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## 8.1 LAKE CHILWA

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Lake Chilwa (Fig. 8.3) is a large shallow endorheic lake situated in a depression in S.E. Malawi. The lake has an important fishery, providing one third of the country's fish protein, and it is classified as an All lake in 'Project Aqua' (Luther & Rzoska 1971). It is bordered by wide areas of Typha swamp, sedge marshes and grass covered floodplain. The water level of the lake fluctuates considerably from wet to dry season, and from year to year, and occasionally (twice this century) it completely dries out. The last major recession was in 1968. The open water of the lake is very turbid and saline, supporting only a few specialised plant and animal species. In the swamps and marshes the water is less turbid, and environmental changes are less extreme, so that the biota is more diverse there. The fact that the lake dries out from time to time means that only well adapted organisms are able to survive. During such times interesting successions are seen, and organisms (e.g. Aeschynomene spp.) appear for limited periods and do not re-appear until the next major recession.

A full account of Lake Chilwa, including check-lists of the plants and animals found in the area, is given in: Kalk et al. (1979).

### 1. Geology

Most of the Chilwa basin is underlain by ancient metamorphic and igneous rocks of the Malawi Basin Complex, which are represented by a group of high grade metamorphic rocks, mostly charnokitic granulites of quartz and feldspar, and biotite gneisses. A series of Precambrian granitic and parthitic rocks are intruded into these gneisses and granites, which frequently form prominent hills. The Chilwa basin lacks the easily eroded Recent volcanic materials, ashes and tuffs, frequently found in other East African lake basins, and thus sedimentation rates are probably lower. A low carbonate level in the lake reflects the absence of extensive alkaline extrusive rocks. It is thought that Lake Chilwa underwent a change from an exorheic to an endorheic system only about 8-10 000 years ago.

The soil of the lake bed varies from extremely sandy in the north, to heavy water-sodden clays in the south. A thick layer of fine silt overlies the whole area of the lake.

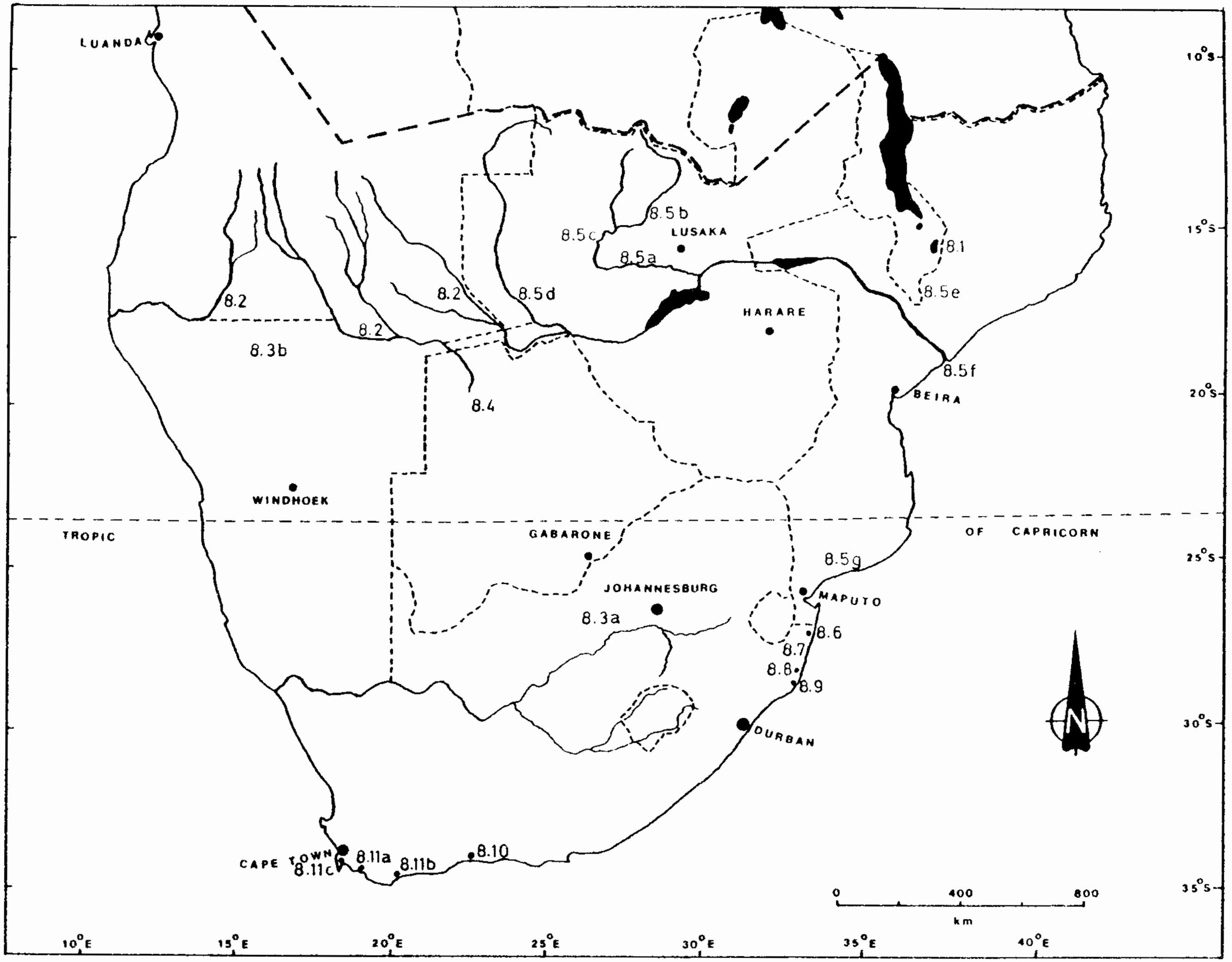



Fig. 8.1 Regional map showing the location of the systems treated in this chapter.

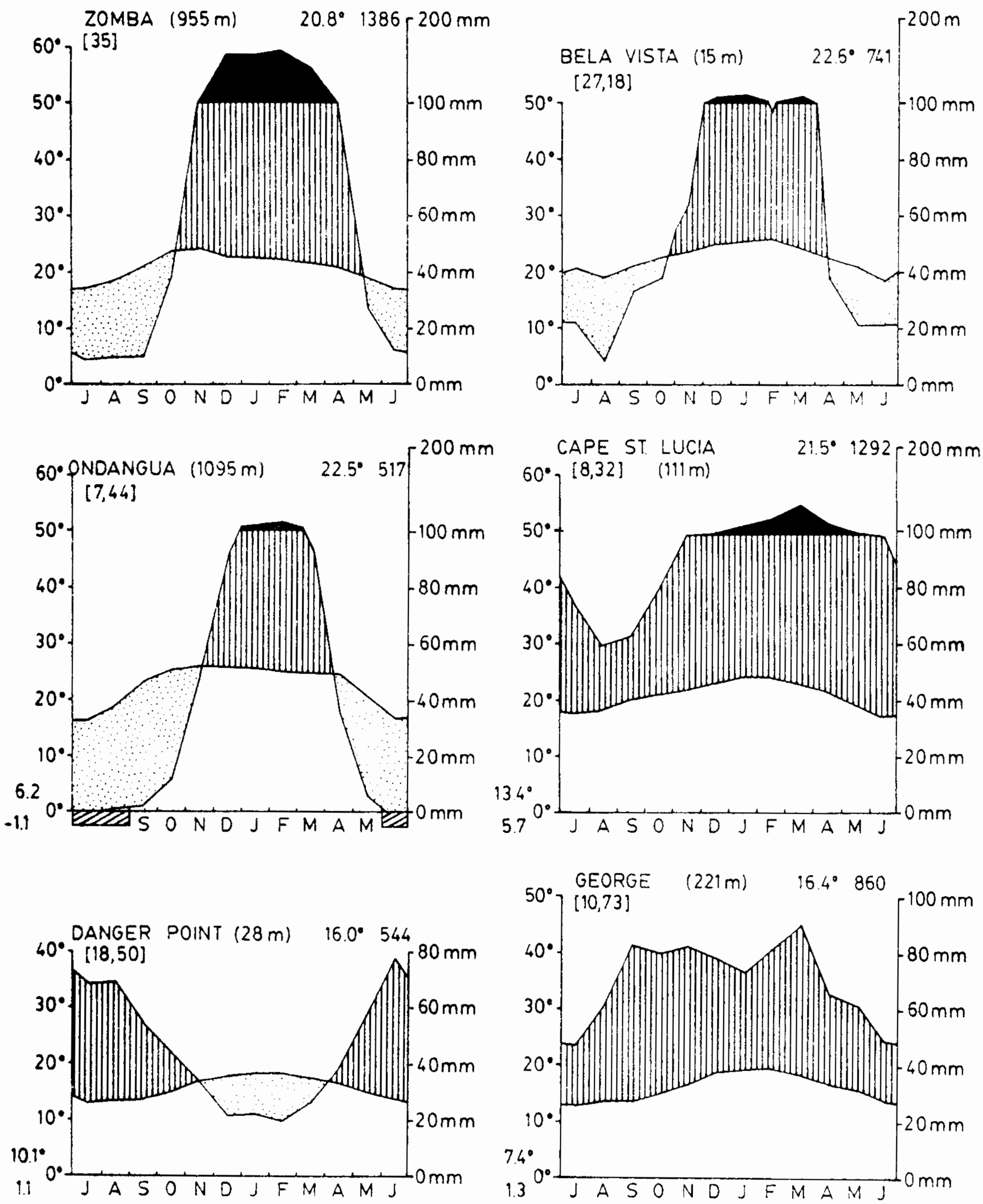



**Fig. 8.2** Climatic diagrams for various stations in the regions of Southern Africa that are treated in this chapter.

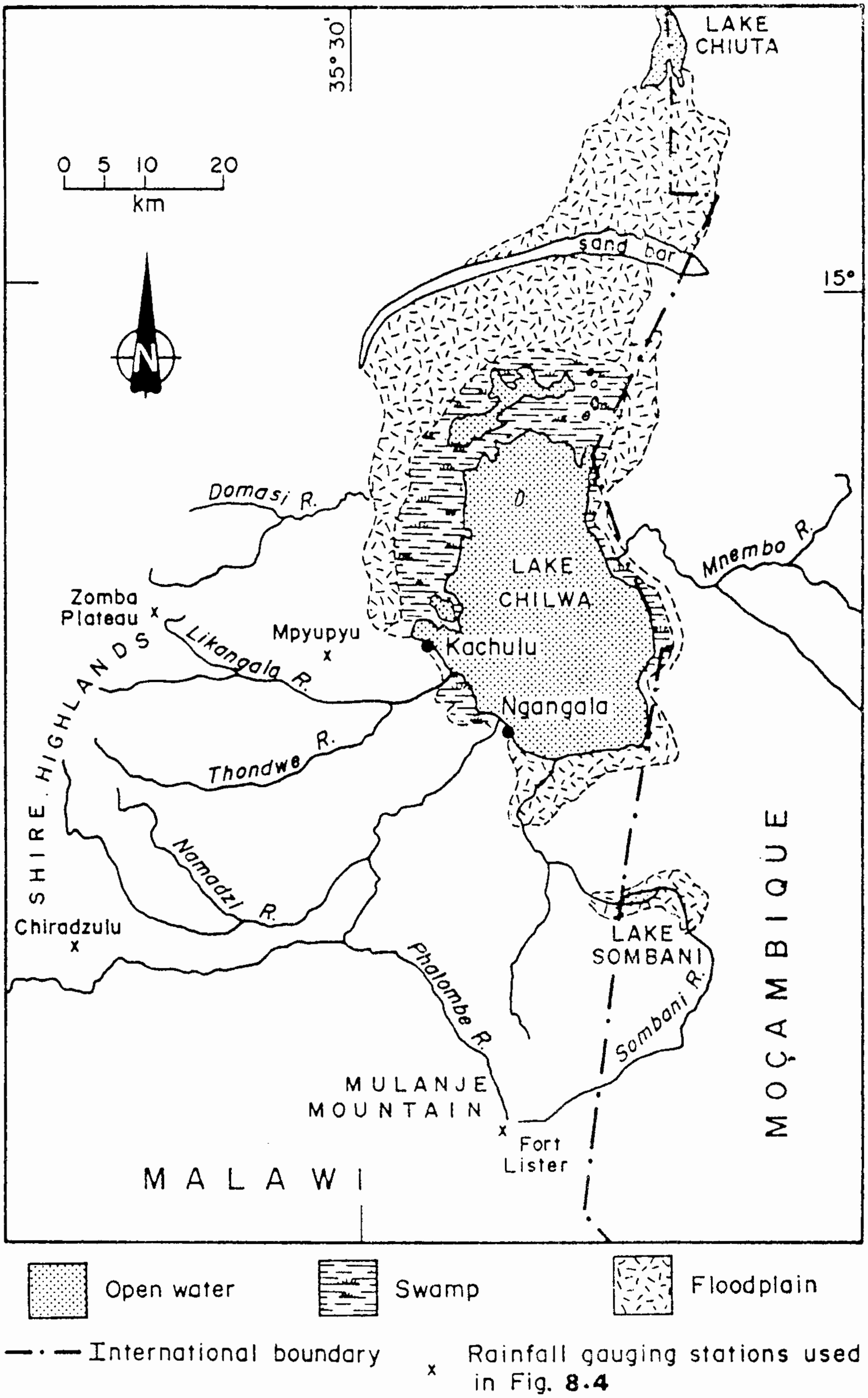



Fig. 8.3 Map of Lake Chilwa, showing important physical features.

## 2. Geography and morphology (Figure 8.3)

The Chilwa basin is approximately rectangular covering an area of about 7500 $km^2$, being 100 km across at its widest point and 160 km long in a N-S direction. It is bounded on the west by the Shire (Chir) Highlands which rise to 1200 m asl, to the south by a flattish marshy area interrupted by the Mulanje Massif (2000 to 2998 m asl), and to the east by a lower range of hills (900 m asl) in Mozambique. A sandbar only 25 m higher than the floodplain separates Lake Chilwa from Lake Chiuta in the north. Although Lake Chilwa is much smaller now than it has been in the past, five distinct lake terraces indicate that there have been long periods of stability. Seventy percent of the total inflow of water comes from five perennial streams, the Domasi, Likangala, Thondwe, Namadzi and Phalombe Rivers, which arise either in the Shire Highlands or the Zomba Mountains further north.

The present Lake Chilwa is roughly oval in shape, about 40 km from N to S and 30 km from W to E. There are several islands on the lake, two of which are inhabited. Nchisi Island, located near Kachulu on the western shore, is 4 km across and rises to 430 m above the level of the lake. The bed of the lake is covered by layers of fine clay which are easily stirred up by wave action, which occurs when strong winds blow across the lake.

Location: 15°30'S; 35°30'E.

Altitude: 622 m.a.sl. (mean for the 26 years 1950-1976)

Area: varies according to the level of the lake. In 1972, a fairly 'average' year, of a total area of 1850 $km^2$, open water occupied 678 $km^2$, swamps and marshes 578 $km^2$ and seasonally inundated grasslands 580 $km^2$.

Depth: In 1972 the deepest part of the lake was 2.6 m in the SW corner. The level of the lake fluctuates annually by 0.8-1.0 m, but larger fluctuations of 2-3 m occur over periods of 6 to 12 years, but occasionally the water dries out completely.

## 3. Climate

There is a strong seasonal pattern: May to September is cool with a little rain over high ground, September to November is hot and dry, and November to May hot and wet. The climatic diagram for Zomba is included in Fig. 8.2.

Type code: $Aw_4a$ (Köppen)

Insolation:
highest months: September, October 9-10 h. $day^{-1}$
lowest months: January, February 5.5-7 h. $day^{-1}$
(taken from records for Mangochi at the southern end of Lake Malawi, and Makoka at the edge of the Shire Highlands for 1968-1976)

<u>Solar Radiation</u>:

| | | |
|---|---|---|
| highest months: | Oct. Nov. (daily mean) | 2.55 kJ. $cm^{-2}$ $day^{-1}$ |
| lowest month: | May (daily mean) | 2.1 kJ. $cm^{-2}$ $day^{-1}$ |

(taken from Khanda, 10 km west of Kachulu on the lakeside from 1967-1971.)

<u>Air Temperature</u>:

| | | |
|---|---|---|
| annual mean | 24°C | |
| hottest months: Oct. to Dec. (monthly means) | | 32-34°C |
| coolest months: May to August (monthly means) | | 24-25°C |

<u>Wind:</u> Predominantly from the east, blowing from N and NE from September to November, and from S and SE from March to September.

<u>Rainfall</u>: (unreliable, great annual variation)

| | |
|---|---|
| annual mean (southern area) | 800-900 $mm.y^{-1}$ |
| month of highest recorded (January) | 325 mm. |
| months of lowest recoded (July, August) | 0 mm. |

In the catchment area rainfall varies from 2000 $mm.y^{-1}$ in the Mulanje and Zomba Mountains to 1100-1600 $mm.y^{-1}$ in the Shire Highlands.

<u>Evaporation</u>: (Class A Pan)

annual mean (1961-71) 1 763 $mm.y^{-1}$ (at Kachulu)

Howard-Williams (pers. comm.) considers that evaporation from Lake Chilwa is 0.88 times pan evaporation, giving a value of 1551 $mm.y^{-1}$ for 1961-71. Assuming that the rate of evaporation from the swamp is 60% that of open water, it has also been estimated that for the same period, the rate of evaporation from the swamp was 931 $mm.y^{-1}$. At Lake Chilwa evaporation is at its highest in October and November when solar radiation and temperatures are high, humidity is low, and winds are moderate.

## 4. Hydrography and hydrology

Lake Chilwa is endorheic, with water flowing in from the Shire Highlands and the Zomba Mountains to the west and northwest, and from hills in Mozambique to the east. The level of the lake normally shows seasonal fluctuations of about 1 m, with the lowest levels occuring in November and December, and the highest, at the end of the rainy season in March and April. Superimposed on this annual cycle is a much larger, long-term fluctation of 2-3 m, which occasionally results in the lake drying completely. When inflow from the rivers exceeds evaporation from the lake and swamp, lake level rises, and <u>vice versa</u>. Lancaster (1979) has shown that variation in lake level is caused mainly by variation of rainfall in the catchment. Figure 8.4 shows the mean rainfall from four stations in the catchment compared with the lake level over the same period of time.

**Mean discharge for main influent rivers (1961-71): ($m^3.sec^{-1}$)**

| River | February | October | annual mean |
|---|---|---|---|
| Sombani | 7.31 | 0.09 | 2.23 |
| Phalombe | 2.90 | 0.08 | 1.03 |
| Namadzi | 0.54 | 0.07 | 0.24 |
| Thondwe | 4.60 | 0.14 | 2.56 |
| Likangala | 6.16 | 0.16 | 2.42 |
| Domasi | 5.71 | 0.20 | 2.10 |

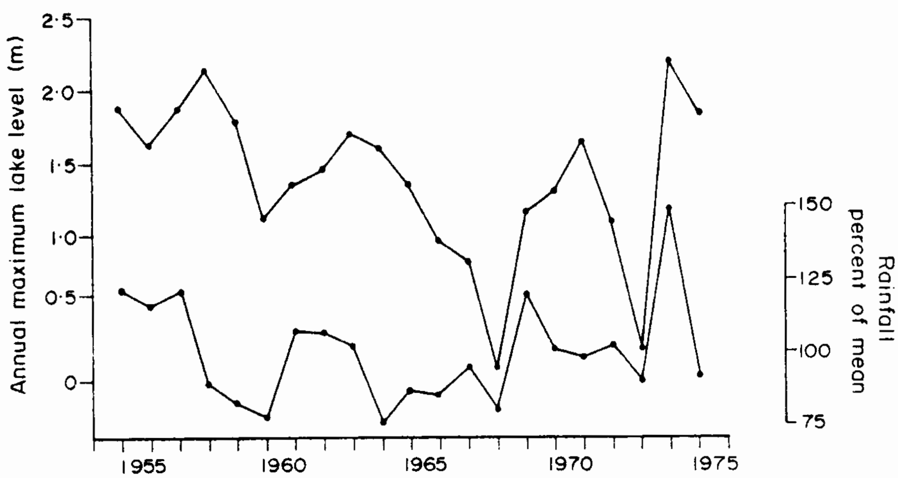



**Fig. 8.4 Relationship between annual maximum lake level at Ngangata Harbour (upper line) and deviation from mean rainfall (lower line) at Fort Lister, Chiradzulu, Zomba Plateau and Mpyupyu (1951-75).**

**Mean of annual discharge into Lake Chilwa gauged rivers (1961-71):**

| | mean rate ($m^3.sec^{-1}$) | mean total annual influx $10^6$ $m^3$ |
|---|---|---|
| **1961-62** | 11.67 | 368.0 |
| **1962-63** | 18.26 | 575.8 |
| **1963-64** | 9.43 | 297.4 |
| **1964-65** | 7.68 | 242.2 |
| **1965-66** | 5.90 | 186.1 |
| **1966-67** | 5.44 | 171.6 |
| **1967-68** | 3.30 | 104.1 |
| **1968-69** | 17.94 | 565.8 |
| **1969-70** | 12.30 | 387.9 |
| **1970-71** | 16.01 | 504.9 |
| **Mean** | 10.79 | 340.4 |

Although figures are not available for river flow from Mozambique, Lancaster (1979) has estimated a generalised water balance for the period 1961-1971 as:

| inflow | + rainfall on lake | = | evaporation from lake and swamp |
|---|---|---|---|
| 410 mm | 893 mm | | 1303 mm |

The assumptions made by Lancaster in arriving at these figures are given in his paper in (Kalk et al 1979).

## 5. Physico-chemical characteristics of the water

The lake and swamp is a complex habitat showing horizontal, vertical and seasonal variations.

Horizontal variations in the waters of lake and swamp:

| | pH | conductivity $10^{-6}$ $S.cm^{-1}$ | transparency % | $PO_4$-P $10^{-6}g.1^{-1}$ | $NO_3$-N $1^{-6}g.1^{-1}$ | oxygen $mg.1^{-1}$ |
|---|---|---|---|---|---|---|
| open water | 8.6 | 1200 | 56 | 990 | 120 | 5.5 |
| mid-swamp | 8.7 | 1250 | 58 | 924 | 52 | 1.14 |
| land's edge of swamp | 7.6 | 1000 | 90 | 33 | 50 | 0 |

Vertical variations in various swamp parameters:

| | |
|---|---|
| temperature: | there is about a 3°C drop in temperature from the top of the vegetation to the water surface. |
| light: | at water level the light intensity is about 50-10% of that above the vegetation. |
| air flow: | at water level the air flow is about 18% of that above the vegetation. |

Surface water characteristics in the open water of Lake Chilwa in a 'normal' year (1970): (- = not determined)

| | February | July | December |
|---|---|---|---|
| depth (m) | 2.05 | 1.55 | 1.0 |
| conductivity ($10^{-6}S.cm^{-1}$) | 800 | 1500 | 2500 |
| pH | 8.2 | 8.6 | 8.8 |
| total alkalinity ($meq.1^{-1}$) | 7.15 | 8.7 | 19.0 |
| oxygen ($mg.1^{-1}$) | 5.6 | 10.0 | 6.7 |
| transparency (Secchi) (cm) | 7.5 | 8.5 | 11.0 |
| $Na^+$ ($mg.1^{-1}$) | 189 | 350 | 780 |
| $K^+$ ($mg.1^{-1}$) | 14.0 | 10.5 | 23.1 |
| $Ca^{2+}$ ($mg.1^{-1}$) | 10.8 | 13.4 | 13.2 |
| $Mg^{2+}$ ($mg.1^{-1}$) | 6.4 | 6.3 | 8.6 |
| $Cl^-$ ($mg.1^{-1}$) | 182 | 277 | 515 |
| $PO_4$-P ($10^{-6}g.1^{-1}$) | 1240 | 1214 | 2000 |
| $NO_3$-N ($10^{-6}g.1^{-1}$) | - | - | 59 |

The conductivity of the lake water tends to remain fairly constant throughout the year, whereas in the swamp it tends to show an inverse relationship with the level of the water. However from December to February, the fall in conductivity is even greater than might be expected, and Howard-Williams (1979) suggests that fresh water from the rivers pushes all the water from the swamps into the lake, thereby causing a considerable water exchange.

As the swamp and floodplain dries, cattle move in and graze the vegetation. When flooding occurs again, many nutrients including nitrogen are released from the dry vegetation and animal dung.

## 6. Macrophytes

Lake: The very turbid waters of the lake keep it free from submerged vegetation. Occasional patches of the sedge Scirpus litoralis and the grass Paspalidium geminatum are found in the open water, and appear to be the only two species able to live in the deep water and to tolerate heavy wind and wave action.

When the lake last dried out, in 1966-68, only three species survived on the hot mud, the grass Diplachne fusca, the sedge Cyperus laevigatus, and the legume Aeschynomene pfundii. The mature plant of the latter species grows in water and can tolerate a wide range of salinities, but the seeds require a dry period for germination and the seedlings cannot grow under water. As a consequence this species had disappeared by 1973, when the lake had been full for several years.

Following the dry spell, small isolated areas supported a richer flora including: Diplachne fusca, Paspalidium geminatum, Vossia cupidata, Echinochloa pyramidalis, Aeschynomene pfundii, Aeschynomene nilotica, the floating stemmed plants Nymphaea spp., Ipomoea aquatica and Ludwigia stolonifera, and the submerged macrophytes Ottelia spp. and Nitella spp. (Howard-Williams 1979).

Swamp: Most of the swamps are dominated by pure stands of Typha domingensis. At the interface between lake and swamp a few free floating species are found, e.g. Pistia stratiotes, Ceratophyllum demersum, Utricularia spp. and various members of the Lemnaceae. In the wet season several species, e.g. Cyperus esculentus and Hibiscus cannabinus grow, flower and die within a few months. These are replaced by Panicum repens, Nymphaea caerulea and Utricularia spp. which then decline rapidly as water levels fall. Howard-Williams (1979) estimates the total littoral swamp production of Typha at $0.9 \times 10^6$ $t.y^{-1}$ dry weight.

Swamp transition zone: This is a fairly broad area found to the north of the lake shore where the alkaline soils dry out during the dry season, but periodically get wetted by a rise in water level caused by southeasterly winds blowing over the lake (wind tides). The area is characterised by Cyperus laevigatus, Scirpus maritimus and the grasses Diplachne fusca and Panicum repens. Scattered clumps of Typha domingensis may also be seen.

Alkaline marsh: is found to the south of the lake where the heavy clay soils have a pH greater than 7.5. Here mixed swards of Vossia cuspidata and Cyperus longus occur, interspersed with Aeschynomene pfundii.

Neutral to acid marsh: is found on the west side of the lake where the only stands of Cyperus papyrus are found, opposite the mouths of the Likangala and Domasi Rivers. Here the soils have a pH of

5.0-7.0. The papyrus associations are surrounded by a zone of tall swamp grasses including Phragmites mauritianus, Echinochloa pyramidalis and Vossia cuspidata. Cyperus procerus and the floating grass Leersia hexandra are found in the area between the two rivers.

Floodplain grassland: surrounds almost the entire lake, the widest area being in the north. The plain is flooded for about 3 months per year. Dominant species include Hyparrhenia rufa, Cynodon dactylon, Sporobilus pyramidalis and Eragrostis gangetica (Howard-Williams 1979).

## 7. Algae

Lake: Before the lake dried out, during 1966-67, the lake water was dominated by a dense growth of the blue-green algae, Oscillatoria planctonica and Anabaena torulosa with only a few green algae present. During the dry phase the lake became very alkaline and saline, and was inhabited by large numbers of the species Arthrospira sp., Spirulina sp., and Anabaenopsis sp. When the water retreated, leaving hot saline mud, Oscillatoria spp., Nitzschia palea and Anomoeoneis sphaerophora appeared in patches. As the lake subsequently filled late in 1968 and in 1969, it became very turbid with suspended inorganic matter, and phytoplankton was scarce except for a neuston scum which formed a film on the surface. The presence of Euglena sanguina in this scum made it appear red in the late morning and mid-afternoon, but green later in the day. Other species in the scum included Tracheolomonas sp., Chlamydomonas sp., Eudorina sp., Platydorina sp. and Pandorina sp. During and after the the rains of 1969 a surface film of green algae was present, consisting mainly of members of the Chlorophyceae. By 1971-72 Anabaena sp. and Anabaenopsis sp. were again important. By 1977 there was a much richer flora including Oscillatoria sp., Tracheolomonas spp., Euglena spp., Phacus sp., Cyclotella sp., Nitzchia sp., Anabaena sp., Scenedesmus quadricauda and Peridinium sp. (Moss 1979).

Swamp: It appears that little systematic work has been done on the algae of the swamp, but Moss (1979) mentions that scrapings from Typha domingensis showed the periphyton community to be largely a mass of blue-green algae (Phormidium, Oscillatoria and Anabaena) with Chlorophyta (Spirogyra and Stigeoclonium) and diatoms (Cymbella, Nitzchia palea, Synedra and Eunotia) present.

## 8. Invertebrates

Zooplankton: Only 10 species of zooplankton are broadly tolerant of conditions found in the lake, and of these only three are numerous. Very small species are absent, and rotifers are not numerous in numbers nor in species. The three most robust species are the calanoid copepod Tropodiaptomus kraepelini and the cladocerans Diaphanosoma excisum and Daphnia barbata. Other Crustacea include Moina micrura, Ceriodaphnia cornuta, Alona sp. and the cyclopoid copepod Mesocyclops leuckarti (probably mis-identified. See Isabella Van de Velde, Revision of the African species of the genus Mesocyclops Sars, 1914 (Copepoda: Cyclopoidae). Hydrobiologia, 1984. 109 3-66. She maintains that Mesocyclops leuckarti does not occur anywhere in Africa). Three rotifers Keratella tropica, Brachionus calyciflorus and Filinia (Tetramastix) opoliensis complete the list of dominant species. The paucity of species is attributed to the high turbidity, variable salinity and alkalinity, and the occasional drying of the lake. Most of these organisms do not exhibit regular diapause, but two years before the lake dried they started producing thick-walled eggs and cysts. When the lake started to fill again only a few specimens of Mesocyclops, Brachionus and Ceriodaphnia were found in very shallow water. During that year rotifers became more abundant than crustaceans, but thereafter there was a greater proportion of crustaceans (Kalk 1979).

Other Invertabrates: Lake Chilwa and its swamps provide two major substrates for invertebrates, the mud and the surfaces of the aquatic plants. Generally the mud is far too liquid to support any animals, so that the vegetation, both living and decaying, supplies the major habitat. Thus little benthic life is found under the open waters of the lake since the mud is soft and there are few aquatic macrophytes in the turbid waters.

During the last recession the partially dried mud supplied an important habitat for breeding chironomids, but when the mud completely dried all benthic fauna was obliterated and was replenished from the swamps when filling occurred.

When the lake was full, organisms found in the shallow waters at the edge included the dipterans Chironomus formosipennis, Nilodorum brevipalpis, Nilodorum brevibucca, and members of the Ceratopogonidae and Tipulidae, the trichopterans Dipseudopsis sp. and Economus sp., and the molluscs Lanistes ovum, Bulinus (=Physopsis) globosus and Biomphalaria sp. Of these, only Nilodorum brevibucca and Micronecta scutellaris survived drying.

However other species were found when the lake was dry; the chironomids Cryptochironomus neonilicola, Cryptochironomus stylifer, Dicrotendipes fusconatus, Clinotanypus claripennis and the coleopteran Berosus vitticollis (McLachlan 1979). Most of the invertebrates found in the swamps and marshes are associated with aquatic macrophytes. However, although Typha stands occupy the majority of the area there is a somewhat poor invertebrate standing crop. This is attributed to the shading of the water surface which prevents growth of epiphyton communities on the Typha stems. Small populations of midges are found, and occasional snails and leeches. Far more genera and species are found in the marshes. These include water beetles (e.g. Synchortus sp. and Hydrovatus sp.) and a few members of the amphibious snail Lanistes ovum. Leeches and the snail Bulinus globosus are also common.

The channels and lagoons of the swamp provide a more open habitat and molluscs, midges and beetles are readily found. Bulinus globosus is particularly common at the ends of canoe channels and around beached canoes.

Approximate dry weight of benthic fauna during the recovery phase of the lake (data from McLachlan 1974, 1975):

| | Fauna (mean value) $mg.m^{-2}$ | Area of habitat $km^2$ | Fauna for whole lake kg |
|---|---|---|---|
| permanent swamp | 300 | 600 | 180 000 |
| temporary swamp | 4000 | 80 | 320 000 |
| mud of lake bed | 3000 | 100 | 300 000 |
| total | | 780 | 569 400 |

Insects of Economic Importance: The floodplains are used fairly extensively for the cultivation of rice which is subject to predation from stalk-eyed flies, lepidopterous stem borers and leaf eaters, and various beetles. The most important is the stalk-eyed dipteran Diopsis macrophthalma, whose larvae feed within the stem of the rice and cause yellowing of the terminal leaf, a condition known as 'dead heart'. Up to 10% of seedlings may be killed by these insects (Feijen 1979).

The floodplain grasslands provide one of the eight African 'outbreak areas' for swarming of the red locust Nomadacris septemfasciata. However it has not occurred recently and it is now considered a low grade outbreak area. The last plague originating here occurred from 1930-45 (Brown 1979).

The grasslands of the floodplain are heavily grazed by domestic cattle where dung beetles (Scarabaeidae) are important for burying dung and helping to recycle organic nutrients. The most successful and agressive species include Onthophagus depressus, Onthophagus gazella, Euoniticellus intermedius, Liatongus militaris and Sisyphus sp. (Dudley 1979).

## 9. Fish

The open water community is dominated by three species of fish; Barbus paludinosus, known locally as minnow or 'maremba', Clarias gariepinus (= C. mossambicus) called catfish or 'mlamba' and Sarotherodon shiranus, a mouth brooding cichlid known as 'makumba'. These three have an omnivorous diet which includes filamentous and non-filamentous green algae, blue-green algae, diatoms, detritus from higher plants, zooplankton (crustaceans and rotifers), gastropods, aquatic and terrestrial insects, fish eggs and fish. The food taken varies according to the size of the predator and the availability of the food. During recessions of the lake these fish migrate into the swamps where they take refuge in lagoons and streams. In addition Clarias is anatomically and physiologically adapted to withstand desiccation and to tolerate high conductivity of the water in which it lives. It is also able to move over the surface of the mud supporting itself on its spiny fins. These three species are most important in terms of protein for the people of the Lake Chilwa area, and estimates are available for catches over a number of years, including times of drought and high water. A selection of these are given below.

**Total fish landings from Lake Chilwa and swamps and percentage relative proportion of Sarotherodon shiranus, Barbus paludinosus and Clarias gariepinus:**

| year | mean depth (m) | total mass t. | Sarotherodon % of total | Barbus % of total | Clarias % of total |
|---|---|---|---|---|---|
| 1965 | 1.08 | 8 820 | 48 | 26 | 26 |
| 1968 | 0 | 97 | 4 | 7 | 89 |
| 1970 | 1.05 | 4 166 | 8 | 35 | 57 |
| 1973 | 0.02 | 1 903 | ? | ? | ? |
| 1976 | 2.00 | 19 746 | 14 | 52 | 34 |

The figures for 1976 not only reflect increased productivity after the recession of water during the years 1966-68, and the minor recession of 1973, but also improved methods of assessment. The catch for that year represents 159 kg $ha^{-1}$ $y^{-1}$ for Lake Chilwa, and was one third of the total national fish landing for Malawi in 1976, indicating the importance of Lake Chilwa to the nation's food supply.

The swamps harbour other fish, and those commonly caught for human consumption include members of the Cichlidae (Haplochromis callipterus, Tilapia rendalli, Pseudocrenilabrus philander), Cyprinidae (Barbus trimaculatus, Labeo cylindricus, Alestes imbiri), Characidae (Hemigramnopetersius barnardi) and Mormyridae (Petrocephalus catastoma, Marcusiensis (= Gnathonemus) macrolepidotus.

The chief predators of the fish include fish eating birds such as gulls, terns, cormorants, pelicans and herons, crocodiles, monitor lizards and otters (Furse, Kirk, Morgan and Tweddle 1979).

## 10. Other vertebrates

Amphibia: Some frogs and a few toads live in the Lake Chilwa environment. They show a variety of adaptations that enable them to survive the harsh conditions found there. Xenopus muelleri is found in larger pools on the floodplain but is absent from the more saline lake. It survives drought by aestivating in soft damp mud. Phrynobatrachus acridoides lives on the floodplain in shallow, almost fresh water, but survives the dry season by moving to perennial streams. Hyperolius parallelus is found along the swamp edges, spending much of its time resting on stems of Typha. It has an area of hygroscopic skin on the inner flanks of the thighs, and it is thought to aestivate in termitaria. The adult Chiromantis xeramphelina is able to excrete uric acid and can live on land, but the larval stages require water. The most highly specialised amphibian is Powers rainfrog Breviceps poweri, which lives permanently on land. Its feet are not webbed and it cannot swim, although it can inflate its lungs which allows it to float. It spends most of its time underground, and the tadpoles remain inside the egg membranes until metamorphosis. (Dudley 1979).

Reptiles: Some nineteen species are listed for the area, including some of special interest. The soft shelled turtle Cycloderma frenatum has an accessory breathing apparatus in the mouth that enables it to survive in the water for 12 hours without using its lungs, and it can aestivate in soft mud for up to one year without food. Crocodylus niloticus is now very rare in Lake Chilwa and in times of drought will bury itself in mud, migrate up rivers or traverse the sand bar to Lake Chiuta. Many snakes are found in the area including Python sebae (African python), Atharis superciliaris (lowland viper) and Bitis arietans (African puff adder). (Dudley 1979).

Birds: Lake Chilwa has over 150 species of resident birds and up to 37 species of palearctic visitors. The open water of the lake attracts fish predators such as the pink backed pelican, grey headed gull and reed cormorant. Ducks and geese frequent the lagoons and river mouths, and the swamps harbour a great variety of species including cranes, rails, warblers and red-shouldered widows. The marshes support ducks, moorhens, jacanas, rails, cranes, reedhens, egrets, storks and ibises, and the floodplains sandpipers, greenshanks, ruffs and flamingoes. Vultures are not resident in the area but fish eagles and African marsh harriers are resident birds of prey (Stead and Schulten 1979).

Mammals: Until the end of the last century the Lake Chilwa area supported a wide variety of game including kudu, bushbuck, rhinoceros, elephant, eland, impala, duiker, klipspringer, gnu, zebra, oribi, buffalo, hippopotamus, warthog, bushpig, leopard, lion, and hyaena, but many of these are now absent from the area. Mammals still found there in relative abundance include Papio cynocephalus (yellow baboon), Cercopithicus aethiops (vervet monkey), Aonyx capensis (cape clawless otter), Viverra civetta (civet cat), Atilax paludinosus (water mongoose), Crocuta crocuta (spotted hyaena), Hippopotamus amphibius, Redunca arundinum (reedbuck), Tatera leucogaster (gerbil) and Mastomys natalensis (common rat). In addition large numbers of cattle graze on the plains. (Dudley 1979).

## 11. Human influence

Until the end of the nineteenth century Lake Chilwa was at a crossroads of central Africa. Caravans of people, including slave traders passed N-S and E-W through the area. Lake Chilwa and its inhabitants provided food, supplies and a place of rest for the travellers, some of whom remained and diversified the population. Others migrated to the area to hunt and fish, and thus the area became quite cosmopolitan. Today there are 14 major ethnic groups in Malawi, most of which follow a matrilineal culture: Chewa, Comwe, Nyanga, Mang'anga, Ngoni, Tumbuka, Ngonde, Yao, Sena, Tonga, Lukwa, Lambya, Wemba, and Nyakyusa.

In the past the people of the area have accommodated to the continually changing situation, by migrating away from the lake during times of drought and returning to fish as the lake re-filled. However, today the places where they were once able to subsist on berries, roots and meat from wild animals are now extensively cultivated with rice, tea, tobacco and coffee. Consequently the former plants and animals are no longer available for these people in times of severe drought. However, improved fishing, storage and general management should help to minimise the effects of the next major regression. It has been suggested that in the past the effects of drought have been far more devastating than over-fishing and that commercial fish production could be increased markedly without causing a deleterious effect on the fish population. To this end a successful experimental trawling programme was carried out 1970-71 in the deeper waters of the southwestern part of the lake, which previously had not been fished.

Today fishing forms a major part of the local economy supplemented by subsistence farming. The floodplain is also important for rice production and stock keeping. Major problems facing the area now include rapid accumulation of silt as a consequence of increased agriculture on the floodplains and in the catchment. Since the lake is endorheic the silt is not carried away, causing the lake to become more shallow and turbid, leading to greater oxygen deprivation (Kalk 1979). Another problem, also associated with agricultural practices in the catchment, is the build-up of insecticides and herbicides, again exacerbated by the fact that the lake has no outflow.

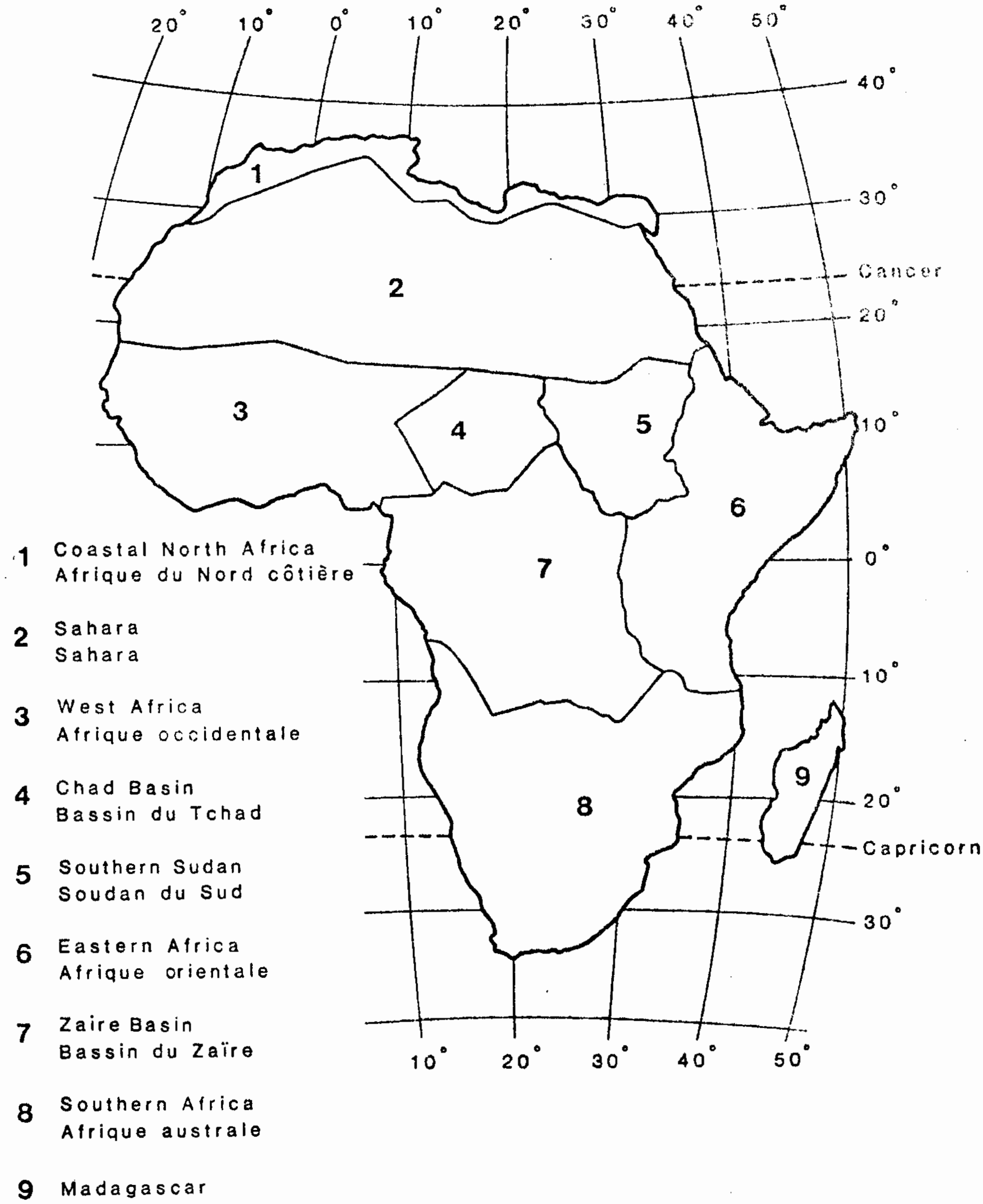
## 8.2 WETLANDS OF ANGOLA

by R.H.MEPHAM

No definitive accounts of the wetlands of Angola appear to have been published and information for the sketchy account given has in the main, been gleaned by personal communication with ANGOP (London), Information Services of the Portuguese Embassy (London), Hunting Surveys Ltd., and personal knowledge of the area.

The principal wetlands are associated with the floodplains of rivers on the Central African Plateau in the southern and eastern parts of the country. These rivers rise in the Central Highlands and flow either west to the Atlantic Ocean or east to the Indian Ocean via the Zambesi. Other important wetlands occur on the Cuanza River which also rises on the plateau but flows to the Atlantic Ocean.

Perhaps the best known river is the Cunene (Kunene) which rises at about 1840 m asl near Novo Lisboa, at a latitude of 13°S, and in its upper course descends swiftly through hilly country to the Central African Plateau. Here, in parts of its middle course, it flows comparatively slowly across the western edge of the plateau, at an elevation close to 1100 m asl. In parts of this region, known as the Cunene Flats, it spills over the plain in most wet seasons following heavy rainfall in the headwater catchments. Here the plateau experiences hot summers with 950 mm rainfall, and warm dry winters. Rainfall over both the flats and the headwater catchment is very variable. On the flats the annual total may fall to 550 mm, but in the upper catchments it may reach 1808 mm. In the past the Cunene River flowed into a large pan on the flats, the existence of which is revealed by deep and extensive alluvial deposits. The fact that these deposits contain palaeolithic tools testifies to their recent age and suggests that this was once a centre of population. From this region the river used to flow southeastwards to Namibia before

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DIRECTORY
REPERTOIRE

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