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for the

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(*PART II*)

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DEPARTMENT OF AGRICULTURE AND FISHERIES
ANNUAL REPORT FOR THE YEAR 1963
FISHERIES RESEARCH
(PART II)

Introduction

During the year the Joint Fisheries Research Organization of Northern Rhodesia and Nyasaland ceased to exist as such, the Northern Rhodesian Government announcing that, with the cessation of Colonial Development and Welfare Fund assistance to the Northern Rhodesian section of the Organization, and the consequent absorption of that section's expenditure into the recurrent vote of their Ministry of Native Affairs, it could no longer contemplate a joint committee to advise on research problems. The Northern Rhodesian Government therefore ceased to recognize the Research Advisory Committee and the arrangement by which a joint annual report was published was terminated. These were the only remaining administrative links between the two sections of the Organization. A connexion at scientific officer level will be maintained between the two now separate research units by the continuation of the annual meeting of fisheries scientists.

In December, as a result of reorganization within the Ministry of Natural Resources and Surveys, responsibility for the research unit passed from the Director of Game and Fisheries to the Director of Agriculture and Fisheries.

The recruitment of a third research officer in May brought the staff of the unit up to the level of its establishment.

The long-awaited move of the headquarters of the unit from Nkata Bay to the new laboratory at Monkey Bay took place in July, 1962, the scheduled date for the completion of the buildings. The fact that in the event the buildings were not completed till December disrupted some of the year's work. The Nkata Bay Laboratory is being maintained as a sub-station.

The new research launch *Ethelwynn Trewavas* arrived on the Lake from England in November. Her fitting out was completed at the Nyasaland Railways dockyard by our Technical Officer and she was commissioned in January.

The laboratory at Monkey Bay was visited in September by Professor C. M. Yonge, chairman of the Fisheries Committee of the Department of Technical Co-operation. In November the Director of Game and Fisheries of Northern Rhodesia and his Chief Fisheries Research Officer came to Monkey Bay for informal discussions about the winding up of the Joint Fisheries Research Organization. The annual meeting of the fisheries scientists of Northern Rhodesia and Nyasaland took place at Monkey Bay in February.

In May Professor V. Vacquier and Dr. R. P. von Herzen of the Scripps Institution of Oceanography, California, visited Lake Nyasa and, in the course of a 12-day cruise in the *Ethelwynn Trewavas*, measured the heat flow through the lake bottom at 21 stations. Such measurements have been made in oceanic areas, but this is the first time they have been made for lakes. They are of great interest in connexion with current geophysical theories of conversion in the earth's mantle.

SENIOR STAFF AS AT 30TH JUNE, 1963

Fisheries Research Officers	D. H. ECCLES, B.Sc.
	R. B. WILLIAMSON, B.Sc.
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Fisheries Research Officer (Temporary) Part-time	MRS. S. I. B. WILLIAMSON, B.Sc.
Technical Officer	A. A. HYDE

Labeo Mesops

Research into the biology of *Labeo mesops* continues. The establishment of the new laboratory at Monkey Bay, where this fish is commoner and more easily caught than in the North, has enabled us to obtain larger and more regular samples. During the year the larval and post-larval stages in life history were recorded for the first time.

1. *Breeding Biology and Juvenile Growth and Development*

The riverine phase in adult and juvenile life history was studied in the Nkandwe stream. This is a small watercourse rising between Kasankha Bay and Namadzizi hill and entering the lake 2½ miles south of Monkey Bay; completely dry in the dry season it flows for only short periods during the rains. Mature fish ran up the Nkandwe on the 9th February after two days of rain had brought it down in heavy spate. The actual spawning was not observed but probably took place that night or early the following morning as large numbers of spent fish were caught on their way downstream on the morning of the 10th February and none seen thereafter. On the 11th, eggs, subsequently identified as *Labeo mesops*, were collected by dragging a fine meshed net along the flooded banks of the stream at a point two miles by water from the lake. More eggs and some larvae were collected using the same net set stationary across the main current. Larger numbers of larvae but no eggs were collected on the 14th. No young stages of *L. mesops* were caught after the 16th February, by which time the stream was contained entirely between its banks and its flow very slight.

Some eggs and larvae from Nkandwe were kept in the laboratory, principally to let them grow to such a size as to allow of their positive identification. The various stages in the development of these were recorded and a series preserved. The last of the eggs in the laboratory to hatch did so on the morning of the 12th February, about 24 hours after the first. Due to this variation in the time of hatching and to the uncertainty over the exact time of spawning it is not possible to put a precise figure to the period between spawning and hatching. It is between 30 and 65 hours, the mean probably falling between 30 and 45 hours. The larval yolk sac is elongate, as it is in some other members of the genus, and this supports the contention recently put forward that this characteristic may be of considerable taxonomic importance. The larvae started to feed in the laboratory tanks on the 13th February, 3–4 days after they were spawned. Rates of growth and development were rapid but varied considerably between different tanks. In the tank which showed a rate of growth close to that found in the natural population most adult characters were developed by 24 days and larvae 4.3mm. on hatching reached a length of 36mm. 44 days later.

The rate of growth of the wild fish derived from the spawning in the Nkandwe was followed by sampling, with small meshed seine nets, the population at its mouth which is conveniently isolated from other streams by stretches of exposed rock and sandy beaches. At first the fish were found in the mouth of the stream which was flooded back several hundred yards due to the high lake level. After the 12th March the samples were taken from a *Phragmites*-enclosed lagoon adjacent to the stream mouth. From 21st May no young *L. mesops* were caught in the area, possibly due to their moving into waters where our gear could not reach them. After this date samples were collected from Coco Bay 1½ miles to the north, which offered an unobstructed seining beach and in whose afferent stream a spawning migration had been noted on the same date as that in the Nkandwe.

The length frequency distributions of the samples are given in Table I and are illustrated in Figure 1A. The distributions are unimodal and this confirms our observation that there was only one spawning migration in the area this year, that of

9th February. Had there been more we would expect the later distributions to be bi- or poly-modal. In Figure 1B the mean length of each sample is plotted against the number of days after the hatching date of the Nkandwe population (taken as 11th February) and a point added, 4.3mm. at age 0 to represent the length at hatching. The rate of change of length with time (growth rate) can be represented for the period covered by a straight line. The growth rate indicated is very rapid being about 2.5cm. per month.

It has been stated in the past that it was unlikely that *L. mesops* could satisfactorily breed in the area of the south east arm of Lake Nyasa due to the ephemeral nature of its afferent rivers. It is now evident that, due to the extremely short time that both adults and juveniles require to spend in a river, spawning can be successfully completed there. That the young fish can survive being carried downstream at an early age (2–5 days) is indicated by the appreciable numbers of them caught in the lake between March and July. Larvae were collected from two other streams in the Monkey Bay area and young fish were caught at a number of seining beaches so it does not seem that the successful spawning noted at Nkandwe was in any way exceptional.

The very short period spent by the juveniles in their native stream is of interest in connexion with the present controversy over the basic reasons for breeding migrations in African fishes. It is, however, not proposed to discuss this here.

2. *Adult Growth and Behaviour*

The adult population in the Monkey Bay area was sampled throughout the year with a graded fleet of gill-nets of mesh sizes from 2 to 5 inches by ¼ inch increments. The monthly length frequency distributions are given, for males and females separately, in Table II and as percentage frequency histograms in Figure 2. They are polymodal in form, most exhibiting at least two obvious modes. The positions and relative importance of the different modes changed from month to month.

In a fish with a single spawning period each year the distribution of length at age can be represented by a normal curve and it is assumed that the above distributions are compounded of a number of such curves each representing one age group. Further, it has been shown that the modes of a heterogeneous curve are usually near the modes of its constituent distributions and we therefore take the modes evident in the distributions to be the modal lengths of the various age groups composing them. In Figure 3 the positions of the modes in the female distributions have been plotted against the month in which they occurred, data from Figure 1B being added to cover the juvenile age group. The points fall naturally into four series each of which can be represented by a line of positive and decreasing slope. To them has been fitted the parts of that smooth line of continuously decreasing slope that best fits *all* the points (i.e. the lowest line in the figure, ending in December, is continuous with the next higher line, starting in January, and so on). This curve indicates the most probable growth rate from birth to three years. Assuming a mean birth date for the population of mid February, it would suggest a length at the end of the first year of 22cm., at the end of the second of 31cm., and at the end of the third of 37cm. This is a much more rapid rate of first and second year growth than has been postulated in the past. The data for males when similarly treated yielded no clear-cut trends in the movement of the positions of modes and a continuous line could not be fitted with any degree of confidence. However, a general examination of the two sets of length frequency histograms, taken together with observations on maturity (see below) indicates that the males must either grow more slowly than the females, or grow more rapidly but spawn a year earlier, because the modes about 33.5cm. (males) in December and January and those about 36.5 (females) in the same months are the modes of the maturing fish that spawned the following February

Besides the gradual change in the position of the modes, due to growth, there are two more or less sharp changes in the shapes of the distributions of both males and females. The first occurred between July and October and consisted of a considerable increase in the proportion of larger fish in the catch. It is shown below that these larger fish consist almost entirely of mature or maturing individuals and it would seem likely, therefore, that this change in the shape of the distributions is due to a change in the behaviour of the fish as they mature, rendering them more liable to capture by our gill nets, rather than to a real change in the proportions of large fish in the true population. Either these fish are more active and therefore more easily caught by stationary gill nets or, more probably, the maturing fish move inshore as the spawning season approaches and they are therefore more easily caught in our fleet of nets which were set close to the shore. If the latter is the main cause the former will give an added effect since the essential movement entailed in any migration will render the fish more liable to capture. If such a migration occurs the data indicates that it starts about August and this would help to explain the widely different impressions of the composition of the *L. mesops* population that have been gained in the past from successive annual samples in July and August. Obviously a small change in the dates of sampling or of the timing of a migration would give large differences in the length frequency distributions of the catch.

The second change, which is more striking, is the virtual disappearance of the large fish mentioned above, after February. This is almost certainly connected with the spawning run that occurred in the Monkey Bay area on 9th February, for a close examination of the February distributions showed that before that date the shape of the distributions approximated to those of January while after it to those of March. The reason for the change may again be behavioural, spent fish immediately moving offshore. However, a contributory factor is probably the amount of fishing mortality exerted on the fish during its short riverine phase and perhaps also an increased element of natural mortality at this time.

3. *Maturity and Fecundity*

The length at first maturity was determined using fish from the gill net catches of October to December during which period mature and maturing fish can be easily distinguished from those that are immature. Figure 4 shows the percentage of fish that were mature of maturing in each length group plotted against length.

The points lie on a sigmoid curve and the 50 per cent. level on this curve is taken as the median value for length at first maturity. The values indicated by the figure are 28.9cm. for males and 33.5cm. for females. These values show that the large modes at the right-hand side of the male and female length frequency distributions from August to January (see Fig. 2) consist almost entirely of mature and maturing individuals. The significance of this has been discussed above. Assuming that the suggested rate of growth of females is valid, the value of 33.5cm. for length at first maturity indicates that female fish bred for the first time at an age of three years.

A measure of fecundity was derived by estimating the number of eggs in the ovaries of each of six ripe fish of various sizes. The ovaries of each fish were first immersed in Gilson's solution for several days to ensure complete separation of the eggs from each other. Five random samples from each set of eggs were weighed and the number of eggs counted. Knowing the weight of all the eggs of each fish estimates of total number of eggs were obtained. These ranged from 85,000 to 140,000 depending on the size of the fish. The sample is far too small to form the basis of a relationship between number of eggs and size of fish. All that can be said at this time is that the Fecundity Factor (number of eggs per gram of body weight) is of the order of 180

The size frequency distribution of the eggs within an ovary appears to be unimodal, as may be expected in a fish with a single short spawning season each year.

4. *Food and Feeding*

L. mesops is a benthic species and feeds on algaceous mud. Analyses of the gut contents of adult fish indicates that the identifiable organic matter consists predominately of diatoms, especially *Rhopalodia spp.* The green alga *Oedogonium* is also commonly present.

The gut contents of the larval and juvenile fish analysed differed slightly from that of the adults. In the river the fish appeared to be feeding on detritus containing the fragments of higher plants. At the mouth of the river, and along the margins of the lake close to it, green algae (flagellates and the desmid Cosmarium) were commonly found in the guts of fish from 3 to 9 weeks old, along with diatoms of the genera *Nitzschia, Cymatopleura, Navicula, Gomphonema* and *Cymbella,* and a few blue-green algae. With the movement of the fish into somewhat deeper water in May at an age of 3 months, the composition of the algae became similar to that found amongst the adults. Diatoms predominated, *Rhopalodia spp.* being the commonest.

In the course of collection of data on the degree of fulness of the gut of the fish caught in our gill nets it was noticed that during some months there seemed to be a correlation between the degree of fulness and length of fish, especially among the females. The figures for November, for example, show that the majority of females between 20cm. and 29cm. had a full gut whereas in the majority of those between 30cm. and 44cm. the gut was empty. The latter group of fish contain those that are maturing and it is possible that the comparative emptiness of the gut may be connected with this and with the inshore migration of mature fish tentatively postulated elsewhere in this report. It must be emphasized that this apparent correlation has not yet been rigorously examined and any conclusions based on it must be regarded with extreme caution.

5. *The Riverine Fishery for Mature Fish*

The methods of fishing the spawning migration differ between Nkata Bay and Monkey Bay. At Nkata Bay on the Limpasa river permanent weirs are erected across the river and these are furnished with large basket traps to catch the fish as they move upstream to spawn. Small fish fences with smaller basket traps are also used in the drainage channels of the dambos and these can be used to catch fish moving either upstream or downstream. In the Monkey Bay area fish weirs and basket traps are not much used against *L. mesops,* the principal fishery depending on the *Thumbadza*, a bag-shaped hand net.

Observations on the Limpasa river during the rains confirmed the impression gained in previous years, that the fishing weirs are not efficient barriers to fish migration. Catches were recorded from two weirs, each theoretically a total barrier to fish migration in the main river, one 400 yards upstream of the other. It was found that the catch at the upstream weir was slightly greater than at the downstream one. If the weirs are of the same order of efficiency (they are of the same basic design) then it is obvious that the level of that efficiency must be very low. The very fact that four such weirs have been erected in a stretch of less than one mile of river indicates that their efficiency cannot be very high.

The thumbadza net used at Monkey Bay cannot, because of its design, be used efficiently against fish moving upstream and the catch in this fishery consists largely of spent fish that are moving out of the dambos after spawning.

It is felt therefore that, at present, neither of the two methods of fishing described above seriously deplete the size of the spawning stock in the areas in which they have been observed.

TABLE I

Length frequencies, in 2mm. groups, of *Labeo mesops* from small-meshed seine nets in the Monkey Bay area.

Length	5/3/63	12/3/63	19/3/63	26/3/63	2/4/63	8/4/63	16/4/63	24/4/63	30/4/63	1/5/63	Length	10/5/63	1/5/63	14/6/63	8/7/63
11	—	—	—	—	—	—	—	—	—	—	65	1	—	—	—
13	—	—	—	—	—	—	—	—	—	—	67	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	69	1	1	—	—
17	1	—	—	—	—	—	—	—	—	—	71	6	—	—	—
19	4	—	—	—	—	—	—	—	—	—	73	7	1	—	—
21	6	—	—	—	—	—	—	—	—	—	75	2	2	—	—
23	3	5	—	—	—	—	—	—	—	—	77	7	1	—	—
25	1	23	—	—	—	—	—	—	—	—	79	3	5	—	—
27	1	48	2	—	—	—	—	—	—	—	81	3	3	—	—
29	—	25	3	—	—	—	—	—	—	—	83	—	4	1	—
31	—	4	18	—	—	—	—	—	—	—	85	2	1	—	1
33	—	—	19	3	—	—	—	—	—	—	87	2	3	—	—
35	—	—	13	22	1	—	—	—	—	—	89	—	1	1	—
37	—	—	8	32	—	1	—	—	—	—	91	3	1	1	1
39	—	—	2	47	5	—	—	—	—	—	93	—	2	2	2
41	—	—	1	64	15	1	—	—	—	—	95	1	—	3	—
43	—	—	—	32	12	2	1	—	—	—	97	—	—	3	1
45	—	—	—	11	17	1	1	—	—	—	99	—	1	6	2
47	—	—	—	8	14	2	4	—	—	—	101	1	—	6	—
49	—	—	—	3	4	5	2	—	—	—	103	—	—	6	3
51	—	—	—	—	5	6	7	—	—	—	105	—	—	14	1
53	—	—	—	—	1	4	5	1	2	—	107	—	—	9	1
55	—	—	—	—	—	4	11	3	8	—	109	—	—	9	—
57	—	—	—	—	—	2	19	5	1	—	111	—	—	5	2
59	—	—	—	—	—	—	30	7	—	—	113	—	—	5	1
61	—	—	—	—	—	—	27	6	2	1	115	—	—	5	2
63	—	—	—	—	—	—	21	5	2	4	117	—	—	5	7
65	—	—	—	—	—	—	6	5	3	4	119	—	—	2	—
67	—	—	—	—	—	—	3	1	8	2	121	—	—	2	5
69	—	—	—	—	—	—	—	2	3	1	123	—	—	—	4
71	—	—	—	—	—	—	1	—	3	11	125	—	—	—	—
73	—	—	—	—	—	—	—	1	—	3	127	—	—	1	—
75	—	—	—	—	—	—	—	—	—	3	129	—	—	3	1
77	—	—	—	—	—	—	—	—	1	2	131	—	—	1	—
79	—	—	—	—	—	—	—	—	2	—	133	—	—	—	1
81	—	—	—	—	—	—	—	—	—	1	135	—	—	—	—
83	—	—	—	—	—	—	—	—	—	—	137	—	—	—	—
85	—	—	—	—	—	—	—	—	—	—	139	—	—	—	—
87	—	—	—	—	—	—	—	—	—	—	141	—	—	—	1
Mean	21.3	27.0	33.3	40.1	44.4	50.0	58.6	61.1	63.9	69.9		78.3	82.7	107.4	112.8

TABLE II

Length frequencies of male and female *Labeo mesops* from gill-net catches in the Monkey Bay area, July, 1962, to June, 1963

MALES

Length (cm)	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June.
16	—	—	—	—	—	1	—	1	3	1	—	—
17	1	—	—	1	—	3	—	5	4	—	1	—
18	2	—	—	—	—	—	—	5	2	—	2	—
19	—	1	—	—	—	—	—	3	—	2	5	—
20	6	6	2	1	1	—	1	6	1	2	3	2
21	3	8	6	1	—	—	1	2	3	5	4	2
22	8	18	10	4	3	4	6	3	7	8	2	—
23	9	6	7	2	1	4	3	10	9	5	—	1
24	16	14	7	1	4	4	5	6	17	1	2	—
25	19	18	10	1	2	3	7	1	18	3	3	3
26	26	19	11	5	1	2	5	2	6	3	3	2
27	16	28	9	9	3	1	1	3	2	3	3	3
28	25	29	9	8	3	4	4	—	—	1	3	1
29	18	52	9	9	7	7	5	3	—	1	3	2
30	11	43	22	16	9	15	22	8	1	1	4	7
31	13	42	30	17	19	14	26	15	10	2	6	3
32	9	35	16	20	21	15	41	19	2	2	4	6
33	7	20	12	14	17	13	50	16	4	2	2	3
34	1	7	6	10	10	20	41	9	—	—	—	1
35	1	2	—	6	4	9	16	11	—	—	—	1
36	—	3	4	—	2	4	6	6	—	—	—	—
37	—	4	—	1	—	3	—	3	—	—	—	—
38	—	2	—	—	—	1	—	—	—	—	—	—
39	—	—	—	—	—	—	—	—	—	—	—	—
40	—	—	—	—	—	—	—	—	—	—	—	—
41	—	—	—	—	—	—	—	—	—	—	—	—
42	—	—	—	—	—	—	—	—	—	—	—	—
43	—	—	—	—	—	—	—	—	—	—	—	—

FEMALES

Length (cm)	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
16	—	—	—	—	—	—	—	1	2	—	—	—
17	—	—	—	—	—	—	—	2	1	—	2	—
18	1	—	—	—	—	—	—	2	1	1	1	—
19	2	1	—	1	—	1	—	2	2	1	3	—
20	3	2	1	1	—	—	—	1	1	3	5	1
21	19	8	7	1	1	—	—	2	2	8	3	1
22	22	20	8	9	3	1	4	5	6	9	8	1
23	7	26	10	3	9	1	5	10	17	13	4	—
24	15	21	14	5	9	4	6	19	21	7	4	2
25	24	25	19	2	9	3	8	10	10	5	4	4
26	19	26	15	9	6	5	5	11	14	4	8	1
27	26	29	22	5	5	5	6	9	14	5	7	—
28	17	28	15	14	7	3	3	4	4	3	6	2
29	14	21	13	6	8	2	2	1	2	5	3	2
30	8	26	14	8	3	2	6	2	3	3	20	6
31	8	38	16	10	2	1	4	5	7	2	7	3
32	14	35	11	19	5	2	7	6	7	3	9	4
33	5	37	20	11	8	3	13	3	4	4	10	3
34	7	34	20	22	14	9	21	9	6	1	5	1
35	3	36	22	20	7	6	20	16	3	1	2	5
36	6	33	26	21	10	10	42	9	7	2	5	—
37	5	40	18	13	5	8	23	17	2	1	3	1
38	5	29	18	10	4	8	29	11	2	1	1	1
39	3	14	16	2	6	7	12	14	2	—	—	—
40	3	1	7	5	1	2	11	8	1	—	2	1
41	—	4	4	—	2	—	3	2	—	—	—	—
42	—	5	1	1	2	—	1	4	—	—	—	—
43	—	—	1	1	—	—	1	—	—	—	—	—

Hydrology

Few hydrological observations were made during the year, since for most of the period there was no launch available at Nkata Bay, while the *Ethelwynn Trewavas* was not available at Monkey Bay before the departure on leave of the Research Officer principally responsible for hydrological observations.

At Monkey Bay a routine station has been set up, from which series of readings were obtained between April and June. On 19th April a marked thermocline was present between 30 and 50 metres, but by 4th May the surface water had cooled by 2.5°C to a depth of 40m. while the deeper water had dropped about 0.75°C, a thermocline was, however, still present. On 13th May this had disappeared, and by the 6th June the water column was homothermal at 23.4/C. Cooling continued until 21st June, after which the temperature of the upper 40 metres began to rise.

In the course of a cruise from Monkey Bay to Fort Johnston and back, between 24th and 26th June, temperature readings from a number of stations indicated that surface chilling might be taking place at the southern end of the lake, with a northward flow of cool water along the bottom. This may play an important part in maintaining the stability of the deep cool hypolimnion found below 200 metres in the deeper parts of the lake.

Phytoplankton

Regular qualitative sampling of the phytoplankton was started in the Monkey Bay area in November, 1962. From January, 1963, when a technique for their analysis was perfected, quantitative samples were also taken. Drawings have been prepared of all species found and identification at generic level established in almost all cases. Due to limited library facilities it has not been possible to establish specific identification in more than a few cases.

Phytoplankton is present in much greater quantities at Monkey Bay than at Nkata Bay where samples have been taken in past years. This is not unexpected when we consider the shallowness, and therefore greater potential productivity, of the south end of the lake compared to the north. The species composition also differs between the two localities. Filaments of *Melosira spp.*, found only rarely in the North, were present in all samples from Monkey Bay and species of Peridiniales not noted from Nkata Bay were found in abundance in the Monkey Bay samples.

The abundance of different species, and to a certain extent the species composition, in the Monkey Bay samples varied with the depth at which they were taken and with the date of sampling, but the period over which regular sampling has taken place is too short to allow of conclusions being drawn from these variations. One very large " bloom " of *Anabaena sp.* and to a lesser extent of species of *Nitzschia* and *Peridinium* was noted on the 22nd May. This bloom followed the breakdown of the thermocline which was noted on the 13th May, (see under Hydrology) and the two occurrences may well be correlated.

Recent Publications

Eccles, D. H. An internal wave in Lake Nyasa and its probable significance in the nutrient cycle. Nature 194 4831: 832–833 (1962)

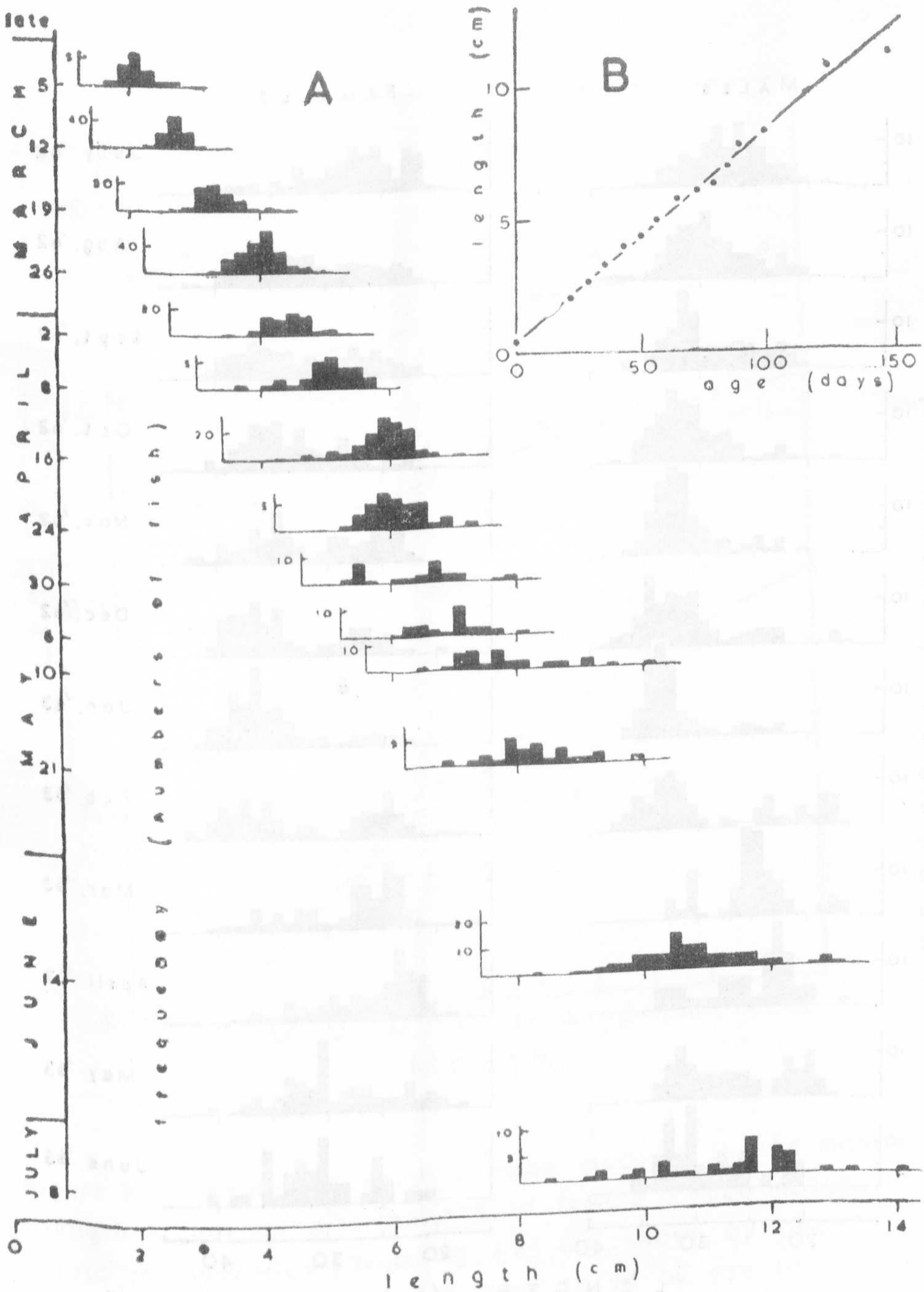

Figure 1. Labeo mesops from small meshed seine net catches in the Monkey Bay area, March to July 1963

A. Length frequency distributions

B. Mean length of each sample plotted against number of days after probable hatching date

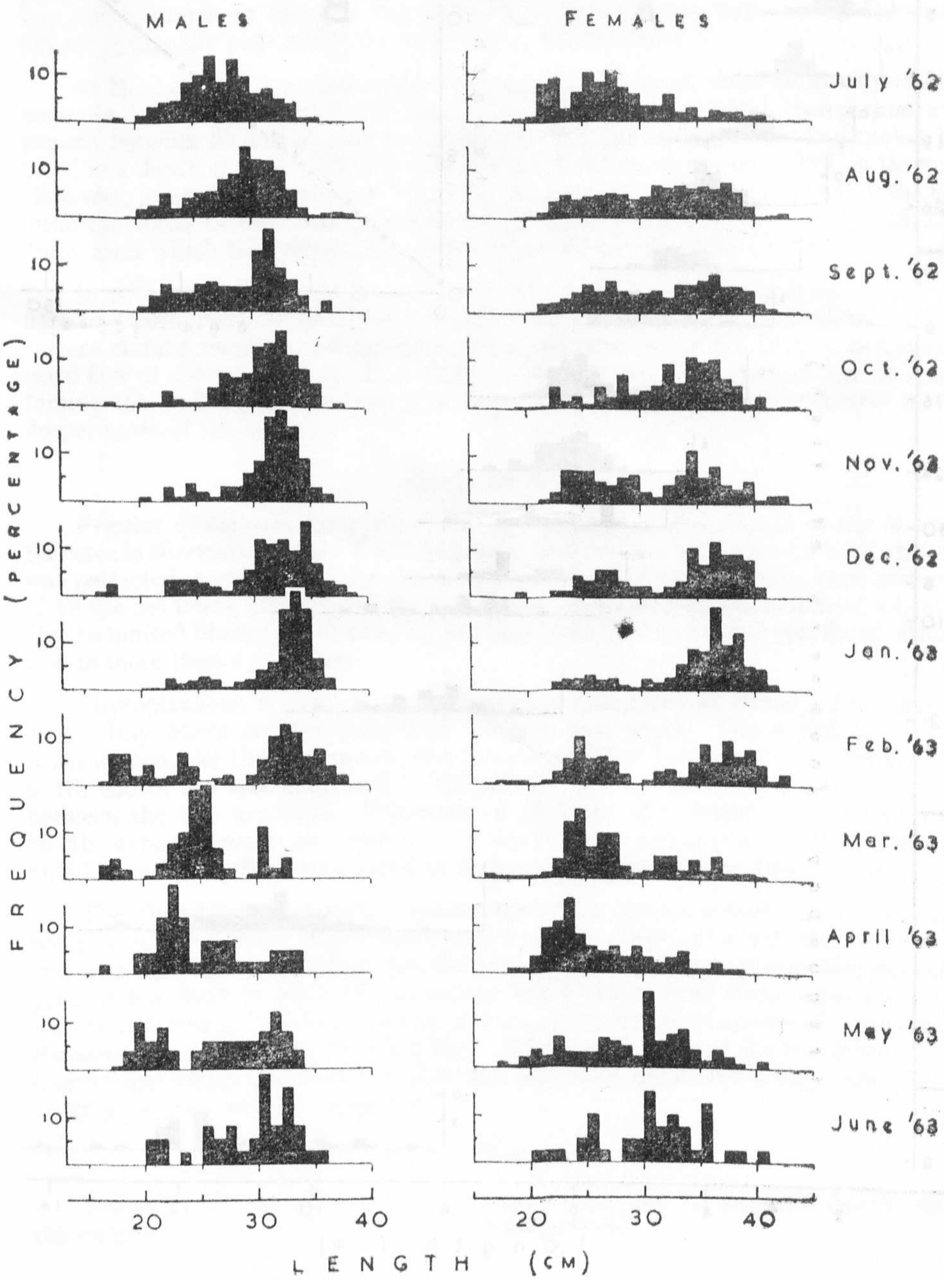

Figure 2. Length frequency distributions of male and female Labeo mesops caught by a graded fleet of gill-nets in the Monkey Bay area, July 1962 to June 1963.

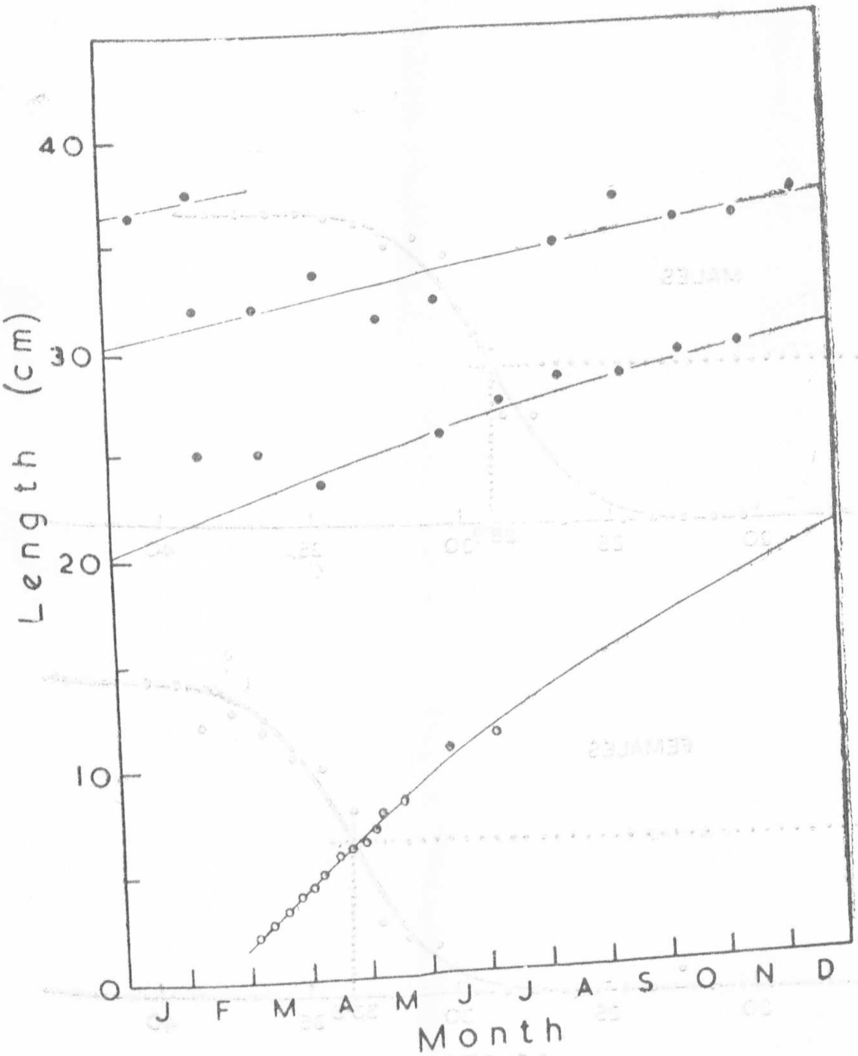

Figure 3. Lengths at which a mode occured in the monthly length frequency distributions of female Labeo mesops. Data for juveniles (from fig. 1B) are shown by open circles. A smooth line has been fitted by eye to indicate probable growth rate.

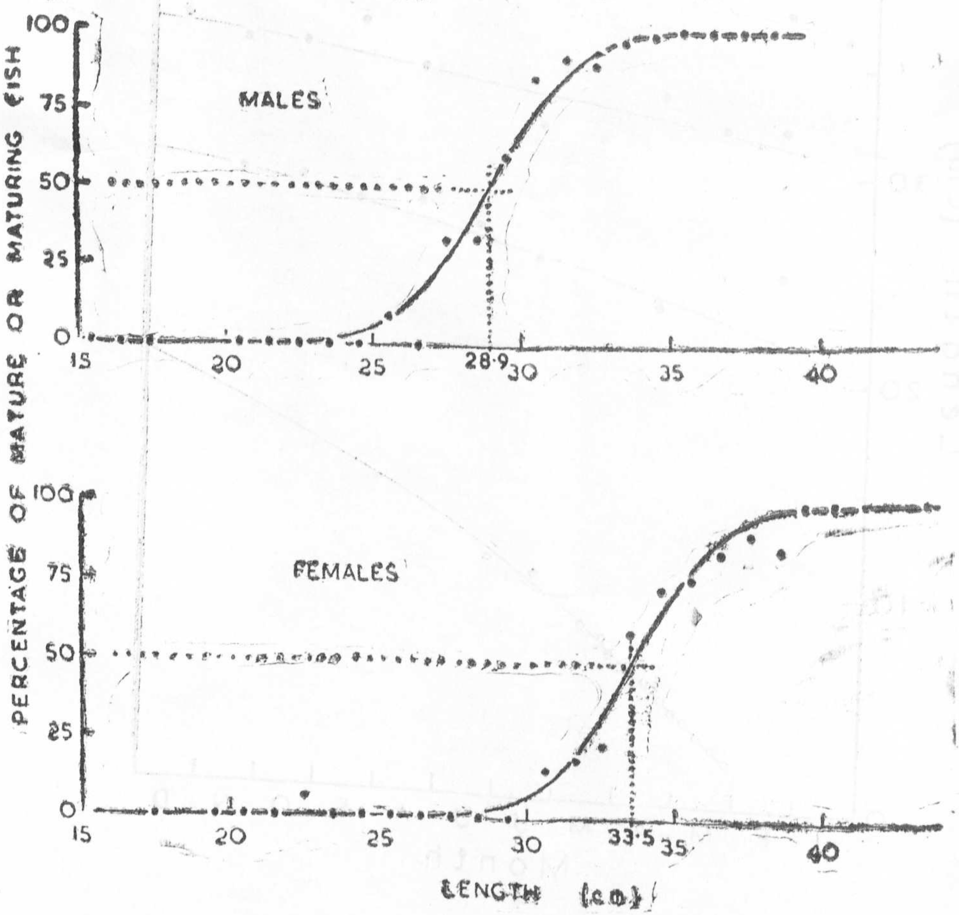

Figure 4. Labeo mesops. Percentages of mature or maturing fish in centimetre length groups. Dotted lines indicate the 50 % levels