(Rev. Zool. Bot. Afr., LXXX, 3-4) *(A paru le 31 decembre 1969).*

A comparison of certain aspects of the biology of *Lates niloticus* (LINNE) in some East African Lakes (1)

J. M. GEE
East African Freshwater Fisheries Research Organization Jinja, Uganda.

(*Rev. Zool. Bot. Afr.*, *LXXX*, *3-4*) (*A paru le* 31 *décembre 1969*).

A comparison of certain aspects of the biology of *Lates niloticus* (LINNE) in some East African Lakes (1)

J. M. GEE
East African Freshwater Fisheries Research Organization Jinja, Uganda.

INTRODUCTION

Lates niloticus (Nile Pel1ch) occurs naturally in only two East Mrican lakes, Lake Albert and Lake Rudolf, but foss]l records indicate a wider East African distribution in the past. Fossils of [the genus *Lates* are found in the Miocene beds of the Lake Victoria basin, (GREENwOOD 195.1) and in later Lower Pleistocene to Holocene beds in Lake Edward, (GREENWOOD 1959). The present drainage pattern of t:l1e Nile (Fig. 1) is probably a result of the earth movements and climatic changes which took place in the Pliocene and Pleilstocene eras. During this time L. *niloticus* apparently beoame extinct in the Nile basil]) above Lake Albert but survived in Lake Rudolf which was cut off from the main ri'Ver and became the centre of its own drainage basin. Recolonization of the present headwater lakes of the Nile was not possible because of the formation of the Murchison Falls (isolating Lakes Victoria and Kyoga) and 'uhe Lakes Edward and George).

With the separation of these lakes from the rest of the Nile system, rapid evolution of endemilc faunas ensued, particularly among the Oichlidae. Lake Victoria now has two endemic species of *Tilapia*, five

(1) This paper was first presented at a Symposium on Man-made Lakes organized by the Ghana Academy of Sciences in November 1966.

endemic monotypic at least 120 endemic species of *Haplochromis*. The Cichlidae dominate the fish fauna and *Tilapia* has long formed the basis of the fishing industry whereas *Haplochromis* although far more abundant, are commercially unimportant and almost regarded as a « trash fish ». The suggestion that *L. niloticus*

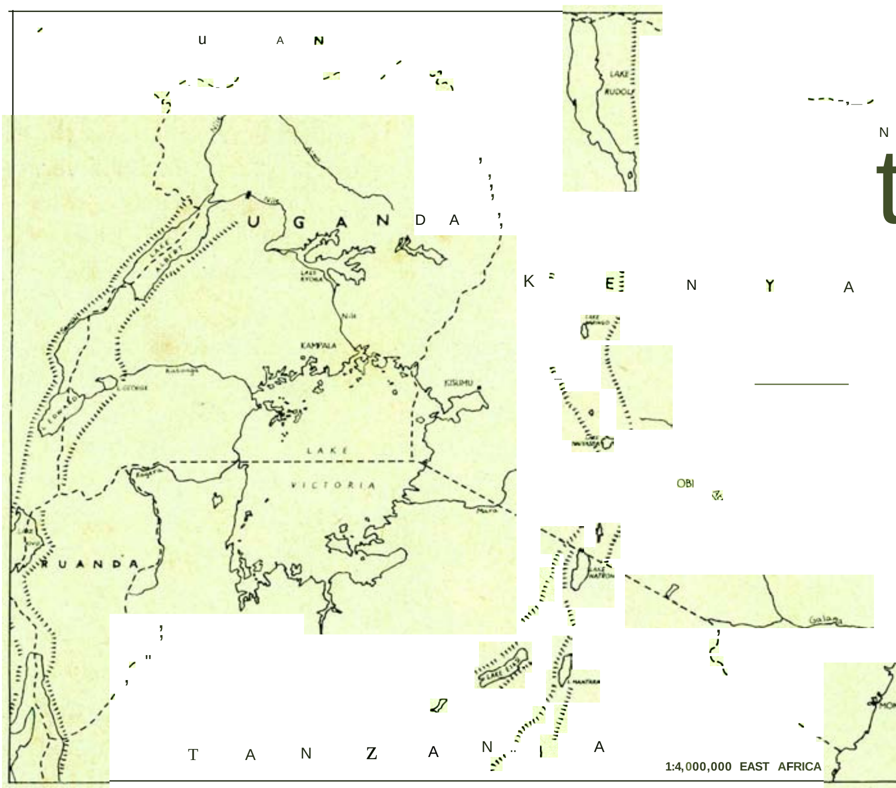

Fig. 1. - Sketch map of the northern part of East Mrica showing the position and relationship of the main lakes of the Nile drainage basin. The eastern and western Rift Valleys are also shown.

be introduced into Lake Victoria as a means of utilizing this «trash» element in the fauna was first mooted in 1928 (GRAHAM 1929) and since then many arguments have been advanced for and against such an act, (FRYER, 1960 and ANDERSON, 1961). In 1955 a duction was made in Lake Kyoga and in a number of smaller lakes and dams in order to attempt an assessment of the effect of an introduction of L. *niloticus* into a cichlid dominated fauna. Since 1963

L. *niloticus* have formed an element of the commercial catches on Lake Kyoga but many of the other pilot schemes were unsuccessful or of In 1960 *L. niloticus* first accidentally gained acoess to Lake Victoria and were later deliberately introduced, (GEE, 1964). They are now increasing in numbers and becoming more widely distributed thToughout the lake although, as yet, they form only an insignificant peYcentage of the commercial catch.

The number of observations of *L. niloticus* on which this paper is based is small due to the inaccessibility of some of the lakes and the present which are caught in Lake Victoria. However, such data as are avaiJlable yield enough information to indicate that there are certain fundamental differences between the biology of L. *niloticus* from Lake Albert and Lake Rudolf and those introduced into Lake Victoria and Lake Kyoga.

There is no doubt that L. *niloticus* can be easily and successfully introduced into a wide variety of waters, both natural and artifiJcial and exhibits, for a tropical species, a wide range of tolerance for new enviTonments. It is probable that in species will be used even more for stocking suitable waters in various parts of the world (MIDGLEY 1968), and it is hoped therefore that the information so far gained in this work may be useful in this regard.

BIOLOGIOAL DATA

In the past there has been a considerahle amount of confusion over the systematics of the genus *Lates* occuring in Uganda and Kenya and early authors are of the opinion that two subspecies of *L. niloticus* exist in Lake Albert and Lake Rudo'lf. According to DAVID and POLL (1937) and WORTHINGTON (1929), Lake Albert contains a large, shallOW watel' fonm L. *n. albertianus* and a smaller deep water form *L. n. macropthalamus*. SimilaI11y in: Lake Rudolf, WORTHINGTON (1932) recognises two subspecies, a large inshore form *L. n. rudof.· fianus* and a deep water fonm L. *n. longispirmis*. GREENWOOD (1958) is doubtful if this distinction holds good for the Lake klbert *Lates* when a lange number of specimens are examined and HAMBLYN (1962) endorses this view, regarding the two subspecies merely as ecotypes. However, HOLDEN (1967) in a study based on a large number of specimens has shown conclusively that L. *n. albertianus* must be synonomysed with L. *niloticus* (LINNÉ) and that the deep water Dorm must be recognised as a di's,tinct speaies L. *macropthalamus* (WORTHING-TON). As yet a similar detailed study ()if the affinities of the Lake RudoLf *Lates* has not been made.

The Nile Perch introduced into both Lake Kyoga and Lake Victoria are L. *niloticus* from the Lake Albert stock, except some eight specimens of a Lake Rudolf form, almost certainJy L. *n. rudoltianus*, which were introduced i'nto the Kavirondo Gulf at Kisumu by the Kenya Fi'sheries Department (GEE 1964). Therefore only that data collected from Lake Rudolf and La'ke Albert which pertains to these forms ,is us'ed for oomparison with the data obtained from Lake Victoria and Lake Kyoga.

Feeding.

The predation pnessure and possible effects on a virgin fauna of a newly il.1Jtroduced predator a're best assessed by an analysis of the stomach contents of the predator. Stomachs of a number of *L. niloticus* from the various ,lakes have been examined (see Appendix A) and ,their contents simply analysed in Tables 1-3.

Table 1 shows that between one and a ha:Lf and as many *L. niloticus* from Lakes Victoria and Kyoga contained prey, as from Lakes Albert and Rudolf. This is probably a reflection of different prey availability in the different lakes. In Lake Albert and Lake

Table 1. - An analysis of the stomach contents of *Lates*. Percentage of fish examined with and without stomach contents.

	L. *Victoria*	L. *Kyoga*	L. *Albert*	L. *Rudolf*
Number of *Lates* examined	215	108	75	17
% with 'stomaoh contents	35	52	36	12
% without stomach contellJts	65	48	64	88

Rudolf 1ll10S't of the potential prey species found in inshore waters are probably of too lange a size to be taken by the size range of L. *niloticus* examined and the young of ,these species and adults of smaller species appear to use the cover of the sublittoral *Ceratophyllum* zone and the s'hallOiw lagoons in ODder to escape predation. Lake Victoria and Lake Kyoga on the other hand, have an abundance of maH species, mainly Cich'lidae, Mormyridae and Cyprinidae, probably not adapted to avoiding predation by *L. niloticus* who there-Dore find the capture of food in these new environments a much easier task.

Table 2 is an analysis of the types of prey taken by *L. niloticus* in Lakes Albert, Kyoga and Victoria. The number of stomachs containing food from Lake Rudolf is too small for any significant conclusions to be dnawll. The indication is that *L. niloticus* do not feed specifically on amy one species or group of fish but are catholic in their tastes. The Cichlidae are by most abundant group of fish found in Lakes Victoria and Kyoga whereas in Lake Albert the

Table 2. - Analysis of stomach contents of *Lates*. Types of prey taken.

	L. *Victoria*		L. *Kyoga*		*L. Albert*	
	No. of prey	No. of fish in which prey occurred	No. of prey	No. of fish in which prey occurred	No. of prey	No. of fish in which prey occurred
Unidentified fish	—	37	-	17	-	8
Mormyridae (unident.)	21	16	-	-	—	—
Marcusenius nigricans *	6	3	—	-	—	—
Marcusenius grahami *	7	4	—	—	—	—
Alestes jacksoni *	6	5	—	-	—	—
Alestes baremose +	-	—	-	-	6	4
Engraulicypris sp.	13	11	-	-	3	3
Barbus sp.	6	3	-	—	-	-
Clarias sp.	1	1	2	2	—	-
Lates niloticus	-	—	1	1	-	—
Cichlidae (unidentif.)	44	20	-	—	10	1
Tilapia sp.	23	12	29	14	1	1
Haplochromis sp.	119	49	181	31	1	1
Caridina nilotica	-	-	—	-	Many	8
Insects	-	2	—	2	-	-
Odonata nymphs	-	-	13	5	3	2
Bivalve molluscs	1	1	-	—	2	1
Gastropod molluscs	-	—	2	2	-	-
Chironomid larvae	1	1	-	—	-	-
Plant remains	-	-	-	3	—	—

* Species occurring in Lakes Victoria and Kyoga only.
\+ Species occurring in Lake Albert only.

Tilapia stocks are relatively smaller and *Haplochromis* not abundant, only five species being recorded from that lake. This varying faunal composition is reflected in the food of *L. niloticus*. In Lake Victoria, Cichlidae, particularly *Haplochromis*, form the main component of the diet of *L. niloticus*, being found in 50 % of the fish with any stomach contents. Mormyridae appear to be the next most important group of prey and Cyprinidae also making a significant contribution. In Lake Albert, on the other hand, the Cichlidae form a less significant part of the diet of *Lates* and their place appears to be taken by *Alestes* (Characidae), *Engraulicypris* (Cyprinidae) and the freshwater prawn *Caridina nilotica*. HAMBLYN (1966) has shown for Lake Albert that in *L. niloticus* less than 60 cms total length invertebrates form a significant part of the diet but above this size they are virtually absent.

Table 3 shows that only a small percentage of the fish with stomach contents had more than one prey species in the stomach at anyone time. Most of the *L. niloticus* however had more than one fish of the same species in the gut, all of which were in approximately the same stage of digestion suggesting that they were taken more or less simultaneously. The largest number of prey so far

Table 3.. Analysis of stomach contents of *Lates*. Number of prey species present.

	L. Victoria	*L. Kyoga*	*L. Albert*
Number of fish with prey	125	42	14
% with more than one prey species	15	25	14
% with more than one prey of the same species	47	50	57
% with only one prey	38	25	29

encountered was 35 cichlids in the stomach of a 55 cm standard length *L. niloticus* from Lake Kyoga. These observations may reflect the feeding habits of *L. niloticus* in that this species appear, whenever possible, to attack a shoal of one particular species of prey and gorge themselves on it rather than attacking a wide variety of isolated individuals. COULTER (1965) reports a similar type of feeding behaviour for *Lates mariae* and *Lates angustifrons* from Lake Tanganyika.

So far little information has been obtained on the size of prey taken because of the largely digested nature of much of the stomach contents, but such information as is available is shown in Figure 2. The size of prey which can be taken whole by a predator depends

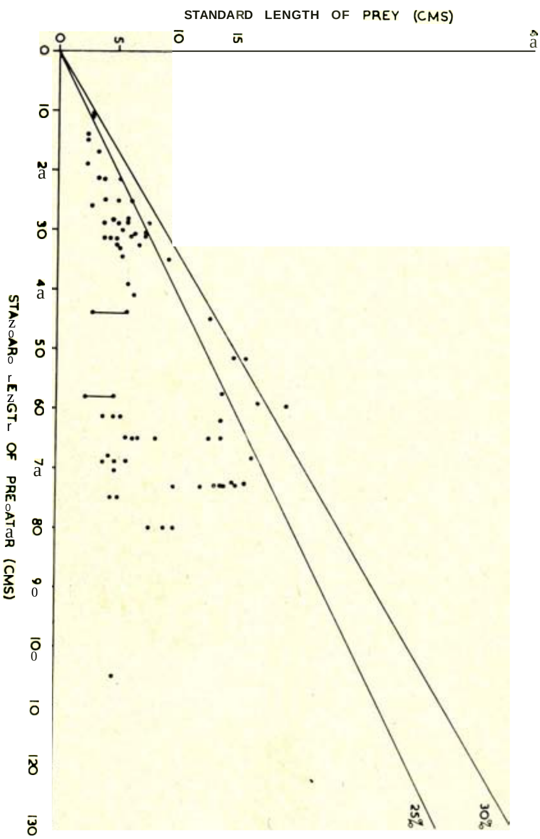

Fig. 2. - Scatter diagram of the standard length of prey in relation to the standard length of *L. niloticus*.

on the size of the mouth, the volume of the buccal cavity and the volume of the stomach when fully distended, but it can be seen from the figure that while the maximum size of prey taken increases with predator size the minimum size of prey does not increase. Large *L. niloticus* generally consume a larger number of small prey rather than fewer large ones. The largest prey so far found was 33 % of the body length of the predator but generally the prey length does not exceed 25 % of the predator length and rarely exceeds 30 %. This agrees with the field and experimental observations of HAMBLYN (1966). Although the number of observations are small it is interesting to note that 77.5 % of prey found in *L. niloticus* stomachs, irrespective of the size of pTedator, are under 10.0 cms S.L. and 97 % are under 17.5 cms. The greatest impact of predation on prey species therefore is likely to be when they are between about 3.0-17.5 ems. LOWE (1959) and JACKSON (1961) have shown that in those Jakes where *Lates* or *Hydrocynus* are present, the behaviour of prey species has been modified so that they live in localities bfifering 'Proteotion from predators until thet reach a « safe» size. In Lake Victoria however, where these pJ1edators are not natural elements of the fauna, there ave a large number of *Haplochromis* ('and oiller species) which never gJ10W as large as 10.0-17.5 oms S.L. and which are not confined to the sublirttoral weed cover. WELCOMME (1964) has shown Dhat *Tilapia variabilis* migrate from the sheltered nursery beaches when they are around 5.0 cms long.

Length/weight relationships.

When standard length and weight are plotted on double logarithmic graph paper, the resulting points fall about a series of straight lines. Thus the relationship bebween length and weight can be expressed by the formula

$$\text{Log } w = \text{Log } n + k.\ \text{Log } l$$

where w is the weight in gms, *n* a constant for the non-intersecDion of the origin, *k* a constant for the slope of the line and *l* the standard length in ems. The length/weight relationship of *Lates niloticus* has been most accurately worked out for Lake Victoria because all the fish of this species coming into Masese fishmarket (Jinja) for the last five years have been measured and weighed by EAFFRO staff and recoJ1ds are now available for *over* 5,000 fish. When the mean weight for each length group shown in Appendix A2 was plotted, the resulting graph showed that the length/weight relationship consists of three distinct elements and interruptions and changes iIi the slope of the straight line oocur at around 20.0 cms S.L. and 43.0 cms S.L. (Fig. 3). Using the above formula, the line representing each of these three groups can be expressed by the following equations:

for *Lates* smaller than 20.0 oms S.L.	$\text{Log } w = 0.059 + 2.64.\ \text{log } l$
for *Lates* 20.0 to 42.9 cms S.L.	$\text{Log } w = 0.032 + 2.90.\ \text{log } l$
for *Lates* 43.0 cms S.L. and larger	$\text{Log } w = 0.024 + 3.02.\ \text{log } l$

The reasons for the interruption of the slope of the line at these particular points are not absolutely clear but it is suggested that the 20.0 cms one is roughly correlated with the onset of maturity and that fish at about this length start maturing for the first time.

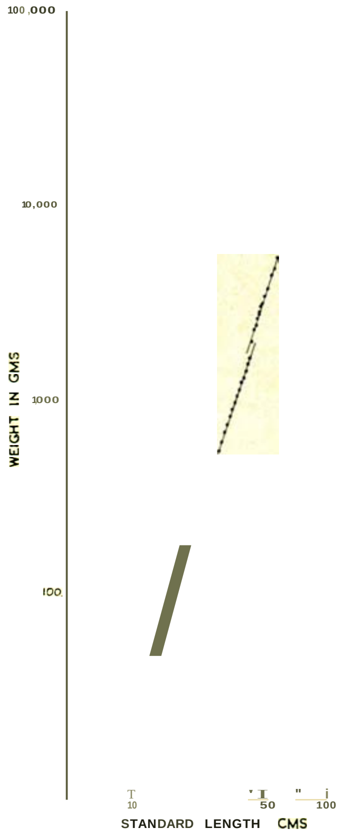

Fig. 3. - The length/weigth relationship of *L. niloticus* from Lake Victoria, caught over the period 1963-1968.

However the smallest fish so far encountered with near ripe gonads is in the region of 23.5 cms S.L. It is more difficult to see a satisfactory explanation for the break at 43.0 cms but an analysis of the sexes of fish over this size show that females are more common than males and almost all the fish over 70.0 cms so far encountered are female.

The values of *k* (defining the slope of the line) in the above equations show a progressive increase in the various size groups of fish indicating that the larger fish are relatively heavier for their length than the smaller ones. Unfortunately comparisons of these *k* values with those for L. *ni10ticus* from Lakes Kyoga, Albert and Rudolf oannot be made by this method because accurarte length/weight graphs canDJot be drawn for these lakes due to the much smaller number of fish for which data are available. However the *condition factor* (K) has been calculated aocording to the formula

$$K = \frac{100.w}{l3}$$

for all *L. ni10ticus* obtained from Lakes Albert, Rudolf and Kyoga and a sample of the Lake Viotoria L. *ni1oticus*. The mean condition faotor for each of the three size gJ10UpS defined from the Lake Vjctoria length/weight relationship graph, and the numbers of fish representing eaoh group, are quoted in Table 4.

Table 4. - Values of K (condition factor) for *Lales* of various Jenght classes. The number of fish in each length class is shown in brackets.

LAKE	LENGTH CLASSES Under 20.0 cms	20.0-42.9 cms	43.0 ems and larger
Lake Albert	1.90 (10)	1.94 (85)	1.92 (5)
Lake Rudolf	none	2.03 (2)	2.11 (14)
Lake Kyoga	1.82 (1)	2.19 (12)	2.36 (32)
Lake Victoria	2.09 (79)	2.25 (401)	2.65 (208)

From this tahle it can be seen that the mean condition factor for all size groups of L. *ni10ticus* from Lakes Victoria and Kyoga (except the smallest group from Kyoga which is represented by only one specimen) is higher than in the corresponding size groups from Lakes Albert and Rudolf. This has been suggested previously (GEE 1964) for data from Lake Albert only but more recent data from Lake Ruddlf confirms this. When comparing this data however, sample size discrepeneies should be noted as a farily wide range of K values has been enoountered in each group, particularly from Larke Viotoria where the samples are largest; e.g., the values of K in the over 43.0 cms group from this lake vary between 1.82 and 3.90 (mean 2.65).

Within the lakes in which *Lates* occur naturally, the condition factors for Lake Rudolf *L. niloticus* are higher than those for Lake Albert. The difference in sample size is probably partly responsible for this (25 out of the 85 Lake Albert *L. niloticus* in the intermediate size group had condition than the two quoted for Lake Rudolf) but it may also be correlated with the great difference in the degree of commencial exploitation to which the fish stocks of these two lakes are subject; there being relatively little or no commercial fishing carried out on Lake Rudolf stocks. In Lake Victoria and Lake Kyoga, where *Lates* have been introduced, Table 4 shows that there is a steady increase in condition with an increase in the size of *Lates* (at least up to 100 cms). The increase would appear to be in Lake Victoria fish than in Kyoga specimens but again this may be due to sample size discrepencies. This phenomenon is not nearly so marked in fish from Lake Rudolf and Lake Albert, and indeed, in the latter lake there is no significant increase at all and a decrease is indicated in the larger group. This is most noticeable in the very large fish, for example the value of K for one specimen from Lake Albert over 100 cms S.L. is 1.72 (127 cms S.L) while the average K value for 9 fish from Lake Victoria is 2.56 (104-137 cms S.L.).

These marked differences in condition, particularly in the two larger size groups, are perfectly obvious to anyone who has handled *Lates* from both groups of lakes. The very convex belly line and larger girth measurements along with the relatively smaller looking head make *L. niloticus* from Lakes Victoria and Kyoga « look more like fish » E.A.F.F.R.O., 1965). There is so much fat lining the bodycavity and internal organs of these fish that the men remove it and render it down for use as cooking fat.

DISCUSSION

It has been shown that marked differences are found in some aspects of the biology of *Lates niloticus* from lakes where they occur naturally and lakes where they are introduced. The higher condition factors of *L. niloticus* from the latter environments correlate with the much higher feeding rates found in these lakes. Both these factors seem to be associated with the colonization of new habitats which have a relatively greater abundance of suitably sized prey species, not previously subject to predation by a large predator like *Lates*. *Bagrus docmac* and a large number of small *Haplochromis* are the only other piscivorous predators present in Lakes Victoria and Kyoga but so little is known of both the quantitative and qualitative aspects of their feeding habits that it is difficult to assess their importance in comparison with *Lates*. In Lake Albert and Lake Rudolf the prey species have evolved in the presence of both *Lates* and *Hydrocynus*, another important predator of African waters, and are therefore likely to possess a behaviour pattern in which avoidance of predators will be one of the main components. The difference in the *Lates* populations may continue for a considerable time but it is likely that eventually a balance will be struck in the more recent habitats as the number of *Lates* increases and the behaviour, and perhaps numbers, of the prey species becomes adapted to the presence of this new predator.

One of the main objections to the introduction of Nile Perch into lakes other than Lake Albert in Uganda was the possible detrimental effect they would have on the *Tilapia* fisheries of these lakes. If the *Tilapia* stocks are significantly reduced, any corresponding increase in the *Lates* not adequately compensate, for the simple reason that the conversion rate of the primary elements in the food chain is about five times greater in a herbivore such as *Tilapia* as it is in a carnivore such as *Lates*. If on the other hand the *Tilapia* fishery was not seriously affected, but large quantities of the *Haplochromis*, small mormyrids, *Engraulicypris* and *Alestes* were utilized, even though the conversion rate may be inefficient, these « trash » elements would be converted into fish flesh both more palatable and it was hoped, more marketable, and therefore represent a gain to the present fishery.

Lates have been present in Lake Kyoga for 13 years and Table 5 gives the annual commercial catch figures for *Tilapia* and *Lates* from 1958-1965. From these it can be seen that there has been no consistant decrease in the catches of *Tilapia* over this period which can be correlated with the catches of *Lates*. The latter have continued to increase considerably. The work of WELCOMME (1966) indicates that the trends in *Tilapia* catches on Lake Victoria are almost identical with those given here for Lake Kyoga and that the fluctuations are closely correlated with the rise and fall of lake level and the availability of nursery grounds. Table 2 shows that the Cichlidae do in fact form the most important element in the diet of *Lates* in Lake Victoria and Lake Kyoga. However, in Lake Victoria, *Tilapia* occurred in only

Table 5. - The commercial catches of *Tilapia* sp. and *Lates niloticus* from the nine most important areas of Lake Kyoga.

	Tilapia		*Lates niloticus*	
	Number	Wt. (lbs.)	Number	Wt. (lbs.)
1958	7,109,021	2,746,549	32	130
1959	10,106,OS3	4,403,858	1,893	9,543
1960	8,129,991	3,621,582	4,738	26,119
1961	10,515,540	4,520,050	5,858	40,429
1962	8,589,290	3,911,497	24,748	53,438
1963	15,479,438	7,563,615	IS3,547	439,434
1964	12,133,068	5,501,973	269,188	885,045
1965	10,428,884	4,434,321	989,916	8,737,739

19,6 % Off the *Lates* in which either *Haplochro111.is* or *Tilapia* could be identified as stomach contents. *Tilapia* formed only 16,1 % of the total number of identifiable cichlid rprey oonsumed and 11.0 % of the total number of prey of all species taken by *Lates*. The pel"Centages for Lake Kyoga are very similar but slightly hower on the side of *Tilapia*. As 97.5 % of the *Lates* examined from Lwke Victoria are relatively small (below 40 cms S.L.) it could be argued that when they become larger their impact wOUild beoome greater on the larger prey species, i.e. *Tilapia*. So far there is no evidence that this is so as Figure 2 shows that large *Lates* still feed mainlly on small prey. In fish over 40 cms. S.L. caught in Lake Kyoga only 2 out of 23 had one large *Tilapia* in the stomach, all 'uhe remainder contained between 1 and 35 small *Haplochro111.is* or *Tilapia*. It woulld appear therefore that at preserut the introduction of *Lates* into Lake Victoria and Lak'e Kyoga is having little effect on the *Tilapia* fisheries of these lakes but because they leave the '11JUrsery grounds at the mOS1 vulnerabJe size *Tilapia* jU'veniles are stilll liable to predation by *Lates*, so that this may effect the stocks in future years.

SUMMARY

Lates niloticus occur natw'ally in only two East African lakes Albert and Rudolf. In 1955 this species was introduced into a llumber of other lakes in Uganda, most important of which is Kyoga. This was a pilot introduction to determine the advisability or otherwise of stocking Lake Victoria with these predators to utilise the *Haplochromis* element in the populatio:n. In 1960 Nile Perch gained access to Lake Victoria and are now increasing in numbers and patial distribution.

Biological data have been collected on *Lales* from these four lakes and some differences between fish from Lakes Albert and Rudolf and Lakes Victoria and Kyoga are found. These are thought to be correlated with the associated faunas of the various lakes, the abundance of prey species of a suitable size, the behaviour of prey in relation to predator and the presence or absence of competition from other predators similar to *Lates*.

Length/weight relationships and condition are higher, particularJy in the larger fish, in Lakes Victoria and Kyoga than in Lakes Albert and Rudolf. In the former two lakes the feeding intensity of the predators is high, Cichlidae and Monll.yridae formilllg the main part of the diet whereas i:n Lakes Albert and Rudolf Characidae and Cyprinidae along with the freshwater prawn *Caridina* are most important as food.

Some observations are made on the question of *£ates* introduction relative to the *Tilapia* fishery of Lakes Kyoga and Victoria. There is no indication that the presence of *£ales* is seriously affecting the *Tilapia* stocks at the moment.

REFERENCES

ANDERSON, A. M. (1961). - Further observations concerning the proposed il1ltm duotion of Nile Peroh illlto Lake Victoria. -- *E. Afric. agric. for* J. XXVI, 4, rprp. 195-201.

COULTER, G. W. (1965). - The genus *Lates* in Lake Tanganyika, and comparative I1lotes on other *Lates* spp. - *E. Afric. Soc. BioI. Res. Syl1posium. Kampala, Uganda.* March 1965.

DAVID, L. & POLL, M. (1937). - COI1ltributions à 1a faune ichthyoJogique du Congo BeIge. - *Ann. Mus. Congo Belg. (Zoo1.).* S. 1, T. III, Fasc. 5, pp. 189-294.

E.A.F.F.R.O. (1965). - Annual Report, (1964), p. 7.

FRYER, G. (1960). - Conceming the proposed introduction of Nile Perch into Lake Victoria. - *E. Afric. agric. for* J. XXV, 4, pp. 267-270.

GEE, J. M. (1964). - Nile PeJllCh investigaNon. - *E.A.F.F.R.O. Annual Report.* (1962-63), *Appendix A.*

GEE, J. M. (1965), - investigation. - *E.A.F.F.RD., Annual Report.* (1964), *Appendix A.*

GRAHAM, M. (1929). - *The Victoria Nyanza and its Fisheries.* A report on the fishing survey of Lake Victoria 1927-28 and Appendices. - Crown Agents for the Colonies, London.

GREENWOOD, P. H. (1951). - Fish remains from Miocene deposits of Rusinga ISland and Kavirondo Province, Kenya. - *Ann Mag. nat. Rist.*, Ser. 12, vol. IV, p. 1192.

GREENWOOD, P. H. (1958). - *The Fishes of Uganda*. - The Uganda Society, Kampala, Uganda., pp. 98-100.

GREENWOOD, P. H. (1959). - Quaternary Fish Fossils. - *Institut des Pares Nationaux du Congo Belg. Exploration du Pare National Albert.* Fasc. 4(1), pp. 1-80.

HAMBLYN, E. L. (1962). - *E.A.F.F.R.O. Annual Report 1961.*

HAMBLYN, E. L. (1966). - The food and feeding habits of Nile Perch *Lates nilolieus* (LINNÉ) (P,i'sibes: Centropomidae). - *Rev. Zool. Bot. Afr.*, LXXIV (1-2), pp. 1-28.

HOLDEN, M. J. (1967). - The systematics of the genus *Lates* (Teleosti : Centropomidae) in Lake AlbeI1t, East Africa. - J. *Zool. Land.* 151, pp. 329-342.

JACKSON, P. B. N. J. (1961). - The impact of predation, eSpecially by the Tiger-fish *(Hydroeyon vittalus* CAST.) on African freshwater fishes. - *Proc. Zool. Soc. Land.* 136, 4, pp. 603-622.

LOWE (MCCONNELL), R. H. (1959). - Breeding behaviour patterns and ecological differences between *Tilapia* species and their significance for evolution within the genus *Tilapia* (Pisoes, Ciohlidae). - *Proc. Zool. Soc. Land.* 132, 1.

MIDGELEY, S. H. (1968). - A study of Nile Perch in Mrica and consideration as to it's suitability for Australian Tropical Inland Waters. - *The Winston Churchill Memorial Trust (Australia). Fellowship Report* NO.3.

WELCOMME, R. L. (1964). - The habitat and 11abitat preferences of the young of the Lake Victoria *Tilapia* (Pisces, Giohlidae). - *Rev. Zool. Bot. Afr.*, LXX, Fasc. 1-2.

WELCOMME, R. L. (1966). - The effects of rapidly changing water levels of Lake Victoria upon the commercial catches of *Tilapia* (Pisces, Cichlidae). - *Ghana Symposium on Man-made Lakes.* November 1966.

WORTHINGTON, E. B. (1929). - New species of fish from the Albert yanza and Lake Kioga. - *Proc. Zool. Soc. London, 1929*, pp. 429-440.

WORTHINGTON, E. B. (1932). - Scientific I1esults of the Cambridge expedition to East African-Lakes 1930-1. Fishes other than Cichhdae. - *Linn. Soc.* J. *Zool*, XXXVIII, 258.

AP.PENDIX A

1). The foUowing is a summary of the standard length and sex of the specimens of *Lates niloticus* taken from Lake Victoria, Lake Kyoga, Lake Rudolf and Lake Albert, on which an analysis of the stomach contents was made.

Lake Victoria. All the smaller specimens were caught in 1963 and 1964 and a few of the large ones were taken in 1966.

Ls	Number	Male	FemaJe	Ls	Number	Male	Female
16.0	3	I	2	35.0	I	I	-
17.0	4	3	I	36.0	J	1	-
18.0	4	3	1	37.0	1	1	-
19.0	3	1	2	39.0	I	-	1
20.0	4	2	2	42.0	1	-	1
21.0	2	-	2	51.0	J	-	J
22.0	2	1	J	52.0	J	1	—
23.0	4	3	1	54.0	1	1	-
24.0	2	-	2	57.0	2	1	1
25.0	5	2	3	58.0	1	-	1
26.0	11	7	4	59.0	1	-	1
27.0	24	16	8	62.0	1	-	J
28.0	38	21	17	63.0	1	1	-
29.0	28	15	13	65.0	2	1	1
30.0	27	10	17	67.0	1	1	—
31.0	15	9	6	68.0	1	-	1
32.0	11	6	5	73.0	1	-	1
33.0	3	3	-	80.0	J	-	1
34.0	4	3	1	81.0	1	-	1

Lake Kyoga. Specimens caught in November 1963 and October 1964.

Ls	Number	Male	Female	Ls	Number	Male	Female
19.0	1	?	?	48.0	2	1	I
22.0	1	?	?	49.0	1	-	1
25.0	1	?	?	51.0	3	I	2
26.0	I	?	?	52.0	1	-	1
35.0	1	1	-	54.0	1	?	?
37.0	2	2	-	56.0	2	1	1
38.0	3	2	1	57.0	1	1	—
39.0	1	1	-	59.0	J	?	?
41.0	1	-	I	70.0	2	1	1
42.0	1	-	1	73.0	I	-	1
43.0	2	1	1	74.0	1	-	1
44.0	3	2	1	75.0	2	1	1
45.0	1	1	-	78.0	1	-	1
46.0	4	1	3	80.0	1	-	1
47.0	2	1	1				

Lake Kyoga 1966. These specimens were measured (total length only) and weighed by the Uganda Fisheries Department and the stomachs sent to EAFFRO for content analysis. As only total lengths were supplied it was necessary to calculate the standard lengths shown here using the formula $x = 0.84y$.

Ls	Number	Male	Female	Ls	Number	Male	Female
55.0	3	3	-	71.0	1	1	-
57.0	1	1	-	72.0	2	-	2
59.0	7	7	-	73.0	1	-	1
61.0	5	5	-	74.0	1	-	1
62.0	2	2	-	82.0	1	-	1
64.0	3	3	-	83.0	2	-	2
65.0	6	4	2	84.0	1	-	1
66.0	7	6	1	85.0	1	-	1
67.0	5	4	1	88.0	2	-	2
68.0	5	1	4	89.0	1	-	1
69.0	1	1	-	91.0	1	-	1
70.0	3	-	3	98.0	1	-	1

Lake Albert. Specimens caught in December 1963 and October 1964.

Ls	Number	Male	Female	Ls	Number	Male	Female
17.0	1	1	-	32.0	2	2	-
18.0	3	2	1	34.0	3	1	2
19.0	1	-	1	35.0	1	1	-
20.0	3	2	1	38.0	1	1	-
21.0	2	-	2	39.0	1	1	-
22.0	1	-	1	40.0	1	1	-
25.0	1	1	-	50.0	1	1	-
26.0	4	1	3	60.0	1	1	-
27.0	6	4	2	62.0	1	1	-
28.0	9	5	4	66.0	1	-	1
29.0	15	8	7	70.0	1	-	1
30.0	8	4	4	127.0	1	1	-
31.0	6	2	4				

Dake Rudolf. Specimens collected in August 1965.

Ls	Number	Male	FernaJe	Ls	Number	Male	Fernale
35.0	1	1	-	69.0	1	-	1
40.0	I	-	I	76.0	2	2	-
45.0	1	1	-	90.0	1	-	1
48.0	1	I	-	101.0	I	-	1
49.0	1	-	1	111.0	I	-	1
57.0	2	2	—	127.0	1	-	1
59.0	1	-	1	135.0	1	-	1
63.0	1	I	-				

2). The following is the data used for the calculations of the length/weight relationships of *Lates niloticus* from Lake Victoria. It is also from some of these fish that the condition factors for Lake Victoria, given in Table 4, have been calculated.

Length Class (cms)	No. of fish	Mean Weight (gms.)	Length Qass (ems)	No. of fish	Mean Weight (gms.)
13	2	57.5	39	57	1325
14	2	60.6	40	37	1426
15	5	81	41	23	i553
16	12	98	42	8	1675
17	20	108	43	17	2024
18	30	120	44	20	2315
19	24	152	45	27	2442
20	59	190	46	29	2682
21	44	240	47	35	2792
22	92	265	48	32	3110
23	136	298	49	31	3205
24	259	324	50-51	93	3482
25	429	366	52-53	45	3805
26	476	410	54-55	45	4450
27	386	460	56-57	25	4830
28	435	505	58-59	22	5473
29	407	562	60-64	20	6615
30	357	623	65-69	16	7853
31	224	701	70-74	7	10586
32	215	767	75-79	9	12407
33	185	839	80-84	5	15134
34	171	917	85-89	10	18891
35	181	990	90-94	5	18690
36	152	1074	95-99	3	24763
37	124	1151	1()()"104	6	27715
38	85	1266			

The calculations of condition factors for *Lates niloticus* from Lake Albert are based on the fish listed in section 1 of the appendix and on an additional sample collected by EAFFRO in February 1969 for which no stomach content data are available. A summary of the 1969 sample is as follows:

Length Class (oms)	No. of fish	Length Class (oms)	No. of fish
8	1	27	2
11	1	35	1
12	1	39	1
13	1	40	1
17	1	44	1
20	2	46	2
21	1	48	1
22	2	50	1
23	2	52	1
24	3	54	2
25	5	70	1
26	1		