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Biological Stαdy of Red Snapper, *Lutjanus Sanguineus*

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Abstract

Among the red snappers caught by trawling in the South China Sea, *L. sanguineus* is the most important species, comprising more than 10% of the total catch. Although *L. sanguineus* is widely distributed in the South China Sea, its pattern of distribution seems to be rather patchy. However, they were most abundant at 35–80 m. water depth and inhabit muddy-sand areas especially where "Neptune's cup" are abundant.

Size frequency histograms indicate four to six size groups, with peaks of almost the same height. The growth rate of fish of 23 cm. was taken to be approximately 2 cm. per month.

As no significant difference in length-weight relationship between male an female was observed, the followinng formula can be applied for both sexes.

$$W = 7.64 \times 10^{-5} L^{2.823}$$

where, W = body weight (g).
L = body length (mm).

The number of ovarian eggs ranged from 69 to 260.10^4 and the regression between the number of eggs in thousand (N) and fish weight in gram (W) was N =0.4459W + 83.2.

High values of gonadal index from March to November with a peak in April–June suggests a prolonged spawning season.

1. INTRODUCTION

In the South China Sea, red snappers are the most important fishes in the trawl catch, the dominant species being *Lutjanus sanguineus* (Cuvier et Valenciennes).

Since few publications on the fisheries biology of this species are available, in spite of its relative importance in the fisheries of Southeast Asia, the Marine Fisheries Research Department of the Southeast Asian Fisheries Development Center (SEAFDEC) carried out some biological studies on the fish.

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2. MATERIALS AND METHODS

This study is based mainly on the data and materials obtained from trawl operations carried out by the 387–ton research vessel CHANGI from February 1971 to September 1971. However, data collected in 1970 and from October 1971 to October 1972 (including two trips of bottom longline fishing survey) are also incorporated.

Specimens collected were measured and weighed fresh on board th vessel, while ovaries and stomachs were weighed and preserved in 10% formalin for laboratory analyses. Measurements of total length were taken for all *L. sanguineus* caught by CHANGI. Additional measurements and collection of ovaries and stomachs were also made on the commercial catch from the South China Sea landed in Jurong Fish Market, Singapore in March, May and August 1971.

3. RESULTS

3.1 Fisheries Status and distribution

3.1.1 Importance of *L. sanguineus* in trawl fisheries.

Although species composition of trawl catch by CHANGI in the South China Sea varies from area to area, red snappers usually constitute an important part of the catch. In most areas, more than 20% of the total catch were red snappers (Senta, et al. 1973), of which *L. sanguineus* was the most important species, usually occupying about 70% of the total amount of red snappers caught.

3.1.2 Fishing grounds

Figs. 1a and 1b show the values of catch per hour for each half degree block of 30 square miles in each month, from January 1970 to September 1971. Although *L. sanguineus* may be said to be distributed almost all over the South China Sea, its distribution pattern seems to be rather patchy. For example, in August 1970 (Fig. 1b), a catch of more than 50 kg per hour of *L sanguineus* was obtained from a block while its immediate neighbouring blocks yielded none. Also in May 1970 (Fig. 1a), two areas of good catch were separated by several blocks of poor and no catch; and 2 blocks out of a total of 13 yielded more than 50 kg/hr, while 5 blocks yielded no *L. sanguineus.* In February, June, July and October 1970 the species was caught in almost every block although none yielded more than 50 kg/hr. Due to the lack of regular monthly surveys in each area, it is difficult to assess the seasonal variation of its distribution pattern in the South China Sea.

3.1.3 Distribution by depth

In contrast to geographical distribution, the distribution of *L. sanguineus* by depth was much more consistent. Table I shows the seasonal change in catch per hour by depth. During the period of January–March, the catch was best in shallower areas, but as the year progressed best catch was obtained in deeper water, and after July, areas shallower than 50 m yielded poor catch. However, the catch was always poor in areas deeper than 90 m.

The bottom feature was thought to have an influence on the distribution of *L. sanguineus*. From the samples

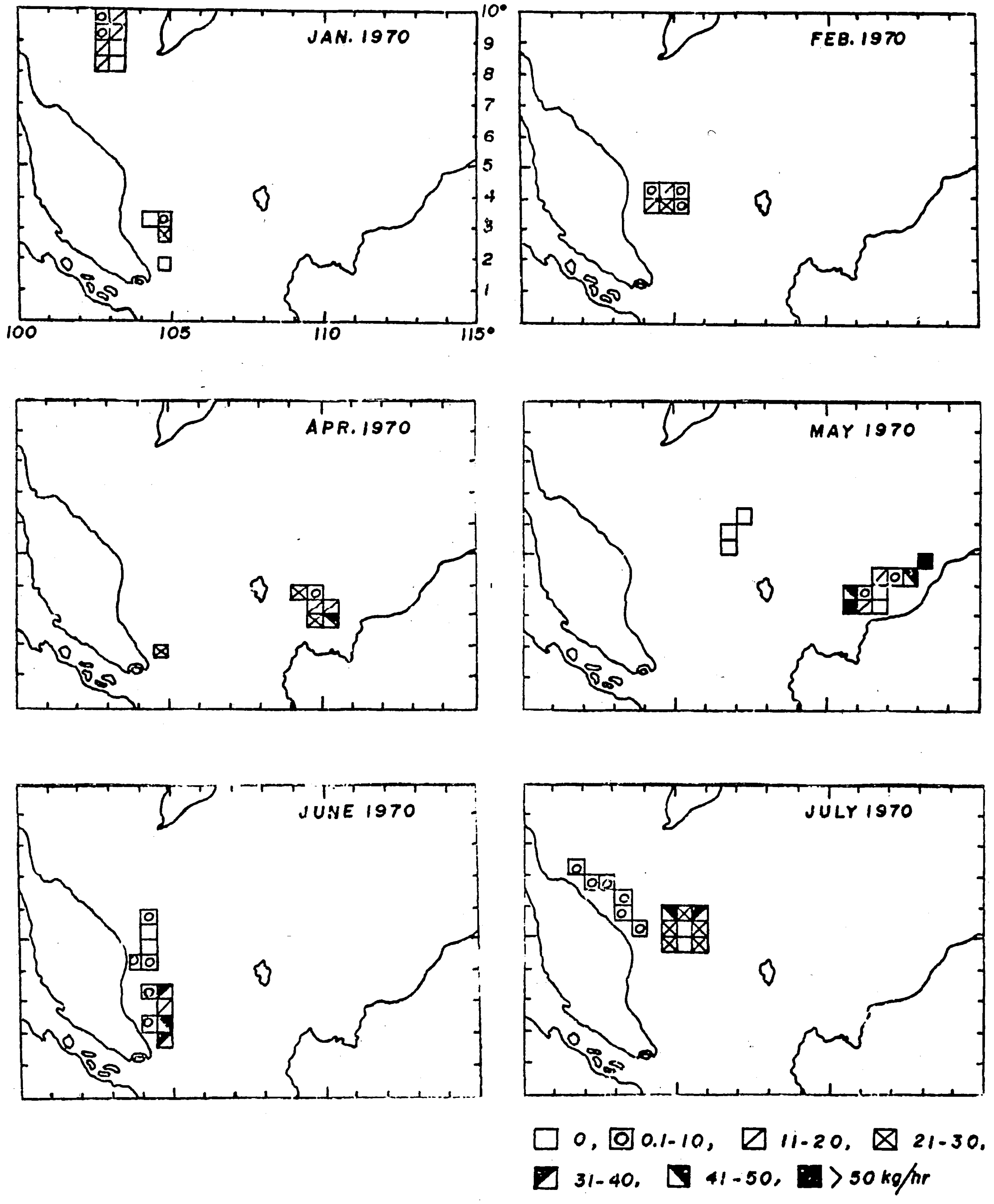

Fig. 1 (a) Monthly variation of catch (kg/hr) of *L. sanguineus.*

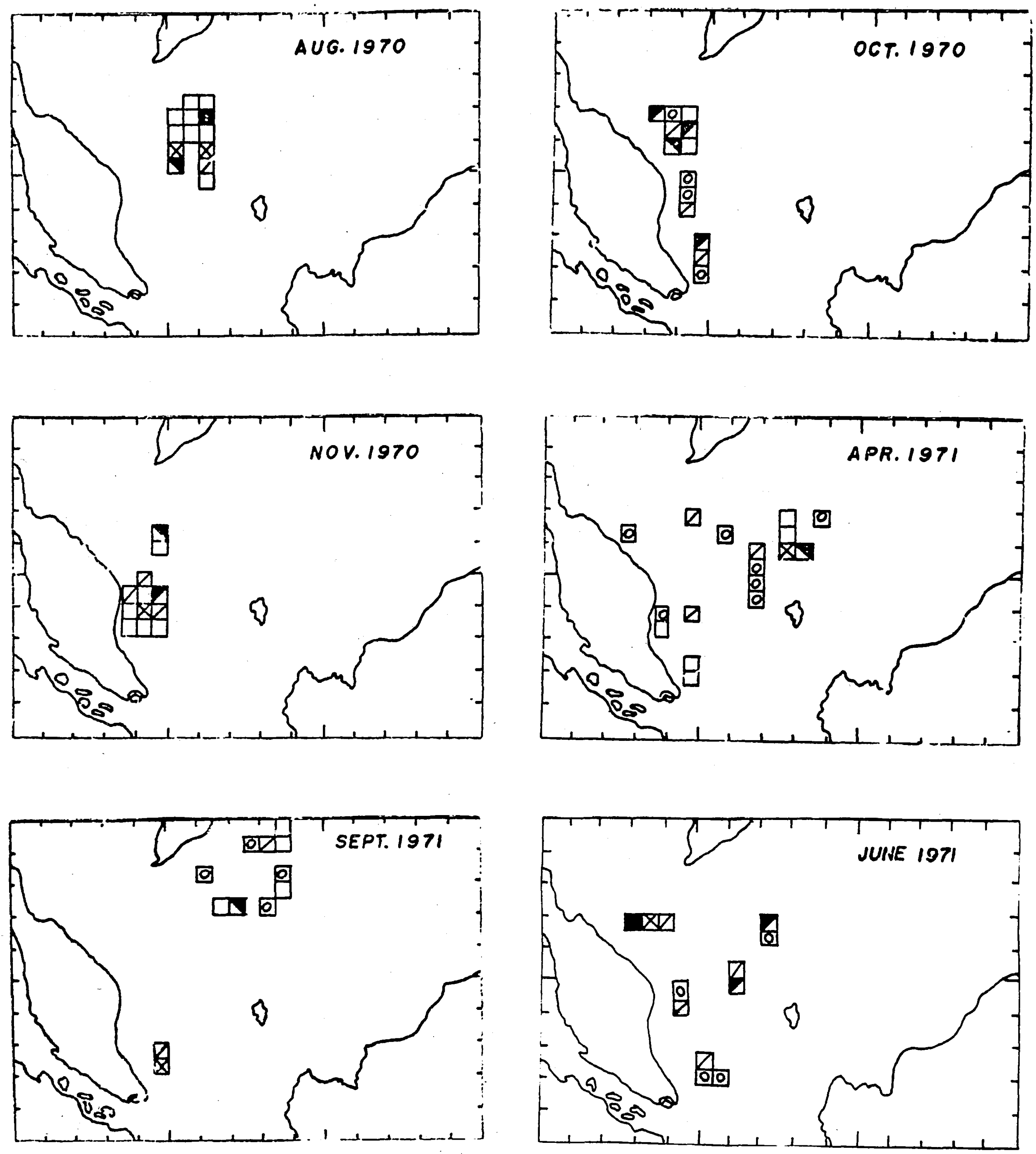

Fig. 1 (b) Monthly variation of catch (kg/hr) of *L. sanguineus.*

Table I. Catch per hour of *L sanguineus* by depth, by periods, 1970 – 1971

Depth (metres)	Jan.–March H	Jan.–March C/hr/kg	April–June H	April–June C/hr/kg	July–Sept. H	July–Sept. C/hr/kg	Oct.–Dec. H	Oct.–Dec. C/hr/kg
25–40	6	22.4	7	10.23	9	2.1	4	0
41–50	9	18.9	21	31.96	28	13.3	6	2.5
51–60	6	15.3	42	16.99	36	12.6	16	21.7
61–70	19	11.9	60	14.48	17	20.0	29	7.8
71–80	5	15.5	20	31.51	10	14.3	2	15.5
81–90			18	9.94	10	17.8		
91–100					3	1.0		
100					4	4.3		

H = No. of hauls; C = catch

Table II. Relationship between catch per hour of *L. sanguineus* and types of sea beds

Type of bottom	No. of hauls	Catch per hour (kg)
Clay	17	16.36
Mud	10	14.69
Mud + sand	70	20.35
Sand + mud	63	18.22
Sand + shell pieces	13	3.71
Sand	–	–

collected by SK-type mud sampler the sea beds of the fishing grounds were classified into 6 types (Table II). The catch was found to be best on bottoms with a mixture of mud and sand, and the poorest in areas with sand and shell pieces. It was observed that good catches of *L. sanguineus* were often accompanied with a lot of coral (*Melitodes* sp). It is likely that these organisms form a kind of natural fishing reef.

3.2 Size and growth

3.2.1 Body length distribution

Fig. 2 shows the length frequency distribution of *L. sanguineus*. The total length of the species caught by trawl ranged from 16 to 82 cm. Fish of 55–70 cm in total length occupied the largest portion in catch. However, the size range of the catch obtained by bottom longline in June 1972 was 30–70 cm and the largest portion of the catch comprised of fish ranging from 42 to 50 cm. It appears that trawling is not as selective as bottom longline in the exploitation of the population of *L. sanguineus*.

The size frequency histograms of June 1971 and of September 1971 to October 1972 were analysed by the probability paper method developed by Harding (1949), and the mean value of length, standard deviation and percentage of each component group in the total catch were graphically determined. The normal curves thus obtained were superimposed on some of the histograms (Fig. 2). Most of the histograms have four to six peaks of nearly the same height. In fact the higher peaks are often seen for the larger size range, indicating a relative abundance of large-sized fish.

3.2.2 Growth

From Fig. 2 it is difficult to trace the growth rate of fish in every size group from month to month for a long period, as a continuous collection of sufficient data in a certain area was not attained because of monthly shifts of areas visited by CHANGI. Due to the lack of sequence in the size groups, the growth rate can only be inferred approximately from the present data.

In Fig. 2, there is a prominent peak at 23 cm in June 1971 and a similarly prominent peak at 29 cm in September 1971. Supposing that both were from the same 'age' group, then it could be inferred that fish of 23 cm length in June grew by 6 cm within 3 months. In this case the first group would have grown by 24 cm in a year provided that the growth rate remained the same throughout the year while the third peak (45 cm) could be considered to be one year older than the first. Similarly the second size group in the data from September 1971 may be traced to the third size group in October 1971 giving a growth rate of 2 cm per month. In September 1971, the fourth size group (63.6 cm) could similarly be considered to be one year older than the second size group. Presuming that the above inference is correct each year class may therefore consist of two size groups indicating that there may be at least two major spawning seasons a year.

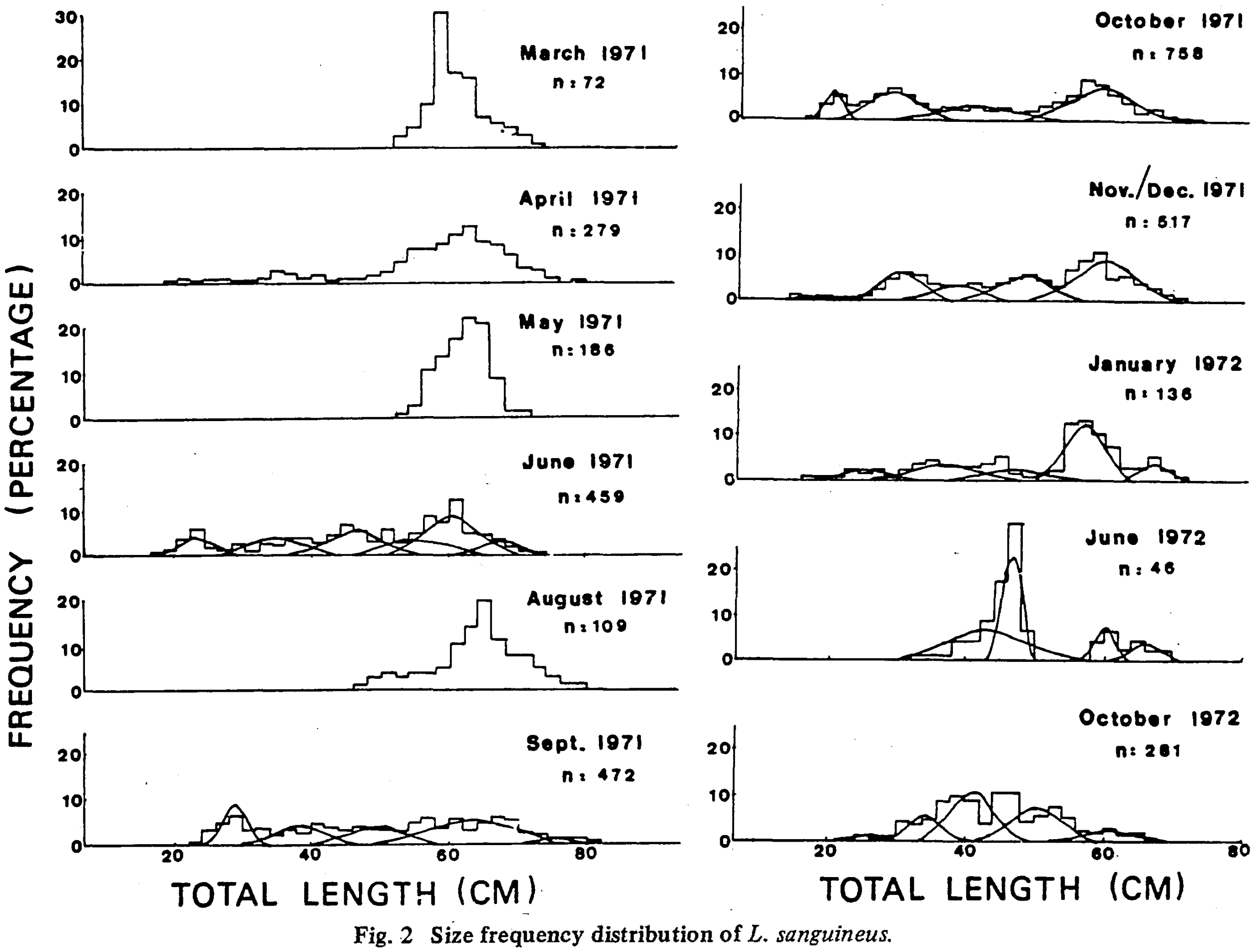

Fig. 2 Size frequency distribution of *L. sanguineus*.

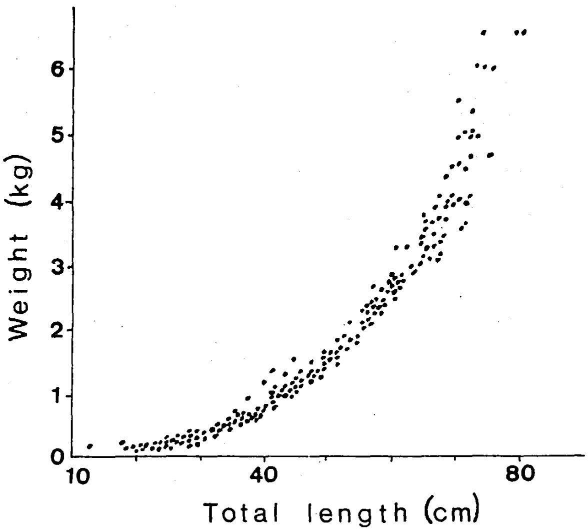

Fig. 3 Length-weight relationship of *L. sanguineus*.

3.2.3 Length-weight relationship

Measurements of total length and body weight for 1213 fish were taken at 2 cm intervals of total length. Average body weight was calculated for the midpoint of each class, and the measurements of body weight were plotted against that of total length (Fig. 3). The regression of weight in gram against total length in mm for each sex were determined by least square method. The resulting formulae were: for male $W = 6.415 \times 10^{-5}\ L^{2.877}$ or log W = 2.877. log L-4.562; for female $W = 1.173 \times 10^{-5}\ L^{3.000}$ or log W = 3.000. Log L-4.869. Since F-test showed that there was no significant difference between sexes, the data were combined to form a single formula representing the length-weight relationship for the species: $W = 7.462 \times 10^{-5}\ L^{2.823}$ or log W = 2.823 log L-4.419.

3.3 Reproduction

3.3.1 Sex ratio

Of the 255 fish examined, 126 were males and 129 were females, giving a sex ratio of 0.98 which could be taken as 1:1. by χ^2 test.

3.3.2 Seasonal variation in gonad index

Gonad indices were calculated by the following formula:

$GI = GW/BW \times 10^3$ where GI = gonad index
GW = gonad weight (g)
BW = bady weight (g)

The monthly cange in average gonad index is shown in Fig. 4, in which the highest value is seen in April. However, during the peak of the spawning season, some fish would have spawned and consequently would have low GI values, thereby lowering the average value of gonad index for the group. To avoid this, the ovaries were classified into the following four stages according to the GI value and the state of maturity:

Stage I : GI = 0.1 – 5; immature and spent ovaries
Stage II : GI = 5.1 – 15; matureing ovary
Stage III : GI = 15.1 – 30; mature ovary
Stage IV : GI = 30.1; ripe ovary with bimodal distribution of eggs, the larger mode being at 0.70 – 0.75 mm. Some eggs are transparent.

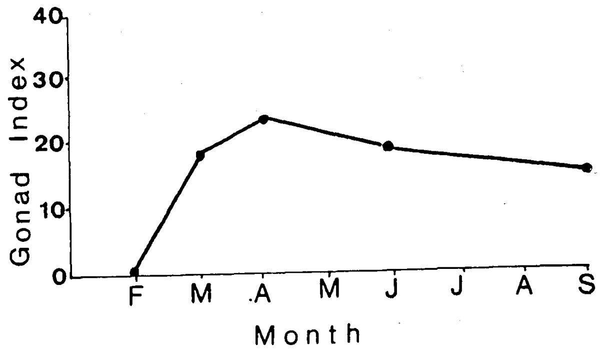

Fig. 4 Monthly change of mean of gonad index.

The percentage of stage IV increased through March to April when it showed its highest value (Fig. 5). The value dropped from 35% in April to 9% in June, and remained at this level from June to September. Since the combined percentage of stages III and IV amounted to 60% it could be inferred that *L. sanguineus* spawn in these months. However, data collected in November 1971, showed that some individuals had GI of around 30, indicating that there may be a prolonged spawning period from March to the end of the year.

3.3.3 Biological minimum size

From the fishery biology point of view, the words "biological minimum size" here is used to mean the minimum size at which a significant part of a population participates in spawning for the first time.

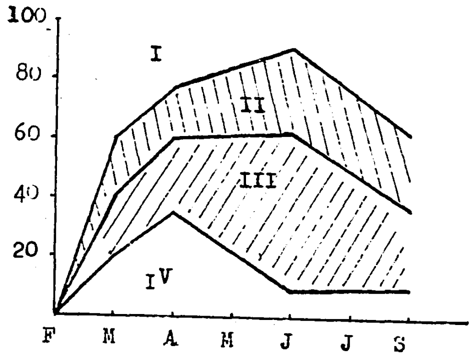

Fig. 5 Monthly change of different class gonad index (cumulative percent)

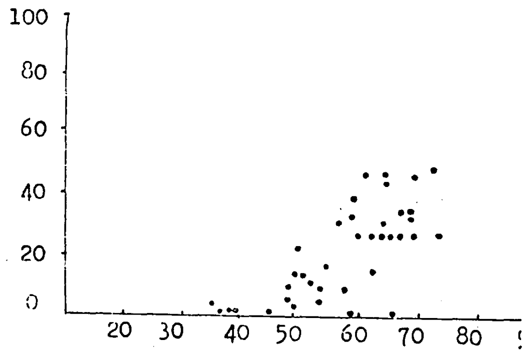

Fig. 6 Relationship between size of fish and gonad index.

Since the highest average gonad index and the highest percentage of stage IV gonads occurred in April, the individual values of gonad indices in April were plotted against the total length of fish. Fig. 6 shows that fish smaller than 50 cm in total length belonged to stage II, the highest gonad index for these fish being 10. The data in June and September were also examined in the same way. Here again, the highest gonad index for fish less than 50 cm was 3 in June and 11 in September.

The biological minimum size of *L. sanguineus*, therefore, may be considered as 50 cm.

3.3.4 Fecundity

In order to study egg distribution within an ovary, the technique described by Kipling & Frost (1969) was followed. Ten counts of 1-g samples, five from each of the paired ovaries, were obtained from different parts of the ovaries of a fish of 58.3 cm in total length and 3.0 kg in weight, caught in April 1971.

The location of each part and the result of counting are shown in Fig. 7. The average number of eggs per sample was approximately 400 and the differences in the number between parts were less than 5%. There was also no significant difference between countings of each of the paired ovaries. These ten 1-g samples were later used for examination of ovarian egg size.

In subsequent study on fecundity, only 4 counts of 1-g samples, 2 from each ovary, were made. Total number of ovarian eggs were estimated by multiplying the mean of 4 counts by weight in gram of ovaries. The estimations were done for 10 females ranging 522–736 mm in total length and 1.7–5.8 kg in weight . The number of ovarian eggs increased with the increase in body weight (Fig. 8), from 691,000 to 2,620,000 eggs as shown in Table III. The regression of the number of eggs in thousands on the body weight of the fish in gram were calculated by least square method with resulting equation:

$N = 0.4459\ W + 93.2$

where N = number of eggs in thousands

W= body weights (g)

3.3.5 Size distribution of ovarian eggs

As mentioned above, the size of eggs sampled from 10 different parts of the ovaries was measured.

The diameter of eggs ranged from 0.20 to 0.86 mm and two modes in each of the 10 parts were recognized. In almost all samples, the smaller mode was 0.40–0.45 mm and the larger one at 0.70–0.75 mm (Fig. 9). According to the result of χ^2-test, there was no significant difference between size frequency distributions of any two parts.

Among the two normally distributed groups of eggs, the eggs of the larger group were all transparent.

3.3.6 Spawning season

The seasonal change of the ovaries both in the average gonad index and in the percentage of gonads of advanced stages showed that the spawning must have occurred during the period from April to November, with at least one peak being in April to June. Due to lack of information about ovarian conditions during the months from October to February, it is too early to conclude that April to June is the only main spawning season of *L. sanguineus.*

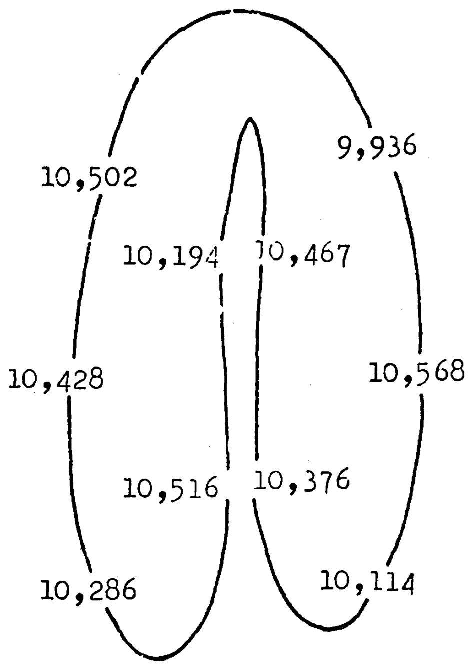

Fig. 7 Diagram of the ovaries of *L. sanguineus*, 58.3 cm in total length, 3.0 kg in wt. showing the position of sampling and number of eggs per grams in each sample.

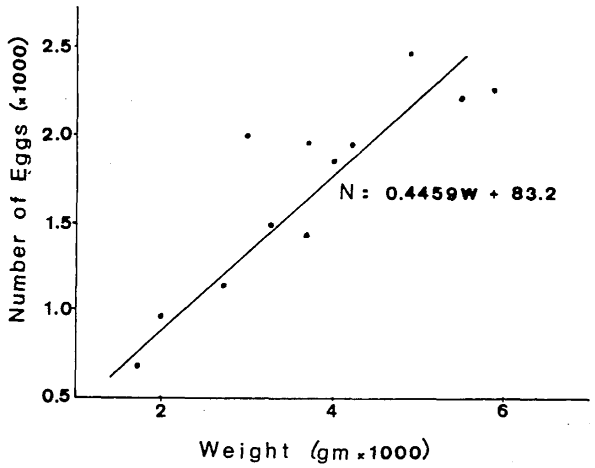

Fig. 8 Relationship between number of eggs (X 10^3) and fish weight (grams).

Table III. Fish size and calculated egg number

T.L. (mm)	Wt. (gm)	Ovary wt.	Estimated no. of eggs ($\times 10^3$)
566	2750	86.99	1,150
583	3600	239.42	2,040
736	5800	158.90	2,280
645	3600	159.65	1,980
690	4900	230.30	2,620
636	3700	104.20	1,440
670	4000	141.80	1,870
642	4200	158.35	1,960
590	3200	122.74	1,500
522	1700	81.60	691

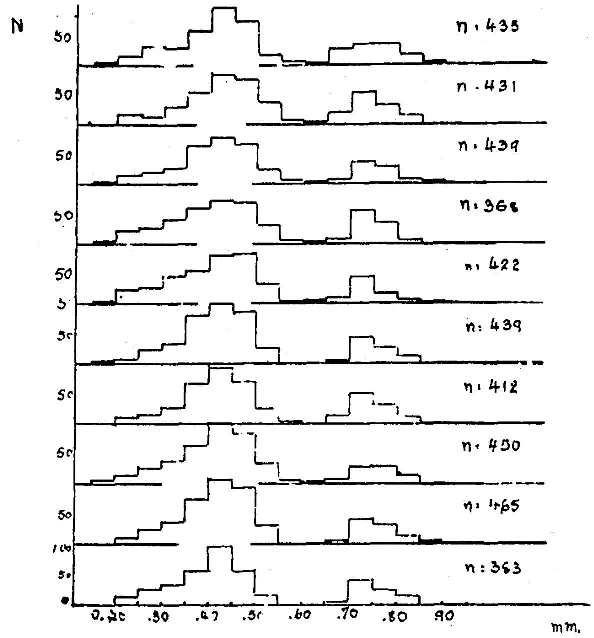

Fig. 9 Distribution of egg size in ten samples from the ovaries of a *L. sanguineus* individual.

The study on the larval fishes in the South China Sea by Yong (1971) and Vatanachai (1971) revealed that lutjanid larvae occurred from June to November, most abundantly in August, although species identification was not yet established.

Since fish schools are usually denser during the spawning season the very high degree of patchiness in geographical distribution of *L. sanguineus* observed in May suggests that the main spawning season occurs in this month.

In considering the various factors mentioned above the months of April, May and June can be regarded as the main spawning season or, at least, one of the two or three spawning seasons.

3.4 Feeding Habit

This topic is discussed in a separate paper (Senta and Peng, 1973). The following summarizes the results.

The main categoires of food organisms of *L. sanguineus* were fishes, crustaceans and molluscs. Small-sized demersal fishes were the most important food items. Among crustaceans, small to medium sized crabs were the most important, followed by various species of stomatopods. Shrimps were only important for the juvenile and smaller fish of the species. Cephalopods were only members of significant importance among molluscs.

The feeding habit of *L. sanguineus*, however, was found to be rather flexible. Under certain circumstances, they were found to feed on almost every kind of benthic organisms. All stomachs of the fish caught off the southern coast of Vietnam in Sepgember 1971 were full of one kind of tunicate, *Botrylloides* sp.

On the other hand, *L. sanguineus* were not found in the stomach contents of various species of piscivorous fishes such as *Saurida* and *Rachycentron* which also occurred in the fishing ground. There was also no evidence of cannibalism of the species.

In a word, *L. sanguineus* occupied the highest niche in a food pyramid among the bottom fauna.

4. DISCUSSION AND CONCLUSION

Most of *L. sanguineus* caught by trawl fishery in the South China Sea were considered to be about 3 years old and above their biological minimum size.

Size frequency distribution (Fig. 2) showed that the most prominent peaks were near the larger end of the body size range. This suggests that the habitat of smaller fish may differ from that of larger fish, and may occur in some place other than the fishing ground for trawl fishery. The presence of these equally prominent peaks over the range of body size may indicate the comparatively low mortality rate of the species during the first few years of their lives.

The existence of less prominent peaks, or sometimes the existence of too many equally prominent peaks, suggests that there may be some subage groups within one age group. This may be a consequence of a long, dragging spawning season or several spawning seasons in a year.

Since they have not been found to be subjected to predation by other piscivorous fishes and since their feeding habit is rather flexible it can be said that they occupy the highest position in the food pyramid of the bottom fauna.

It may also be said that *L. sanguineus* is well protected from overfishing by trawling. :The fact that they tend to seek for habitat in the Neptune's cup zone suggests that a certain part of its population is living in untrawlable areas. Also, as their distribution spreads over a wide area and is not concentrated in a restricted fishing ground for trawl fisheries they are further protected from overfishing.

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