HYDROGRAPHIC SURVEY OF LAKE NYASA (1955 TO 1959)

by Lt. Cdr. R. T. BAILEY (*), R.N.V.R.

Lake Nyasa lies between Lat. 9 ½° S and 14 ½° S, and is the southernmost of the African Rift Valley lakes. 360 miles long and 40 miles wide, it has some of the characteristics of the sea rather than of a lake. It becomes extremely rough, with steep short seas as much as 15 feet high. In the northern part, the lake is flanked by high mountains.

In 1954 M. V. *Ilala* (620 tons) struck a rock in the approaches to Deep Bay and did herself considerable underwater damage. This expensive casualty focussed the attention of the authorities on the inadequacy of the existing Admiralty charts, and on the need for an up-to-date hydrographic survey. The Federal Government of Rhodesia and Nyasaland approached the Hydrographic Department of the British Admiralty. The then Hydrographer, Vice Admiral Sir A. Day, K.B.E., C.B., D.S.O., was on the point of retiring, and undertook to form a team and to put the task in hand — on a civilian basis. The writer was lucky enough to be invited to join as the second member of the team, the third being Mr. A. Crosby, an ex-leading seaman with hydrographic experience. This small team arrived in Salisbury, Southern Rhodesia, in September 1955, with very little idea of Africa or of the task ahead of them, and with no equipment save two borrowed sextants.

Salisbury was to be our base. Though nearly 600 miles from the lake it had the advantage of offering accommodation, facilities for drawing and printing charts, and the availability of stores and instruments. Africa is a land of vast distances, and 600 miles did not seem excessive, even though it meant traversing the appalling road through Tete on the Zambesi, in Portuguese East Africa. Within 5 weeks of arrival, Sir Alfred Beit's fast motor launch *Bonnie* had been chartered and an echo sounding machine installed, and the team was not only afloat but sounding.

The general plan was to carry out large-scale surveys of a dozen or so ports of call and their approaches, and then to do extensive small-scale coastal surveys of areas of navigational interest, where islands and other features existed. A survey of the whole lake was never contemplated. It would be a task of many years, and as most of the water is deep the cost

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would not be justified by any advantage to navigation. Nevertheless there was always the intention of adding to scientific knowledge by exploring the deeper parts of the lake when on passage. Each local survey started ab initio, and depended on a base measurement, usually along a sandy beach, extended by triangulation, the whole being fixed and orientated by star observations for geographic position and azimuth. Only on the three small-scale surveys at the south end of the lake was there any connection with the primary triangulation. Very little of the lake shore had been mapped at all, but some of it was covered by air photographs.

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Sounding was carried out in the first place by a Kelvin Hughes MS 21 echo sounding recorder with outboard oscillator. While this set was admirable in comparatively shoal water, it was difficult to operate in deep water with an uneven and erratic bottom. Having a scale of 90 feet, and sounding only in feet, it called for acrobatic manipulation to keep track of the soundings, which might shoal from 500 to 100 feet in half a minute. Likewise the interpretation of the echo trace ashore, with very frequent phase changes, was difficult. The normal range of the set is 570 feet, but by a system of double phasing we achieved soundings far beyond this limit, and in fact on one occasion recorded a sounding of 1 200 feet — twice round the clock plus 240 feet.

Our own launch (of which more later) was fitted with a Kelvin Hughes MS 26 set, sounding in feet or fathoms, recording on dry paper, and with more than ample range. But when this excellent machine developed a mysterious defect after a year's trouble-free service, which defeated our combined efforts to repair, it was more than twelve months before the set was in commission again, bearing witness to the lack of local technical facilities, and to the indifferent communications to the civilised world. Though this period was occupied in some useful triangulation and coast-lining, the progress of the work was seriously interrupted, and only one small survey was completed — by reverting to the lead line, with the Officer-in-Charge acting as leadsman.

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The first authentic chart of Lake Nyasa was made at the end of the last century by Lt. Cdr. E. L. Rhoades, R.N.R., then serving in H.M. gunboats which were combatting the slavers on the lake. Before that, various sketch maps had been made by missionaries. Livingstone reached the lake in 1859, and those indomitable travellers, the Portuguese, two centuries earlier, according to less well authenticated records. The current Admiralty charts (the lake is covered by two sheets) are based entirely on Rhoades' surveys. They are sketchy, not to say inaccurate, in parts. But considering the difficulties in those early days, and the fact that he was not a surveyor, they are a remarkable piece of work.

To Rhoades is reputed to go the honour of the first shot fired in World War I, and certainly the first naval victory. On 6th August 1914 he launched an attack on the small German armed mission steamer, on a slipway on the

Tanganyika side, and put her out of commission. His erstwhile drinking companion, the German commander, came off to protest against what he took to be a practical joke in the worst of taste, and was taken prisoner. It was hardly fair — he had not heard that war had been declared.

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Even before we reached the lake, or Africa, the need for a survey launch was realized. Using the hull design of a launch already being built for service on the lake, the lay-out of a survey launch was drawn up, and the building put in hand at the Berwick yard of the Fairmile Construction Co. Ltd. The hull dimensions had been very carefully planned to give clearance under the bridges on its journey by rail from Beira to the lake, and could not exceed 46 feet in length and 11 ft 3 in beam, with the moulded depth whittled down to something less than the normal for such a vessel. The superstructure was shipped separately. Had these limits not been accepted, it would have been a question of shipping the components of a vessel and reassembling at the lake shore. This has been the method adopted for all the larger vessels on the lake, including the first *Ilala*, brought out by Scottish missionaries in 1875, which was assembled at the Zambesi mouth, steamed up the river, dismantled and portaged in head-loads up the Murchison cataracts of the Shire River, and finally reassembled at the lake. It was a great day in March 1957 when the *Edmund Rhoades*, named after our predecessor, reached the railhead at Chipoka and was lowered successfully into the lake by an ancient break-down crane strained to its creaking limit. Every movable piece had to be stripped out of the launch to reduce her weight to less than the safe working load of 20 tons.

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The first survey completed by the team was at Monkey Bay headquarters of the Nyasaland Railways Lake Service at the southern end of the lake. This was an admirable place to start. The area of the bay was very small, and the triangulation of the simplest. There were the facilities of the small dockyard, and an empty house to live in, so that we were not at once thrown into the much more arduous conditions up the lake, where we had later on to make ourselves entirely self-supporting. It enabled the team to shake down, sort out our various duties, and work out a sounding routine, which took the somewhat unorthodox form of the Admiral at the wheel, while the writer and Crosby took angles, plotted and tended the echo respectively. Later we were able to train a coxs'n for our own launch. He handled her well and steered an excellent compass course; but we were never able to teach an African the art of steering a transit. They simply had no eye for it.

A small survey was then made at the shallow and exposed anchorage at Chipoka, the railhead, where all cargo for lake ports is loaded. It was here that the team had the unusual experience of being lent an aged railway engine in which to do a brief reconnaissance of the hinterland.

A more extensive survey of Kota Kota, stronghold of Islam since the

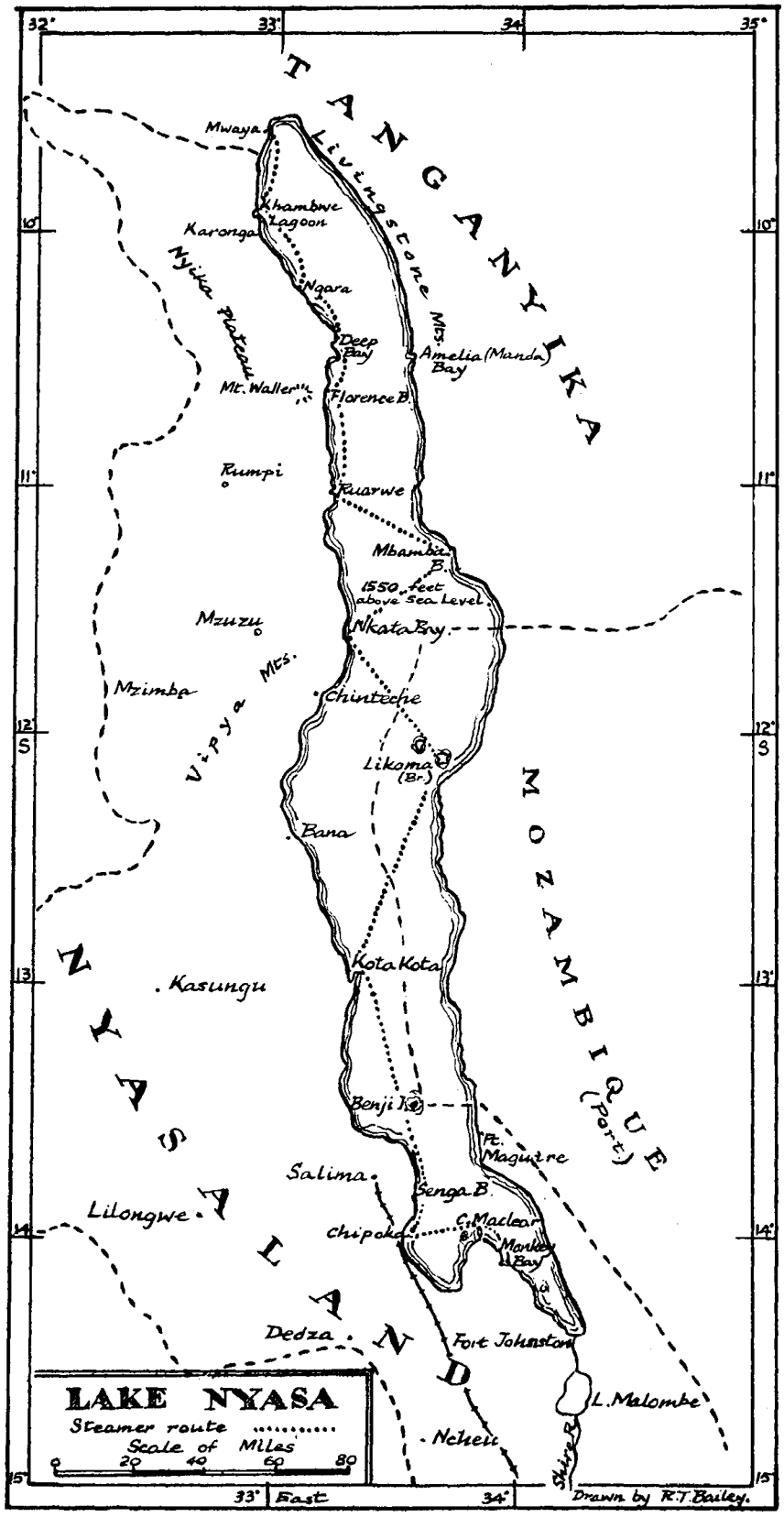
days of Arab infiltration, and with an anchorage sheltered by a four-mile sand spit, was next completed, and when the team made the bone-shattering journey back to Salisbury for Christmas 1955, we felt that we had not only accomplished something, but had also got the measure of the lake and of the task. We had also learnt from our experience of African mechanics that a European engineer was essential for the smooth running of the survey, and the strength of the team was consequently increased to four by the engagement of Mr. Ron Farrer, an ex-Merchant Navy engineer.

By the time the *Edmund Rhoades* arrived the survey had made considerable progress, using such craft as came to hand. *Bonnie* was replaced by the Nyasaland Government launch *Search*. Modified for our purpose, though with a speed of only 6 ½ knots and a small forra'd cabin that leaked like a sieve, she and her African skipper, Duncan Saizi, performed great things for us. In 8 months of survey work her steaming hours far exceeded those of her whole 6 years on the lake. Skipper Duncan Saizi was quite an old man of the lake, and was able to foretell the onset and duration of the fierce southerly wind. He had convivial companions up and down the lake littoral. His equanimity was only once seriously disturbed, when he contrived to get himself entangled with the stern anchor which he was letting go and went over the side with it. It was a day or two before he forgave us our unseemly mirth.

With *Search* we surveyed Nkata Bay, main port for the Northern Province, Deep Bay, Manda and Mbamba Bays on the Tanganyika side, Khambwe Lagoon, and Mwaya at the very top end of the lake. It was at Deep Bay, as already mentioned, that *Ilala* met with near-disaster. Inside a line of rocks, gleaming white with guano, is a channel about half a mile wide which was commonly used by the lake steamers. Its southern end was found to be generally foul. The rock which *Ilala* had struck came up sharply on the echo trace from 90 to 6 feet. We saluted it as the feature which had caused us to come to Lake Nyasa. To locate another submerged rock off Deep Bay we were conned by a fisherman in his dugout canoe, who put us on to it by his own special transits, though three miles from the shore. Hydrographic surveyors often have to have recourse to local knowledge.

Manda Bay lies beneath the towering Livingstone Range. Distances there are expressed in hours — hours of walking. There the Admiral and the writer had the honour of being accommodated in the bishop's palace — thatched dwelling of the bishop when on periodic visits — where daily a chicken would cluck round the breakfast table and lay an egg in a chair as soon as it was vacated. The survey of Manda Bay was quickly justified, as the place was soon included in the lake steamer's schedule.

In July 1956, after six surveys had been completed, Admiral Day left to take up an appointment as Co-ordinator for the International Geophysical Year, and his place was taken by another officer from the Royal Naval Surveying Service — Commander R.T. Tripp, R.N. (Rtd.). Comdr. Tripp was initiated to life on the shores of Lake Nyasa at camps at Mwaya and Khambwe, low-lying and swampy, and viciously infested with mosquitoes, where stars were observed to the accompaniment of the snort and grunt of hippos in the reeds and wallows. Khambwe is a shallow, reedy anchorage, sheltered from the south, in a cotton-growing area. Mwaya, in Tanganyika Territory, is connected by road to Lake Tanganyika and the north, and


32°
33°
34°
35°
10°
11°
12°
13°
14°
15°
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TANGANYIKA
Livingstone Mts.
Mwaya
Khambwe Lagoon
Karonga
Nyika Plateau
Ngara
Deep Bay
Amelia (Manda) Bay
Mt. Waller
Florence B.
Rumpi
Ruarwe
Mbambia B.
1550 feet above Sea Level
Nkata Bay
Mzuzu
Mzimba
Vipya Mts.
Chinteche
Likoma (Br.)
Bana
MOZAMBIQUE (Port.)
Kota Kota
Kasungu
NYASALAND
Benji I.
Pt. Maguire
Salima
Senga B.
Lilongwe
Chipoka
C. Maclear
Monkey Bay
Dedza
Fort Johnston
L. Malombe
Ncheu
Shire R.
LAKE NYASA
Steamer route .....
Scale of Miles
0 20 40 60 80
33° East
34°
Drawn by R.T. Bailey.

Pl. 1

handles transit freight. It could become a place of some importance as the outlet for a nearby coalfield as yet undeveloped, but the very shallow approach makes the construction of port installations of doubtful value.

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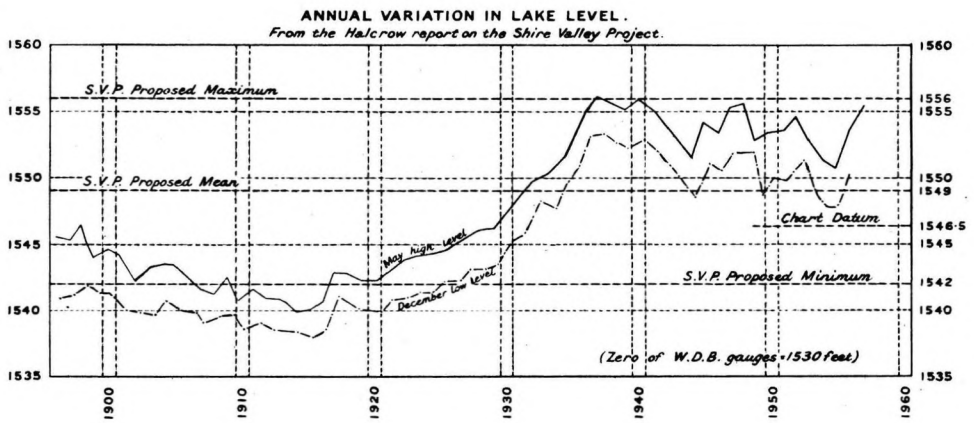
The commissioning of M. L. *Edmund Rhoades* in March 1957 greatly extended the scope of the work. *Bonnie* and *Search* were only suitable for day cruising from the camp ashore. Though the *Rhoades* had only two settee berths, the team of four frequently spent many days and nights on board, two sleeping below, one in the wheelhouse, and one on deck forra'd. With the launch's crew and the cook and a few odd hands there were sleeping bodies everywhere. These jaunts were essentially a fine weather exercise. Rain made life a misery.The year's programme was designed to avoid the worst of the rain — January to March — and the worst of the southerly blows — June to August. During part at least of these months the team repaired to Salisbury to draw fair charts, replenish stores, recover from the rigours of 4 months on the lake, and prepare for the next spell. Meanwhile, the launch was laid up for refit at Monkey Bay. Another feature which had to be taken into account when planning the programme was the poor visibilty to be expected towards the end of the dry season, by reason of the smoke from innumerable bush and grass fires.

It is at the southern end of the lake that such development as there has been has mostly taken place. It is shallower, and is full of fish. Three or four European fishing concerns operate. The five lakeshore hotels are there and a number of lakeside bungalows. Moreover there are Monkey Bay and Chipoka, headquarters port and railhead respectively. An extensive survey of this area was called for, and it was covered by three small-scale surveys — Fort Johnston to Monkey Bay, Monkey Bay to Chipoka including the Marelli Islands, and Senga Bay and Domira Bay including the Mbenji Islands. For these surveys primary trig. stations at Nkopola Hill, Nkunguni Mountain and Senga Mountain formed a valuable basis. The existence of islands, or the proximity, in parts, of the eastern shore, made a broad triangulation scheme possible. Many visits were paid to exciting and remote islands, homes of untold thousands of cormorants, of monitor lizards and of crocodiles — Boadzulu, the Marellis, Mbenji with its girdle of jagged rocks, and various marble-smooth islets rising sheer from the deep water.

For two of these surveys which included only one trig. station, the tellurometer which we had on loan proved invaluable for establishing a base measurement. Likewise, for another considerable coastal survey in the northern part of the lake — Cape Manulo to Ruarwe — where the nature of the country would have rendered a regular triangulation a formidable task, a very satisfactory scheme was made possible by the use of this instrument, consisting of a coastal traverse closed by a long ray between the extreme stations. But even this method was of no avail on another stretch of coast, where the reedy and thorn-encumbered river mouths made obstacles which could neither be observed across nor round.

Southeastward of Ruarwe is the deepest area in the lake. The existing chart shows 386 fathoms. Later reports have given over 400 fathoms. The

greatest sounding revealed by the present survey was 371 fathoms (2 226 feet). Beyond the immediate influence of coastal features of which the effect is continued beneath the surface of the lake, the bottom is remarkably flat and consists almost entirely of mud. So regular is it that on one occasion we noted six miles of the same sounding. The deepest sounding was not in the nature of a sudden rift, but a very gently shelving depression, some four miles from the shore, which there falls away very steeply to a great depth. Not unnaturally, some of the older lakeshore residents have invested the lake under whose influence they have lived for so long with an air of mystery — tales are heard of unfathomable depths and of no bottom at 10 000 feet. It is disappointing to have to explode such picturesque beliefs. Nevertheless, 371 fathoms is no mean depth, and it is more remarkable when it is considered that as the surface of the lake is 1 550 feet above sea level, the bottom there is nearly 700 feet *below* it.



Pl. II. — Diagram showing variation in level of Lake Nyasa. The upper line is the seasonal high level in May, and the lower line the seasonal low level in December. The lowest recorded was 1 538 feet in 1915, when all outflow ceased. The level gradually rose until the highest recorded level was reached — 1 556 feet — in 1937. The lake level depends on rainfall, evaporation and outflow.

In point of fact the level of the lake is far from stable, and this is one of its most noteworthy features. The accompanying diagram shows its pattern since records began in 1897. There is a seasonal rise and fall of about 3 feet, but superimposed on this is a long-period variation which has amounted to as much as 18 feet. In 1915 it was at its lowest recorded (1 538 feet) and all flow down the one outlet — the Shire River — ceased. Reeds and sudd quickly possessed the channel and it was not until 1937, when the impounded waters of the lake reached their highest recorded level of 1 556 feet, that they broke through and scoured the channel. This erratic behaviour is the result of three complex factors, rainfall, evaporation and outflow. Evaporation may cause a loss of some 70 inches annually, whereas contrary to popular belief outflow is unlikely to account for more than 12 inches. It is a delicate hydrological balance which has only recently been investigated by Sir William Halcrow and Partners, consultants for the Shire Valley Project. A part of this vast project, which was chiefly concerned with

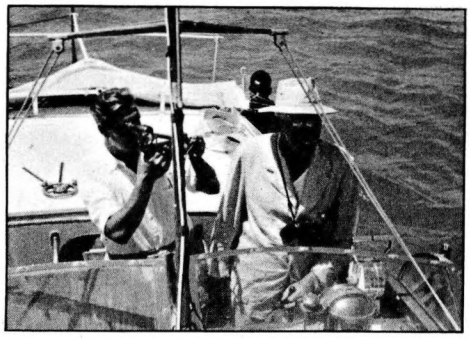


FIG. 1. — Admiral DAY at the wheel of *Bonnie*, with Mr. CROSBY handling sextant.

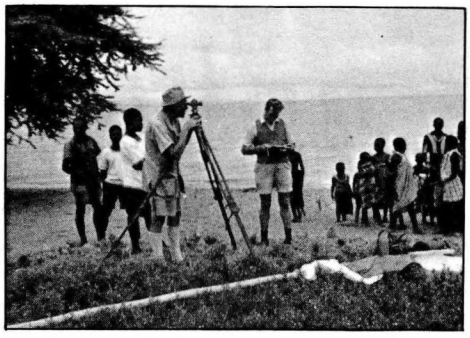


FIG. 2. — Admiral DAY observing, Mr. CROSBY recording, and African survey boys standing by, with the usual crowd of onlookers keeping their distance.

FIG. 3. — When the launch was not available dug-out canoes had to be used for visiting off-lying islands.

FIG. 4. — M. L. *Edmund Rhoades*, 46 feet, powered with two Gardner 6-cylinder diesel engines to give a speed of 10 knots.

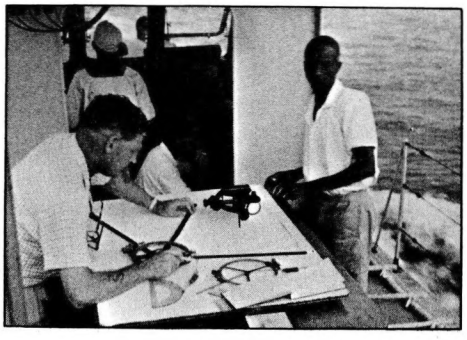


FIG. 5 — Sounding Routine Commander TRIPP plotting a station pointer fix, Mr. CROSBY at the echo sounding recorder, an African clerk writing down, and the coxs'n at the wheel.

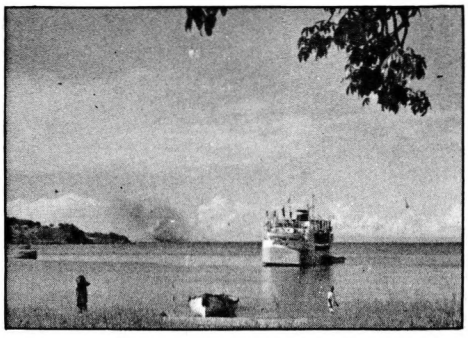


FIG. 6. — The passenger vessel *Ilala* lies off Nkata Bay. The smudge on the horizon is a hatch of lake-fly. On these occasions women hasten to catch them in baskets, and press them into basins as *relish*.

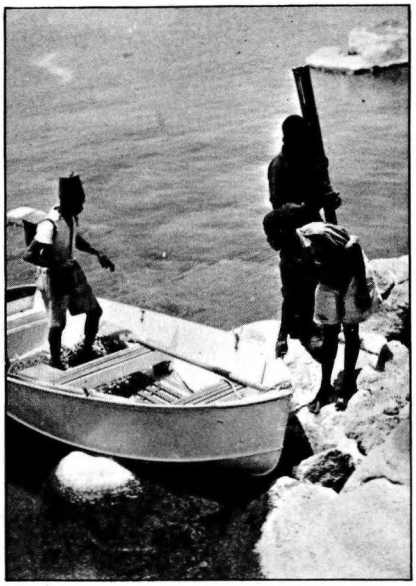


FIG. 7. — Landing on a rocky island from the aluminium dinghy with survey gear.

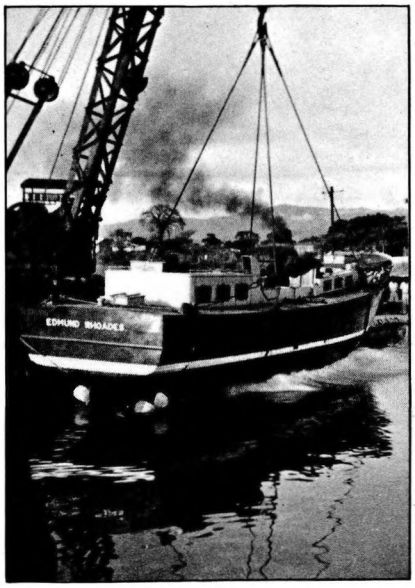


FIG. 8. — The stripped hull of M. L. *Edmund Rhoades* is lowered by crane into the waters of Lake Nyasa at Chipoka, at the end of her journey by sea and rail from England.

FIG. 9. — *End of line.* Lines of soundings were frequently carried right up to the shore Commander TRIPP takes a sextant angle.

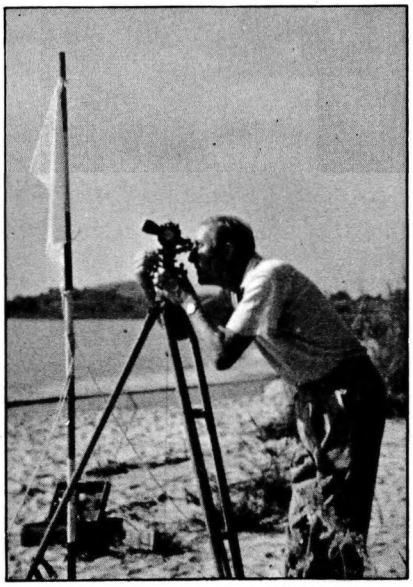


FIG. 10. — The author observing the sun for azimuth at the end of one of the beach base lines.

hydroelectric power, irrigation and flood control, was a degree of stabilization of the lake level. The plan is for the time being in abeyance.

In addition to the long-period and seasonal variations, a rise and fall of about 3 inches, having a period of 6 hours, is sometimes noted. This is in the nature of a seiche, but is more complex than was thought and is not a simple oscillatory movement; readings at the northern and southern ends of the lake are *not* reciprocal — the one is not high when the other is low.

As can be imagined, the long-period variation has been a factor which discourages the construction of permanent harbour works. It might render such a port as Mwaya unworkable for a number of years on end. Jetties built at high lake levels become high and dry at low levels. Others constructed when the lake is low may become submerged. The writer has seen the railway jetty at Chipoka both when there was not enough water alongside for a launch drawing 2 feet of water, and when there were fish swimming about on the top of it.

This vagary of the lake created a problem in selecting a datum for soundings. The lowest recorded level might have been in accordance with the hydrographic principle that datum should be a level below which the lake seldom if ever falls, but it would not have been a realistic basis. The datum selected was 1 546.5 feet above Mean Sea Level, as determined in the Shire Valley Project. This would have been 4.5 feet above the predicted minimum had that project materialized. The predicted high level of the lake was not regarded as High Water Springs, and any feature above datum was shown as a height. This gave rise to an unavoidable anomaly, in that a rock shown as having a height of 6 feet might in fact cover. When using the charts the mariner must bear in mind the actual level of the lake and correct soundings and heights accordingly. Heights of mountains and coastal features had also to be referred to chart datum rather than to M.S.L., as being of more use to the mariner when thus expressed.

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It was originally planned that the hydrographic team should carry out such surveys as were required on the Portuguese shore, but in the event, the Portuguese undertook this work themselves and a party of naval surveyors reached the lake with their launch *Mina* in 1957. Their programme was more ambitious than ours, and included a primary triangulation of 150 miles of difficult country, so it was not surprising that their team was the better equipped. They had naval ratings, both Portuguese and African, over a hundred boys against our half dozen, and their own hunters to supply game for the mess. Their work, needless to say, was of as high a standard as their organization. Their hospitality was embarrassing. The only thing in which we excelled them was our launch, but as she was at the time rather a lame duck with one propeller shaft out of action and a defective echo sounding machine, this advantage was hardly apparent. We jointly carried out the survey of Likoma Island (Nyasaland) and the adjacent Portuguese mainland, there 3 miles distant. At Likoma is the headquarters of the Universities Mission to Central Africa, established in 1880, where there is a remarkable cathedral, exceeding Winchester's in

length. The Portuguese too met with a serious setback. When we left Likoma a black cloud of smoke was rising from their camp, and later we learnt that all their stores and much valuable equipment had been destroyed by fire caused by an African carelessly pouring petrol.

FIG. 11. — Mbamba Bay, on the Tanganyika shore
It was here that the author, coastlining in the small dinghy, went to fix a rock awash which disappeared in a flurry of water as he approached.

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Nyasaland is a small country with a very large African population, and labour was never a problem. Boys for a day or for a month were usually to be picked up. Some became intelligent recorders. Our nucleus was seldom more than the launch's crew of three and the camp cook and houseboy. Over and above that we signed boys on and off as required. The initial period of a survey, entailing the erection of marks, triangulation,

and perhaps bush-clearing, required more boys. That done, we took to the lake for sounding and required none.

We were forever at pains to point out to the villagers that the erection of flags on their hilltops, along their beaches and in their fields, did not mean that the Government was going to deprive them of their land. That was a suspicion frequently met with. Only once did we meet with any obstruction, in an area south of Nkata Bay, where a tedious indava with chiefs and sub-chiefs was necessary before we could erect our marks. It was there that cemented survey stations were destroyed almost as soon as made, and flags pulled down. This was shortly before the unhappy disturbances early in 1959, and may have been the result of false propaganda and roused sentiments.

What delayed the progress of the survey more than any other factor (except the failure of the echo sounding machine) was the weather. For much of the year it blows hard on the lake at least half the day. As an instance, during the survey of Cape Manulo to Ruarwe, there arose regularly a northeast wind at 6 a.m., preceded by a swell. It blew furiously until midday, and the swell continued long after that. It was usually too rough to land at all in the forenoon. Most of the work, especially sounding, was confined to the afternoon. In 40 miles of coast there was literally but one place offering shelter — under the lee of a tiny island (inhabited by a lone baboon) with a shelf just large enough to drop an anchor on. There we spent most nights and forenoons, while the wind whistled over the top and round the sides. At another season of the year the « mwera » — a southeasterly wind blowing up the length of the lake — whips the surface into a fury of white horses, raising waves 10 feet high and over. This wind may last a week. An untold number of hours and days were lost to the weather, and we had some extremely rough passages. Good sheltered anchorages are few and far between. Senga Bay is a particularly exposed one and the *Edmund Rhoades* very nearly came to grief on the beach, which has seen the end of at least four good craft, when her cable parted during a night blow.

The published charts, which are at the present time not completed, were drawn in Salisbury by Mr. J. M. Goodhall, who had spent many years as a cartographer in the Admiralty Chart Branch, and the standard of the drawn charts is excellent. The various surveys will be incorporated in ten charts, printed at the Government printing establishment and available at the Department of Federal Surveys. The drawing of three small-scale charts covering the whole lake and incorporating all the latest information had to be discontinued for the time being owing to discrepancies in the existing maps, such as they are.

Our camp was a comfortable one. We each had a $12' \times 10'$ tent, and a $25' \times 15'$ marquee tent served as mess and drawing office. In many places there was some house or building we could use instead of this. We did not forego more comforts than necessary. We carried a 7-cu-ft refrigerator around with us, an electric light plant (necessary for charging batteries) and even a kitchen stove. Moves were to be dreaded but somehow all our miscellaneous possessions were loaded on board the *Ilala* and off-loaded at our next camp site. We have seen the fridge being carried ashore by women up to their waists in water, and the camp table floating off with its three

legs in the air ; likewise the tin bath — never by any chance used *as* a bath — with our four Tilley lamps in it.

It was never so used because the lake was our bath, and in it we used to plunge nightly with our cakes of soap. It was also our drink, and no boiling necessary. And if a lake is one's bath and one's drink, and livelihood into the bargain, one must get very attached to it. We did.