APPENDIX D

STUDIES ON ENCLOSED LAGOONS IN THE JINJA AREA

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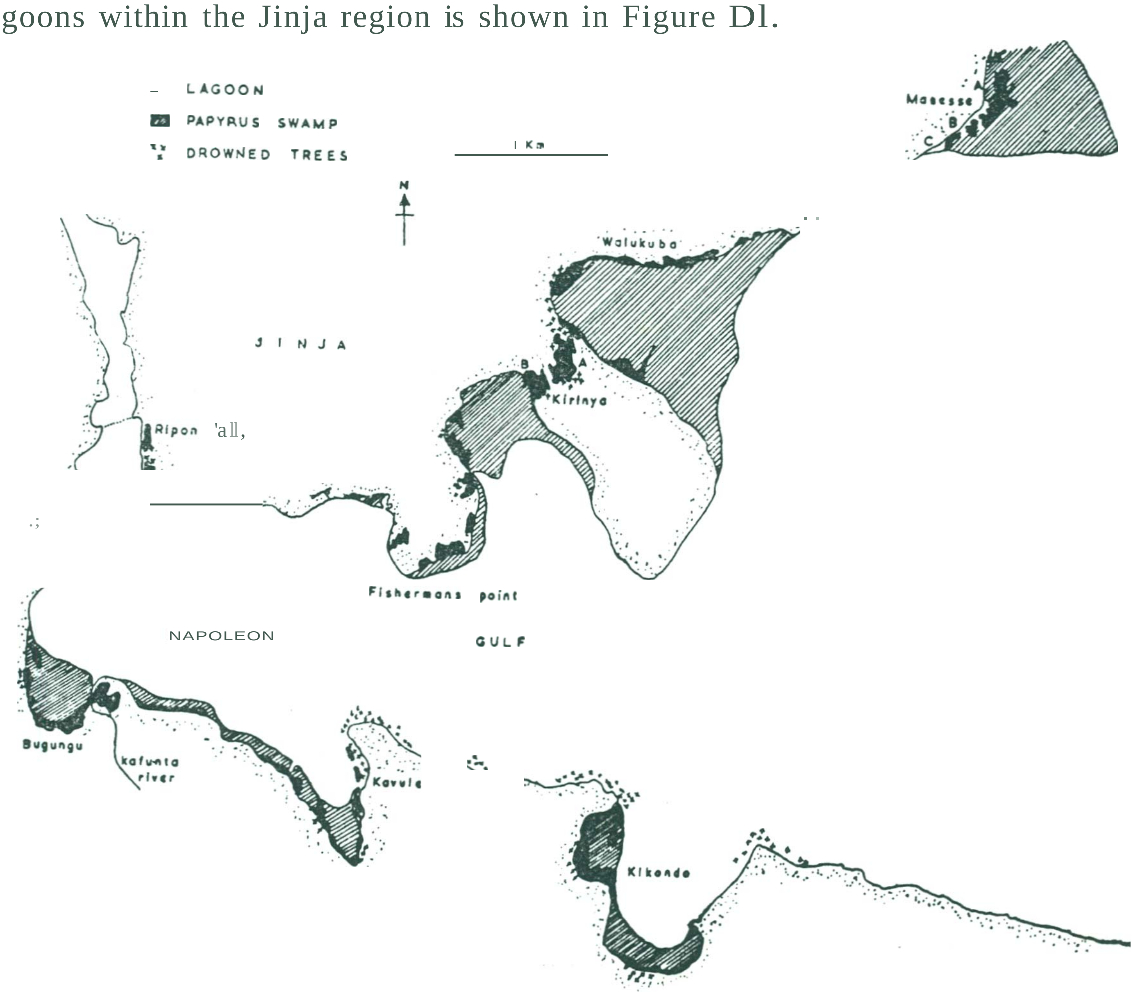
A number of lagoons have been studied in the Jinja region and a visit has been made to waters in Mwanza. Observations from aircraft have shown lagoons to be widely distributed at least throughout the northern and eastern shores of the lake, and because sand and rocky shores have remained relatively unaltered by the rising water level it seems possible that the flooding of swampy shores to form lagoons has been the principal environmental change due to rising water level.

During these studies two types of enclosed lagoons have been distinguished:-

(1) Those waters formed by the flooding of low-lying ground behind papyrus swamps which may be termed papyrus lagoons, which are often separated from tbe lake by a considerable depth of vegetation and which consist of a central area of deep water with marginal grass swamps.

(2) Those areas where fringing forests have been inundated and the trees killed which may be termed forest lagoons. These are characterized by a deep central area of water choked with dead trees; there is little marginal swamp and the lagoons are usually close to tbe lake.

There bas, however, been a tendency for the papyrus fringes, behind which the lagoons have appeared, to die back and to expose the once isolated waters to the open lake; these are referred to as open lagoons. In the course of this process further pools have appeared within the papyrus swamps. Tbe distribution of the lagoons within the Jinja region is shown in Figure Dl.



The studies have shown that both types of isolated lagoon are occupied by a similar group of cichlid species, principally comprising the genera *Haploehromis* and *Tilapia,* although other non-cichlid genera including *Aploeheliehthys, Protopterus, Ctenopoma* and *Clarias* have also been recorded in some of these waters but they are never numerically important.

The composition of the population present in any lagoon is apparently related to the degree of isolation of the lagoon from the lake. Thus, following changing environmental conditions, changes have been recorded in the relative numbers of the cichlid species present and also in the relative numbers of *Haplochromis* and *Tilapia* species themselves. The data given in Table Dl shows that the quantity of *Haploehromis* relative to *Tilapia* decreases as the lagoons become increasingly isolated.

As previously noted (Welcomme 1965), a characteristic aggregation of *Haploehromis* species is found associated with the lagoons and further investigations have shown that the same species are common in all lagoons close to the lake but that in those lagoons separated by greater depths of vegetation the number of *Haploehromis* species present falls with increasing separation (Table D2). A decreased number of *Haploehromis* species is also shown in marginal lagoons containing very high populations of large *Tilapia.* Thus in Bugungu lagoon in 1965 when 35 per cent of the *Tilapia leueostieta* were 19.5 ± 1.0 cm. standard length only two species of *Haploehromis* were present, but in 1963 when the *Tilapia* were smaller, 9.9 ±2.5 em. S.L., six species of *Haploehromis* were common.

All six of the *Tilapia* species at present recorded for Lake Victoria were found in the lagoon systems; however, it has been the introduced species that have colonized these regions the most efficiently. Differences in the composition of *Tilapia* population have arisen between the different types of lagoon (Table D3).

The dominant species in the papyrus lagoons was always *T. leucostieta,* which was also present in large quantities in forest lagoons where *T. zillii* comprised the greatest part of the catch. The open lagoons usually had a major population of one or other of the nature species *(T. variabilis* and *T. esculenta)* in firm-bottomed lagoons, and on some fairly exposed drowned forest shores *T. variabilis* was the most abundant species whereas in the more sheltered muddy inlets *T. esculenta* was dominant. In some very shallow, sheltered and mud-bottomed inlets, Kavule, for example, a high proportion of *T. leueostieta* was still present.

ASPECTS OF THE BIOLOGY OF *Tilapia leucostieta*

The mean, maximum and minimum length frequencies of adults of *T. leueos{ieta* from various lagoons is shown in Table D4; there appears to be a correlation between the depth of vegetation separating the enclosed waters from the open lake and the length characteristic of the population. This correlation may be due to the readiness with which larger fish may enter or leave the lagoons with the denser vegetation acting as a kind of filter. In the waters nearest the lake there are usually two length frequency *(L/F)* modes within the population and of these the larger group is largely composed of ripe or breeding males. For example, in Bugungu lagoon the population was composed of two *LIP* modes: 65 per cent, 11.5 ± 2.2cm. (standard length) and 35 per cent, 19.5 ± 1.0 cm., of which the females were: 75 per cent, 11.6 ± 1.6 cm. and 25 per cent, 17.5 ± 1.8 em., while the males comprised: 60 per cent, 11.3 ± 1.3 cm. and 40 per cent, 20.0 ± 1.1 cm.

There was little difference between the *L/F* distribution of the shorter groups of males and females respectively and these groups resembled populations from the more isolated lagoons. The larger groups consisted of males that were larger than the mean length and which contributed a larger proportion of the fish present, while the females were smaller and fewer. As 47 per cent of the males were in the active-ripe or ripe stages, it suggests that male fish may actively enter the lagoons for breeding purposes.

In the different lagoons there were also variations in the size at which maturation occurs, Table D5. The smallest ripe fish in each lagoon was: Kirinya, 6.4 em.; Massesse, 7.7 em.; Bugungu, 8.4 em. Although male fish may mature at a small size they do not actually ripen until a greater length, for instance, the smallest mature male in Bugungu was 8.6 em. (standard length) but the smallest ripe male was 12.3 em. Furthermore, as the size of males increased a greater proportion were found to be ripe; this indicates that the larger male fish compete for territories and by greater size and pugnacity exclude the smaller males from the breeding ground.

ASPECTS OF THE BIOLOGY OF *Haploehromis nubilus*

The data given in Table D6 shows that there are differences in the *L/F* distributions of *H. nubilus* from various lagoons; in the more isolated lagoons the fish are smaller than in the lagoons near the lake or in the shallow inlets amongst vegetation fringing the open water. Similarly the size at which maturation occurred varied between lagoons; Table D7 gives details of the minimum lengths at which maturation was found to occur in Kirinya and Massesse lagoons. In other lagoons (Bugungu and Walumbe) where the fish were larger the males matured at a greater size (6.4 em.) and the females matured at 3.8 em. Ripe females were found at all sizes after the onset of maturity but the males showed a lag in the appearance of ripe fish. Thus, in samples from Massesse B lagoon active fish were found at 4.4 em. but ripe fish did not appear until 4.7 em., and in Bugungu fish in the inactive-active to active conditions were recorded at 6.2 em. but ripe fish were not caught under 7.0 em. (standard length). A greater proportion of the fish were found to be ripe as the length increased.

In conclusion it can be noted that both *T. leueostieta* and *H. nubilus*, which were the only species found in all lagoons investigated, showed the characteristics of stunted growth, i.e. small size and precocious sexual maturation in isolated waters; moreover, the degree of stunting appeared to increase in relation to the isolation of the lagoon population from the lake.

References

WELCOMME, R. L. (1965).-Notes on the *Haploehromis* of Bugungu lagoon, Lake Victoria. *EAFFRO Annual Report for* 1964, 32-42.

ADDENDUM

Reference was made in the Annual Report for 1964 (Welcomme, 1965) to the length-weight relationship and condition factors of *T. leueostieta* and *T. nilotiea* in Lake Victoria, and these results were compared with data from other lakes obtained by Lowe (1957, 1958). The discrepancy noted between these two sets of data arose from the fact that the data taken from Lowe was calculated from total length (T.L.) while that g:ven for the Lake Victoria fish (Welcomme) was calculated from standard length (S.L.). When the value of K, as calculated from total length for *T. leueostieta* (K= 1.88) and for *T. nilotiea* (K= 1.94) from Lake Victoria, is compared with the values for *T. leueostieta* (K= 1.6) (Lowe, 1957) and *T. nilotiea* (K= 1.6 to 2.2) (Lowe, 1958) from the native lakes there is little difference.

LOWE, R. H. (1957).-Observations on the diagnosis and biology of *Tilapia leueostieta* Trewavas in East Africa. (Pisces: Cichtidae). *Rev. Zool. Bot. Afr.*, 55, 3-4, 353-373.

LOWE, R. H. (1958).-Observations on the biology of *Tilapia nilotiea* Linne in East African waters. *Rev. Zool. Bot. Afr.*, 57, 1-2, 129-170.

WELCOMME, R. L. (1965).-Further observations on the biology of the introduced *Tilapia* species. *EAFFRO Annual Report for* 1964, 18-31.

TABLE D1-THE NUMERICAL RATIOS OF *Haplochromis* AND *Tilapia* IN VARIOUS LAGOONS DURING 1965

Type of lagoon	Site	Degree of isolation (distance from lake in metres)	Percentage *Haplochromis*	Percentage *Tilapia*
Open lake (1.5 metres alongside papyrus)		0	98	2
Open lagoon	Kikondo ..	0	92	8
	Kavule ..	0	92	8
Drowned forest ..	Walumbe ..	15	57	43
Papyrus	Bugungu ..	20	44	56
	Kirinya B..	100	42	58
	Massesse A ..	200	9	91
	Massesse B ..	200	7	93
	Kirinya A ..	600	17	83

TABLE D2-THE NUMBER OF SPECIES OF *Haplochromis* PRESENT IN VARIOUS LAGOONS DURING 1965

Lagoon	Degree of isolation (Distance from lake in metres)	Number of *Haplochromis* species
Kikondo	0	19
Walumbe	15	7
Bugungu	20	2
Massesse A	200	1
B	200	1
Kirinya A	600	1
B	100	1

TABLE D3-PERCENTAGE REPRESENTATION OF SPECIES OF *Tilapia* IN THE LAGOONS IN 1965

Type	Lagoon	Indigenous		Introduced		
		T. esculenta	*T. variabilis*	*T. leucosticta*	*T. zillii*	*T. nilotica*
Papyrus ..	Bugungu	1	1	75	22	1
	Kirinya A	4	1	92	-	3
	Kirinya B	5	1	72	-	22
	Massesse A	10	-	77	-	13
	Massesse C	17	3	73	-	7
Drowned forest ..	WalumbeA	8	5	35	51	1
	WalumbeB	-	-	39	59	2
Open ..	Kikondo ..	11	56	17	16	-
	Kavule ..	9	6	72	13	-
	Lake View	41	14	26	19	-

TABLE D4—MEAN, MAXIMUM AND MINIMUM LENGTHS OF ADULT *Tilapia leucosticta* FOUND IN VARIOUS LAGOONS

Lagoon	Degree of isolation (distance from lake metres)	Adult standard length (em.)		
		Mean	Max.	Min.
Kirinya A	600	8·0	12·9	6·4
Massesse A	200	10·3	20·0	6·4
Kirinya B	100	11·7	16·3	9·0
Bugungu	20	14·7	22·6	8·3
Walumbe	15	17·0	24·3	11·2

TABLE D5-LENGTH OF MATURATION *Tilapia leucosticta* IN THREE LAGOONS

Length Class em.	Percentage mature		
	Kirinya A	Massesse A	Bugungu
5·0- 5·9	0	0	0
6·0- 6·9	25	0	0
7·0- 7·9	67	7	0
8'0- 8·9	70	48	25
9·0- 9·9	100	80	57
10·0-10·9		100	76
11·0-11·9			100

TABLE D6-RANGE OF LENGTHS OF ADULT POPULATION OF *Haplochromis nubilus* CAUGHT BY SEINE-NETS IN VARIOUS WATERS

Length Class em.	Percentage frequency					
	Massesse and Kirinya		Bugungu and Walumbe		Inlet off lake	
	Females	Males	Females	Males	Females	Males
3,1-3,5	8					
3·6-4·0	22		2		2	
4·1-4·5	35	16	14		11	
4·6-5·0	23	24	14		11	
5,1-5,5	11	35	36		28	
5·6-6·0	1	14	25		20	
6,1-6,5		8	7	4	7	3
6·6-7·0		-	2	8	16	11
7,1-7'5		3		28	5	43
7,5-8,0				41		18
8,1-8'5				13		10
8·6-9·0				6		8
9,1-9'5						7

TABLE D7-MATURATION OF *Halpochromis nubilus* IN KIRINYA AND MASSESSE

Standard Length em.	Percentage Immature	Percentage Females	Percentage Males
2,81-3,0	100·0		
3,01-3,2	89·0	11·0	
3,21-3'4	91·0	9·0	
3'41-3,6	66·6	33·3	
3,61-3,8	53·8	46·2	
3·81-4·0	20·0	80·0	
4·01-4·2	11·7	58·9	29·4
4'21-4·4		50·0	50·0