Scientific results of the Cambridge Expedition to the East African Lakes, 1930-1.—1. General introduction and station list. By E. B. WORTHINGTON, M.A., Ph.D., Balfour Student at Cambridge University.

(PLATES 1-5)

[Read 28 April 1932]

THE Cambridge Expedition to the East African lakes was organised in 1930 to continue limnological investigations in Kenya and Uganda. The early African lake expeditions at the beginning of the century concentrated on Lake Tanganyika, but made collections of the fauna and flora of Lakes Victoria, Edward, Albert, etc., and other collections have been brought to European museums by individual collectors. A summary of knowledge up to date was given by Dr. Cunningham (1921), but since that time the sciences of limnology and ecology have undergone considerable development and we are now able to approach the problems from a somewhat different standpoint, considering the animals and plants in relation to their physical and biological environments, and attacking problems of geographic distribution with a sounder backing from geology. This modern type of research on the African lakes may be said to have started on Lake Victoria, the second largest lake in the world, with an area of 26,000 square miles, of which the biology was studied in detail by Mr. Michael Graham, whom I had the advantage of assisting, during the Government fishing survey in 1927-8. The results of this survey were embodied in an official report (Graham, 1929). Following on this a similar survey was made of Lakes Albert and Kioga in 1928, the results of which were published by Worthington (1929 etc.). In 1929 Miss Penelope Jenkin (1932) did detailed biological work on certain small lakes in the Kenya rift valley—Lakes Naivasha, Elmenteita, and Nakuru.

The object of last year's expedition was to complete the biological map of the Kenya and Uganda lakes. In Kenya, Lake Rudolf was the main objective, a vast area of water 185 miles long with a maximum width of 37 miles, only 1,250 feet above sea-level, which lies in the northern part of the Kenya rift valley and was very little known from the biological point of view. The deepest sounding we recorded was 73 metres (40 fathoms), but we have shown that the lake was formerly at a level 475 feet above the present, and therefore was three times as deep. When the lake was high during the pluvial periods it must have covered a vast area of what is now the Turkana desert, and we have concluded that it overflowed to the north-west into the basin of the Sobat river and so into the Nile near Khartoum. In those times the water must have been practically fresh, but in the period which intervened

between the pluvials and the present day the lowering of the lake-level has caused a concentration of dissolved salts until now the water is so alkaline as to be exceedingly unpleasant to drink (alkaline reserve = 0.02 Normal).

The daily shade temperature of the Lake Rudolf littoral reaches 100° or 110° F., and the vegetation map of Africa shows that the lake lies in an isolated area of desert or steppe-desert, the nearest similar vegetational areas being those of Somaliland and the Eritrean shore*. Consequently the land-fauna, which was collected in fair detail, is of considerable interest, as Mr. Parker's paper in this series on Reptiles will show. One of the best descriptions of this region yet published is that by von Höhnelt (1894) concerning its original exploration.

Lake Baringo which was also studied in detail lies at a height of 3,150 feet in the rift valley to the south and is much smaller, about 12 by 6 miles. It is shallow with an even bottom at 7½ metres, and the water is yellow and muddy with a lower alkalinity (alkaline reserve = 0.006 Normal).

Continuing the series down the rift valley, Lakes Hannington, Nakuru, and Elmenteita are smaller very alkaline lakes (alkaline reserve = 0.16, 0.19, and 0.22 Normal respectively). The last two are very shallow, and Hannington is probably also shallow, though it has not been sounded in detail. Lake Naivasha lies at a height of 6,200 feet still further to the south in the rift valley; it measures about 8 by 9 miles and has a maximum depth of 18½ metres. Although, like the foregoing, it apparently lies in a closed drainage basin, the water is practically fresh (alkaline reserve = 0.003 Normal) and probably there is a subterranean outlet causing a through current of water. High-level beaches point to the conclusion that during the first (Kamasian) pluvial period all the Kenya rift lakes from Baringo to Magadi were united.

In Uganda, Lake Edward, the greater part of which lies within Belgian Congo Territory, and Lake George were the chief subjects of study. Lake Edward, which is 48 miles long by 25 miles wide, lies at a height of about 3,000 feet in the western rift valley. It was found to have a deep trough descending to a depth of 118 metres near the steep escarpment to the west, from which the bottom shelves evenly to the swampy south-east shore. On the other hand, Lake George, which is about 12 miles square and lies in a branch of the rift valley under Mt. Ruwenzori, is very shallow with an even bottom at 2½ metres; much of its shore is bordered by papyrus swamp. The two lakes are connected by the Kazinga Channel, a unique physiographical feature about 30 miles long by ½ mile wide, which presents bionomic problems of great interest. The region is beset with problems of river reversal and changes of lake-level, which have greatly affected the aquatic fauna.

* Unfortunately, several recently published maps (for instance, Hurst and Phillips, 1931) show the Rudolf region to have a high rainfall and to have a savannah or savannah-forest vegetation. This is probably due to lack of data concerning the area. Actually such information as there is suggests that the northern part of the Kenya rift in which Lake Rudolf lies has an annual rainfall considerably less than 20 inches, and the vegetation near the lake shore is certainly desert or scrub-desert except along the dry water-courses.

While the Expedition was in Uganda the Government took the opportunity of having surveys made of the following smaller lakes with a view to fisheries' development, which, of course, involved collecting the fauna and flora and studying the ecology :—

Lake Bunyoni is an excellent example of a modern lake with no indigenous fish-life, and lies at a height of 6,400 feet in the highland Kigezi district. It was formed in recent times by a lava flow which poured across one of the steep-sided Kigezi valleys, ponding a stream to form a beautiful fresh-water lake about $17\frac{1}{2}$ miles long, some 40 metres deep, with long rambling bays and numerous islets.

Lakes Nakavali, Kachira, and Kijanebalola are an interesting series of shallow swampy waters lying on one of the drainage systems which virtually connect Lake Edward to Lake Victoria. They have a pronounced faunistic interest, since most of the modern fauna of Lake Edward was probably derived from Lake Victoria along these unique drainage systems, which arise in swamps and now flow both eastward to Lake Victoria and westward to Lakes Edward and George.

Lake Nabugabo is a small oval stretch of water 5 miles long by 3 miles wide and only $4\frac{1}{2}$ metres deep, lying close to the north-west corner of Lake Victoria. It was originally a part of Victoria, but has become completely shut off by the growth of a sand-spit, and contains an isolated sample of the Victoria fauna. Along one side it is bordered by a large acid *Sphagnum* swamp, one of the very few acid swamps in East Africa. Nabugabo is less alkaline than any other East African lake.

A general account of the lake regions visited has already been published in the 'Geographical Journal' (Worthington, 1932), so it is unnecessary to burden this introduction with physiographical details. For further information concerning the smaller Kenya lakes, see Gregory (1921) and Leakey (1931).

The *personnel* consisted of Dr. E. B. Worthington as leader and zoologist, who concentrated on fish, plankton, the general ecology of the lakes, and fisheries' development. Mrs. Stella Worthington as geographer collaborated with the leader in all this work and in addition made detailed surveys and maps of parts of Lake Rudolf, the results of which are published here as Map 1. Mr. L. C. Beadle as chemist and zoologist was concerned with the study of water chemistry in relation to biology, and did other work on the bionomics of swamps to compare the conditions in Africa with those in the South American Chaco. Mr. V. E. Fuchs as geologist studied the high-level beaches and where possible made fossil collections representing the lake-faunas of the pluvial periods. Unfortunately, Fuchs was taken seriously ill with spirillum and malarial fevers after the first two months, and as a result was incapable of work for four months out of the year. After the other members returned to England, however, he joined Dr. L. S. B. Leakey's archaeological expedition in East Africa and spent an additional four months in the field continuing his researches. The other members of the expedition enjoyed good health on the whole, but Worthington and Beadle suffered from occasional

slight attacks of malaria and Mrs. Worthington was laid up for 10 days in camp on Lake Edward with dysentery.

For the first two months Mr. R. E. Dent, Assistant Game Warden in charge of fish in Kenya Colony, accompanied the expedition by arrangement with the Kenya Government. He collaborated in the biological work, his experience of the country was invaluable, and he saved the expedition a severe amount of expense and inconvenience by lending his house on the shore of Lake Naivasha for the whole year. This house was used as a headquarters, being in a healthy part of the country; not only was it an excellent place for recuperation after strenuous work in the unhealthy regions of Baringo and Rudolf, but it served as a base for investigations of Lake Naivasha itself. Mr. Dent's 20-foot sailing-boat on the lake was also lent to the expedition.

The *means of transport* to and from the lakes was always provided by motor-cars and lorries. Once arrived at the lake-shores travel was generally accomplished by open boat, but occasionally by foot safari and head-porterage. A 12 h.p. outboard motor was transported everywhere with the other equipment and attached to different craft as occasion demanded. It was chiefly due to the reliability of this machine that we were able to cover so much water, for small boat navigation on many of the lakes is difficult and sometimes dangerous by reason of the sudden storms and heavy swells.

The *itinerary* was as follows :—

The first two months in the company of Dent were occupied by a preliminary examination of the Kenya lakes. Work started at the beginning of November on Lake Naivasha, and at the end of November we moved to Baringo, transporting there a 14-foot open row-boat. In the middle of December we set out for Lake Rudolf and succeeded in transporting our equipment and a 20-foot metal lifeboat, lent to the expedition by the railway and harbour authorities and delivered by them to railhead at Kitale, over the 300 miles of bad road and desert from Kitale to the lake shore, arriving there on Christmas Eve 1930.

A fortnight was spent building a permanent base-camp at the mouth of the Kaliokwel River about half-way up the west shore of the lake, a situation partly protected by the sand-spit of Ferguson Bay. A preliminary visit was made to Central Island and a general idea gathered of the work waiting to be done. After returning to Naivasha for fresh supplies and equipment we moved to Baringo towards the end of January for the main working time on that lake. In the middle of March the expedition travelled again to Lake Rudolf for two months, during which Ferguson Bay, Central Island, and the adjoining parts of both east and west shores and the open water were studied in detail. During this time Beadle made a trek to the north end of the lake near Lokitaung, while the Worthingtons accomplished a long open-boat journey, crossing the lake in two places and examining unknown parts of its shores.

During May some further work was done on Lake Naivasha and the whole expedition moved its headquarters from Naivasha to Lake Edward in Uganda,

taking a 16-foot open boat specially designed for the outboard motor and built from timber obtained locally, the first non-native craft on either Lakes Edward or George. Work started at Katunguru on the Kazinga Channel at the end of May, continued on Lake Edward through June and July, during which time the Worthingtons made a boat journey round and across the lake, while Beadle and Fuchs, working from the land, studied the shores and walked into the Congo to visit the Semliki Falls and nearby regions. Most of July and the beginning of August was spent on Lake George, after which Beadle had to return to England and Fuchs to Naivasha. Dr. and Mrs. Worthington then moved to Lake Bunyoni for a clear fortnight and afterwards spent another month until the middle of September examining Lakes Nakavali, Kachira, Kijanebalola, and Nabugabo. They returned to England at the end of October after submitting preliminary reports to the Uganda Government.

The whole expedition cost the sum of about £1,700, which was contributed by the following bodies :—Royal Society Government Grants, British Museum (Nat. Hist.), Percy Sladen Memorial Trust, British Association, Cambridge Balfour Fund, Royal Geographical Society, Gloyne Fund, Gonville and Caius College, Worts Fund, and the Uganda Government. In submitting the accounts a balance of £170 was shown, which it has been arranged to put towards the expense of publishing the scientific results in the 'Journal of the Linnean Society.'

The collections have been sorted at the Zoological Laboratory, Cambridge, and at the Natural History Museum, South Kensington, where all the specimens will be deposited finally. The different groups of organisms have been submitted to the following authorities for examination, several of whom will be contributing papers in the series of results :—

Mammals to Miss St. Leger ; Reptiles and Amphibians to Mr. H. W. Parker ; Cichlid fishes to Dr. C. Tate Regan, F.R.S., and Miss E. Trewavas ; fishes other than Cichlidae to Dr. E. B. Worthington ; Mollusca to Major M. Connolly ; Oligochaeta to Lt.-Col. J. Stephenson, F.R.S. ; Parasitic Worms to Dr. H. A. Baylis ; Leeches to Dr. J. Percy Moore ; Sponges to Mr. M. Burton ; Polyzoa to Dr. A. Hastings ; Rotifera to Prof. P. de Beauchamp ; large Crustacea to Dr. I. Gordon ; Argulidae to Dr. W. A. Cunningham ; parasitic Copepoda to Mr. Leigh-Sharpe ; Planktonic Crustacea to Mr. A. G. Lowndes ; Myriapoda and Arachnida to Dr. S. Finnegan ; Hydrachnida to Dr. O. Lundblad ; adult insects to members of the British Museum entomological department ; insect larvae to Dr. A. D. Imms ; land-plants and water-weeds to Mr. J. Ramsbottom ; and Phytoplankton to Miss F. Rich.

As a result of the expedition's work it may now be said that all the important lakes in Kenya and Uganda have received a thorough preliminary biological survey, but it is not claimed that every organism from every lake has been collected ; such a feat would have been impossible with the time at our disposal, and indeed certain forms of life are inevitably overlooked in any faunistic work. Many problems have been cleared up, but at the same time many others have been opened for further investigations. Moreover, there

are still many fresh waters in this region not yet studied at all. The rivers and streams present innumerable problems in themselves, and it has not yet been possible to examine the small crater lakes which abound in the Ankole and Toro districts of Uganda. In Kenya, Lake Magadi, a saturated solution of soda with fresh-water streams flowing into it, and Lake Jipe, which lies under the massive volcano of Kilimanjaro, have been left out of our work. In Tanganyika Territory there are still untouched fields for fresh-water research: the large alkaline lakes of Natron and Eyassi in the eastern rift have not yet even been collected and the abyssal depths of Lake Tanganyika itself, which is known to be almost a mile deep, have only been plumbed at three points, while nothing is known of the abyssal fauna which may or may not live near the bottom. Lake Nyassa presents similar deep-water problems which could not be tackled by the early expeditions owing to lack of suitable equipment. It is to be hoped, therefore, that before long a further expedition will be organized, thoroughly equipped for deep-water work, to proceed to Tanganyika, Nyassa, and the small unknown lakes of Tanganyika Territory with the object of elucidating still further the problems of the African lakes.

I should like to take this opportunity of thanking the members of the expedition for their helpfulness, often in trying conditions, Professor J. Stanley Gardiner for assistance in organizing the expedition before leaving England and for advice in all its stages, His Excellency Sir William Gowers for his interest and help in Uganda, and the many friends both in East Africa and in England who have helped the expedition on its way.

The following Station List is abridged from the expedition's log-books, to include only those stations from which specimens were preserved. The object of printing it here is to save much unnecessary space in the following series of papers, since the locality and data concerning specimens can be referred to simply by a station number.

Maps 1-3 are reproduced from the 'Geographical Journal,' vol. lxxix, by permission of the Royal Geographical Society. Maps 4 and 5 have been prepared by my wife.

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ABRIDGED STATION LIST.

Lake Naivasha.

Station.	Date.	Time.	Locality.	Gear.	Notes.
1.....	10/11/30.	1800-0630.	E. shore.	gill-nets.	depth 3 m.
2.....	11/11/30.	0630-1600.	"	"	"
3.....	12/11/30.	1200-1400.	E. shore off McRae's.	"	"
5.....	13/11/30.	1700 1200.	mid-lake.	"	depth 7 m.
6.....	"	1210-1220.	"	dredge, plank- ton-nets.	horizontal haul.
7.....	15/11/30.	0700.	E. shore.	—	native fishing.
8 & 9..	"	1230.	"	pond-net &c.	weedy shore- collection.
10 A ...	16/11/30.	—	pond on Kinankop.	—	"
11.....	17/11/30.	1100.	weed area of E. shore.	winch, pond- net, &c.	general collection.
12.....	19/11/30.	1700-0700.	E. shore.	gill-nets.	—
14.....	20/11/30.	1630-1700.	Crescent Is. crater.	water-bottle, plankton-nets.	depth 17 m., vertical hauls.
15.....	"	1750-0700.	E. shore.	gill-nets.	—
16.....	21/11/30.	1400.	rainpool.	pond-net.	collection.
18.....	23/11/30.	1300.	middle of lake.	plankton-nets, water-bottles.	depth 10 m., vertical hauls, dhan-buoy fixed.
19.....	"	1500.	Crescent Is. crater.	water-bottle.	depth 18 m., dhan-buoy fixed.
21.....	24/11/30.	0830.	"	"	—
22.....	25/11/30.	0830-0630.	"	gill-nets.	—
23.....	"	1200.	Morendat River.	pond-net.	shore-collection.
24.....	26/11/30.	1300-1700.	W. of lake near rocky islets.	gill-nets.	—
26.....	9/2/31.	1800-0600.	near E. shore.	"	—
27.....	24/2/31.	—	E. shore.	pond-net &c.	fishermen's collecting.
28.....	"	1100.	near E. shore.	plankton-nets.	horizontal hauls.
29.....	26/2/31.	1230 on- wards.	Crescent Is. crater.	coarse plankton-net.	24 hours' plankton observations, vertical hauls.
30.....	"	"	"	fine plankton-net.	—
31.....	27/2/31.	1700.	weed area near E. shore.	plankton- nets.	vertical hauls.
32.....	28/2/31.	—	L. Nakuru.	pond-net &c.	shore-collection.
33.....	1/3/31.	1100-1600.	crater lake 2 miles W. of L. Naivasha.	plankton-nets, grabs, water- bottles, &c.	vertical hauls.

Lake Naivasha (continued).

Station.	Date.	Time.	Locality.	Gear.	Notes.
34.....	1/3/31.	1100-1800.	crater lake 2 miles W. of L. Naivasha.	pond-net.	muddy shore- collection.
35.....	2/3/31.	1600.	Crescent Is. crater.	centrifuge, water-bottle.	centrifuge plankton.
36.....	3/3/31.	1500.	"	"	"
37.....	5/3/31.	1700-0630.	near E. shore.	gill-nets.	"
38.....	8/3/31.	1200.	S.W. bay of Naivasha.	plankton-nets.	depth 11-7 m., vertical hauls.
38 A ...	"	"	"	water-bottle, centrifuge.	lines of sounding made.
39.....	"	—	E. shore.	pond-net &c.	shore-collecting.
40.....	11/3/31.	1200.	near centre of lake.	plankton-nets.	depth 7 m., vertical hauls.
42.....	11/5/31.	1200.	Crescent Is. crater.	"	depth 8 m., vertical hauls.
43.....	"	1230.	weedy area near E. shore.	"	depth 3 m., vertical hauls.

Lake Baringo.

Station.	Date.	Time.	Locality.	Gear.	Notes.
101.....	4/12/30.	1100	S.W. shore.	seine &c.	sandy shore collection.
102.....	5/12/30.	0630-1700.	near S.W. shore.	gill-nets.	depth 4 m.
103.....	"	1730-1130.	"	long line.	small hooks.
104.....	"	1100.	"	pond-net &c.	sandy shore collection.
103 A ..	6/12/30.	1800-1000.	"	long line.	large hooks.
105.....	7/12/30.	1100-0630.	near rocky island.	gill-nets.	depth 7 m.
105 A ..	"	1130-1300.	"	thermometers, &c.	lines of soundings.
106 B ..	"	1700.	S.W. shore.	seine.	—
106.....	8/12/30.	1200.	near rocky island.	plankton- nets.	depth 7 m.
106 A ..	9/12/30.	—	S. shore.	pond-net &c.	swamp-collection.
107.....	"	—	open water.	grab.	lines of soundings.
108.....	"	1600-0600.	"	gill-nets, long line.	—
109.....	"	1100.	S.W. shore.	—	sandy shore collection.

Lake Baringo (continued).

Station.	Date.	Time.	Locality.	Gear.	Notes.
111.....	24/1/31.	1100.	river at Marigat.	seine &c.	stony shore collection.
112.....	25/1/31.	1100.	S.W. shore.	pond-net &c., plankton-nets.	"
114.....	26/1/31.	0900-1200.	S. shore.	pond-net &c.	swamp-collection.
115.....	"	1600-1700.	W. shore.	—	stony shore collection.
116.....	27/1/31.	1800-0600.	open water near rocky island.	gill-nets.	dhan-buoy fixed.
117.....	28/1/31.	0900.	"	plankton-nets.	horizontal hauls.
118.....	"	1700-0600.	"	gill-nets.	depth 7 m.
119.....	"	"	"	long line.	—
119 A ..	28/1/31.	1100-1130.	open water near rocky island.	trawl.	—
121.....	"	1700.	"	grab, plankton-nets, dredge.	depth 7 m., vertical hauls.
122.....	30/1/31.	1700-1800.	"	trawl.	3 hauls.
123.....	31/1/31.	0600.	"	water-bottle centrifuge.	—
124.....	"	1000.	"	plankton-nets.	vertical hauls.
125.....	"	1200.	"	centrifuge.	—
126.....	"	1600.	"	native fishing.	lines of soundings.
127.....	"	1700-1800.	rocky island.	pond-net &c.	shore-collection.
128.....	2/2/31.	1100.	large island.	—	hot-spring collection.

Lake Hannington.

Station.	Date.	Time.	Locality.	Gear.	Notes.
129.....	3/2/31.	—	N. shore.	pond-net &c.	muddy shore collection.
130.....	"	—	river entering lake.	"	"
131.....	4/2/31.	—	N. shore.	seine.	—
132.....	"	—	river entering lake.	pond-net.	shore-collection.
134.....	"	—	N.E. shore.	pond-net.	"

Lake Rudolf.

Station.	Date.	Time.	Locality.	Gear.	Notes.
201.....	24/12/30.	0630.	base camp at mouth of Kali-okwel River.	seine.	muddy shore.
202.....	"	1100.	lee of Ferguson spit.	"	sandy shore.
204.....	"	1800-0600.	Ferguson Bay.	gill-nets.	depth 3 m.
205.....	Xmas Day.	1500.	lee of Ferguson spit.	seine.	sandy shore.
206.....	26/12/30.	0600.	base camp.	—	native fishermen with catch.
207.....	"	1100-1530.	Ferguson Bay.	gill-nets.	depth 4 m.
207 A ..	"	1130-1600.	lee of Ferguson spit.	2" gill-net.	along shore.
208 A ..	"	1300.	"	long line for <i>Lates</i> .	—
209.....	"	1500.	"	seine.	sandy shore.
210.....	29/12/30.	0600.	base camp.	—	native fishermen's catch.
211.....	"	1000-1400.	just outside Ferguson Bay.	gill-nets.	—
211 A ..	"	1030.	Ferguson spit.	long line for <i>Lates</i> .	—
211 B ..	"	1130.	"	pond-net &c.	collection in closed alkaline pool.
212.....	30/12/30.	0600.	base camp.	—	native fishermen.
213.....	"	1230.	"	pond-net &c.	shore-collection.
214.....	31/12/30.	0600.	"	—	native fishermen.
215.....	1/1/31.	1045 0630.	open water 1 mile from spit.	gill-nets.	bottom fishing, depth 18.5 m.
216.....	"	1200.	"	plankton-nets.	depth 18.5 m., vertical hauls.
217.....	2/1/31.	1200 1700.	Ferguson Bay.	gill-nets.	depth 3 m., crocodile smashed nets.
218.....	3/1/31.	1200.	Central Island.	pond-net.	shore-collection, lines of soundings.
219.....	4/1/31.	1800.	lee of Ferguson spit.	seine.	sandy shore, 3 hauls.
220.....	5/1/31.	0900 1100.	base camp.	pond-net and sieves.	shore-collections.
221.....	6/1/31.	1600 1800.	lee of Ferguson spit.	2" gill-net.	set along weedy shore.
221 A ..	"	"	off point of Ferguson spit.	"	—
222.....	"	1700.	"	seine.	—
223.....	"	1830.	"	long line.	—

Lake Rudolf (continued).

Station.	Date.	Time.	Locality.	Gear.	Notes.
225.....	7/1/31.	1800-1400.	lee of Ferguson spit.	long line.	—
226.....	8/1/31.	0730-1130.	open water near Central Island.	gill-nets.	depth 60 m., bottom fishing, lines of sounding.
227.....	"	0800.	"	grab.	depth 57 m.
228.....	9/1/31.	1700.	lee of Ferguson spit.	seine.	4 hauls.
229.....	10/1/31.	1700-1900.	"	gill-nets.	—
230.....	"	1730-1900.	"	Long line.	—
231.....	20/3/31.	1100.	"	1" seine.	—
232.....	"	1100-1500.	"	long line.	—
232 A ..	"	1200.	off point of spit.	trawl.	much mud.
234.....	21/3/31.	1100.	open water 1 mile off spit.	plankton-nets.	depth 25 m., vortical hauls.
235.....	"	"	rain-pools near base camp.	pond-net.	pool collection.
236.....	22/3/31.	1500-1100.	open water beyond spit.	gill-nets.	depth 12 m., surface fishing, dhan-buoy fixed.
237.....	"	0900.	lee of Ferguson spit.	long line.	Record <i>Lates</i> , 95 kg.
238.....	24/3/31.	1100.	"	1" seine.	—
240.....	"	1700.	base camp.	pond-net.	collection from enclosed river-mouth.
241.....	24/3/31.	1800.	base camp.	—	shore shell collection.
242.....	"	1730.	Ferguson spit.	seine.	crocodile smashed seine.
243.....	"	1800.	"	long line.	—
244.....	25/3/31.	1600.	Ferguson Bay.	seine.	—
245.....	27/3/31.	1100.	"	"	—
246.....	"	1130.	"	pond-net.	sandy shore collection.
247.....	28/3/31.	0900.	S. end of Ferguson Bay.	plankton-nets.	depth 3 m., horizontal haul.
248.....	"	1000.	intermediate position.	"	depth 4 m., horizontal haul.
249.....	"	1100.	"	"	depth 3-3 m., horizontal hauls.
250.....	"	1200.	N. end of Ferguson Bay.	"	depth 4-7 m., horizontal hauls.
251.....	"	—	S. end of Ferguson Bay.	pond-net.	shore-collection.

Lake Rudolf (continued).

Station.	Date.	Time.	Locality.	Gear.	Notes.
253.....	30/3/31.	0900.	lee of spit.	seine.	—
254.....	"	0930-1800.	"	long line.	—
255.....	"	1000-1215.	Ferguson Bay.	gill-nets.	—
257.....	"	1300.	Ferguson spit.	—	algae from closed alkaline pool.
258.....	31/3/31.	0900.	entrance to Ferguson Bay.	plankton-nets.	depth 9.1 m., horizontal hauls.
259.....	"	1000.	intermediate position.	"	depth 12 m., horizontal hauls.
260.....	"	1100.	open water.	"	depth 17 m., horizontal hauls.
261.....	"	1200.	"	"	depth 21 m., horizontal hauls.
262.....	"	1230.	outside of spit.	gun.	pelican and cormorant stomachs.
263.....	2/4/31.	1800 on-wards.	open water W. of Central Is.	plankton-nets.	depth 48 m., 24 hours' plankton observations, vertical hauls.
264.....	"	1700.	Central island.	1" seine.	—
266.....	"	1700.	"	gun.	fishes shot.
267.....	3/4/31.	0900-1700.	open water.	gill-nets.	depth 50 m., bottom fishing.
269.....	"	1000.	crater lake B.	—	plankton-collection.
270.....	4/4/31.	1000.	crater lake A.	1" seine.	—
271.....	"	1100.	"	plankton-nets.	depth 9 m., horizontal hauls.
273.....	"	1600.	crater lake C.	1" seine.	water sample preserved.
274.....	5/4/31.	—	Central Island.	—	shore shell collections.
275.....	8/4/31.	1700.	Ferguson Bay.	trawl.	3 4 m.
277.....	9/4/31.	1700.	"	gill-nets.	—
278.....	11/4/31.	—	S. end Ferguson Bay.	1" seine.	—
280.....	"	—	base camp.	pond-net.	alkaline pool collection.
281.....	12/4/31.	—	Central Island.	"	rocky shore collection.
283.....	14/4/31.	0900.	E. shore of lake near Mt. El Moitat.	"	sandy shore collection.
284.....	"	0600.	"	—	fossil shell collection.

Lake Rudolf (continued).

Station.	Date.	Time.	Locality.	Gear.	Notes.
285.....	14/4/31.	1100.	E. shore near Mt. El Moitat.	1" seine and pond-net.	woody lagoon.
286.....	15/4/31.	0630.	"	pond-net.	woody shore.
287.....	"	"	"	1" seine.	"
288.....	15/4/31.	0900-1200.	"	gill-nets.	depth 2 m.
289.....	"	—	"	1" seine.	muddy shore, baby crocodiles.
290.....	"	—	"	pond-net.	shore collection.
291.....	16/4/31.	1200.	near Turkwel River mouth, W. of lake.	"	hot fresh- water spring.
292.....	17/4/31.	—	"	—	shore shells.
293.....	"	—	Adach lagoon.	1" seine, pond-net.	muddy shore.
295.....	19/4/31.	1700-0900.	Ferguson Bay.	long line.	—
296.....	17/4/31.	1700-0800.	N.W. shore, near Mt. Labur,	gill-nets.	—
298.....	21/4/31.	0630.	open water $\frac{1}{2}$ mile beyond spit.	plankton-nets, grab, contri- fuge.	depth 19-8, vertical hauls.
299.....	"	1800-0630.	"	gill-nets.	—
301.....	22/4/31.	—	base camp.	pond-net, 1" seine.	muddy shore.

Kazinga Channel.

Station.	Date.	Time.	Locality.	Gear.	Notes.
501.....	24/5/31.	1700-0630.	Katunguru, mid-channel.	gill-nets.	depth 2-5 m.
502.....	"	"	"	long line.	small hooks.
503.....	25/5/31.	—	"	—	native fisher- men's catch.
504.....	"	1700-0600.	"	gill-nets.	close to papyrus edge.
505.....	26/5/31.	1700-0630.	1 mile N.E. of Katunguru.	gill-nets.	depth 2-5 m.
506.....	27/5/31.	1700-0630.	Katunguru.	gill-nets.	set very close to shore.
507.....	28/5/31.	1100.	"	pond-net.	collection from papyrus swamp.
508.....	"	1400.	"	1" seine.	—
509.....	"	1700-0600.	"	long line.	—

Kazinga Channel (continued).

Station.	Date.	Time.	Locality.	Gear.	Notes.
510.....	29/5/31.	1100.	Katunguru.	plankton-nets.	horizontal hauls.
511.....	"	1200.	"	1" seine, pond-net.	shore collection.
512.....	30/5/31.	—	River Cham- bura near Katunguru.	1" seine, pond-net.	"
513.....	"	1700-0600.	2 miles N.E. of Katunguru.	gill-nets.	lines of soundings.
514.....	31/5/31.	"	W. of Katun- guru.	"	depth 2.5 m.
516.....	2/6/31.	—	near Katun- guru.	pond-net.	collection from papyrus swamp.
516 A ..	"	—	Katunguru.	"	weed collection.

Lake Edward.

Station.	Date.	Time.	Locality.	Gear.	Notes.
517.....	5/6/31.	1700-0800.	1½ miles beyond mouth of Kazinga Channel.	gill-nets.	depth 2.5 m.
518.....	"	1800-0600.	mouth of Channel.	long line.	—
519.....	6/6/31.	"	as 517.	gill-nets.	—
520.....	8/6/31.	—	Mweya pro- montory.	1" seine, pond-net.	—
521.....	"	—	mouth of Channel.	—	—
522... {	9/6/31.	} — {	rivers along	pond-net.	Invertebrate collections.
523.....	11/6/31.		East shore.		
523.....	8/6/31.	1700-0700.	3 miles W. of Channel mouth.	gill-nets.	depth 8.3 m.
524.....	9/6/31.	1100.	5 miles S. of Channel mouth.	large and small seines.	—
525.....	"	1700-0600	As 518.	long line.	—
527.....	11/6/31.	1000.	¼ mile up Channel.	plankton-nets.	horizontal hauls.
528.....	"	1030.	½ mile } W. of	"	"
529.....	"	1100.	1 mile } Channel	"	"
530.....	"	1130.	2 miles } mouth.	"	"

Lake Edward (continued).

Station.	Date.	Time.	Locality.	Gear.	Notes.
531.....	11/6/31.	1700-0630.	2½ miles N.W. of Channel mouth.	gill-nets.	depth 4 m.
532.....	12/6/31.	1700-0630.	½ mile up Channel.	"	—
534.....	15/6/31.	—	Katwe.	1" seine.	—
535.....	"	1700-0600.	near Katwe.	long line.	—
536.....	"	"	"	gill-nets.	—
537.....	17/6/31.	—	near Kisenyi, E. shore.	grab.	depth 7·1 m., lines of soundings.
538.....	"	1800-0600.	"	gill-nets.	depth 8·5 m.
539.....	18/6/31.	1600-0600.	"	long line.	"
540.....	19/6/31.	0700.	"	seine.	—
541.....	19/6/31.	0900.	"	—	shore shell collection.
542.....	"	1100.	mouth of R. Niamweru.	1" seine, pond-net.	shore collection.
543.....	"	1300.	1 mile S. of 542.	"	"
544.....	"	1700-0600.	near Kanyamwongo.	gill-nets.	depth 8·8 m.
544 A ..	"	1700.	"	grab.	depth 8·8 m., lines of soundings.
545.....	20/6/31.	0900.	"	seine.	—
546.....	"	1100.	"	plankton-nets.	depth 11·8 m., vertical hauls.
547.....	"	1200.	open water behind K. spit.	pond-net.	depth 1·2 m.
548.....	"	1700-0600.	near Kanyamwongo.	gill-nets.	depth 4·6 m.
549.....	21/6/31.	1200.	mouth of R. Ishasha.	seine.	International boundary.
551.....	"	1700-0530.	near Katanda.	gill-nets.	depth 6 m.
552.....	22/6/31.	1200.	open water, 5 miles from W. shore.	plankton-nets, grab, pond-net, water-bottle.	depth 60·2 m., vertical hauls, line of soundings on crossing lake.
554.....	"	1700-0630.	½ mile from W. shore.	gill-nets.	depth 55·4 m., bottom fishing.
555.....	23/6/31.	0900-1800.	close to shore.	2" gill-net.	depth 2 m.
556.....	"	1000.	¾ mile from shore.	plankton-nets.	depth 58·9 m., vertical hauls.
557.....	"	1500.	W. shore.	pond-net &c.	rocky shore collection.

Lake Edward (continued).

Station.	Date.	Time.	Locality.	Gear.	Notes.
558.....	24/6/31.	1700-0530.	Congo shore.	gill-nets.	depth 13 m., bottom fishing.
559.....	25/6/31.	1400.	1½ miles from Congo shore, further N.	water- bottle &c.	depth 117 m.
560.....	26/6/31.	—	2 miles from Congo shore, further N.	„	depth 93.5 m.
561.....	„	1200.	„	gun.	pelican stomachs.
563.....	26/6/31.	1700.	Semliki source.	rod.	18 fish,
564.....	27/6/31.	1700-0630.	near Semliki source.	gill-nets.	depth 3.5 m.
565.....	28/6/31.	1100.	„	1" seine.	—
566.....	„	—	„	—	collection of shore and fossil shells.
567.....	29/6/31.	1200.	Semliki River.	1" seine, pond-net.	shore collection.
568.....	„	1700.	„	gun.	cormorant stomachs.
569.....	„	1800-0630.	near Kasomia.	gill-nets.	depth 7 m.
570.....	30/6/31.	1100.	„	pond-net.	stony shore collection.
570 A ..	2/7/31.	1200-0600.	¾ mile W. of Kazinga Chan- nel mouth.	gill-nets.	—
571.....	3/7/31.	1200.	near middle of lake.	plankton- nets, water- bottle &c.	depth 33.7 m., vertical hauls, lines of soundings.
572.....	5/7/31.	1300.	near Kisenyi, E. shore.	seine.	—
573.....	„	1500.	near Kisenyi.	pond-net.	swamp-collection.
574.....	12/7/31.	1200.	deep open water.	plankton- nets, water- bottle, &c.	depth 90 m. vertical hauls.
575.....	„	1800.	source of Semliki.	—	shore collection.
576.....	13/7/31.	—	Kaianda lagoon.	plankton-nets.	horizontal hauls.

Lake George.

Station.	Date.	Time.	Locality.	Gear.	Notes.
600.....	15/7/31.	1100.	E. end of Ka- zinga Channel.	gill-nets.	depth 3·5 m.
600 A ..	"	"	"	long line.	—
601.....	15/7/31.	—	E. end of Ka- zinga Channel.	seine.	sandy shore.
602.....	16/7/31.	1000.	"	plankton-nets.	horizontal $\frac{1}{4}$ min. hauls at surface.
603.....	"	—	"	pond-net.	rain-pools behind camp.
604.....	19/7/31.	1730-0600.	"	gill-nets.	depth 3·5 m.
605.....	18/7/31.	—	crater-lakes Bagusa and Masecha.	pond-net &c.	—
606.....	21/7/31.	—	E. end Ka- zinga Channel.	pond-net.	stones and rocks.
607.....	"	1700-0600.	"	gill-nets.	depth 3·0 m.
608.....	23/7/31.	1700-0600.	L. George near Channel.	gill-nets.	—
609.....	24/7/31.	—	E. shore of lake.	—	shore-collection.
610.....	"	1800-0600.	$\frac{1}{2}$ mile down Channel.	gill-nets.	—
611.....	"	1830-0630.	E. end of Channel.	long line.	—
612.....	26/7/31.	1800-0600.	Mayura.	gill-nets.	depth 2·5 m., $\frac{1}{3}$ mile out.
613.....	27/7/31.	—	"	seine.	sandy shore.
614.....	"	1800-0630.	"	gill-nets.	depth 2·2 m., $1\frac{1}{4}$ miles out.
615.....	28/7/31.	—	cruising up E. shore.	pond-nets.	floating Nile cabbage.
616.....	"	—	"	rifle.	pelican stomachs.
617.....	"	—	N. shore, in river mouth.	pond-net, plankton-net.	swamp collection.
618.....	29/7/31.	—	N.E. corner of lake.	seine.	mud shore.
619.....	"	1800-0600.	"	gill-nets.	near papyrus swamp.
620.....	29/7/31.	1800-0600.	N.E. corner of lake.	2" net.	tied to papyrus.
622.....	30/7/31.	1100.	near N. shore.	plankton-nets.	brown water near papyrus swamp.
623.....	"	1130.	"	"	green water, depth 2·8 m.
624.....	"	1700-0600.	Iragara Isl.	gill-nets.	—
625.....	"	"	"	long line.	—

Lake George (continued).

Station.	Date.	Time.	Locality.	Gear.	Notes.
626.....	31/7/31.	1100.	Iragara Isl.	pond-net.	rain-pools behind shore.
627.....	"	—	"	—	native fishermen.
628.....	1/8/31.	—	"	pond-net.	muddy shore.
628 A & B	2/8/31.	1800-0600.	E. end of Kazinga Chan.	long line.	—
629.....	"	1215.	Kisenyi.	seine.	sandy shore.
630.....	3/8/31.	0930-1200.	"	gill-nets.	—

Lake Bunyoni.

Station.	Date.	Time.	Locality.	Gear.	Notes.
702.....	12/8/31.	overnight.	all round shores.	—	native fishermen with baskets.
703.....	13/8/31.	"	near Bufundi.	—	"
703 A ..	"	"	Bufundi.	—	"
704.....	12/8/31.	—	"	gill-nets.	close to weeds.
705.....	"	—	"	pond-net.	at landing.
705 A ..	13/8/31.	1130.	"	grab.	depth 39.2 m., dhan-buoy fixed in middle of lake.
707.....	"	—	"	pond-net.	near shore in weeds.
709.....	"	1500.	"	plankton-nets.	depth 37 m., vertical hauls.
711.....	14/8/31.	—	southerly arm of lake.	pond-net.	depth 3.8 m., among weeds.
713.....	"	—	near Bufundi.	gun.	otter stomachs.
714.....	15/8/31.	—	Eastern arm.	gun.	cormorant stomach.
715.....	16/8/31.	—	Bufundi.	pond-net.	in water-lilies.
716.....	"	—	"	"	depth 10 m., in weeds.
720.....	"	—	"	pond-net.	swamp collec- tion.
721.....	18/8/31.	—	Western arm of lake.	"	middle of deep part of lake.
722.....	"	1400.	"	plankton-nets.	depth 29.5 m., oblique hauls.
723.....	19/8/31.	—	Bufundi.	grab.	depth 16.5 m., mud.
723 A ..	"	—	"	pond-net.	along shore.
724.....	"	—	"	"	among lilies.

Lake Bunyoni (continued).

Station.	Date.	Time.	Locality.	Gear.	Notes.
729.....	19/8/31.	1700-0700.	Bufundi.	gill-nets.	among weeds.
730.....	20/8/31.	2200.	"	plankton-nets.	depth 37 m., vertical hauls at buoy.
731.....	22/8/31.	1700-0700.	"	gill-nets.	close to lilies by island opposite camp.

Lake Nakavali.

Station.	Date.	Time.	Locality.	Gear.	Notes.
801.....	28/8/31.	1700-0630.	middle of lake.	gill-nets.	—
802.....	"	1100.	S. end of lake.	seine.	by landing.
803.....	"	1200.	"	pond-net.	"
804.....	"	1800.	"	baskets.	native fishermen.
806.....	29/8/31.	overnight.	"	"	"
807.....	"	"	"	long lines.	"
809.....	31/8/31.	1100-1000.	N. end of lake.	"	—
811.....	"	1000-1700.	S. bay.	2" gill-net.	by water-lilies in bay.
812.....	"	—	"	pond-net.	among weeds.
813.....	1/9/31.	—	S. end of lake.	collecting.	lumps of papyrus on shore.
814.....	"	—	middle of lake.	plankton-nets.	horizontal hauls.
815.....	"	—	"	gun.	darter stomachs.
816.....	"	0600-1700.	S. bay.	2" gill-net.	—

Lake Kachira.

Station.	Date.	Time.	Locality.	Gear.	Notes.
822.....	4/9/31.	—	W. shore.	long line.	native fishermen.
823.....	"	—	"	baskets.	"
824.....	"	—	middle of lake.	plankton-nets.	depth 4-0 m., horizontal hauls.
826.....	"	—	W. shore.	seine.	in 2 muddy clearings.
827.....	"	—	E. shore.	pond-net.	among weeds.

Lake Kijanebalola.

Station.	Date.	Time.	Locality.	Gear.	Notes.
828.....	6/9/31.	—	E. end of lake.	1" seine.	native catches.
829.....	"	—	"	pond-net.	shore-weeds.
831.....	"	—	"	long line.	native fishermen.
832.....	"	—	"	gun.	darter stomachs.
833.....	7/9/31.	1200.	centre of lake.	plankton-nets.	depth 4 m., horizontal hauls.
834.....	6/9/31.	—	E. end of lake.	2" gill-nets.	near weeds.
835.....	7/9/31.	—	"	—	native fishermen.
836.....	"	—	"	pond-net.	shore-collection.

Lake Nabugabo.

Station.	Date.	Time.	Locality.	Gear.	Notes.
837.....	10/9/31.	1700-0830.	middle of lake.	gill-nets.	depth 4·5 m., lines of soundings.
839.....	12/9/31.	0600.	W. shore.	1" seine.	sandy beach.
840.....	"	0700.	"	nets.	native fishermen.
841.....	"	0900-0600.	E. shore.	gill-nets.	depth 2 m., among weeds.
842.....	12/9/31.	1100.	E. shore.	pond-net.	swampy shore.
844.....	13/9/31.	0700.	W. shore.	nets.	native fishermen.
845.....	"	1000.	middle of lake.	plankton-nets.	depth 4·4 m., vertical hauls.
846.....	"	1100.	"	"	horizontal hauls.
847.....	"	1700-0700.	W. shore.	gill-nets.	close to shore.

No. 4. LAKE NAIVASHA

No. 5. LAKE BUNYONI

EXPLANATION OF THE PLATES.

PLATE 1.

Fig. 1. Lake Naivasha (Station 1-43). [Photo E. B. W.]

Fig. 2. Lake Kijanebalola (Stations 828-36). [Photo E. B. W.]

PLATE 2.

Fig. 3. View of Lake Rudolf from the summit of Central Island, with west shore in the background. Crater lake A in foreground (Stations 270-1). [Photo S. W.]

Fig. 4. Sandspit at the foot of Mt. El Moitat, East shore of Lake Rudolf (Station 285). [Photo S. W.]

PLATE 3.

Fig. 5. The western shore of Lake Edward (Stations 557-61). [Photo E. B. W.]

Fig. 6. South end of Lake George (Stations 601-4). [Photo E. B. W.]

PLATE 4.

Map 1. Part of Lake Rudolf. (Expedition survey by S. Worthington.)

Map 2. Lakes Edward and George.

Map 3. The East African Lakes.

PLATE 5.

Map 4. Lake Naivasha. Shore outline and some of depth contours from a survey (Kenya Colony, P.W.D., no. 4920) by Mr. H. C. H. Jones.

Map 5. Lake Bunyoni. Shore outline from Africa, 1 : 250,000, $\frac{\text{North A. } 37}{5}$ 1914.