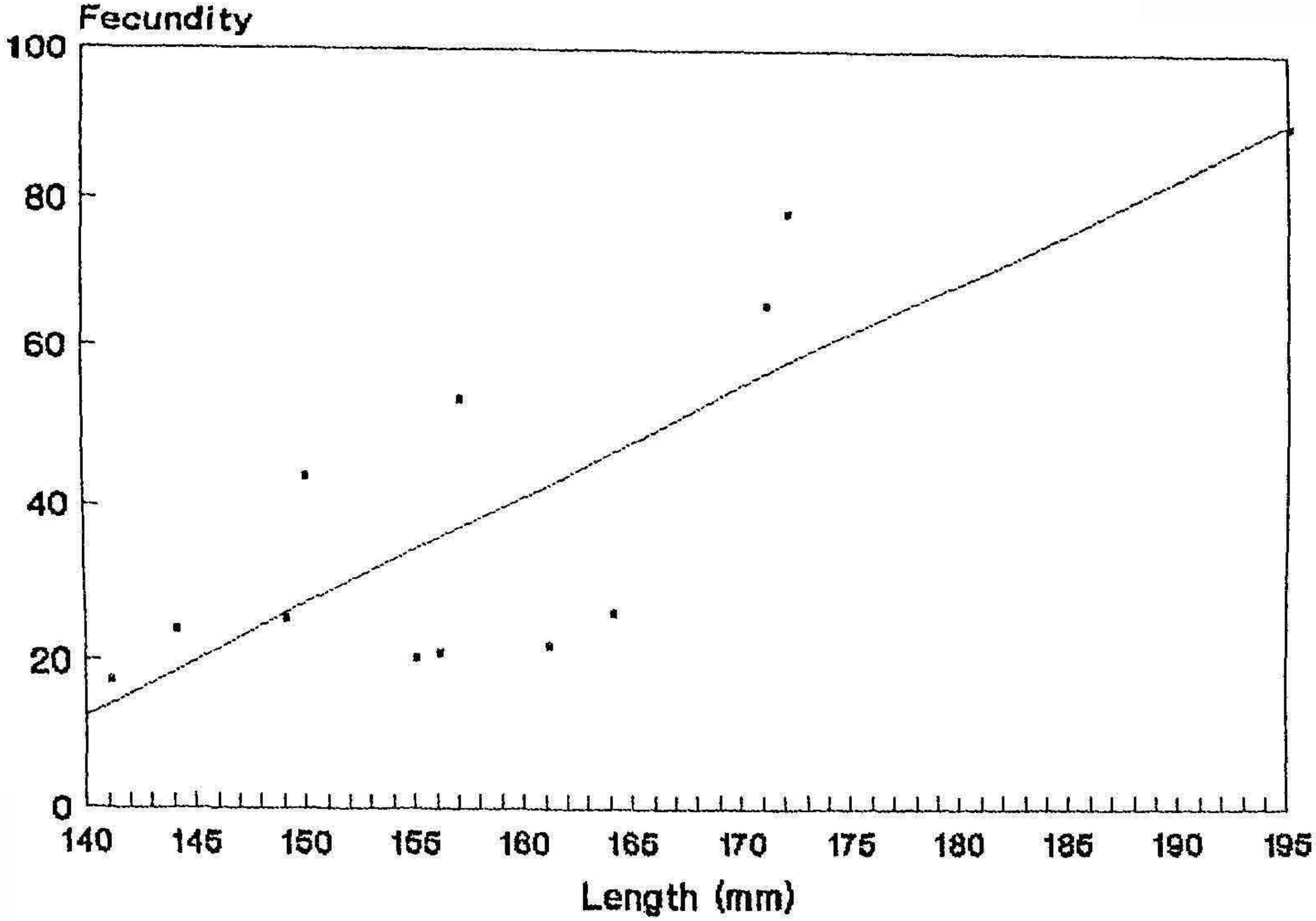


Fig. 8. Fecundity of *G. filamentosus* in relation to length (Stage V)

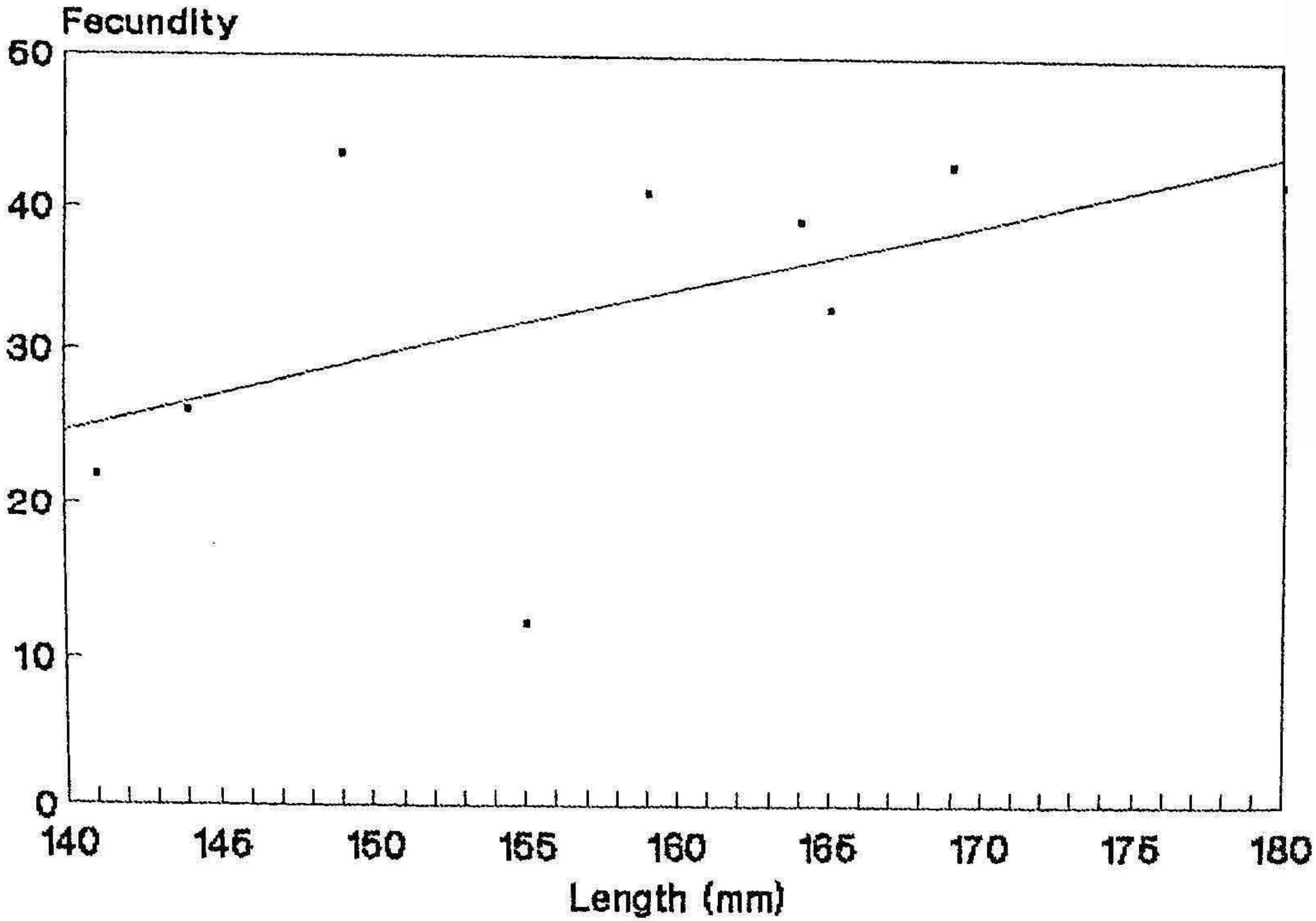


Fig.9. Gerres filamentosus : Maturity curve of female as a function of length

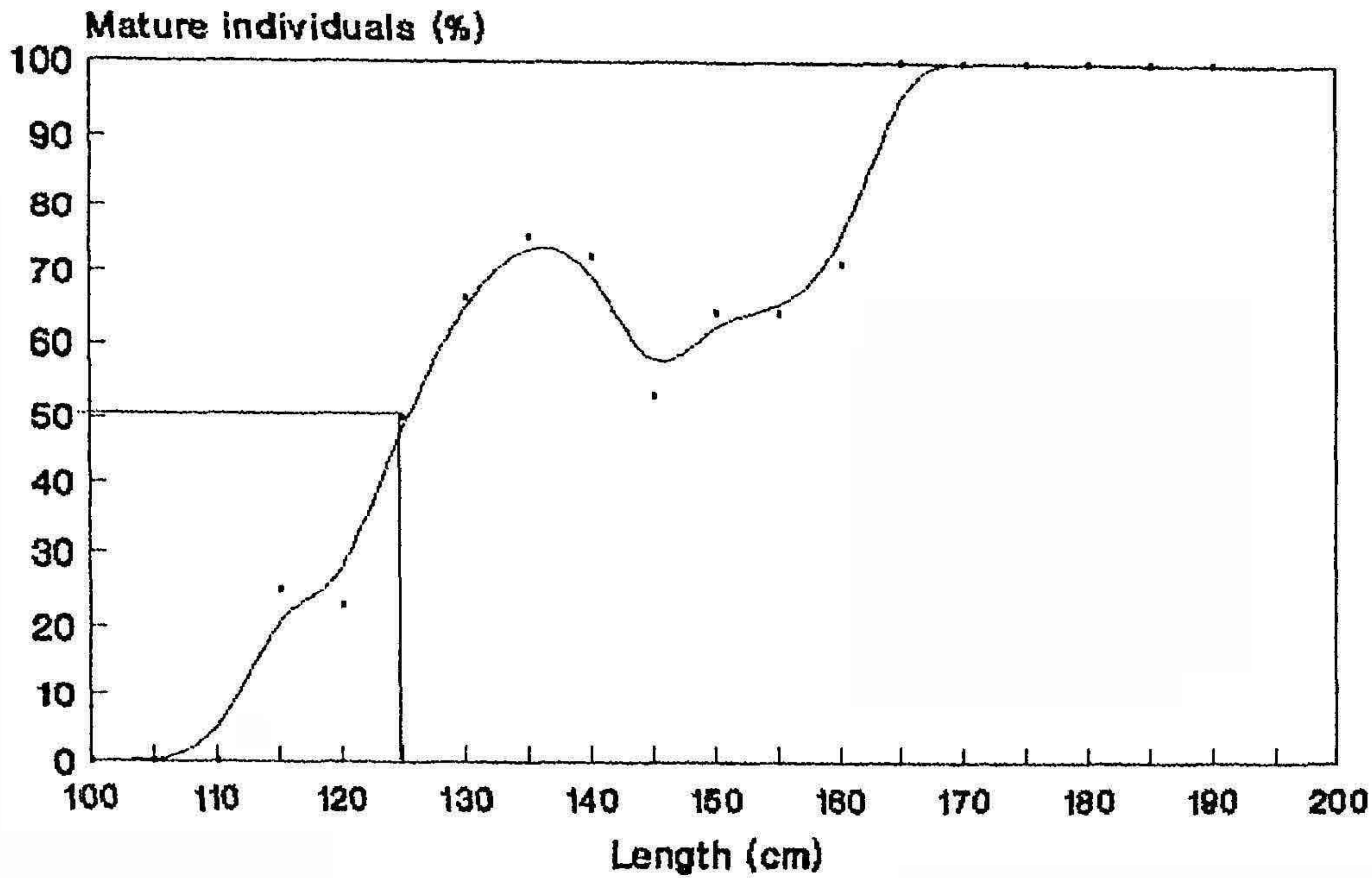


Fig.10.Length-frequency distribution of *Gerres filamentosus*

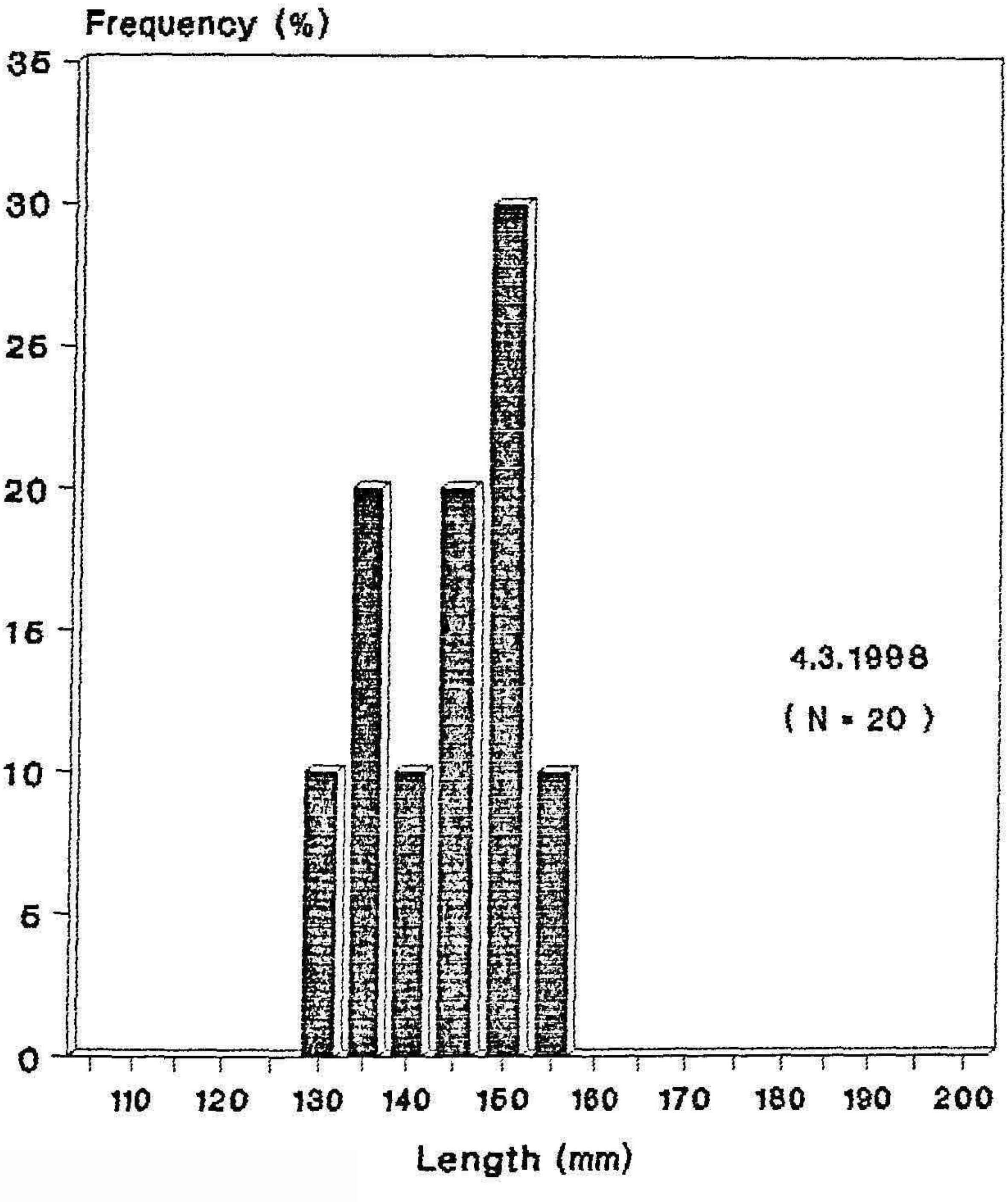


Fig.12.Length-frequency distribution of *Gerres filamentosus*

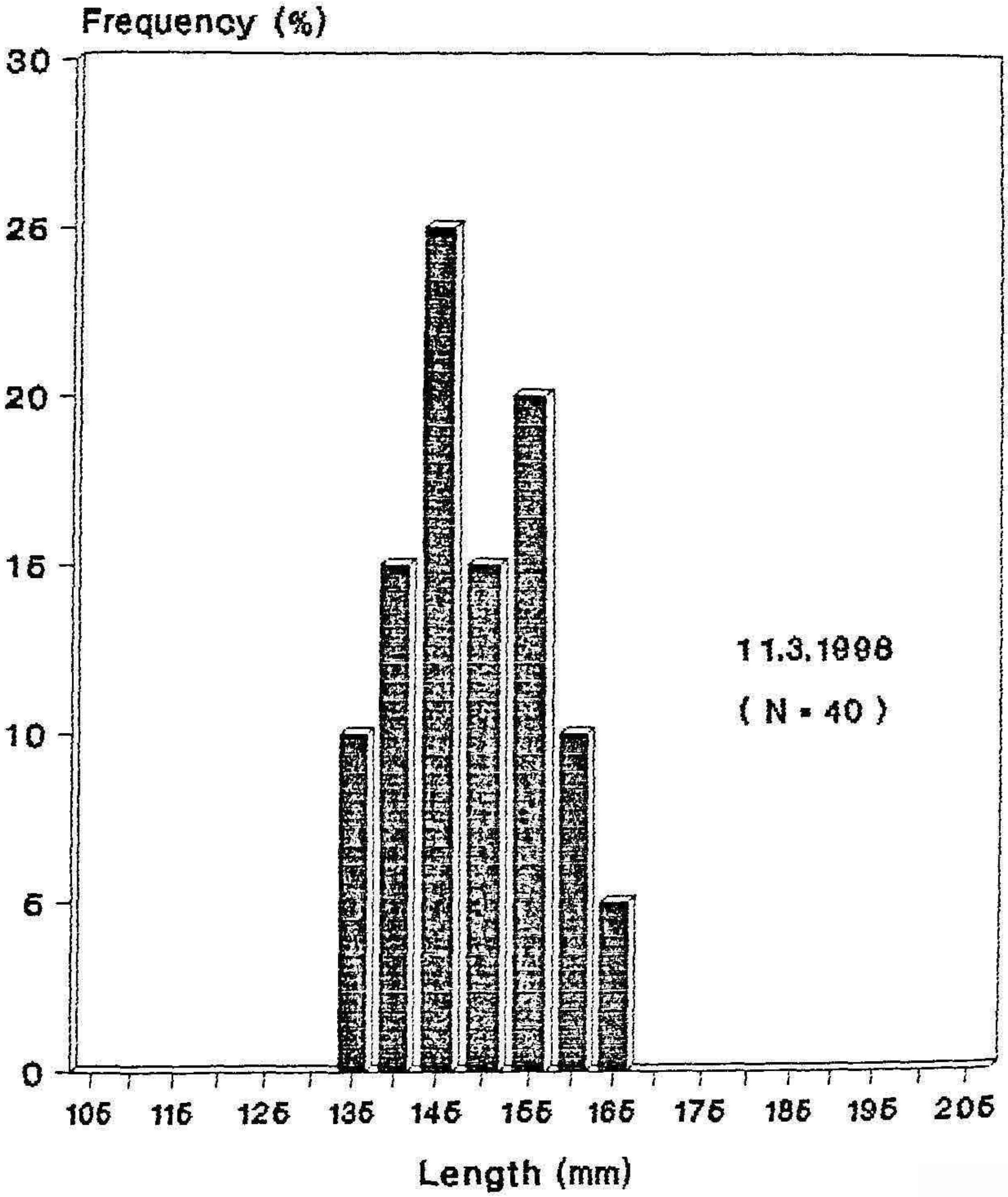


Fig.13.Length-frequency distribution of *Gerres filamentosus*

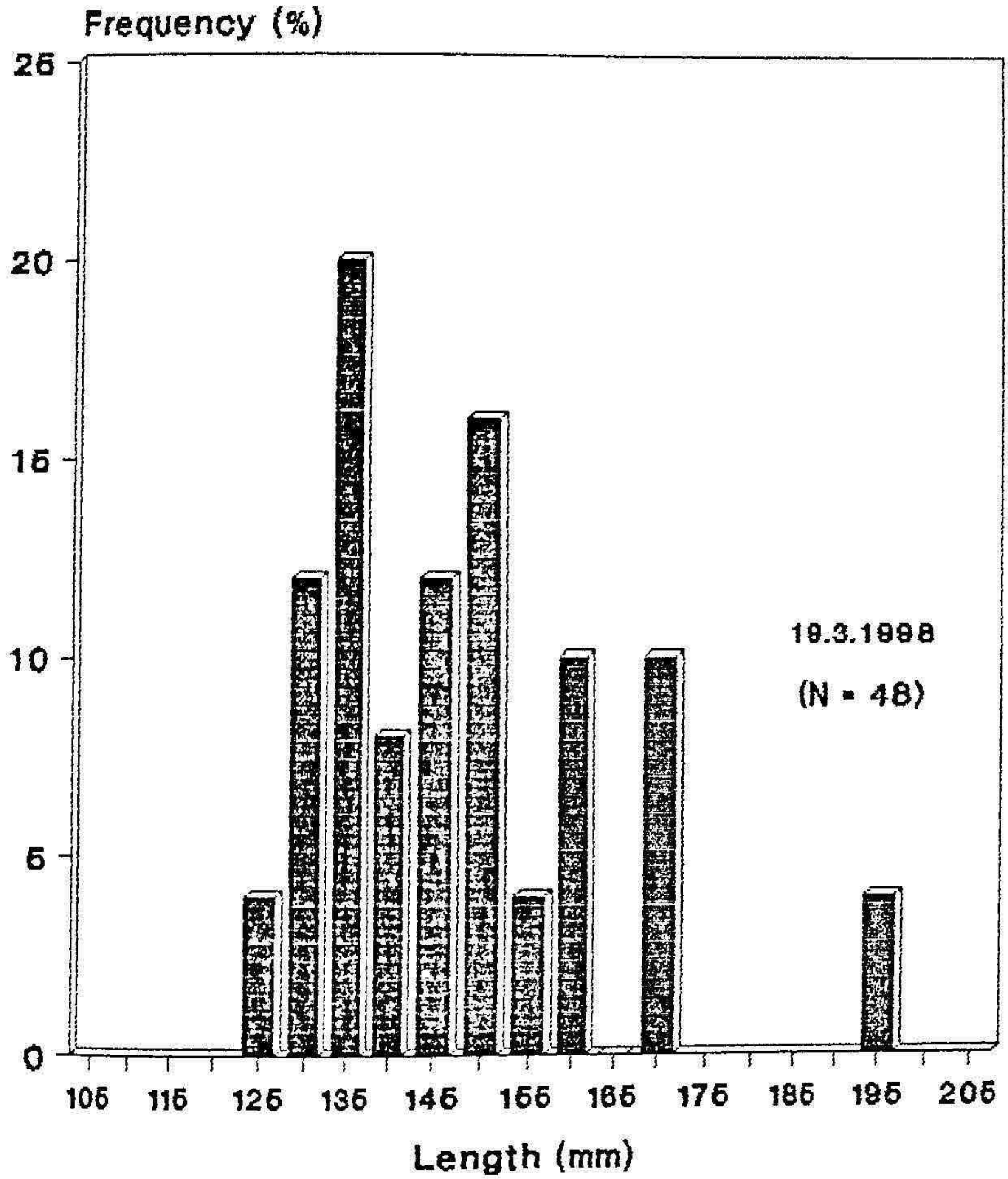


Fig.14.Length-frequency distribution of *Gerres filamentosus*

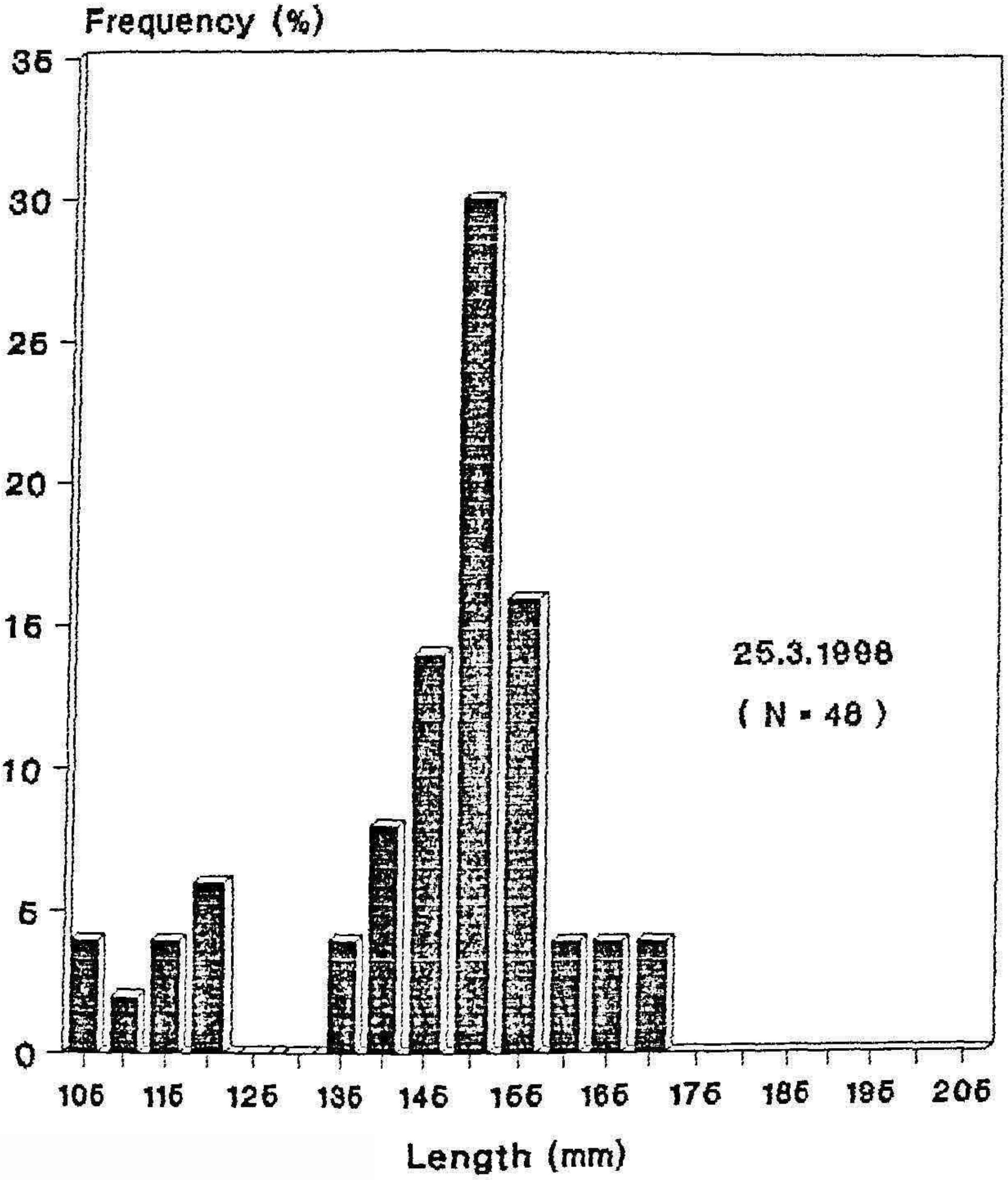


Fig.15.Length-frequency distribution of *Gerres filamentosus*

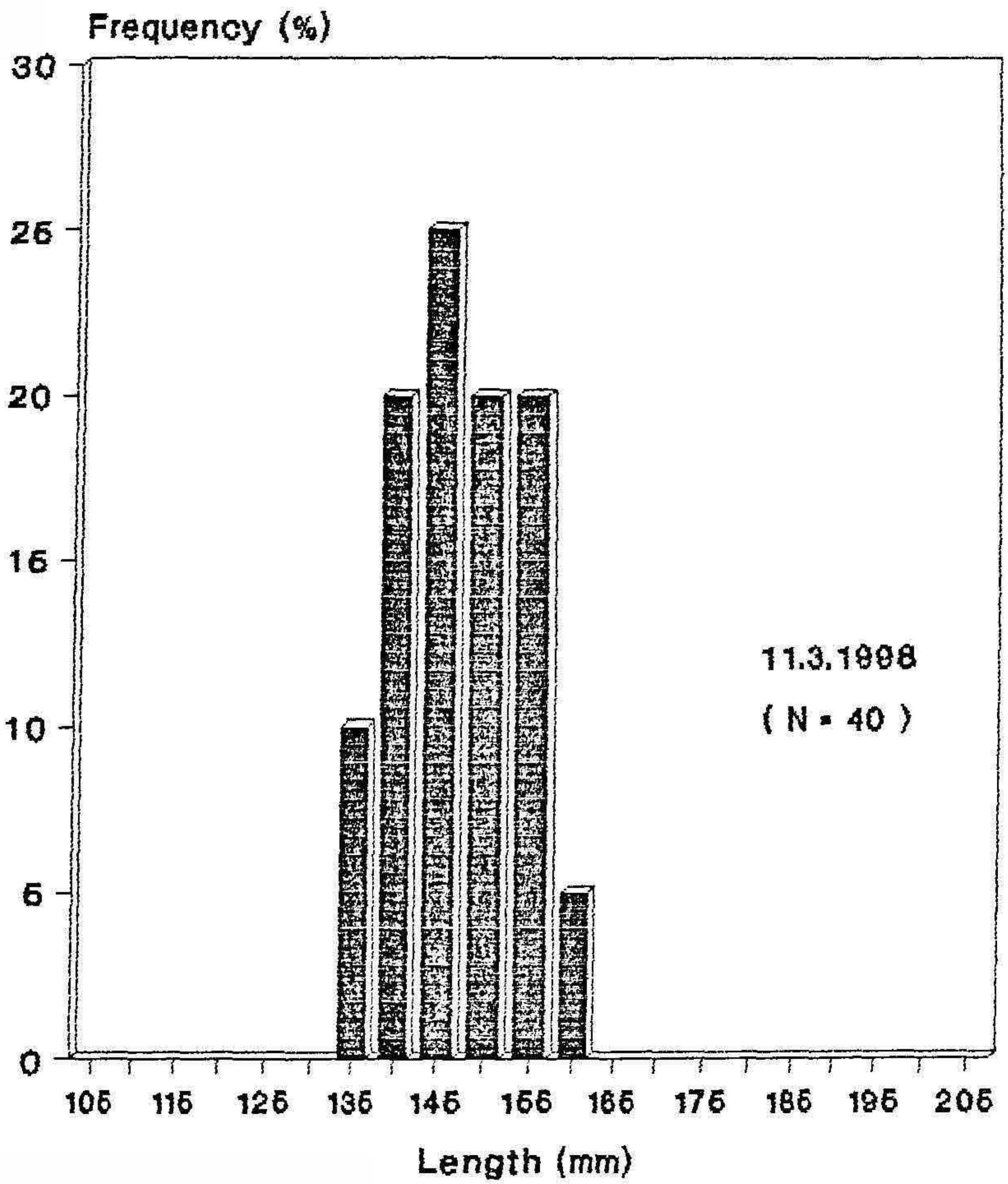


Fig.16.Length-frequency distribution of
Gerres filamentosus

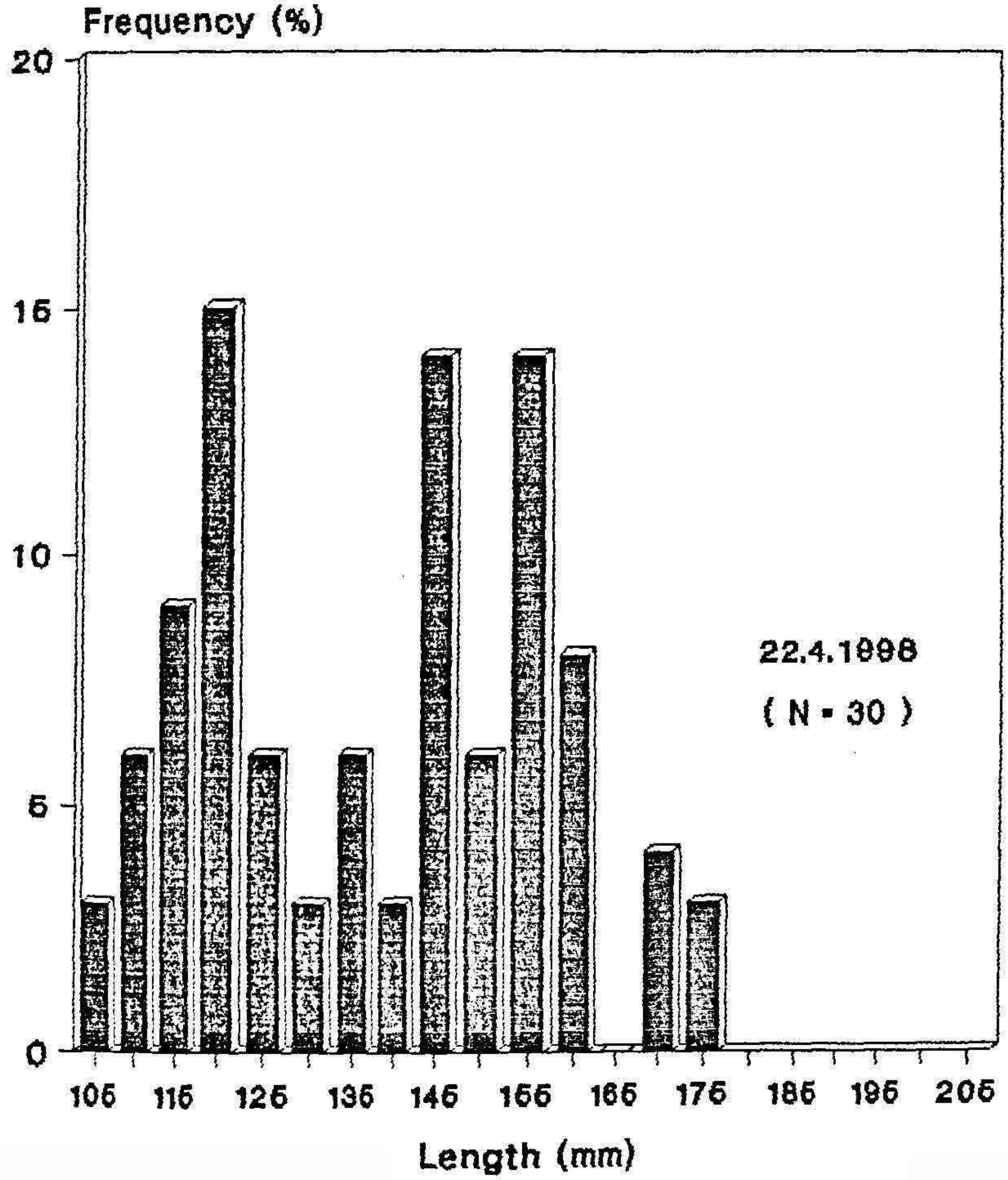


Fig. 17. Oocyte diameter frequency graph of different stages ovary (6.3.98)

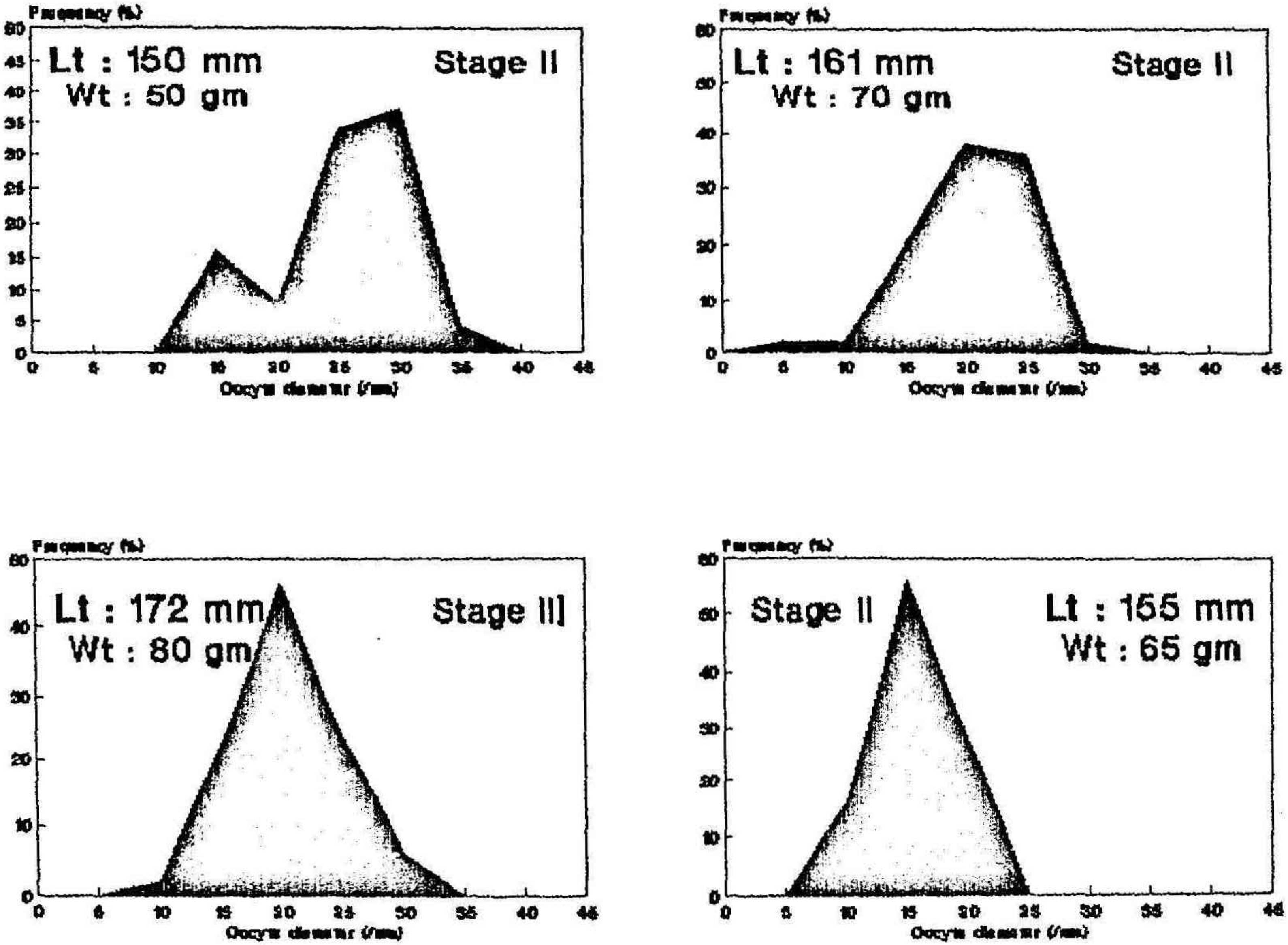


Fig. 18. Oocyte diameter frequency graph of different stages ovary (19.3.98)

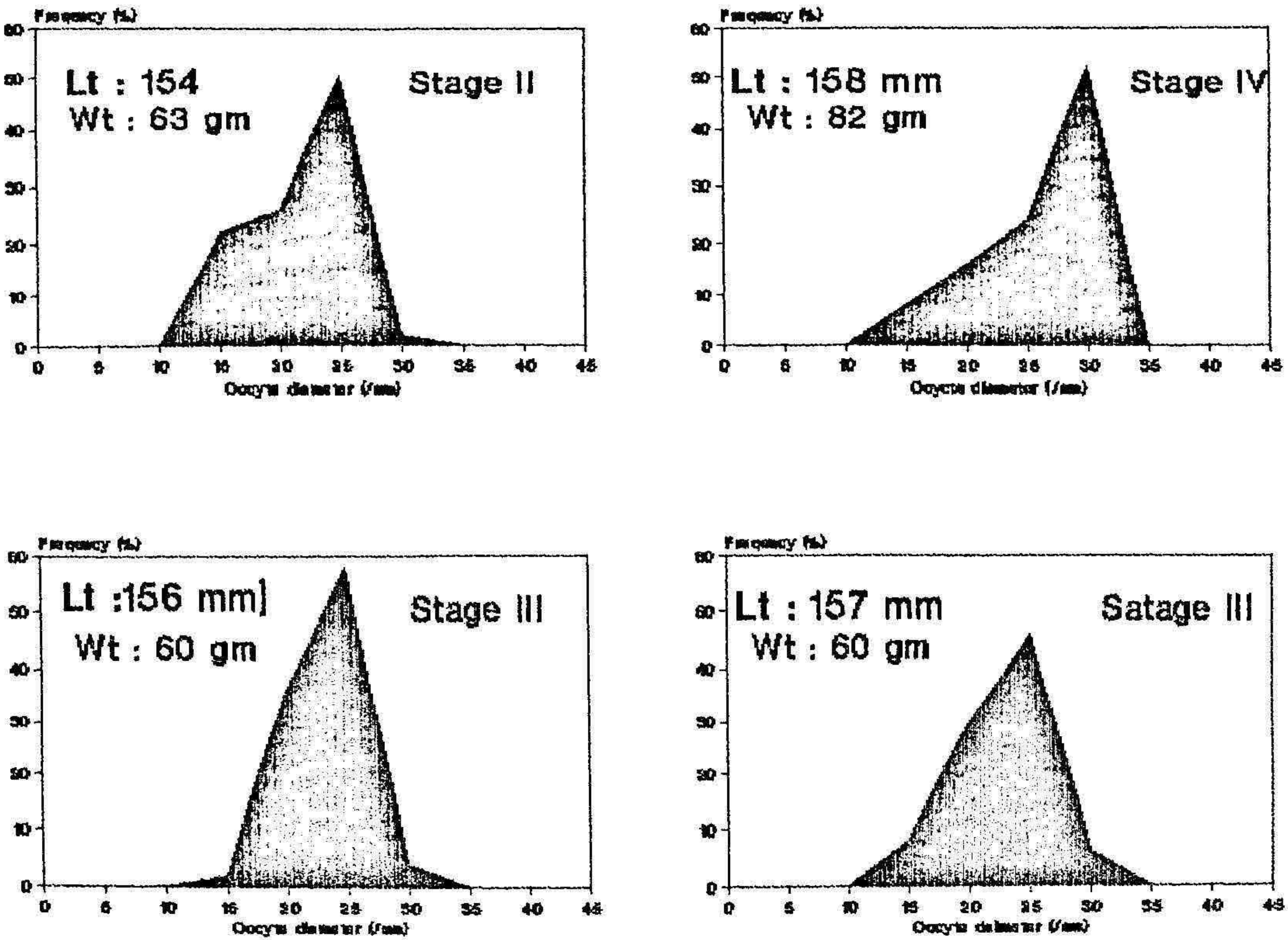
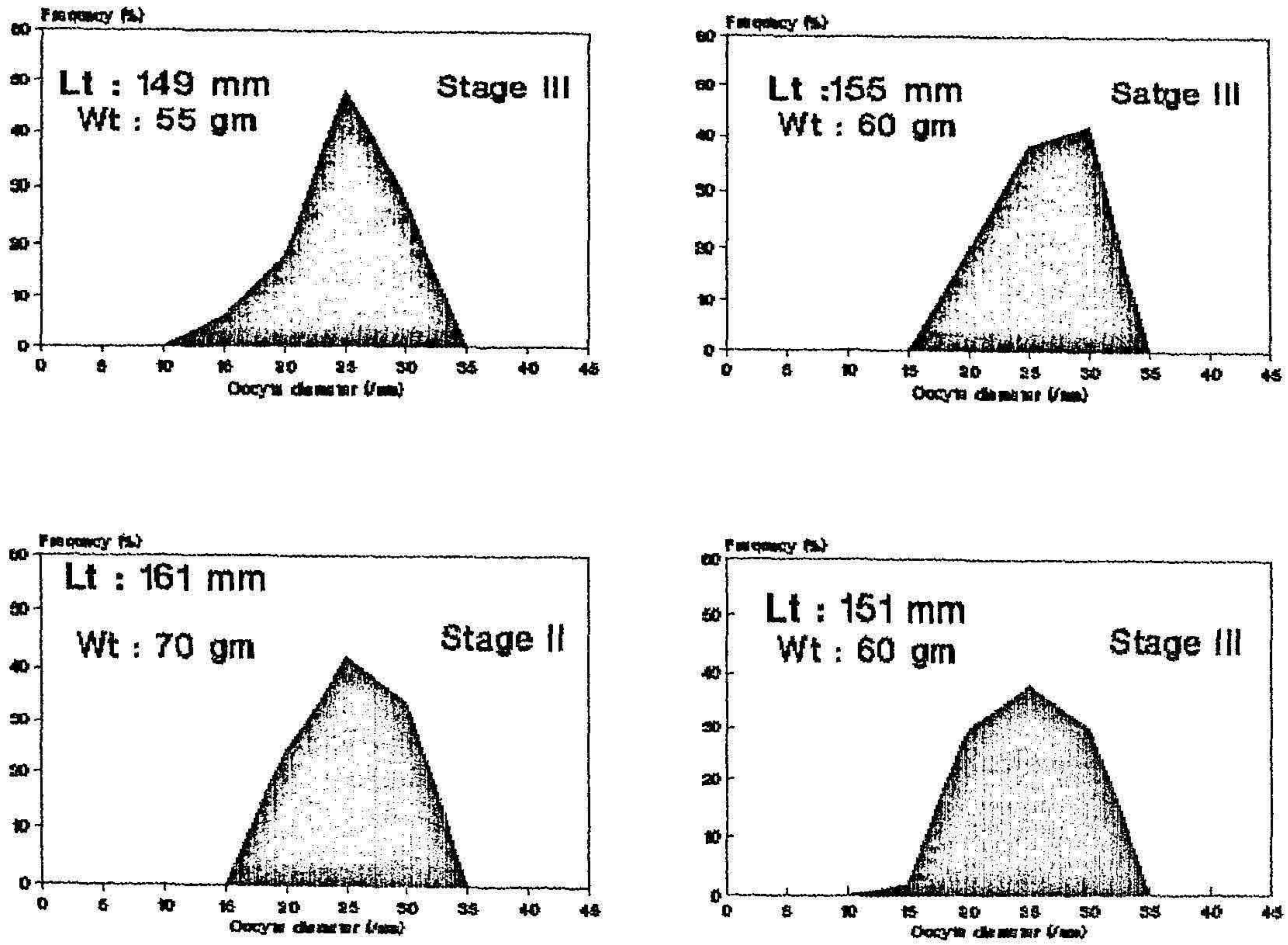


Fig. 20. Oocyte diameter frequency graph of different stages ovary (1.4.98)



DISCUSSION

Areas and seasons of spawning

Fish reproduction is almost always a seasonal or cyclical phenomena in the tropical and subtropical reagion, were environmental conditions seems relatively stable, there may be still be a cycle of gonadal maturation impossed by the energy demands of maturing a batch of eggs (Hoar, 1969).

The breeding biology of fishes of the family Gerreidae, of Pulicat and Chilka lakes was investigated by Jhingran and Natarajan (1969), Rao (1970) and Patnaik (1971). In Chilka lake, Jones and Sujansingani (1954) observed the male specimens of *G. setifer* in ripe condition with flowing milt and female with ovary almost in ripe condition, but they were not able to say whether the species bred in the lake or not. Jhingran and Natarajan (1969) observed the occurrence of males and females of *G. setifer* with oozing gonads in the southern sector of Chilka lake. Rao 1970 stated that *G. oyena* with oozing gonads were not encountered from Pulikat lake and so he persumed that the final stage of maturity of the species was attained only in the sea. Fishes with fully matured gonads occured through out the year and hence concluded that *G. oyena* bred in the east coast of India in the year round.

Patnaik (1971) noticed that *G. setifer* bred in Chilka lake and outwardly migration of this species from Chilka lake had not been taking place. Kurup and

Samuel (1991) observed that fishes collected from Cochin barmouth areas of Vembanad lake showed a higher degree of maturity than those specimens collected from adjacent areas and hence assumed that fully ripe fishes undergo migration to near by costal area for the purpose of spawning. Specimens of *G. filementosus* with oozing gonads were not observed in their study, inferred that the final stage of maturity was attained in the sea.

In the present study the specimens collected from trawlers includes *G. filamentosus* with oozing gonads inferred that the final stage of maturity was attained in the sea. Not only the oozing the gonads were present but the matured specimens collected from the inshore area of depth range 10-20 m supports the above conclusion. The present results agreees with the results of Kurup and Samuel (1991), where samples are mainly collected from gillnets, sines and castnets. Cyrus and Blaber (1989) carried out investigation about the reproductive cycle in the Natal estuaries concluded that hatching as well as spawning of *G. filamentosus*, *G. acinacus* and *G. rappi* occurs throughout at the sea.

Sarre *et al.* (1997) observed a temperate Gerried *Parequula melbournensis* spends throughout its life cycle in offshore area. The samples were abundant in the inner continental shelf of lower cost of Australia at depth range of 5-35 m. The Juveniles of some species of closely related family Leognathidae were also found in areas other than along the shore line and in estuaries (Blaber *et al.*, 1994, 1995). Domeir *et al.*, 1996 observed spawning migration of Gray snapper in Florida, they observed movements of adult Gray snapper from inshore to offshore sites. Similarly Hyndes *et al.*, 1996 noted spawning migration of *Sillago burrus* and *Sillago vittata*.

The endocrine system forms the major link between environment and the organs concerned with reproduction. Changing environmental condition, operating through the sensory systems and specific centers in the brain, trigger neurosecretion which inturn regulate the activities of pituiary gland. The pituiary hormons have direct effects on gametogenesis, matabolism and behaviuor. These hormones also regulate the development of gonadal endocrine tissue. Many marine fish species in the tropical or subtropical waters, including those of Gerriedae have long spawning season where as those species that inhabit temperate waters, where conditions in the winter are more severe, typically have shorter more clearly defined breeding periods(Castro and Cowen, 1991; Conovar, 1992)

The spawning seasons of *G. setifer* in Chilka lake was from May to September (Patnaik, 1971). Spawning period of *G. filametosus* in cochin estuary was from October to February (Kurup and Samuel, 1991). In the present study, samples collected during March to June showed all the maturity stages in the sample. The presence of advanced oocyte in some ovary during April, suggest that spawning was imminent in that month. The lack of clearly defined modal length classes in the sample in this season and no conspicuous progression of modal length classes over successive seasons indicate that spawning occurs in this season. Compiling earlier works, it can be assumed that the spawning of *G. filamentosus* occuring throughout the year. Quasim(1955) and Harder Jones(1968) have studied that protracted spawning seasons are charecteristic in tropical region, because of duration of period of suitable temperatures and food availability, for survival of juveniles

The spawning of *P.melbournensis* occurs throughout the year (Sarre *et al*, 1997)and far less protracted spawning periods for similar species Mugilidae, Clupiedae, Gerreidae(Chubb *et al.* 1981, Chubb and Potter 1984; Sarre *et al.*, 1997). Multiple spawning over a prtracted period or even full year is associated with species found in less seasonal environments (Burt *et al.*, 1988). Multiple spawning increases the number of eggs that can be produced in a year (Burt *et al.*, 1988), spreads the risk of predation on eggs and larvae over an extented period (Lambert and Wase 1984) and acts as a buffer against adverse fluctuation in the amount of food available to the larvae (Mc Evoy and Mc Evoy, 1992).

Gonad development

Arora (1951) carried out investigations of *L. Splendens* in Rameswaram island and arrived at some conclusion regarding to the breeding habit of this fish. He classified females into three groups based on the gross examination of ova. The three groups are immature, intermediate and maturing groups. Immature ovaries contained number of eggs visible to the naked eye; Intermediate ovaries small, creamy white, opaque eggs visible to the naked eye and maturing ovaries contained larger eggs which are translucent rather than opaque, According to Arora, *L. splendens* spawns more than once in a season. Obviously the fish spawns from March till August and September but the peak spawning occurs during the months of April and August. He stated that the species first matures at an average length of 60mm. Standard length.

Kurup and Samuel (1991 classified ovaries of *G filamentosus* into five stages, based on the ovadiameter studies. They were **1.** *Immature stage* : Most of the oocytes were less than 0.2 mm with mode at 0.05 mm. This immature oocytes were found in the ovaries of all stages of development. **2.** *Maturity virigin and recovering spent* : Immature oocytes and another batch of ova of 0.2 mm was seen. **3.** *Ripening* : A group of opaque ova with a mode of 0.3 mm were found **4.** *Ripe* : One batch of transparent ova with a mode of 0.45 mm **5.** *Spent* : Mode was 0.05 mm.

Cyrus and Blaber (1984) were recorded seven stages in ovaries of *G. filamentosus*, *G. acinales* and *G. rappi*. Sarre *et al* (1997) found seven stages in the ovaries of *P. Melbournesis*. On the basis of the histological observation seven stages of Oogenesis was postulated.

State I : Oogonia were present throughout the year in addition and mean size was 10μm.

Stage II : Large number of pre vitellogenic Oocytes were present in immature and inactive ovaries. These Oocytes had large nuclei (23μm).

Stage III : At onset of gonad development the Oocyte increase in size developing into yolk preserved stage (34 μm)

Stage IV : In this non staining yolk stage a non cellular membrane begins to form between follicular layer and the developing oocyte.

Stage V : In the red-staining yolk stage development in Gerres is characterised by Cytoplasm which is completely filled with secondary yolk and few primary granules

Stage VI : Classified as ripe

Stage VII : spent

In the present histological observation, it was found that six maturity stages in the case of females. They were 1. Immature 2. Inactive/resting 3. Developing 4. Mature 5. Ripe and running 6. Spent (Modified from Kesteven, 1960; Nikolsky, 1963; Davis, 1977, Cyrus and Blaber 1984; Kurup and Samuel 1991; Sarre *et al.*, 1997). The male gonads were classified into four stages in the present observation, they were immature, maturing, mature and spent.

The main stage of Oogenesis were investigated and documented according to developmental sequence. Similar to studies done by Dipper and Pullin (1979) which was divided as follows, stage i - Oogonia, Stage ii - Previtallogenic oocytes; stage iii to v - Vitellogenesis; Stage iii - yolk precursor; Stage iv - nonstaining yolk; Stage v- red staining yolk Stage vi - completion of development.

The developing oocytes lie along the ovigerous folds, embedded in the loose connective tissue (Cyrus and Blaber 1984) Main stages of oogenesis of *Gerres* is Natal estuaries was as follows, Oogonia were present throughout the year in adult. Oogonia develops into Pre-vitellogenic oocytes are were present is immature and inactive ovaries. Small numbers present in developing ovaries but fewer were observed in mature ovaries. This oocyte develops into yolk precursor stage. The nuclei were irregular and nucleoli were visible. A non cellular membrane begins to form between the follicular layer of yolk precursor stage and develops into Non staining yolk stage. Next stage was development of small red stained granule (Red-stained yolk) and complets the development.

Fecundity

A total count of ova in both ovaries yeilds an estimate of female reproductive potential or fecundity. Patnaik (1971) observed that the fecundity of *G. setifer* varied from 17,2937 to 1,61,505 eggs in length range 88 - 193mm fish. Rao (1970) observed that the fecundity of *G. oyena* varied from 1,04,211 to 14,43,785 eggs in the size rages from 148-282 mm. Kurup and Samuel (1991) observed that the fecundity of *G. filamentosus* varied from 64,278 to 3,87,576 in the size range of 100-148 mm SL. In the present study the observed fecundity varied from 5460 to 89,560 in the size range of 141-195 mm.

According to Simpson (1954) and Beverton and Holt (1957) the number of ova should depend upon the volume of the ovary. Therefore, fecundity has been related to length cubed (Bagenal, 1968). Fecundity is a function of size and size is obviously a reflection of the growth process which is directly affected by temperature interacting with nutrition. Temperature functions primarily as a controlling factor, where as diet and ration funtion as limiting factor (Honston, 1982).

Sex ratios

Table 6 shows the sex ratio obtained in the present study. The ratio was found to be deviated from the normal expected value 1:1 ratio. The sex ratio was significanlty different in March, April, and May. The present result was in agreement with the results of Kurup and Samuel (1991). The skewed sex ratio was due to the ponderance of females over males. Quasim (1966) suggested that the ponderance of one sex in a population was because of sexual difference in growth rate between sexes.

The difference in sex ratio have been suggested to be due to difference between males and females with respect to growth, mortality or availability (shaefer, 1987). The diversity in the sex ratio might be due to partial segregation of mature forms, either through habitat preference or because of school formation, then rendering one sex to be more easily caught than the other. During the period March - May season females were more as compared to males in the present species may be due to behavioural difference between two sexes.

Size Composition

The maximum length of *G. filamentosus* reported in the present study was 195 mm is similar to that of gerreids *G. filamentosus G. nigri, Diapterus rhombeus,* and *P. melbournensis* but is less than that of *G.oyena* (300 mm) (Austin, 1971; Albaret and Des fossez 1988; El-agamy 1988; Kurup and Samuel, 1991; Sarre *et al.*, 1997). Absence of clearly defined modes in the sequential defined modes, in the sequential length frequency data means that model progression analysis could not be used to elucidate either age composition or growth rate.

SUMMARY

1. A brief study of the reproductive biology of *G.filamentous* occuring at Cochin estuary was carried out from March 1998 to June 1998. A total of 246 specimens of *G. filamentosus* were examined for determining gonadal maturity stages, ova diameter, fecundity and spawning based on the standard methods used.

2. In the present study, the specimens collected from trawlers included *G. filamentosus* with oozing gonads, inferred that final stage of maturity was attained in the sea. Not only the oozing gonads were present but the mature specimen collected from the inshore area supports the above conclusion.

3. In the case of female *G. filamentous* six stages of maturity were observed. They were (i) Immature (ii) Inactive/resting (iii) Developing (iv) mature (v) Ripe and running (vi) Spent. The male maturity stages were (i) immature (ii) maturing (iii) mature (iv) spent

4. The fecundity observed in the present study varied from 5,460 to 89,560 in the size range of 141-195 mm. The sex ratio were found to be deviated from the normal expected value 1:1 ratio, during the month of March, April and May.

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