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A PRE-IMPOUNDMENT STUDY OF SWAMPS IN THE KAINJI LAKE BASIN

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ABSTRACT

This paper gives an account of the wet season swamps in the River Niger valley within the area now submerged by the Kainji Lake. Their ecology was studied with respect to the soils, plant cover, water chemistry and plankton concentrations. Their value to the fishery in the river basin was discussed.

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INTRODUCTION

Of the 1250 Km² of land now submerged as a consequence of the formation of Lake Kainji, swamps formerly occupied about 40% (EVANS and JENNES, 1967). These swamps are no more and it now appears very unlikely that extensive swamps will be formed at the margin of the new lake. Apart from some general references made about the importance of these swamps WHITE (1965), REED, (1967), COOK (1968) IMEVBORE (1969) no real study of their ecology has been undertaken. This is why this study was undertaken in order to describe their general ecology as it was before the lake was formed, to draw attention to the important role which they played in the economy of the river and to enable the situation before to be contrasted with that after the lake was formed.

This study was undertaken between 1966 and 1968 and it deals with the plant cover and soil of the swamps, chemistry of swamp waters, their micro-organisms and fish. The soil was sieved for particle size, then analysed for organic carbon by the wet oxidation and the semimicro Kjeldahl method reported by NEWELL (1965) and various other workers. The micro-organisms present in the water and in the top soil were determined according to the method described by POCHON and TARDIEUV (1962). Fish caught in the river-swamp system were measured and weighed and their stomach contents analysed.

General features

Descriptions of the geology and geography of the Niger valley in the area now submerged by Lake Kainji have been published elsewhere (NEDECO, 1959, WHITE,. 1965, COOK 1968, and IMEVBORE 1970). The rocks in the area are precambrian Basement Complex and Createous sediments, both of which are overlain in some parts by alluvial deposits. Before the Lake started to form on 2nd August 1968, the river level rose twice annually, during the major floods (called White Floods) in July—September (discharge 6000–8000 m^3/sec) and during the subsidiary floods (called Black Floods) in December—February (discharge 1500–2000 m^3/sec). The weather here was dominated by the alternation between the wet season (April—October) with an annual total rainfall between 66–135 cm, and a dry season (November-March) often without any rainfall. The entire area was savannah woodland (KEAY, 1959). Figure 1 shows the river, the Lake basin and the seasonally inundated flood plains containing swamps.

Swamp formation and plant cover

The swamps in the area under study were all wet season swamps formed for the most part when the river and its tributaries flooded their banks. The swamps were generally shallow (less than 3m deep) and were waterlogged from early July or August until February. Thereafter they dried up rather quickly, and some completely until the next July when they received a fresh supply of water. The swamp vegetation was comprised of grasses and sedges. Among these *Echinochloa pyramidalis* and *E. stagnina* were predominant. Other important species were *Cyperus procerus*, *Vossia cuspidata*, *Polygonon senegalensis* and *Bracholaria* spp. COOK (1968) gave a full list of the aquatic and marsh plants in the area and showed that the swamps had a luxuriant growth of "sudd" plants.

The swamps may be divided into two classes by considering their position in relation to the river valley. The first consists of fringing swamps which occurred in indentations in the river shoreline. These contained different types of vegetation in different parts of the basin depending on the soil. For example, near the mouth of the tributary River Swashi, *Echinochloa* spp were dominant and seemed favourable for young *Alestes* fish. On the other hand, near the mouth of River Kpan, *Polygonon senegalensis* and *Cyperus* spp were dominant and *Tilapia* was commonly found there.

The second type of swamp found in old river beds received its water mainly from rainfall and ground water. One prominent example (here named SW—swamp) located six miles south of Shagunu in the valley of a silted stream, was about 30m wide and several hundred metres long. It was covered by an association of *Cyperus procerus*, *Oryza barthii*, *Brachiolaria* sp. and *Fimristylis dischotoma*. Another swamp of the same type was the Tunga-teku swamp located north-west of Foge Island (see Figure 1). It was found in a huge depression which must have been an old valley of the River Niger. There, small oxbow lakes were interspersed with extensive swamps.

In all cases the swamps had a dense plant cover, with *Echinochloa* dominating the wetter areas while *Polygonon* and *Cyperus* dominated the drier areas. However, marked zonation in the vegatation was not noticed.

Swamp soils

Table 1 shows the results of the grading of deposits from the main river, tributary streams and neighbouring swamps. The results confirm that swamp top-soils were dominated by silt while running water bodies had higher proportions of sand. Table 2 shows the carbon and nitrogen content of the same deposits.

The results show clearly that swamp deposits contained higher organic matter than the river and its tributaries. It is clear therefore that for deposit feeders such as

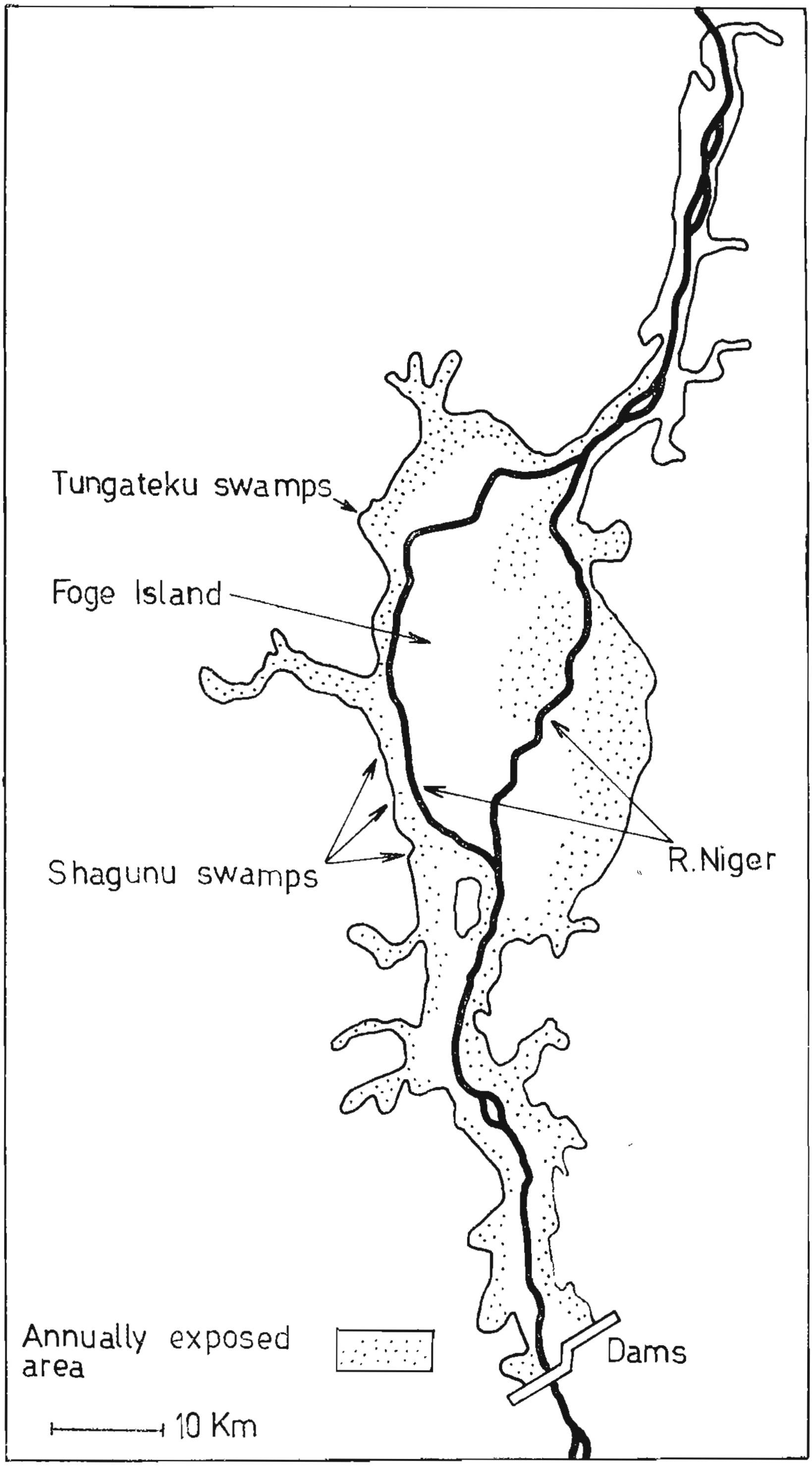
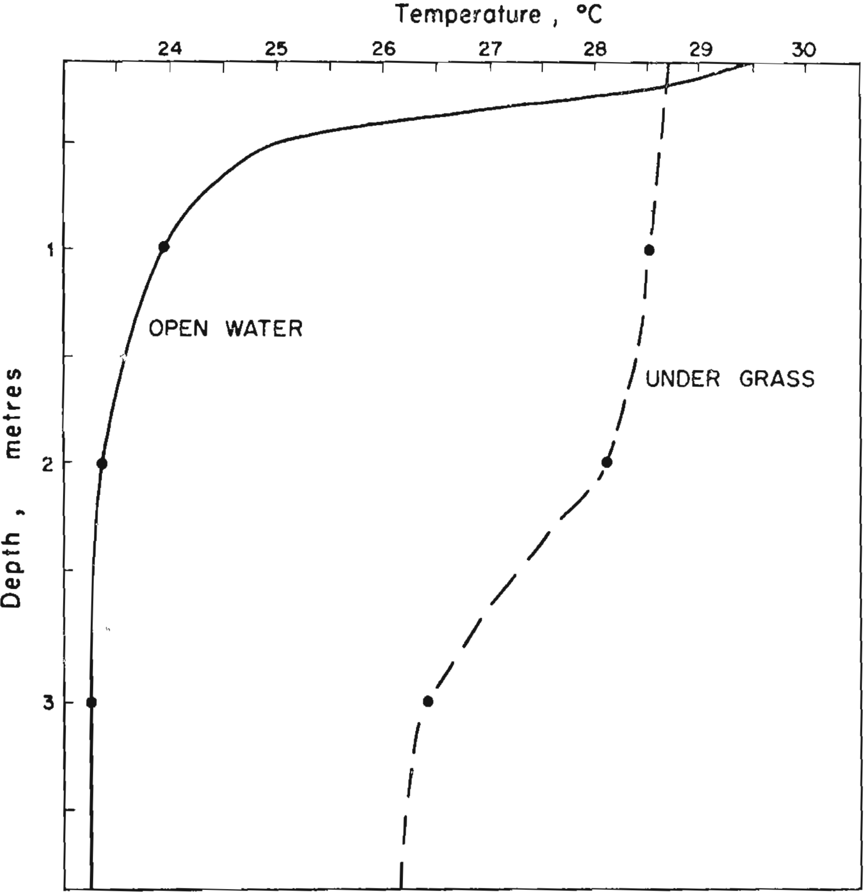


Figure 1. Map of The Kainji Reservoir Showing the extent of the Annually Exposed Areas with Seasonal Swamp.



gure 2. Temperature profile in open water and undergrass.

Table 1. The particulate composition of the bottom deposits of the River Niger, its tributaries and its swamps (BAKARE, 1970). Data as percentages)

	RIVER NIGER		TRIBUTARIES				SWAMPS	
Type of Particle	Shagunu	Kainji	Kpan	Swashi	Timu	Yumu	Shagunu	Tunga Teku
Granules (2 mm.)	0.0	5.8	6.8	2.1	7.2	5.3	0.0	13.8
Very coarse sand (2–1 mm.)	0.0	7.3	7.2	6.3	15.6	3.8	0.0	5.6
Coarse sand (1–0. mm.)	0.4	38.4	23.0	31.9	53.3	12.7	0.0	12.4
Medium sand (0.5–25 mm.)	62.5	22.5	32.7	22.1	15.6	25.7	1.0	14.9
Fine sand (0.25–15 mm)	34.0	5.9	18.9	16.6	3.0	34.5	3.0	22.9
Very fine sand (0.15–0.06 mm)	0.9	1.2	5.8	9.0	0.4	8.6	8.5	9.3
Silt (0.06 mm.)	1.0	1.9	5.0	11.9	0.4	9.1	86.4	16.7

Table 2. Percentage of nitrogen and carbon present in the various grades of deposits (Kainji Basin) BAKARE, 1970.

	Coarse sand (1–0.5 mm.)		Medium sand (05.–0.25 mm.)		Fine sand (0.025–0.15 mm.)		Very finre sand (0.15–0.06 mm.)		Silt (0.06 mm.)	
	N	C	N	C	N	C	N	C	N	C
River Niger, Shagunu (edge of river)	—	—	—	—	—	—	0.09	0.59	0.14	1.15
River Niger, Shagunu (middle of river)	—	—	—	—	—	—	0.05	0.09	0.19	0.65
River Niger, Kainji (middle of river)	0.01	0.06	0.04	0.19	0.07	0.25	0.07	0.74	0.09	0.62
River Kpan	0.01	0.04	0.02	0.08	0.04	0.12	0.04	0.22	0.11	0.85
River Swashi	0.06	0.10	0.09	0.60	0.11	0.75	0.12	0.59	0.18	1.30
River Timu	—	—	—	—	—	—	0.13	1.55	0.18	1.62
River Yumu	—	—	—	—	—	—	0.06	0.34	0.17	1.64
Tunga Teku Swamp	—	—	0.06	0.41	0.05	0.45	0.06	0.51	0.07	0.55
Shagunu Swamp	—	—	—	—	—	—	0.30	2.71	0.26	2.00

fish and molluscs, the swamps were richer feeding grounds than either the main river or its tributaries.

Physical and chemical properties of swamp water. Light penetration and temperature

As expected, practically no light reached the water where the plant cover was complete. On the other hand, Secchi disc readings taken in open patches of water within the swamps showed that swamp water was very transparent. For example, when Secchi disc transparency was 0.8 m and 0.65 m in the river in December and February respectively, corresponding values in a fringing swamp within the same neighbourhood were 3.1m and 1.1m. The difference in transparency between swamp and river

Table 3. Surface water temperatures in swamp and river. (°C)

Date	Air	SWAMP		River
		Open Water	Under Grass	
23.11.65	27.9	23	21	24
15.12.65	32	26.9	22.0	28.5
15.12.65	32	29.5	23	26.5
6.12.67	32.7	28.1	22	no reading
6.12.67	34	29.0	22.3	27
7 1.68	30.1	27	26	25.7
15 1.68	36	29.5	25.8	28.2
9. 3.68	33	28.7	26.2	28.4

water was due undoubtedly to a faster sinking rate of suspended matter in stagnant swamp water.

Table 3 compares surface water temperatures taken in swamps and the river. As the temperatures were not taken at the same time of day during the different months, the figures do not represent seasonal variations. They show however, that in all months, the temperature of shaded water was lower than that of both flowing water and open lagoons within the swamps. Unshaded water was found to be superficially stratified but swamp water tended to stratify more in the immediate layers above the mud (see Fig. 2). It is interesting to note that CARTER, (1955) found a similar result within papyrus swamps in Uganda.

Composition of Swamp Waters

The swamp waters were generally acid or weakly alkaline (see Tables 4 and 5). The concentrations of sodium and postassiumi was higher in the fringing swamp than in the more permanent Tanga-teku swamp. The same was true for phosphate but the reverse was the case with dissolved iron. The concentration of calcium showed a seasonal variation with the highest values in December and lowest during the June-September period. The high value in December could be associated with the enrichment from the Black Flood (IMEVBORE, 1970a). Nitrate and chloride concentrations were appreciable but total alkalinity was particularly high (over 1 meq/L). IMEVBORE (1970a) has pointed out that such high alkalinities but low pH was probably due to the presence of high carbon dioxide concentrations resulting from organic decomposition. On the other hand, it was remarkable that oxygen values were appreciable and ammonia concentrations fairly low see (Table 6).

Compared with the river, swamp waters were much richer in their overall composition. Therefore, those swamps fringing the river must contribute ions to the river particularly during times of low water levels (April-June) when there was a gentle current from swamp to river.

BIOLOGICAL DATA

(*a*) *Micro-organisms*

The results for the microbiological analyses for both water and mud are shown in Table 7. While fungi were more abundant in the river, the concentrations of those organisms such as actionomycetes, starch decomposers, petcin and hemi-cellulose decomposers which obtain their energy from organic substrates were substantially higher in the swamps. On the other hand, nitrifiers, denitrifiers

Table 4. Chemical properties of swamp waters. (mg/l)

	pH	Na	K	Ca	Mg	Fe (total)	PO_4	HCO_3 (meq/l)	NO_3	Cl	O_2	SIO_2
Fringing Swamp												
2.9.66 (Shagunu)	6.7	3.5	1.6	3.8	4.3	2.4	0.16	0.74	—	0.6	—	—
2.11.66	6.67	5.2	1.9	1.3	3.3	3.5	0.28	0.77	—	1.6	5.03	—
3.11.67	6.68	6.2	1.4	2.5	3.1	8.0	0.12	0.77	—	4.0	—	—
3.12.67	6.35	4.0	2.3	6.7	3.6	3.25	0.02	0.70	—	1.79	5.4	—
2.2.68	7.25	3.1	1.35	4.5	2.3	0.24	0.2	0.77	—	3.0	9.4	—
9.3.68	—	3.5	1.8	5.0	2.0	0.1	0.03	0.77	—	1.5	9.9	—
Open water in Swamp												
2.2.68	7.20	2.7	1.35	3.7	1.8	0.15	0.08	0.77	—	2.0	5.44	—
9.3.68	—	3.7	1.7	4.5	2.0	0.07	0.07	0.048	—	0.77	2.0	—
Shagunu-SW-Swamp												
23.11.65	6.44	0.16	0.45	5.17	2.09	0.96	1.0	0.76	—	0.56	—	—
15.12.65	6.3	0.43	0.307	18.75	0.26	0.7	0.4	1.7	0.12	0.07	7.13	16
23.6.66	6.64	6.25	4.0	10.2	8.71	0.1	0.13	0.9	0.28	2.0	18.2	160
28.6.66	6.73	4.5	0.65	11.03	3.19	0.78	0.06	0.89	0.28	2.2	7.84	110
6.7.66	6.45	3.6	0.75	3.8	1.31	0.07	1.4	1.4	—	2.5	4.95	—
2.9.66	6.85	1.1	2.45	2.5	3.60	4.8	0.12	0.6	3.6	1.0	—	3.6
2.11.66	6.61	3.7	2.4	5.5	4.6	10.8	0.008	0.77	2.9	1.0	—	2.9
2.12.66	6.51	5.0	2.0	5.04	4.6	12.5	0.12	1.01	0.28	3.0	—	2.5
Tunga–Teku Swamp												
23.11.65	0.84	3.39	4.49	5.38	0.28	1.6	1.2	0.95	0.05	0.07	14	14
10.12.65	6.84	3.99	8.93	10.99	0.39	0.70	0.4	1.05	0.1	0.08	3.83	32
11.1.66	6.93	4.18	9.48	7.76	3.8	0.28	0.4	1.1	0.06	0.14	6.38	50
12.3.66	—	3.99	9.97	8.67	4.53	0.08	0.4	1.15	0.4	4.5	4.92	100
23.6.66	6.62	4.1	10.0	6.97	7.94	0.09	0.16	0.65	0.73	4.0	11.9	180
16.9.66	—	0.8	1.6	1.7	2.5	5.15	0.28	—	—	1.0	—	61
3.12.66	6.64	4.1	2.6	5.5	13.3	6.0	0.2	0.87	—	4.0	—	4

Table 5. Chemical properties of some fringing swamps (mg/l)

Date	Kokora	Amboshidi	Wara	SWASHI	
	12.11.66	12.11.66	12.11.66	12.3.66	12.11.66
pH	6.0	6.34	6.08	—	7.14
K+	0.8	4.7	4.7	4.50	3.2
Na	3.3	3.5	2.2	2.6	3.3
Mg	11.7	3.6	4.1	3.67	2.3
Ca	3.4	3.4	2.5	7.75	2.5
PO_4	0.004	0.04	0.005	0.4	0.024
Fe (total)	0.24	0.37	0.50	0.12	0.62
SIO_2	50.0	50.0	42.5	100	3.75
HCO_3	1.45	0.87	0.72	0.85	0.68
Total N.	29.1	14.5	9.7	—	24.2
Cl	1.0	2.0	2.0	2.49	1.0
O_2	—	—	—	6.95	—
Al	0.47	0.12	0.67	—	0.12

Table 6. Ammonia Concentration in the main river, tributary streams. Swashi and Kpan and neighbouring Swamps. mg/1)

Date	RIVER			SWAMPS	
	Niger	Swashi	Kpan	Tunga-Teku'	Shagunu Sw
23.11.65	0.06	0.04	0.06	0.08	0.12
11.1.66	0.02	—	0.02	0.10	—
12.3.66	0.18	0.10	0.16	0.20	—
23.6.66	0.59	0.36	0.63	0.73	0.49
28.6.66	—	0.58	0.63	0.57	0.40
12.8.66	0.46	0.14	—	—	0.66

and ammonifiers were most abundant in the river water. Swamp water also contained higher densities of aerobic nitrogen fixers, anaerobic nitrogen fixers, aerobic cellulose decomposers and anerobic cellulose decomposers than river water. All in all, the bacterial flora in the both swamp water and mud was denser than that in the river. The same result was true for phytoplankton (see Table 8). With respect to zooplankton, no direct sampling was done, but the examination of fish stomachs of *Synodontis* and *Alestes* spp showed that the invertebrate fauna was by far more abundant in the swamps than in the river. This was particularly the case with cladocerans which dominated the diet of *Synodontis membranaceus* and *Alestes dentex*. In one specimen of *S. membranaceus* (length 16.5 cm, weight 140 gm), 25,195 cladoceraus were counted.

(b) *Fisheries*

(i) *Distribution of fish*

The systematic list of species found in the area has been given by DAGET (1962), BANKS *et al.* (1965) and MOTWANI and KANWAI (1970). All of the over 100 species living in the river were found at some time or the other within the swamps. According to MOTWANI (1970) the vast majority of the fish responded to the changing hydrological conditions in the river and displayed a seasonal rhythm.

From January to April, the fish populations are stable and confined mainly within deeper regions of running water especially when river level starts to drop and temperatures become high. Later, between May and July, during the onset of the rains the fish move around and upstream. This is also the active feeding phase and the period when a few may start to spawn. Between October-mid November, the young and old populations also feed intensively within the flood plains. From mid-November to December, the older fish return to the river (mostly *Mormyridae*, *Alestes*, *Labeo*, *Barbus*, *Distichodus*, *Chrysichthys*, *Lates*) *Auchenoglanis* and *Clarotes*). Young fish of these species also move out of the swamps at this time although those of *Tilapia*, *Synodontis*, *Clupisudis*, *Gymnarchus*, *Polypterus*, *Clarias* and *Heterobranchus* tend to remain longer in the swamps. In general, species belonging to the Cichlidae, Ophiocephalidae and Mastacembelidae tended to be confined almost exclusively to swamps and those portions of the river adjoining swamps. There is also evidence that *Alestes leuciscus* and *Protopterus annectens* entered the swamps to breed a second time during the December flood (IMEVBORE, 1970b).

As has been pointed out, the swamps were also useful as fish feeding grounds (BAKARE 1969, IMEVBORE 1970, and BAKARE 1970). BAKARE (1970) showed

Table 7. Micro-organisms in water and mud from river and swamps. (No/ml.)

	Content of solids in mud susp. (%)	Total micro-organisms (Calculated)	Total micro-organisms (Estimated)	Actino-mycotes	Fungi	Aerobic Nitrogen Fixers	Anaerobic Nitrogen Fixers	Proteolytic Organisms	Algae
River water (surface)		7.3×10^{6}	3.5×10^{4}	1.0×10^{2}	7.9×10^{4}	10.5	2.9	5.8×10^{3}	6.6×10^{4}
Swamp Water (surface)		7.9×10^{7}	6.3×10^{7}	1.9×10^{5}	7.1×10^{4}	2.1×10^{8}	3.7×10^{6}	9.3×10^{6}	15.2
River Mud	29.89	8.4×10^{11}	1.3×10^{11}	6.6×10^{8}	1.4×10^{3}	10.4	7.5×10^{4}	5.9×10^{11}	7.1×10^{6}
Swamp Mud	8.63	8.2×10^{11}	5.1×10^{11}	7.3×10^{8}	8.7×10^{3}	5.3	1.2×10^{3}	4.9×10^{8}	9.1×10^{7}

Table 7. (Continue).*

	Ammonifiers	Nitrifiers (NO_2)	Nitrifiers (NO_3)	Denitrifiers	Starch decomposers	Pectin decomposers	Hemicellu-decomposers	Aerobic Cellulose decomposers	Anaerobic Cellulose decomposers
River water (surface)	9.1×10^{3}	6.7	5.3	8.8×10^{3}	4.6×10^{4}	8.8×10	5.2×10^{5}	8.2	9.7
Swamp water (surface)	2.9	2.0	5.3×10^{5}	5.3×10^{5}	4.1×10^{5}	7.0×10^{5}	6.5×10^{7}	4.6	8.5×10
River Mud	1.2×10^{10}	7.4×10^{4}	1.9×10^{9}	7.1×10^{9}	6.0×10^{9}	1.2×10^{4}	2.3×10^{11}	7.8×10	1.3×10^{6}
Swamp Mud	7.1×10^{9}	6.2×10	5.8×10	2.9×10^{10}	5.2×10^{11}	2.5×10^{8}	2.6×10^{11}	6.4×10^{11}	3.6×10^{4}

Table 8. Phytoplankton biomass in river and swamp as Chlorophyll A (mg/m³)

Date	River Niger	Fringing Swamp	River Swashi	Fringing Swamp
2.12.67	130	389	123	259
28.12.67	164	258	79	149
2.2.68	157	335	128	410
9.3.68	110	148	189	142

that fish belonging to all trophic levels were feeding mainly in the swamps. The piscivorous species such as *Bagrus bayad*, *B. docmac*, *Hydrocynus vittatus*, *H. forskalii*, *Paraophiocephalus obscurus*, *Polypterus bichir*, *P. endlicheri* and *Schilbe mystus* were found to catch the fry and juveniles of their prey species mainly within the swamps. Similarly, *Alestes dentex*, *A. baremose* and *A. nurse* were found to feed intensely on zooplankton in the swamps.

Herbivorous species such as *Distichodus rostratus*, *D. brevipinnis*, *D. engycephalus* and *Ctenopona kingsleyea* also feed intensely within swamps. In the case of detritus feeders such as *Citharinus citharus*, *C. latus*, *Labeo coubic* and *Barbus occidentalis*, the swamps contained fine particulate matter (particle size 0.06–01 mm in diamter) which was particularly suitable as food because of its high organic matter content. BAKARE (1969) calculated that in fact 95% of the swamp area was covered with this fine particulate matter.

Species in the genus *Synodontis* (forming about 18% of the total fish population in the river) which were more or less ominivorous also found sufficient food in the form of aquatic insects, floating vegetation, grasses and molluscs within the swamps (see Table 9).

DISCUSSION

Despite the many reports on the ecology of tropical African swamps, only a few studies have any relevance to swamps in West Africa. The swamps in East Africa have been most studied (JOSEPH and MARTIN 1902; HOPE, 1902; BROUN, 1905; BEADLE, 1932; 1933, 1957, 1958 1691; BEADLE, & LIND, 1960; THOMAS 1961; DEBENHAM, 1952, CARTER, 1955, EGLELING; 1934, 1935 LIND 1956 LIND and VISSER, 1962; WASAWO, 1963). These swamps are known to be extensive and to include permanently or semi-permanently waterlogged conditions overgrown by *Cyperus papyrus* stands. For example, of Uganda's 80,000 sq miles territory, 6% is permanent swamp (WASAWO, 1963).

The position is very different in West Africa where the geological events did not produce anything equivalent either to the Rift Valleys of East Africa or to the flat swampy basins between them. In the West, swamps are associated with flood and delta plains and owe their origin to the deposition of river-borne material wherever the terrain is flat.

There were about 500 km² of seasonal swamps in the area now covered by Lake Kainji. These were all wet season swamps formed partly by the outflow from the River Niger and partly by rain and groundwater. Though the swamps had an annual life of six to nine months, they had a great effect on the general biological economy of the river. They were very productive and they contained high densities of organic matter, micro-organisms, vegetation, phytoplankton and invertebrates. It was not surprising therefore that they were rich fish-feeding grounds and that they supported a good fish population. REED, (1967) estimated that these swamps contributed over 50% of the fish catches made by the fishermen in the middle Niger valley and

Table 9. Analyses of specimens examined and assessment of their food items by the points method (HYNES, 1950)

	Total no examined	Length (cm)	Weight range (gm)	Stomach content analyses					
				Algae	Succulent shoots	Grass	Chiro-nomid larvae	Molluscs	Trichop-tiran larvae
Synodontis batensoda	5	8.0–15.1	18–98	12	5	7	—	—	—
S. budgetti	33	16.0–23	118–445	—	—	—	33.3	—	33.3
S. clarias	13	13.0–22	35–212	—	—	—	—	66.7	66.7
S. eupterus	21	9 3–18.2	28–160	81	63	67	14.2	—	—
S. filamentosus	4	18	90	—	—	—	—	15	12
S. gambiensis	4	8 1–24.0	10–345	28	18	22	—	—	—
S. nigrita	5	9.0–12.2	40–63	32	6	12	—	—	—
S. occellifer	27	9.7–12.7	10–68	—	—	20	—	60	60
S. schall	6	10.4–14.8	24–158	62	10	16	—	—	—
S. sorex	29	18–22	100–260	—	—	22.2	33.3	56.6	66.7

BAKARE, (1969) explained that the swamps were able to maintain fairly high stocks of fish because competition for food among the fishes seemed to be reduced by the super-abundance of food and by complementary feeding habits among the fishes.

The majority of fishes also entered the swamps annually to breed. (IMEVBORE, 1970b). It is clear therefore that the extent and availability of the breeding grounds provided by the swamps was a positive factor to the fishery in the river basin. This is proved by the fact that many local fishermen took advantages of fish migrations in and out of the swamps to trap large quantities of fish during the breeding seasons. Such was the importance of the swamps to the fishery that in certain areas, fishermen retained fishing rights over portions of the swamps which were delineated and protected.

It may then be asked, why were the swamps so productive? Available evidence shows that *Echinochloa* swamps in the Niger and Nile valleys are always productive. (ANON, 1953–54; DAGET, 1954; REED, 1967; BACALBASE-DOBROVICI, in press). The plants have narrow leaves which may be as long as 2 m. Their rhizomes are also long but unlike *Cypreus papyrus* do not form dense mats which obstruct the flow of water and prevent adequate penetration of light. Thus the presence of a slow current provides conditions for mixing and aerating the swamps. In the case of the River Niger in the Kainji Lake area, the presence of seasonal floods ensures mineral enrichment for the growth of a rich aquatic life. Consequently, many fish species living in the river undertake lateral migrations into swamps (DAGET, 1958). In this respect these swamps differ from the permanent swamps in East Africa which are deoxygenated and devoid of fish life.

Much more important of course was the rate at which organic matter was decomposed (ANON, 1952). Within these swamps, there was a seasonal succession both of environmental factors and biological processes which accelerated the rate at which organic matter was decomposed. Every year, the swamps underwent a seasonal cycle of varying wetness starting from complete submergence in October. This was followed later by wet and damp conditions until by the peak of the dry season, the swamps were more or less completely dry, leaving only isolated pools in some parts. Thus was produced an alternation between wet and dry conditions which is known to enchance the rate of decay (VISSER and IMEVBORE, 1969). During many years, the dry grass was burnt to allow a re-growth of young shoots for cattle. The ash produced from the fires also helped to mineralize swamp water and to support the growth of phytoplankton. The net effect of these was that while they lasted, the swamps supported the growth of populations of algae, bacteria, vegetation, benthic fauna and fish far denser than those found within the main river channel.

In this way the swamps provided environmental diversification (spatial heterogeneity) which enabled river fishes to exploit a different and a richer environment which was also stable for the spawning and breeding of their young. Spatial separation between adult fish in the river and young fish of the same species in the swamp became possible thus reducing the chance of competition for food and space. In the course of time, these factors must have contributed to the great diversity shown by the fish community in the river (LOWE-McCONNELL, 1969).

Unfortunately this complex environment has now ceased to exist because of the formation of the lake. Except at the northern-most part of the lake where some swamps remain, *Echinochloa stagnina*, *E. pyramidalis*, *Vossia cuspidata* and *Polygonon senegalensis* are established only in small islands at the lake margins and only during high water. But, as a consequence of the annual 10 m draw-down this vegetation at the margins of the lake is stranded and thus destroyed. Subsequent to this, terrestrial plants colonize the newly exposed lake floor, but this too is destroyed with the coming of the floods. This annual cycle of events is undoubtedly beneficial in preventing the invasion and establishment of aquatic weeds in the lake but its inherent instability has so far precluded the establishment of swamps in the lake margines (IMEVBORE, 1971). How long this sequence of events will last is yet to be seen. At the moment, it seems to explain the decline in the numbers of such swamp-living fish genera such as *Tilapia*, *Gymnarchus* and *Protopterus* in the new lake. It also raises the question as to whether the size of the fishes in the lake would not be greatly enchanced by swamp formation in the future, and recalls the suggestions made by REED, (1967) about extending the life of seasonal swamps by artificially controlling their water supply.

SUMMARY

The ecology of the swamps in the basin of Lake Kainji was studied prior to the formation of the Lake. Two kinds of swamps were recognized: those fringing the river and those found in the old river and stream beds. All were shallow seasonal swamps formed during the rainy season. They lasted for not more than nine months each year. Their plant cover comprised mainly *Echinochloa*, *Polygonon* and *Cyperus* spp. but the notorius swamp sedge *Cyperus papyrus* was not found.

Measurements of the quality of the water, phytoplankton standing crop (as chrophyll) and concentrations of micro-organisms showed a higher productivity in the swamps than in the river water.

The high productivity of the swamps can be explained from the seasonal succession of wetness and dryness resulting in a high rate of decay. enrichment of organic matter from the annual floods, the presence of slow currents which mixes and aerates swamp water at all times and the burning of the dry grass.

Because river fish entered the swamps regularly to feed and breed, the swamps were rich fishing grounds.

Now that Kainji Lake has been formed, the large annual draw-down of water prevents the formation of marginal swamps resulting in the decline on the numbers of swamp-living fish genera like *Tilapia*, *Gymnarchus* and *Protopterus*.

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