

**LENGTH-FREQUENCY STUDIES ON THE MALABAR SOLE, *CYNOGLOSSUS SEMIFASCIATUS* DAY AT WEST HILL, CALICUT, DURING THE YEARS 1959-60 TO 1962-63.**

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INTRODUCTION

Some observations were made on the age and growth along with other aspects of the biology of the Malabar sole, *Cynoglossus semifasciatus* Day at West Hill, Calicut during the years 1949 to 1952 (Seshappa and Bhimachar, 1951, 1954 & 1955). The length-frequency studies were found to be very useful in the assessment of age and growth in the above work and the utility of the growth-rings of the scales in the age-determination of the species was also proved. Length-frequency studies were again started on this fish at the Calicut Sub-Station of the Central Marine Fisheries Research Institute from March 1959 onwards, and the present communication incorporated the results of these observations during the period March 1959 to March 1963. This gives a comparative picture of the size and growth trends in this species after a considerable interval during which regular observations were suspended. There is no other published work on length-frequencies in this species subsequent to the above-mentioned publications.

The material used for the study was obtained from weekly departmental boat-seine (*Paithuvala*) collections in the West Hill inshore grounds. The method of measurement was the same as described earlier (Seshappa and Bhimachar, 1955). The ages of different modal groups were checked up by examination of scales occasionally but the scale-analysis work was not adopted as a general routine in the present investigations. The treatment of the males and females separately for the length-frequency study was also not taken up for the present paper in view of the small size attained in the species.

LENGTH-FREQUENCIES DURING 1959-60

During March 1959 two modes were noticeable in the length-frequency distribution, a well-marked one in the 8-8.9 cm. group and a very minor one in the 13-13.9 cm. group. Individuals below 10 cm. in length formed 81.8% while those above 12 cm. formed only 5.8%. During April, the main mode was in the 9-9.9 cm. group, there being a smaller mode in the 6-6.9 cm. group and a still smaller one in the 13-13.9 cm. group. Individuals below 10 cm. formed 66.5% while those above 12 cm. formed 6.7%. During May, only one mode

was visible in the length-frequency distribution, this being in the 9-9.9 cm. group, *i.e.*, in the same position as in the previous month. No mode was visible in the higher sizes although individuals were represented up to the 16-16.9 cm. group. Those below 10 cm. formed 59.1% and those above 12 cm. formed 8.3%. But while the mode in this month remained as in the previous month, the percentage of specimens between 10 cm. and 12 cm. had increased from 28.4 to 36.0. During the month of June also there was only one mode visible and this was in the same size-group as in the previous two months; there were no individuals larger than the 12-12.9 cm. group and 74.9% of the measured specimens were below 10 cm. in total length.

A single specimen collected in July was in the 15-15.9 cm. group and no specimens were available in August. Only 10 individuals were available in September. During October when the fishery started (later than usual) the mode was in the 11-11.9 cm. group. No specimens were found below 7 cm. and individuals below 10 cm. formed only 7.5% of the total for the month. 88.3% were between 10 cm. and 12.9 cm. in total length. The samples actually represented those that had their mode in the 9-9.9 cm. group in June, an increase of 2 cm. being thus noticed from June to October. A small number of juveniles made their appearance in November (in the size-groups below 7 cm.) but the bulk of the catch ranged from the 10-10.9 cm. to the 15-15.9 cm. groups, the mode being in the 12-12.9 cm. group. There were no individuals between 7 cm. and 10 cm. and 67% of the catch was in the 12-13.9 cm. groups. The main mode during December moved further up to the 13-13.9 cm. group but the juveniles of the new brood were fairly well-represented with a mode in the 6-6.9 cm. group; 54.2% of the catch measured below 10 cm. The smallest frequency between the modes of the adults and the juveniles was in the 11-11.9 cm. group. Recruitment of juveniles continued during the next three months and while there were two modes in January and February (in the 9-9.9 cm. and the 13-13.9 cm. groups) in the same positions in both the months, there was only one marked mode in March namely, that of the juveniles, also in the same size-group as in the previous two months; but there was no clear mode in the higher sizes which had also diminished in number, there being 15.1% of the individuals in the groups of 12 cm. and above. Figures 1 to 4 show the length-frequency graphs for the years 1959-60 to 1962-63 in that order.

#### LENGTH-FREQUENCIES DURING 1960-61

Two marked modes were visible in the length-frequency figures of April 1960, one in the 7-7.9 cm. group and another in the 10-10.9 cm. group both representing brood of the same season. Though the higher sizes were fairly represented there was no marked mode among these sizes. 66.9% of the individuals were below 10 cm. total length while 12.5% were above 12 cm. During May the first mode was the same as in April while the second mode had shifted back by a centimetre; 65.5% of the specimens measured below 10 cm.

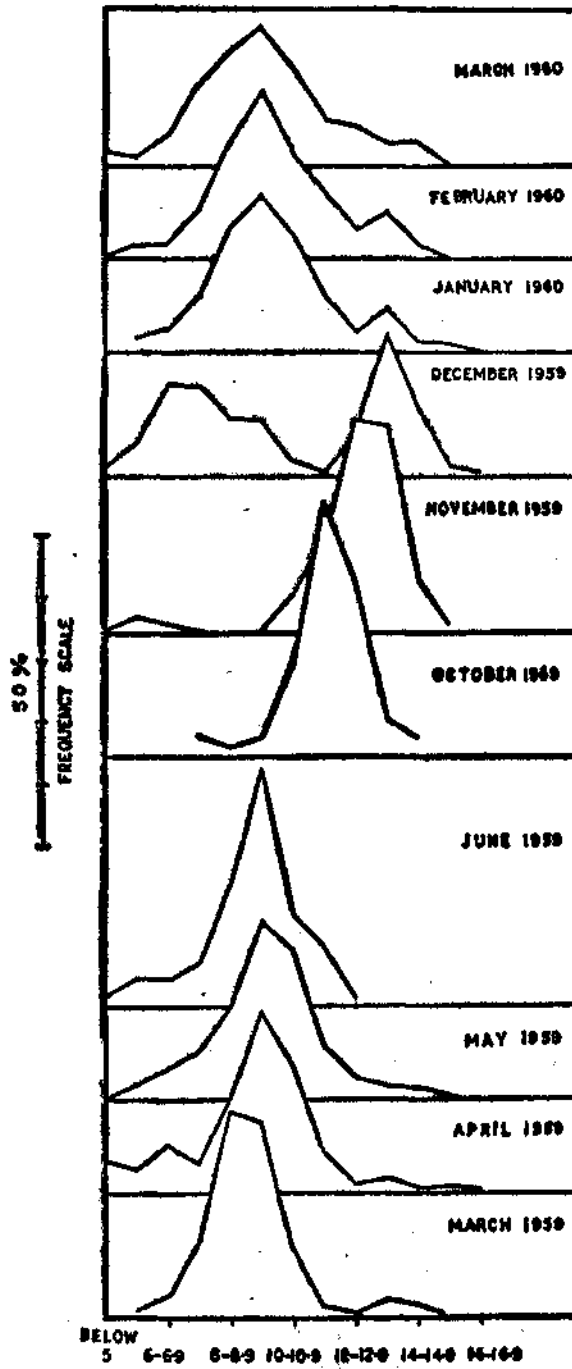


FIG. 1 Length-frequency graphs for 1959-60.

while 18.0% measured above 12 cm. There is no marked mode in the highest size-groups though in the 13-13.9 cm. group the percentage was slightly highest (6.0%) than in the 12-12.9 cm. (5.5%) and the 14-14.9 cm. (5.1%) groups.

No samples were available during the months of June, July and August. The fishing started in September after the monsoon. During this month the size ranged from below 9 cm. to the 17-17.9 cm. group. Two modes were present, namely in the 11-11.9 cm. and the 14-14.9 cm. groups. 0.5% of the specimens were below 10 cm. while 39.1% were above 12 cm. The mode in the 11-11.9 cm. group was the main one for the month. In October the juveniles below 10 cm. were represented by a single specimen (in the 8-8.9 cm. group) out of a total of 199 measured during the month. There were two modes noticeable, a main mode in the 11-11.9 cm. group and a minor one in the 14-14.9 cm. group, as in the previous month. During November the picture changed in that there was no mode in the 11-11.9 cm. group, there being a single mode beyond this group in the 15-15.9 cm. group and the number of specimens in the sizes above 10 cm. being very small compared to October; the juveniles were well represented (from below 5 cm. to the 8-8.9 cm. group) and had a mode in the 7-7.9 cm. group. There was a further reduction in the numbers of the larger sizes during the subsequent months. In December the number of specimens above 9 cm. was negligible (only 1%); the juveniles thus formed almost the entire catch and had a mode in the 6-6.9 cm. group. Practically the same position prevailed during the months of January, February and March, there being a very small and negligible number of specimens in the larger sizes in the last two months and none above 9 cm. in January. The main modes were in the 6-6.9 cm. group in all the three months, growth being unusually non-evident in the data of this period. During March in the larger sizes there was a slightly larger number between 12 cm. and 13.9 cm. (4.0%) than between 10 cm. and 11.9 cm. (2.5%) or between 14 cm. and 15.9 cm. (2.0%), there being no specimens above the 15-15.9 cm. group.

#### LENGTH-FREQUENCIES DURING 1961-62

During April 1961 the mode was in the 8-8.9 cm. group. There were no specimens below 5 cm. during this month and also none above the 10-10.9 cm. group, those below 10 cm. themselves forming 95.3% of the total. In May on the other hand the sizes ranged from the 5-5.9 cm. group to the 15-15.9 cm. group, though again there was only a single mode (10-10.9 cm.); there were no specimens below 5 cm. in this month also; individuals below 10 cm. formed 45.6% of the total while those above 12 cm. formed 5.8%.

An interesting feature of the samples of September after the south-west monsoon was the unusual presence of juveniles of a new brood; these had a mode in the 5-5.9 cm. group and ranged from below 5 cm. to the 7-7.9 cm. group, there being no individuals in the 8-8.9 cm. group. The mode for the larger sizes was in the 13-13.9 cm. group; individuals above 12 cm. formed 71.7% of the total.

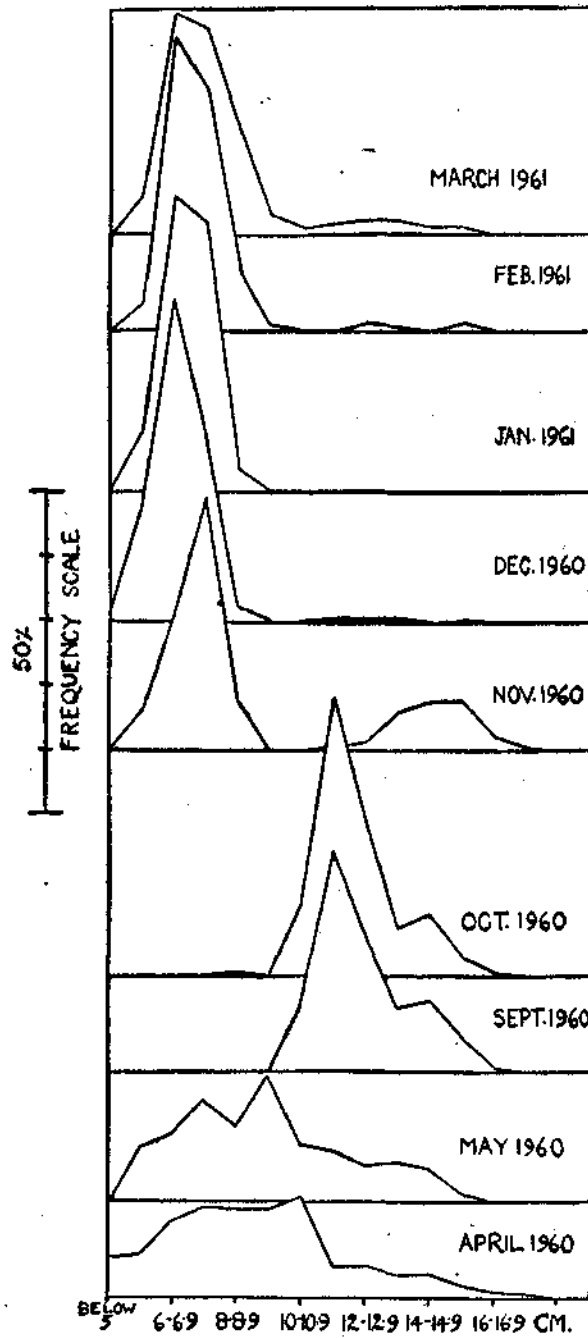


FIG. 2

FIG. 2 Length-frequency graphs for 1960-61.

Along with the small juveniles mentioned above, 10.2% of the total constituted the size-groups below 10 cm.

The month of October, however, showed a complete absence of juveniles in the groups below 9.9 cm. The size-range in this month was only from the 9.9 cm. group to the 16-16.9 cm. group, with the mode in the same position (13-13.9 cm.) as in the previous month. Only 1.5% of the total in the month were found to be below 10 cm. and 1.5% were in the 16-16.9 cm. group; 8.1% were between 10 cm. and 12 cm. and all the rest were between 12 cm. and 16 cm. in length. The size-range for November was from below 5 cm. to the 15-15.9 cm. group. The smallest size-groups were well represented in the month with a mode in the 6-6.9 cm. group; 6.5% of the total were below 5 cm. in length. The mode for the larger sizes was in the same position as in the previous month, in the 13-13.9 cm. group but with a smaller number contributing to this mode; individuals below 10 cm. formed 48.7% and those above 12 cm. formed only 35.2% (*i.e.*, 56.1% less than in the previous month). December showed an expectable increase in the percentage of juveniles and a correlated decrease in that of the adults (of the previous year's class). The mode for the juveniles was in the 6-6.9 cm. group (like the previous month). 42.6% of the total were in the 6-6.9 cm. group, 4.2% below 5 cm. and 0.2% in the 16-16.9 cm. group. The mode for the adults was as before but with a further highly reduced number contributing to this mode; 88.8% of the total measured were below 10 cm. in length and only 8.6% were above 12 cm.

The frequency distribution figures for the months of January to March 1962 show the increase of the larger sizes among the members of the new brood. In January the mode is in the 8-8.9 cm. group, there being a higher frequency in the 7-7.9 cm. group than in the 9-9.9 cm. group. In February the mode is in the same group (8-8.9 cm.) but the frequency in the 9-9.9 cm. group is higher than in the 7-7.9 cm. group. In March this mode is seen in the 10-10.9 cm. group with frequencies of 18.2% in both the 9-9.9 cm. and the 11-11.9 cm. groups and 19.6% in the 10-10.9 cm. group; the larger sizes have a mode in the 12-12.9 cm. group in January but this has also disappeared in the subsequent months. By the end of the quarter therefore, it is seen that the adults of the previous year's class have no mode in the frequency distribution, the samples consisting very largely of juveniles of the year.

#### LENGTH-FREQUENCIES DURING 1962-63

During the year 1962-63 two modes were visible in the April samples, the first representing the juveniles (in the 6-6.9 cm. group) and the second in the 10-11.9 cm. group; the number of individuals above 12 cm. was very small (13.3%) and there was no mode in these higher sizes; the total size-range was from below 5 cm. to the 14-14.9 cm. group. Specimens measuring below 10 cm. formed 57.0% of the catch of this month. During May the dominant mode was

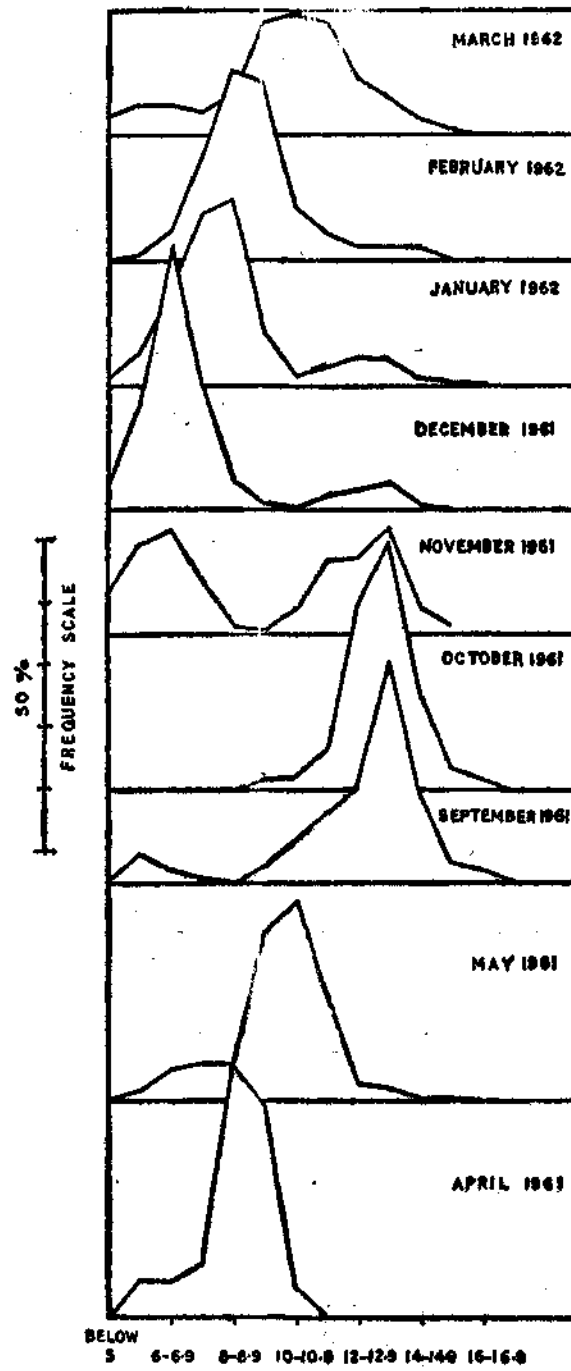


FIG 3. Length-frequency graphs for 1961-62.

in the 7-7.9 cm. group, and there was a minor mode for the adults in the 12-12.9 cm group. Specimens above 12 cm. were only 5.2% during this month. In June the total of the samples measured was rather small (only 45 specimens) and the modal frequencies out of this small number were found in the 6-6.9 cm., 9-9.9 cm., 12-12.9 cm., and the 14-14.9 cm. groups. During July there were no samples and in August when the fishery started after the monsoon, the size-range was 10 cm. to 16.9 cm. with the mode in the 15-15.9 cm. group; 95.5% of the catch was in the groups above 12 cm. during this month. In September the main mode of the adults continued in the 15-15.9 cm. group, but another mode was noticed in the 12-12.9 cm. group; two specimens also occurred in the 17-17.9 cm. group in this month. As many as three modes were seen in October namely, at 10-10.9 cm., 12-12.9 cm., and 14-14.9 cm., the first mode being however, not well marked. It seems obvious that the difference in the occurrence of modes during these post-monsoon months (when not related to year-classes) is connected, with the intermittent and continued spawning activity of the previous season. It will be noticed that the juveniles showed modes in the 8-8.9 cm. group in January and February 1962 but in April and May of the same year the modes for the juveniles were in the 6-6.9 cm. and the 7-7.9 cm. groups respectively. The small sample of June showed modal frequencies for juveniles in the 6-6.9 cm. group and in the 9-9.9 cm. group.

The samples were too small to be significant in November (32 individuals only); the modal frequencies in this total were in the groups of below 5 cm., 10-10.9 cm. and 12-13.9 cm. It was noticed that young ones of the new brood already started appearing in this month for the season. These young ones occurred regularly from December onwards; in December their mode was in the 6-6.9 cm. group; the second mode in this month was not a prominent one and was in the 11-11.9 cm. group. Thus from September onwards the mode for the larger size-classes moved downwards and there was a reduction in the numbers of the larger specimens. During January, the juveniles had the mode in the 8-8.9 cm. group and an insignificant mode was present for the larger sizes in the 13-13.9 cm. class. Only one mode was clearly visible in February, namely, in the 9-9.9 cm. group, the second mode being practically absent. During this month 70.7% of the specimens were below 10 cm. size and 14.4% were above 12 cm. Two modes were noticed in March, one in the 6-6.9 cm. group and the other in the 10-10.9 cm. group.

#### DISCUSSION AND CONCLUSIONS

It was shown by Seshappa and Bhimachar (1954) that the length-frequency analysis gives certain important indications on the growth rate of *Cynoglossus semifasciatus* and the year-class composition of its fishery. They have stated: "The spawning season for this species usually starts about October each year. The resultant young ones start entering the fishery from December or January onwards. It is these new recruits that are responsible for the well-marked first mode (or the only mode, as the case may be) noticeable in the frequency



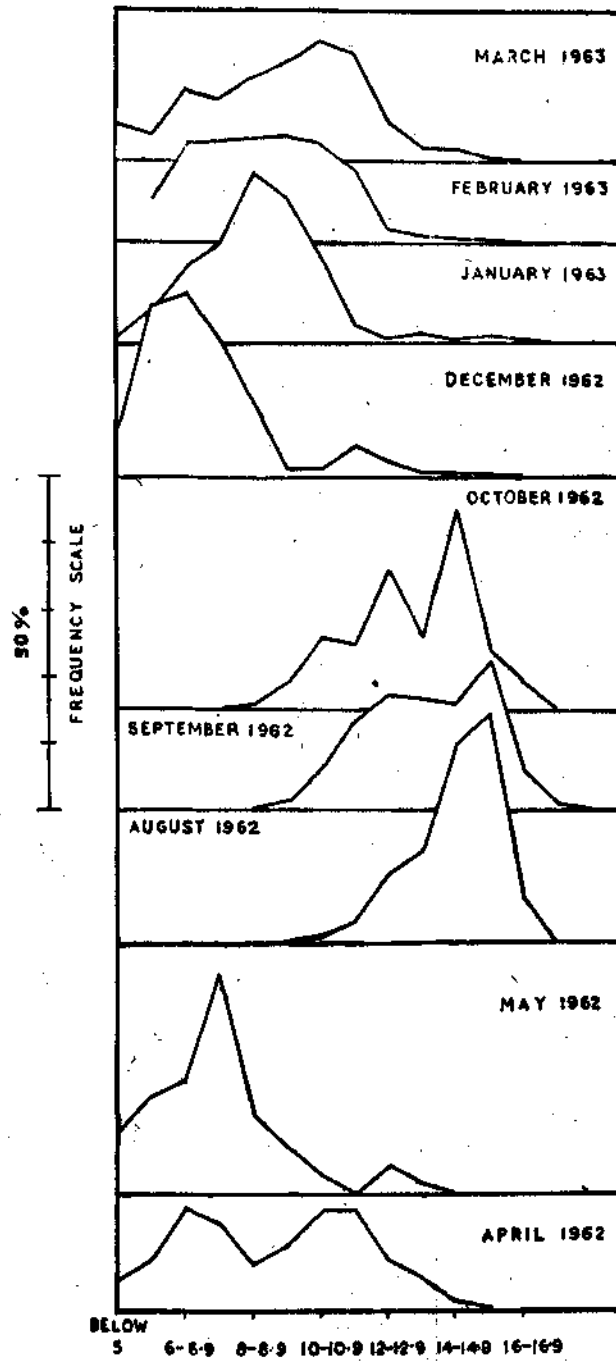


FIG 4. Length-frequency graphs for 1962-63.

curves of the pre-monsoon months... After May, spawning completely stops and recruitment is eventually at a halt. When the fishery starts immediately after the monsoon, the growth of the individuals is therefore clearly visible in the samples, with the smaller groups unrepresented and the mode correspondingly moved upwards. This progressive upward shifting of the mode can be noticed again until a new generation of young ones starts coming into the fishery as a result of the new season's spawning activity." Seshappa and Bhimachar (1955) have also shown that: (1) the bulk of the commercial catches of soles during the years 1949-50, 1950-51 and 1951-52 consisted of individuals that had a single monsoon ring, the older individuals being negligible in proportion. The products of spawning of a particular fishery season grow up to the commercial size and directly enter the fishery in the very next fishery season; (2) during the September-October fishery season in 1949 and 1950 in size-group with the highest frequency was 10-10.9 cm., but in the fishery season of 1951 this was 12-12.9 cm., thus showing a higher growth."

It will be of interest to examine the present data in the light of the above findings and conclusions. In Table I are shown the positions of the various well-marked modes in the size-distribution of *C. semifasciatus* for the years 1949-52 (from the earlier published data of Seshappa and Bhimachar, loc. cit.) and 1959-63 (from the present data) on a month-wise basis, so that a summary view is available at a glance, of the various modal size-groups noticed not only during different months of each of the years, but also during the corresponding months of the different years that are under consideration.

To be considered first of all is the position of the modal frequencies in the size-distribution patterns of the commercial fishery season, i.e., the months of September and October (also August during 1962-63 as in 1951-52). For 1959-60 this is in the 11-11.9 cm. group with the data available for October only, the fishery here having started late during the year. For 1960-61 the adults are represented by two modes, one in the 11-11.9 cm. group (dominant) and the other in the 14-14.9 cm. group (minor). The occurrence of two modes for the adults in this season (i.e., September-October) is a feature that was not noticed in the earlier work. The first mode here corresponds to the October mode of the previous year, but the second one is formed by a small number of surviving individuals of the older "year-class". In 1961-62 there are two modes in the samples, one representing a small number of juveniles (5-5.9 cm. group) and the other representing the "one-year class" (13-13.9 cm. group) corresponding to the 11-11.9 cm. group of the commercial season of the previous year. The rate of growth of this class during the year was therefore more than in the previous year; and the still older individuals did not occur in any good numbers to form a mode in the frequency distribution. The early juveniles of the new brood are seen only in September and not in October. It will be noticed that during the years 1949-52, juveniles of the new brood did not enter the catches until November-December. In 1962-63, samples were available in August also (as

TABLE I

Comparative positions of the modes in the size distribution of *Cynoglossus semifasciatus* during the years 1949 to 52 (data from Seshappa and Bhimachar, 1955) and 1959 to 63 (present data).

Years Months	1949-50	1950-51	1951-52	1959-60	1960-61	1961-62	1962-63
April	8-8.9	9-9.9	6-6.9 14-14.9	6-6.9 9-9.9 13-13.9	7-7.9 10-10.9	8-8.9	6-6.9 10-11.9
May	9-9.9	9-9.9	7-7.9 13-13.9	9-9.9	7-7.9 9-7.9	10-10.9	7-7.9 12-12.9
June	..	..	..	9-9.9	..	..	..
July	..	..	..	..	..	..	..
August	..	..	12-13.9	..	..	..	15-15.9
September	..	10-10.9	..	..	11-11.9 14-14.9	5-5.9 13-13.9	12-12.9 15-15.9
October	10-10.9	10-10.9	12-12.9	11-11.9	11-11.9 14-14.9	13-13.9	12-12.9 14-14.9
November	..	11-11.9	..	5-5.9 12-12.9	7-7.9 15-15.9	6-6.9 13-13.9	10-10.9 12-13.9
December	..	5-5.9 12-12.9	5-5.9 8-8.9 14-14.9	6-6.9 13-13.9	6-6.9 13-13.9	6-6.9 13-13.9	6-6.9 11-11.9

TABLE I—(Contd.)

<u>Years</u>	1949-50	1950-51	1951-52	1959-60	1960-61	1961-62	1962-63
<u>Month</u>							
January . . . . .	9-9.9	7-7.9 13-13.9	7-7.9	9-9.9 13-13.9	6-6.9	8-8.9 12-12.9	8-8.9 13-13.9
February . . . . .	10-10.9	7-7.9 13-13.9	9-9.9	9-9.9 13-13.9	6-6.9 12-12.9 15-15.9	8-8.9 12-12.9	8-8.9 13-13.9
March . . . . .	5-5.9 10-10.9	7-7.9	9-10.9	8-8.9 13-13.9	6-6.9 12-13.9	10-10.9	6-6.9 10-10.9

during 1951-52 in the earlier studies): in this season, August to October, there are two modes, both formed by the adults only, there being no premature occurrence of a juvenile class. The "one-year class" is here having the mode in the 12-12.9 cm. group while the older class has the mode in the 14-15.9 cm. groups taking the three months together. There is also an insignificant mode formed by the 10-10.9 cm. group in October only; this represents the products of a late spawning of the previous season. The "two-year class" is more prominent in this year than in 1960-61, the frequencies in the modal size-group for this class being 34.5% in August, 22.3% in September and 29.7% in October. The relative abundance of this group is a rare feature and was not noticed before.

The modal trends for the commercial fishery seasons of the four years reviewed above thus reveal that while as during the years 1949-52 the bulk of the commercial catch was formed in these years also by the "one-year old" individuals (these showing slight fluctuations in their modal sizes from year to year), the "two-year class" also had a modal frequency in the catches during 1960-61 and 1962-63 (better marked in the latter year than in the former). Premature early occurrence of a "0-year class" in the season 1961-62 is also another feature of this period in contrast to the earlier years.

The trends in the months of November-December following the commercial fishery season may now be considered. It is during this period that the products of the new brood must normally enter the catches as seen during 1950-51 and 1951-52. These make their first appearance in November during 1959-60, and 1960-61, and in December during 1962-63; their earlier occurrence during 1961-62 mentioned above, is followed by their regular occurrence in good numbers from November-December onwards.

As members of the new brood grow up and the individuals of the older age class or classes become increasingly less in the samples month by month, it is the "0-year class" which usually forms the bulk of the catch during the January-May period. As the spawning activity and the recruitment of juveniles to the fishery continue more or less till the commencement of the south-west monsoon, sometimes intermittently, the picture of the growth-trends of the species during these months is not always very clear from the length-modes (for the years now studied). But a reference to the graphs in Figs. 1 to 4 will show clearly the trend for the increasing occurrence of the larger sizes in the later months of the period. The continued occurrence of a mode in the 6-6.9 cm. group during the period December 1960 to March 1961 is an example of unusual occurrences. The month of March shows two modes in 1959-60, one for the "0-year class" and the other for the "one-year class"; two groups are similarly seen in March 1961, these representing again the juveniles of the year and the "one-year class" (12-13.9 cm. group), the still older class having completely disappeared. In 1961-62 there is only one mode in this month, representing obviously the

oldest batch of the "0-year class". The year 1962-63 shows two modes in March but both of the juveniles only.

The modes seen in April-May are mostly of the "0-year class" with occasional representation of the "one-year olds" as in 1962-63 (May) when the 12-12.9 cm. group formed a mode, the constituents of which contributed to the 14-15.9 cm. mode in the following August-October period indicating a good growth for this size at this period of the year. The curve for the "0-year class" becomes unimodal after further growth.

It is thus seen that while confirming the earlier finding that the fishery is essentially an *annual* one with the bulk of the commercial catches consisting of the "one-year class" individuals, these studies have revealed an unusually early occurrence of new recruits of a "0-year class" 1961-62 (September) and also a relatively increased dominance of the "two-year class" in the fishery during 1962-63.

#### SUMMARY

Length-frequency studies were made on the Malabar sole, *Cynoglossus semifasciatus* Day, at West Hill, Calicut during the years 1959-63, the work being designed to get a comparative picture of the size and growth-trends of the species after a considerable lapse of time, in the same sampling grounds where work was carried out on this species during 1949-52. The modal trends for the commercial fishery seasons (mainly September-October months) of the four years reviewed have confirmed that the bulk of the commercial catch in this species is formed by "one-year old" individuals, these showing some fluctuation in their modal size from year to year. But the "two-year class" also had a modal frequency in the catches during 1960-61 and 1962-63 in contrast to the earlier years. The trends of the pre-monsoon months are generally as observed in the earlier work but more modes than one occur frequently in the size-distribution and the growth picture is not always very clear in these months from the modes alone perhaps because of the prolonged and sometimes intermittent spawning period and the consequent recruitment of juveniles almost up to the commencement of the south-west monsoon. The gaps in the above-mentioned modes close up after the cessation of spawning (as a result of differential growth) and there is usually no confusion in the year-class trends during the post-monsoon months. The occurrence of three "year-classes" or generations together has been noticed on some occasions in the present work.

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