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REPORT ON THE KAINJI DAM PROJECT (FISHERIES)

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The construction of a dam across the Niger at Kainji will result in the formation of a reservoir of huge size. At the request of the Federal Government of Nigeria, between 17 December 1960 and 16 January 1961 I made a survey of the region which is to be submerged. The aim of my investigations was to get some basic data on the characteristics of the future lake from the fishing point of view and to advise on the necessary work for setting up and organising the future fisheries.

The channel which will be included in the reservoir extends for a length of about 80 miles, from lat. 10° 55′ N., a little above Yelwa, to 9° 51′ N., at the dam site near Kainji. Numerous small islands are scattered all along its course. The Foge Island is the only one worthy of particular mention for its large size, 35 miles long and 11 miles wide. Rocks are not uncommon, forming rapids, mainly between Bussa and Kainji, where the flow is very fast. Tributaries are small streams, most of them flowing only in the rainy season. It must be emphasised that areas liable to flooding are restricted to the vicinity of the Foge Island. These low-lying lands are covered with semi-aquatic vegetation (*Echinochloa stagnina*, *Polygonum* cf. *senegalense*, *Mimosa* cf. *asperata* . . .) reminiscent of that of the flood zone of the Middle Niger. I saw no papyrus swamp. No aquatic vegetation can grow in the main channel on account of the strong current. Banks, when not under cultivation, have trees and shrubs.

Water tests have given the following results (in running water): pH 6·7 at Agwara, Rofia and in the Swashi River, 6·9 to 7·1 between Bussa and Kainji. Hardness (in French degrees): 2–4 (average 3) in the main River, 4–5° in the Swashi River. Total alkaline reserve (SBV), namely, number of cc. of a N/10 solution of H_2SO_4 needed to make a 100 c.c. sample of water, with helianthine added, change from yellow to pink colour: 0·1 to 0·2. These figures indicate a very low concentration of dissolved salts. In non-running water, salt content is higher. In two small ponds without vegetation: pH 7·2–7·3, hardness 11–12, SBV 0·25–0·35. In another pond with aquatic vegetation: pH 6·7, hardness 11, SBV 0·35.

Data on temperature of running water are shown in the following table:

Date	Position	Time of day	Temperature in C
19-12-60	Kainji	10.00-14.00	26·6-26·9
20-12-60	Garafini	08.00	26·8
21-12-60	Garafini	08.00	26·8
22-12-60	Kainji	08.00-12.00	26·6-26·8
28-12-60	Bussa	08.00	24·0
29-12-60	Kainji	08.00	24·0
30-12-60	Bussa	08.00-12.00	23·4-23·8
31-12-60	Bussa	08.00-12.00	23·2-23·5
3-1-61	Swashi R.	09.30	22·7
4-1-61	Bussa	08.00	22·7
,,	Agwara	12.00	22·7
5-1-61	Agwara	08.00	22·3
,,	Rofia	12.00	22·5
6-1-61	Agwara	08.00	22·1
,,	Bussa	12.00	22·9
7-1-61	Bussa	08.00-12.00	22·5-23·0
10-1-61	Bussa	08 00-12.00	22·4-22·9
12-1-61	Kainji	08.00-10.30	22·3-22·4

A temperature drop is obvious at the end of December.

As regards fish fauna, I collected or identified eighty-one species:

LEPIDOSIRENIDAE . . *Protopterus annectens*

POLYPTERIDAE . . *Polypterus senegalus senegalus*
Polypterus bichir lapradii

MORMYRIDAE . . *Hyperopisus occidentalis*
Mormyrus rume
Mormyrus macrophthalmus
Mormyrops deliciosus
Gnathonemus abadii
Gnathonemus senegalensis
Gnathonemus pictus
Marcusenius psittacus
Marcusenius lhuysii

GYMNARCHIDAE . . *Gymnarchus niloticus*

NOTOPTERIDAE . . *Notopterus afer*

OSTEOGLOSSIDAE . *Heterotis niloticus*

CHARACIDAE . . . *Hepsetus odoe*
Hydrocyon lineatus
Hydrocyon brevis
Hydrocyon forskalii
Alestes dentex
Alestes baremoze
Alestes nurse
Alestes leuciscus
Alestes macrolepidotus
Micralestes acutidens
Micralestes sp.

CITHARINIDAE . .	*Distichodus brevipinnis*
	Distichodus rostratus
	Citharinus citharus
	Citherinus latus
	Citherinus distichodoides
	Narmaethiops mitaeniatus
CYPRINIDAE . . .	*Labeo coubie*
	Labeo senegalensis
	Labeo sp.
	Barbus occidentalis
	Barbus ablabes
	Barbus macinensis
	Barbus leonensis
	Barbus atakorensis
	Barilius senegalensis
CLARIIDAE . . .	*Heterobranchus bidorsalis*
	Clarias anguillaris
	Clarias lazera
SCHILBEIDAE . .	*Eutropius niloticus*
	Schilbe mystus
BAGRIDAE . . .	*Bagrus docmac*
	Bagrus bayad
	Clarotes laticeps
	Chrysichthys furcatus
	Chrysichthys nigrodigitatus
	Chrysichthys auratus longifilis
	Auchenoglanis occidentalis
	Auchenoglanis biscutatus
MOCHOCIDAE. . .	*Synodontis clarias*
	Synodontis eupterus
	Synodontis membranaceus
	Synodontis filamentosus
	Synodontis sorex
	Synodontis budgetti
	Synodontis schall
	Synodontis gambiensis
	Synodontis coellifer
	Synodontis nigrita
	Synodontis violaceus
	Synodontis courteti
CYPRINODONTIDAE .	*Epiplatys senegalensis*
	Epiplatys bifasciatus
	Aplocheilichthys gambiensis
	Aplocheilichthys sp.
CENTROPOMIDAE . .	*Lates niloticus*

CICHLIDAE . . .	*Hemichromis fasciatus*
	Hemichromis bimaculatus
	Pelmatochromis guentheri
	Tilapia galilaea
	Tilapia nilotica
	Tilapia monodi
	Tilapia melanopleura
	Tilapia zillii
ANABANTIDAE . .	*Ctenopoma kingsleyae*
OPHIOCEPHALIDAE .	*Parophiocephalus obscurus*

The above does not exhaust the number of species, for certainly some rare species or species difficult to catch must have escaped my investigations. At any rate the fish fauna seems as rich as that of any part of the Niger.

Riverside people are interested in fishing, but are primarily farmers and take up fishing only as a part-time occupation. They use small dug-out canoes, various kinds of trap, cast-nets, hooks, short set nets occasionally and, when the flow recedes, weirs. All their gear is inexpensive but of low yield and utilisable only in creeks or along the banks. The catch is kept for family consumption and no fresh fish is brought to market-places like Bussa or Yelwa, nor is it cured. Professional fishermen are few and live in settlements removed from villages. Most of them have come from the Niger Republic. They are better equipped than the natives, catch more fish and smoke part of their catch for sale. I saw no dried fish.

The erection of the dam will introduce a number of major changes in the present situation. From November to April, the water level will be kept fairly constant at 465 feet but at the maximum of the flood it may rise to 470 feet. At top level (465 feet) I have calculated that the area of the reservoir will reach 483 sq. miles. In May–June–July–August the water level will draw down to approximately 440 feet; then the area of the reservoir will be reduced by about a third. In September–October the reservoir will fill up. The length of the lake will be approximately 72 miles. In the north of the present Foge Island, most of the small island will be submerged. The area of this part will be only one tenth that of the whole lake, though its length will be 26 miles. The average width at top level (465 feet) will be 1·8 or 1·9 miles, with a maximum of 3 miles and in some places the width will not exceed three-quarters of a mile. Further south the Foge Island will be entirely submerged but the hill directly to the east of Bussa will form a small island. At top level, the middle part of the reservoir will make a large pool 31 miles long and 11·1 miles wide on average. Its area will be slightly more than seven-tenths that of the whole lake. The southernmost part of the reservoir will reach barely a fifth of the total area; its length will be 24 miles and its average width 3·8 miles. The shore line will be very twisty and uneven. Maximum depth will reach 165 feet near the dam.

In comparison with the present situation, the volume and the area of water will be greatly increased. The run of water will slow down, a fact encouraging the growth of plankton. The ground exposed between low-water and flood levels will be extended. The semi-aquatic vegetation will develop. The stock of fish will be greatly enlarged but important modifications in the present state of faunistic balance are to be expected. The central part of the reservoir, corresponding to the present Foge Island, will be the most suited, in every respect, for fishing.

Some particular points of practical interest must now be considered:

(1) Damming a river prevents fish from moving upstream, unless a ladder or a lift is constructed. Such a device is required when maturing species of economic value have to leap the dam to reach spawning-grounds. It is from the behaviour of these mature fish that the most suitable type of pass can be selected. Therefore two questions arise:

(*a*) at the breeding season, namely the rainy season, are any mature fish passing up the river at Kainji, and if so, to what species do they belong ?

(*b*) are these migrations necessary for the maintenance of the exploited stock ?

It is possible that an affirmative answer will be given to the first question but in my view is very unlikely to the second one. However, it is suggested that these points be thoroughly investigated during the next breeding season. From my own experience, gained mainly in the Middle Niger, I have come to the conclusion that providing the dam at Kainji with a fish pass would not be justified.

(2) The present fish population of the river includes species economically valuable by virtue of size and edibility. From Yelwa to Kainji, one can find all the fish which make up the well known wealth of the Middle Niger fisheries: predatory species like *Gymnarchus niloticus*, *Polypterus spp.*, *Hydrocyon spp.*, *Hepsetus odoe*, *Chrysichthys spp.*, *Clarotes laticeps*, *Bagrus spp.*, *Eutropius niloticus*, *Lates niloticus*, *Parophiocephalus obscurus*, *Hemichromis fasciatus*; herbivorous species like *Distichodus spp.*, *Tilapia melanopleura*, *Tilapia zillii*; plankton-eaters like *Heterotis niloticus*, *Tilapia nilotica*, *Tilapia galilaea*, *Tilapia monodi*; insectivorous species like *Alestes spp.*, *Morymyrids*, *Hemichromis bimaculatus*; mud-eaters like *Citharinus spp.*, *Synodontis membranaceus*; bottom feeders like *Labeo spp.*, *Barbus spp.*, *Auchenoglanis spp.*, *Synodontis spp.* I am certain that a rich and well-balanced stock will quickly be attained throughout the reservoir. I think it would be useless and extravagant to develop fish nurseries to speed up the stocking of the reservoir.

(3) It is impossible to estimate exact fish production potential or total biogenic capacity in the future reservoir. Nevertheless we have some leads for predicting the limits of the possible fish production, based on data

available from big natural lakes flooded by the Niger above Timbuktu. In lake Faguibine and lakes Do-Niangaye (areas respectively about 212 and 173 sq. miles) estimations made in recent years have indicated a yield of 45–65 kg./ha. or 230–333 cwt./sq. mile. These lakes are in fact under-exploited and the present yield could probably be increased to 100 kg./ha. or 510 cwt./sq. mile, without over-fishing. On the grounds that the chemical quality of water inflow, seasonal variations of water-level drop and temperature, insolation, composition of semi-aquatic vegetation and fish fauna, are if not identical nevertheless quite comparable, the fish production of the Kainji reservoir is expected to reach easily 120,000 cwt. and increase to 240,000 cwt. At one shilling a pound, the corresponding market value would be £672,000 to £1,344,000. But it must be borne in mind that such a yield cannot be obtained without

(*a*) technical possibilities for efficient fishing,
(*b*) adequate numbers of skilled and well-equipped fishermen.

(4) Since ligneous vegetation does not rot under water, trees and shrubs on the bottom will render full fishery exploitation very expensive through constant damage to or loss of fishing gear. Therefore it is necessary to clear the bottom of vegetation over the widest possible area. It is to be expected that a belt of semi-aquatic plants, mostly *Echinochloa stagnina*, will spread along the banks of the reservoir, preventing the use of seine nets: this sort of net is generally pulled out to sandy beaches or flat shores which will not be found when the dam is built. Total clearing, in which all the trees and bushes are stumped out, is not required. Cutting the stems a short distance above the ground and leaving the stumps is much less expensive and quite adequate for gill-net fishing, set nets and long lines. Nevertheless felling all the trees and shrubs will be a costly proposition. It is suggested to clean first the central part of the reservoir, corresponding to the present Foge Island, the low grounds of which are devoid of trees. Cleaning will later be extended to the southern part of the reservoir depending on funds granted.

(5) Before the dam is built, it would be profitable to continue further investigations on the following points:

(*a*) Upstream migrations in the breeding season as pointed out above.
(*b*) More accurate inventory of the fish fauna, taking advantage of opportunities offered for catching fish at low water level, when the level begins to rise and when the [illegible]. Small species are not to be neglected as they are an important link between plankton and large predatory fish.
(*c*) Dietary and mode of breeding of the different species, chiefly those which are thought to prosper in the reservoir.
(*d*) Biology of the aquatic and semi-aquatic vegetation, conditions required for their implantation and development. Little is known

on this topic which may be of great consequence, for some reservoirs have been invaded very quickly and unexpectedly by plants prejudicial to fisheries.

All these studies do not need the presence of a Fisheries Research Officer all year long. They may be carried out during short tours at judiciously selected times. Bussa seems the most suitable starting point for such investigations.

(6) When the lake starts to fill, new problems will arise which are within the competence of the Fisheries Section of the Ministry of Agriculture, Northern Nigeria. Tackling and solving these problems will need the permanent presence of a Research Officer on the central pool of the reservoir. His action will include limnological and ichthyological studies as well as fisheries management. Only preliminary recommendations can be made on the matters which seem likely to have some practical importance from the fishing angle.

(*a*) Regular survey of water temperature and oxygen content at different depths; these two factors are suspected of inducing vertical migrations of fish.

(*b*) Ascertainment of spawning grounds and times for species economically valuable in order, eventually, to afford them some special protection.

(*c*) Dynamics of exploited fish populations (effectives, rate of reproduction, sex and age distribution, rate of growth). All these data are to be obtained from catch statistics for the setting up of which collaboration of all the fishermen is required.

(*d*) Planning of elaborate regulations to restrict (or increase) the catch of certain species, at determined places and times and in order to enforce the general productivity of the waters.

(*e*) Technical tests of boats, nets and gears of the less expensive kind more suited for fishing in the reservoir. Seine-nets are not to be used but ring-nets may be worth trying in the deepest places.

(*f*) Experiments on the best ways of curing fish for sale. Smoking seems to be recommended on account of prevalent climatic conditions, abundance of fuel and local habits. The clay ovens of the Sorkawas are very convenient but may eventually be improved.

(*g*) Special care is to be taken of insects (Dermestes and Necrobia) which infest smoked fish. These parasites spread very quickly when supply of food and adequate ecological factors are present as at storage points and depots where fish is warehoused.

(*h*) Native fishermen, even though they may be eager to adopt new improved methods of fishing, will not at first possess funds to buy large boats, out-board motors, nylon nets and other gear suited to the full exploitation of the reservoir, nor will they possess skill

and experience to make the best use of them. Cash loans, establishment of co-operatives, demonstration of up-to-date equipment and training of local crews are to be considered. These actions do not concern foreign fishermen who are generally well-equipped and more expert than the native ones.

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