# 9. The fauna associated with the aquatic vegetation

Claude Dejoux

The flora of Lake Chad is relatively poor and consists of common species with no endemisms. These facts plus the area and position of the lake in the Sahelian zone led Leonard (1965) to propose the establishment of a phytogeographic district for Lake Chad.

The aquatic vegetation (submerged or semi-aquatic macrophytes) show considerable variation depending on the hydrology of the lake. In the period of 'Normal Chad' when an area of 12 to 18 000 $km^2$ is under water, the area covered by this vegetation can be very considerable. On the contrary, both the periods of very high water in the lake and relative dryness are generally accompanied by a decrease in vegetation covers.

Few studies were undertaken on this biological component of the lake ecosystem; the locations of these studies are shown in Fig. 1. This is generally true of studies in African lakes whose aquatic vegetation has usually been studied only when it has been a nuisance.

Generally, the aquatic macrophytes of Lake Chad are grouped in associations, which show some varied morphological aspect but are characterized by relatively low species diversity. In the following pages we try to show the faunal composition of the macrophyte populations as well as their dynamics.

## 9.1 Faunal composition

### 9.1.1 *The invertebrates*

The qualitative samples of the submerged macrophytes were taken by manually collecting the vegetation and washing thoroughly through different sized mesh sieves.

The quantitative samples were taken with a 'phyto-isolator', an apparatus specially designed for this purpose (Dejoux and Saint-Jean 1972). Some crustaceans, for example, *Caridina*, can escape from this device and therefore a different system was used for them (Troubat 1975). The submerged or semi-submerged vegetation of Lake Chad consisted of morphologically varied

*J.-P. Carmouze et al. (eds.) Lake Chad*


*ISBN 90 6193 106 1. Printed in the Netherlands*

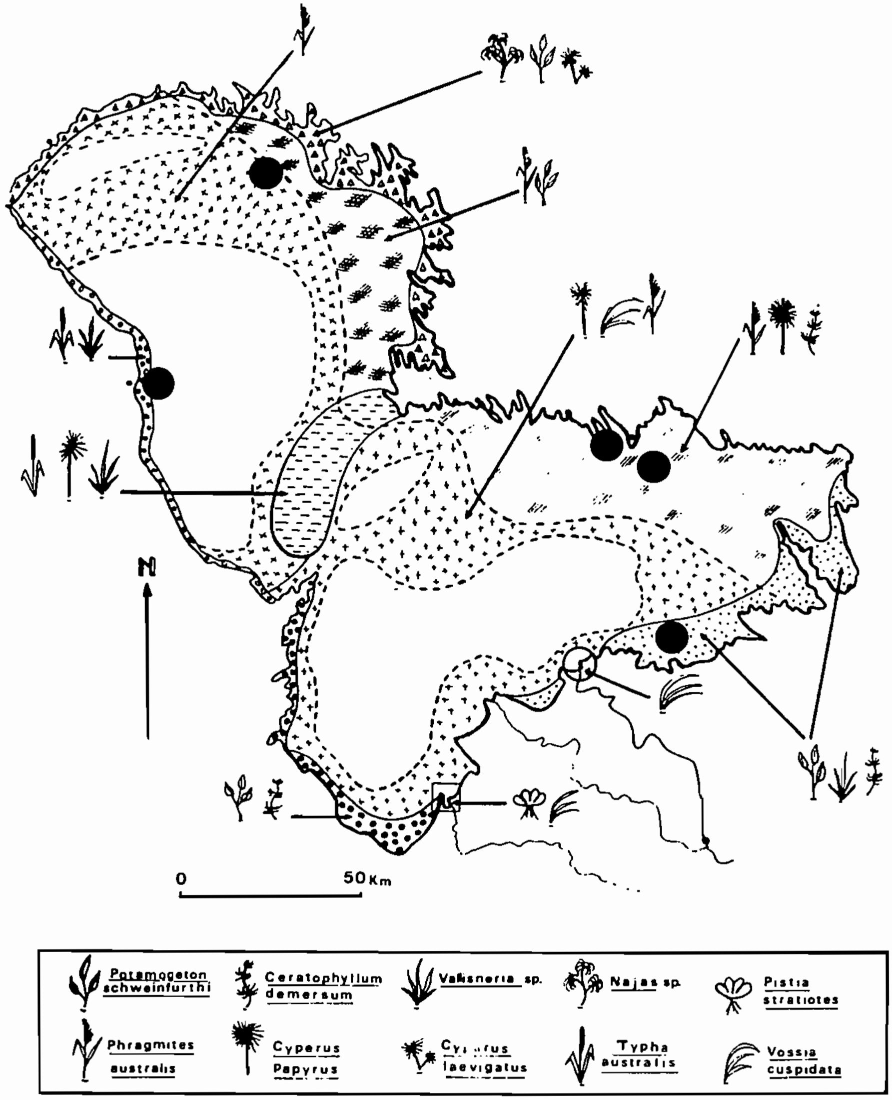



*Fig. 1* Distribution of aquatic macrophytes in Lake Chad in 1968. Areas where special studies have been carried out are shown by black spots. For the different lake regions, decreasing dominances are drawn by ordination from left to right.

macrophytes which did not offer the same potential shelter for invertebrates. For this reason the list in Table 1 related invertebrates to the more important 'facies', a term used to designate a vegetation group where one species formed 90% or more.

*Table 1* Banks of aquatic or semi-aquatic macrophytes.

| Taxonomical groups | P | C | V | TP | RP |
|---|---|---|---|---|---|
| CILIATA | | | | | |
| *Holotrichia* sp. | + | + | – | – | – |
| *Coleps hirtus* | – | + | – | – | – |
| *Didinium nasutum* | – | – | – | + | – |
| *Litonotus quadrinucleatus* | – | + | – | – | – |
| *Tetrahymena pyriformis* | + | + | – | – | – |
| *Colpidium campylum* | + | + | – | – | – |
| *Loxocephalus luridus* | + | + | – | – | – |
| *Neobursaridium gigas* | – | – | – | + | – |
| *Halteria grandinella* | + | + | – | – | – |
| *Urosoma acuta* | – | – | – | + | – |
| COELENTERATA | | | | | |
| *Hydra* sp. | – | + | + | – | + |
| HIRUDINEA | – | + | – | + | + |
| OLIGOCHAETA | | | | | |
| *Branchiodrillus cleistochaeta* | – | – | + | – | + |
| *Dero digitata* | + | + | + | – | + |
| *Aulophorus furcatus* | + | + | – | – | – |
| *Allonaïs paraguayensis ghanensis* | + | + | – | – | – |
| NEMATODA | + | + | – | + | + |
| CRUSTACEA | | | | | |
| Entomostracea | | | | | |
| *Chydorus globosus* | + | + | – | – | – |
| *Chydorus eurynotus* | + | + | – | – | – |
| *Alona diaphana* | + | + | – | – | – |
| *Alona monacantha* | + | + | – | – | – |
| *Alona pulchella* | + | + | – | – | – |
| *Alona verrucosa* | + | + | – | – | – |
| *Simocephalus* sp. | – | + | – | – | – |
| *Macrothrix triserialis* | + | + | – | – | – |
| *Macrothrix goeldii* | – | + | – | – | – |
| *Alona novae zelandiae* | + | – | – | – | – |
| *Alona kanna* | + | + | – | – | – |
| *A. guttata* | + | – | – | – | – |
| *Ilyocryptus spinifer* | – | + | – | – | – |
| Decapoda | | | | | |
| *Caridina africana* | + | + | + | – | + |
| *Macrobrachium niloticum* | + | + | – | – | – |

*Table 1* (continued).

| Taxonomical groups | P | C | V | TP | RP |
|---|---|---|---|---|---|
| INSECTA | | | | | |
| CHIRONOMIDAE | | | | | |
| C1 *Nilodorum brevibucca* | – | + | + | + | + |
| C2 *Polypedilum* sp. | + | + | + | + | + |
| C3 *Stictochironomus caffrarius* | – | – | – | + | + |
| C4 *Cryptochironomus* sp. | + | + | + | + | – |
| C5 *Dicrotendipes* sp. | – | + | – | – | – |
| C6 Orthocladiinae (*Nanocladius*?) | + | + | + | + | – |
| C7 *Cricotopus* sp. | + | + | + | + | + |
| C8 *Tanytarsus ceratophyllus* | + | +* | + | + | ' |
| C9 *Cryptochironomus nudiforceps* | + | + | – | – | ' |
| C10 *Cryptochironomus dewulfianus* | – | – | – | + | ' |
| C11 *Cricotopus scottae* | +* | + | + | + | – |
| C12 *Polypedilum griseoguttatum* | + | + | + | + | – |
| C13 *Polypedilum* sp. | + | – | – | – | – |
| C14 *Dicrotendipes fusconotatus* | +* | +* | + | – | – |
| C15 *Stictochironomus puripennis* | + | + | + | – | – |
| C16 *Cricotopus* sp. | + | + | + | – | – |
| C17 *Tanytarsus nigrocinctus* | + | + | + | – | – |
| C18 *Ablabesmyia dusoleili* | + | + | + | + | – |
| C19 *Polypedilum* sp. | + | – | – | – | – |
| C20 *Polypedilum* sp. | + | + | + | – | + |
| C21 Orthocladiinae | + | + | – | – | – |
| C22 *Stictochironomus* sp. | – | – | – | – | + |
| C23 *Cladotanytarsus* sp. | + | + | – | – | + |
| C24 *Cricotopus* sp. | – | – | – | – | + |
| C25 *Tanytarsus* sp. | + | + | + | – | – |
| C26 *Tanytarsus* sp. | + | + | – | – | – |
| C27 *Polypedilum* sp. | + | + | + | – | – |
| C28 *Cryptochironomus* sp. | + | + | + | – | – |
| C29 *Dicrotendipes chloronotus* | + | – | – | – | – |
| C30 *Cryptochironomus* sp. | – | + | – | – | – |
| C31 *Tanytarsus bifurcus* | – | + | – | – | – |
| C32 *Dicrotendipes sudanicus* | – | + | + | – | – |
| C33 *Polypedilum melanophilus* | – | + | – | – | – |
| C34 *Cladotanytarsus* sp. | – | + | – | – | – |
| C35 *Ablabesmyia nilotica* | – | + | + | – | – |
| C36 Chironominae | + | – | + | – | – |
| C37 Chironominae | – | – | – | – | + |

*Table 1* (continued).

| Taxonomical groups | P | C | V | TP | RP |
|---|---|---|---|---|---|
| C38 Chironominae | – | + | – | – | – |
| C39 *Polypedilum* sp. | + | + | + | – | – |
| C40 *Cryptochironomus* | + | + | + | + | – |
| C41 *Tanytarsus* sp. | + | – | + | – | – |
| C42 *Tanytarsus* sp. | + | + | + | + | – |
| C43 *Cricotopus albitibia*? | + | + | + | – | – |
| C44 *Cryptochironomus* | + | + | + | – | – |
| C45 Orthocladiinae (*Smittia*?) | + | + | + | – | – |
| C46 *Stictochironomus* sp. | – | – | – | – | + |
| C47 *Cryptochironomus* sp. | – | – | + | – | – |
| C48 Orthocladiinae sp. | + | – | – | – | – |
| C49 *Polypedilum* sp. | – | – | + | – | – |
| C50 Chironominae | – | – | + | – | – |
| C51 *Cryptochironomus* sp. | – | – | + | – | – |
| C52 Orthocladiinae | – | – | + | – | – |
| C53 Chironominae | – | – | + | – | – |
| C54 Chironominae | – | – | – | + | – |
| C55 *Polypedilum* | – | – | + | – | – |
| C56 Orthocladiinae | – | + | – | – | – |
| C57 Chironominae | + | – | – | – | – |
| C58 Orthocladiinae | + | + | + | – | – |
| C59 Chironominae | + | + | + | – | – |
| C60 *Cryptochironomus* sp. | + | – | – | – | – |
| ODONATA | | | | | |
| Agrionidae | | | | | |
| Libellulidae | + | +* | + | – | – |
| EPHEMEROPTERA | | | | | |
| Baetidae | + | + | + | + | + |
| *Povilla adusta* | + | + | + | + | + |
| TRICHOPTERA | | | | | |
| *Ecnomus* | | | | | |
| *Orthotrichia straeleni* | + | + | + | + | + |
| *Dipseudopsis* sp. | +* | +* | + | + | + |
| HEMIPTERA | | | | | |
| *Diplonychus grassei* | +* | + | – | – | – |
| *Plea minuta* | + | + | – | – | – |
| *Hydrocyrius* sp. | – | +* | – | – | – |
| *Micronecta scutellaris* | + | + | – | – | – |
| *Naboandelus* sp. | – | + | – | – | – |

*Table 1* (continued).

| Taxonomical groups | P | C | V | TP | RP |
|---|---|---|---|---|---|
| LEPIDOPTERA | | | | | |
| Pyralidae | +* | +* | + | – | – |
| COLEOPTERA | | | | | |
| Elmidae | + | – | – | – | – |
| DIPTERA | | | | | |
| Tipulidae | + | + | – | – | – |
| Muscidae | + | – | + | – | – |
| Culicidae | + | + | – | – | – |
| Ceratopogonidae | + | + | – | – | – |
| MOLLUSCS | | | | | |
| *Bulinus truncatus* and *Bulinus forskalii* | +* | +* | – | – | – |
| *Ferrissia* sp. | +* | + | – | – | – |
| *Biomphararia pfeifferi* | +* | +* | + | – | – |
| *Afrogyrus coretus* | +* | + | – | – | – |
| *Gabiella tchadiensis* | + | + | – | – | – |
| *Bellamya unicolor* | – | + | – | – | – |
| *Gyraulus costulatus* | + | + | – | – | – |
| *Segmentina angustus* | + | + | – | – | – |
| *Limnea natalensis* | – | – | – | – | – |

P = *Potamogeton*; C = *Ceratophyllum*; V = *Vossia*; TP and RP = stems and roots of *Cyperus papyrus*. +* = highly characteristic; + = abundant; – = never collected.

In general, some of the major invertebrate groups were always abundant in aquatic vegetation; these were the Chironomidae, the Hemiptera, the Odonata (Libellulidae and Agrionidae), the Ephemeroptera (Baetidae and some Ephemeridae), the Lepidoptera (Pyralidae), the Ostracods, some Entomostraca and the pulmonate molluscs (Table 1).

These organisms were protected by the vegetation from predators. The vegetation also provided an abundant food source. The abundance of the invertebrates varied greatly with the different morphological structures of each facies.

Major ecological factors regulating the geographical distribution of invertebrates over the whole lake also determined to some extent the distribution patterns of the weedbeds.

### 9.1.2 *The fish community*

The term weedbed dwelling fish groups together several species whose degree of interrelationship with the submerged vegetation can be very different. In fact, some species were permanent inhabitants of weedbeds, while others lived in the spaces of open water between the clumps of vegetation. Others penetrate into the vegetation only to feed or to obtain shelter during a part of the day, while others were only found in these environments as juveniles.

The determination of the composition of these different groups in Lake Chad has been made easier by using ichthyotoxins (Loubens 1969, 1970). Four successive groups were distinguished in order of decreasing interrelationship with the presence of submerged vegetation stands.

(a) A group of species, mostly of small size strictly related to the presence of submerged vegetation and which were only rarely found elsewhere. In particular, there were several species of the genus *Barbus* as well as *Haplochromis bloyeti*, *Neolebias unifasciatius*, *Petersius intermedius*, *Paradistichodus dimidiatus*, *Aplocheilichtys* and *Epiplatys* ... (Table 2).

It is almost certain that the different regions of the weedbeds were populated by different species of fishes as a result of weedbed structure and location. As an example, we will point out the extreme abundance of *Petersius intermedius* in the mixed species vegetation stands of a secondary arm of the Logone, consisting of *Potamogeton* and *Nymphae* (Loubens 1969).

(b) A group of eurytopic species of small size which found temporary shelter in the vegetation but which could also be found in other environments. They include: *Alestes dageti* and *Micralestes acutidens* which were also found in the open water.

(c) A group of medium or large-sized fishes which over the course of their life and especially during the juvenile phase accomplished part of their growth in these environments. These species sought food, and protection against the predators of the open water. The most typical case was that of *Lates niloticus* whose juveniles concentrated in the shallow waters of the lake after their first pelagic phase (until about 2 cm) and became established in the beds of *Vallisneria spiralis*, *Potamogeton* and *Ceratophyllum* (Hopson 1972). Their development period among the aquatic vegetation ceased at a size of 15 to 20 cm. Their predation was exerted principally on the larvae of aquatic insects and crustacea (*Macrobrachium niloticum*) between 2 and 10 cm. After this they became mainly ichthyophagous, above 10 cm. This group included *Alestes baremoze*, *Alestes dentex* and *Distichodus rostratus*.

(d) A group of adult species of average or large size which were frequently found in the vegetation banks but also in other environments. Some, like the Polypterids or *Mastacembelus loennbergi* came there for shelter, others like several Mormyridae (insectivorous) or *Tetraodon fahaka* (malacophagous) fed there. Others, such as *Heterotis*, *Hyperopisus*, *Gymnarchus*, etc. built their nests

*Table 2* Qualitative and quantitative composition of a fish sample collected by poisoning in a region covered with aquatic macrophytes (Matafo 11/8/68).

| Weedbeds | kg | Open water | kg |
|---|---|---|---|
| *Barbus pleuropholis* | 9767 | *Distichodus rostratus* | 134 |
| *Haplochromis wingatii* | 2640 | *Lates niloticus* | 87 |
| *Alestes dageti* | 1803 | *Hyperopisus bebe* | 86 |
| *Barbus calliplerus* | 419 | *Synodontis frontosus* | 83 |
| *Barbus leonensis* | 284 | *Hydrocyon forskali* | 54 |
| *Micralestes acutidens* | 279 | *Synodontis schall* and *S. gambiensis* | 35 |
| *Distichodus rostratus* | 173 | *Gnathonemus cyprinoides* | 31 |
| *Petersius intermedius* | 150 | *Citharinus citharus* | 30 |
| *Paradistichodus dimidiatus* | 133 | *Marcusenius isidori* | 25 |
| *Lates niloticus* | 100 | *Tilapia galilaea* | 19 |
| *Neolebias unifasciatus* | 91 | *Alestes dentex* | 18 |
| *Mochocus brevis* | 60 | *Alestes baremoze* | 12 |
| *Kribia nana* | 48 | *Auchenoglanis occidentalis* | 10 |
| *Alestes dentex* | 29 | *Citharinus latus* | 9 |
| *Hemichromis bimaculatus* | 24 | *Labeo senegalensis* | 6 |
| *Tetraodon fahaka* | 20 | *Malaplerurus electricus* | 5 |
| *Tilapia zilli* | 5 | *Mormyrus rume* | 4 |
| *Alestes baremoze* | 4 | *Alestes macrolepidotus* | 4 |
| *Aplocheilichthys* sp. | 4 | *Tilapia zilli* | 3 |
| *Hemichromis fasciatus* | 3 | *Auchenoglanis biscutatus* | 3 |
| *Auchenoglanis biscutatus* | 2 | *Synodontis clarias* | 3 |
| *Nannocharax* sp. | 2 | *Synodontis batensoda* | 2 |
| *Polypterus senegalus* | 1 | *Tilapia nilotica* | 2 |
| | | *Distichodus brevipinnis* | 2 |
| | 16 041 | *Gnathonemus senegalensis* | 2 |
| | | *Mormyrops deliciosus* | 1 |
| | | *Heterobranchus bidorsalis* | 1 |
| | | *Gymnarchus niloticus* | 1 |
| | | | 672 |
| 23 species | | 28 species | |

in the vegetation and were thus found there at the time of reproduction.

Therefore generally the submerged vegetation of Lake Chad contained a specific fish fauna comprised of small species which lived there permanently plus larger species whose presence was temporary or sporadic.

### 9.1.3 *The other vertebrates*

There is little quantitative information on vertebrate groups other than the fishes associated with the vegetation. What is certain is that the scale of the lake makes them important.

The Batrachia for example (*Bufo* sp.) were particularly abundant in the reed islands and among the entire vegetation belt bordering the islands. The reptiles were less frequent although some snakes were found periodically (*Grayia*, Python ...). They could find various prey species (Batrachia and fishes) in the vegetation.

The crocodiles and the chelonians of the genus *Trionyx* were more numerous but their importance was only apparent after extreme lowering of the water level. They also exploited different trophic levels in the vegetation. The bird could be locally very dense finding temporary shelter (cormorants, grebes ...) or food (Anatidae, water hens, jacanas) in the vegetation. In the papyrus or reeds some species found favorable conditions for their nest building.

The mammals were less numerous over the large scale of the lake, whether the rare *Situtunga* or the hypothetical manatee. On the other hand the hippopotamus and the otters did show some small localized concentrations exploiting the submerged vegetation.

## 9.2 Factors causing abundance and distribution of communities

### 9.2.1 *Structure of some invertebrate populations*

The submerged vegetation was generally much richer in invertebrates than the portion of partially submerged macrophytes growing in the water, especially for the chironomids. Similarly, *Ceratophyllum* was seen to be more favorable to the establishment of the Diptera than *Potamogeton* or *C. papyrus*. The differences in density ranged from 10 to 400. By contrast, if the species richness is studied by the Margalef index $(D(n-1)/(\sqrt{}\log N))$ where $n$ was the total number of species collected in an area, and $N$ the total number of individuals of these $n$ species, it would appear that *Valisneria* has the highest index (9.4) compared with *Potamogeton* (8.0) and *Ceratophyllum* (6.5), and finally the stems and roots of *C. papyrus* with respectively 3.9 and 3.3. These values were obtained from the eastern archipelago but these indices were clearly much lower in the delta region.

It appears that two factors were responsible for these differences: the oxygenation of the environment, related to the penetration of light, and the vegetation texture.

An analysis of some dominant Chironomid species was made in a similar region in two different weedbeds. The mean numbers for 10 grams dry vegetation weight were calculated and then the relative variance $s^2/n$ (Table 3) was calculated. The value of $s^2/n$ was mostly higher than the total for all the species considered and showed their distribution to be contagious. The extent of the error was moreover proportional to the density of the weedbeds and in the present case, was greater among *Ceratophyllum* than among *Potamogeton*. There is no doubt that mechanically the weedbed restrained larval dispersion and the denser the structure, the higher the aggregation of species.

A more complete analysis of chironomid populations from *Ceraphyllum* was made by considering all the species present, and the numbers were classed by frequency distribution after logarithmic transformation. In Fig. 2 we reported the top *n* species having the rank *i* for abcissa and the value of the logarithm of the abundance (log q*i*) for ordinate.

The abundance distribution approximates the log-normal type to one such species association appearing to correspond to 'nomocenoses', according to Daget et al. (1972).

By contrast, in a more open environment, there was a high chance of meeting some truncated and asymmetrical distributions. In comparing *Ceratophyllum* and *Potamogeton* the sampling in the first facies covered 31 species whereas the theoretical number present was 34 and in the second only 27 species were collected for a theoretical number of 48. These figures thus express the great homogeneity of the *Ceratophyllum* facies but by contrast its lesser richness was also confirmed by the calculation of shannon diversity index, S, in the two cases. We actually found an index of 1.523 bits/species for the *Ceratophyllum* against 2.78 in the *Potamogeton* which corresponded respectively to an equitability of 30.7% and 47%.

It would thus appear that *Ceratophyllum* represented a rather more closed environment than *Potamogeton*, explained at the time by the denser structure of *Ceratophyllum* but also by the relative isolation from the bottom. In comparison, *Potamogeton* cannot grow detached from the substrate and thus exchanges with the benthic fauna *sensu stricto* were certainly more numerous.

### 9.2.2 *Spatial variations*

The submerged weedbeds represented a tridimensional environment whose morphological structure could vary largely from one facies to another. In order to show the variations which existed between them and the homogeneity of a facies, we studied the distribution of two groups of well represented organisms, the Entomostraca and the Chironomids.

The mean densities (number of individuals/unit of plant weight) of the Entomostraca and Chironomid species were compared by Kendall's rank correlations method. The samples were taken from two *Potamogeton* vegetation stands, at a distance of 100 meters as well as from two *Ceratophyllum*

*Table 3* Mean numbers and dispersion coefficient calculated for some species of Chironomids from submerged weed beds.

| Species | *Potamogeton* I | | *Potamogeton* II | | *Ceratophyllum* I | | *Ceratophyllum* II | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{N}$ | $s^2/\bar{N}$ | $\bar{N}$ | $s^2/\bar{N}$ | $\bar{N}$ | $s^2/\bar{N}$ | $\bar{N}$ | $s^2/\bar{N}$ |
| *Dicrotendipes fusconotatus* | – | – | – | – | 81 | 97.2 | 303 | 22.7 |
| *Stictochironomus puripennis* | 18 | 33.0 | – | – | 107 | 235.1 | – | – |
| *Rheotanytarsus ceratophyllus* | 197 | 72.4 | 133 | 39.2 | 7358 | 427.1 | 2606 | 306.0 |
| *Cricotopus* sp. | 22 | 15.0 | 42 | 24.0 | 63 | 132.1 | 73 | 67.5 |
| *Polypedilum* sp. C 13 | – | – | 94 | 151.7 | 85 | 121.4 | 424 | 136.8 |
| *Polypedilum* sp. C 20 | – | – | 37 | 9.4 | 43 | 49.0 | 134 | 51.2 |

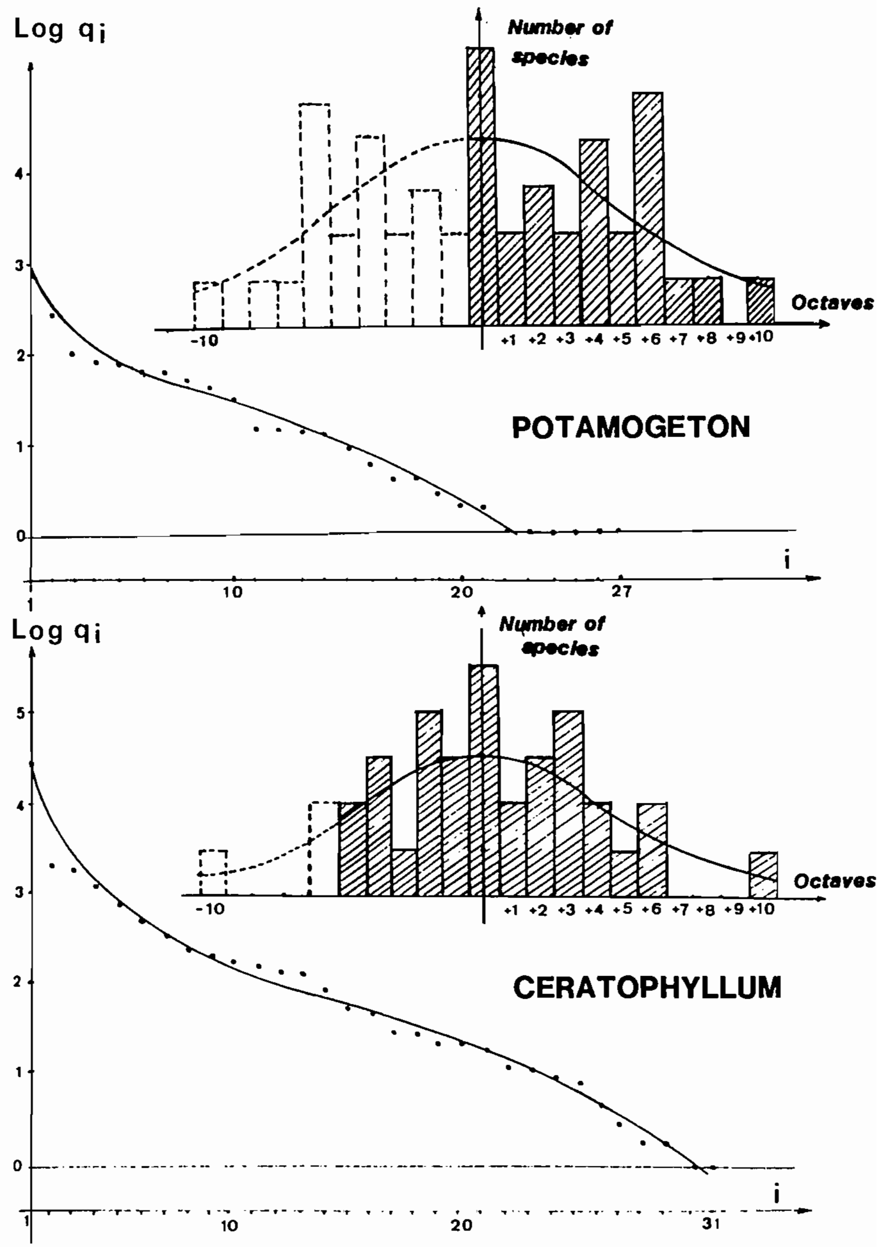



*Fig. 2* Log-normal distribution of Chironomids from aquatic vegetation banks.

vegetation stands equally distanced from one another. A supplementary distinction was made at the time of sampling with some samples taken at the surface of the macrophytes and others in deeper water at about 60 cm.

The correlation coefficients were all positive which indicates some similarity between populations from different facies. Two vegetation banks of the same facies however had greater similarity although one hundred meters apart than two neighbouring vegetation banks of different facies.

Observations on changes in density of the organisms between the surface and a depth of 60 cm were variable from one species to another. They may have been due to physico-chemical factors of the environment but also to the distribution of the organisms in aggregations especially as the action of biotic factors related to the actual vegetation facies (vegetative cycle, morphology ...).

All the coefficients were much less than one, even if the coefficient involved was slightly underestimated by the assignment of a different rank to some species having low and similar densities. The value one must be approached if the community is perfectly homogenous vertically. Generally, when the interior of the same weedbeds or two of the same facies apart from each other are considered, community similarity is always greater for the Entomostracea than for the Chironomids or for other aquatic insects. This is almost certainly because Entomostraca are less attached to the vegetation support than the insects. The bracing of the vegetation banks by the wind and the waves contribute to an even distribution in the open water between the vegetation patches.

The morphological structure of each facies is shown in the distribution of densities of different invertebrates. A study of the Chironomid population of northern Lake Chad (Dejoux 1976) shows a very clear increase in densities related to a change from an open type of vegetation bank (*Potamogeton*) to a compact type (*Najas*) (Table 4).

One can now consider events on a larger scale, e.g. when comparing a facies situated in the zone of the Shari delta with the same facies in the southeastern archipelago, the very numerous invertebrates appeared to be ubiquitous and the dominant forms were found in the two places. The relative abundance could however vary as the greater abundance of *Alonella excisa* was shown in the delta zone in comparison with the zone of the southeastern archipelago. Similarly and although it was impossible to locate some groups which were found sporadically in one of the other stations, three facts can be shown: the absence of hydroid polyps in the delta when they were frequent in the archipelago; the concentration of Hemiptera in *Ceratophyllum* and *Potamogeton* in the two regions and finally, the greater abundance of Lepidoptera in the delta region. The adults of the family Pyrallidae were certainly affected by the more unfavourable climatic conditions which characterized the archipelago in comparison with the southeastern shore of the lake.

The comparison of Chironomid populations finally showed that the fauna was qualitatively richer in the southeastern archipelago region (49 species

*Table 4* Comparative densities of Chironomid larvae inhabiting three different vegetation biotopes of northern Lake Chad (numbers rounded up and reduced to 10 g dry vegetation weight).

| Species collected | Potamogeton | | | | | | Ceratophyllum | | | | | | Najas | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | $\bar{N}$ | 1 | 2 | 3 | 4 | 5 | $\bar{N}$ | 1 | 2 | 3 | 4 | 5 | $\bar{N}$ |
| 1 *Cricotopus scottae* | 202* | 137 | 93 | 177 | 144 | 151 | 326 | 151 | 387 | 251 | 196 | 262 | 281 | 335 | 554 | 376 | 212 | 352 |
| 2 *Cricotopus* sp. (cf. *albitibia*) | 25 | 61 | 5 | 21 | 3 | 12 | 60 | 47 | 22 | 85 | 15 | 46 | 115 | 138 | 145 | 40 | 78 | 103 |
| 3 *Trichocladius* sp. (cf. *metallescens*) | 4 | – | 3 | – | 3 | 12 | 14 | 10 | 3 | 24 | 5 | 11 | 16 | 2 | 13 | 3 | 6 | 8 |
| 4 *Dicrotendipes fusconotatus* | 53 | 36 | 34 | 31 | 38 | 39 | 129 | 83 | 34 | 68 | 108 | 84 | 99 | 83 | 170 | 198 | 223 | 155 |
| 5 *Cryptochironomus dewulfianus* | 72 | 49 | 10 | 59 | 51 | 48 | 385 | 265 | 363 | 201 | 314 | 305 | 532 | 313 | 471 | 297 | 342 | 392 |
| 6 *Tanytarsus nigrocinctus* | 2 | 3 | 1 | – | 9 | 3 | 46 | 36 | 9 | 37 | 44 | 34 | 22 | 5 | 48 | 7 | 3 | 17 |
| 7 *Tanytarsus bifurcus* | 4 | 6 | – | – | 13 | 5 | 5 | – | – | 24 | 15 | 9 | 13 | 7 | 39 | 23 | 38 | 24 |
| 8 *Stictochironomus* sp. | 4 | 3 | 20 | – | 3 | 6 | 5 | 21 | 3 | 55 | 15 | 25 | 19 | 2 | 39 | 43 | 6 | 20 |
| 9 *Ablabesmyia sp.* | – | – | – | – | – | – | – | – | – | – | – | – | 3 | – | 6 | – | – | 2 |
| | | | | | | T=276 | | | | | | T=775 | | | | | | T=1073 |

collected) than in the delta (29 species collected) for all facies studied. Some species with a very wide distribution in one zone were totally absent in another.

### 9.2.3 *Seasonal variations*

The malacological fauna of the grass banks represented an important faunal component because of its diversity, rapid density, rapid growth and the role of the snails in the transmission of some tropical diseases. They were particularly abundant among *Ceratophyllum* and variations in their density were studied over an annual cycle in several regions of the lake (Lévêque 1975).

Some species (Fig. 3) such as *Gyraulus costulatus* and *Bulinus truncatus* did not show distinct variations in their densities throughout the year, or at least these variations did not appear to be related to those major ecological factors affecting the change in the lake. By contrast, some others, amongst which must be included *Gabbiella tchadiensis*, *Ferrisia* sp. *Biomphalaria* sp. and especially *Afrogyrus coretus* and *Segmentina augustus* showed a very clear maximum density during the high waters of the lake, from September to November. This period also corresponded to that of the maximum vegetation from different vegetation bank facies and it is certain that they were a factor favourable to the development of gastropods in providing abundant shelter and food.

We also studied the annual variations in density of several other invertebrate species in a nearby zone of the Shari delta and in a *Potamogeton* stand. Generally, this environment was fairly poor and some taxa were only found one or two times in the year. The oligochaetes and chironomids were by far the most abundant groups, followed by the Ephemeroptera, Baetidae (mainly*Procloeon fraudulentum*), the Hemiptera with mostly *Micronecta scutellaris*, and the Trichoptera with *Orthotrichia straeleni*.

The annual change in densities of the five dominant groups is outlined in Fig. 4: the Oligochaetes and *Orthotrichia* showed two maxima: one in January–February, the other, less marked in June–July at the beginning of the rise of the lake waters. *Pseudagrion*, *Micronecta* and the Baetidae showed only one maximum also during the high water period which partly corresponded to the rainy season. The particular abundance of the insect during this period was moreover a general phenomenon in the Sahelo-Soudanian zone. Several aquatic insects, found better climatic conditions for their dispersion during the rainy season than during the dry season when the humidity of the air frequently fell below 30%.

The annual change in densities of Chironomids showed a completely different profile and the particular abundance at the beginning of the rainy season was much less marked. Having taken into consideration the variation in density of the 11 species inhabiting the weedbeds studied and being given the short duration of the cycles of these insects, the emergence of adults throughout

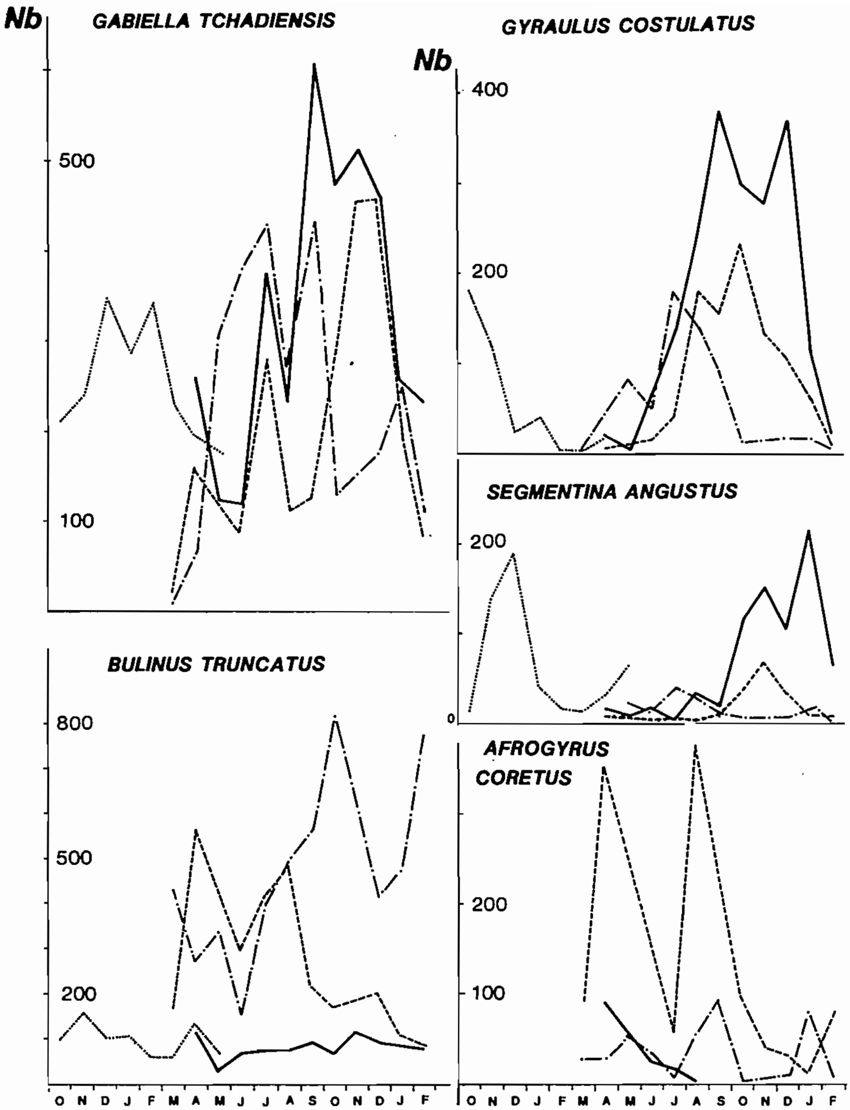



*Fig. 3* Seasonal variations in density of main species of molluscs inhabiting *Ceratophyllum* banks. $N$ = number of individuals in 100 g of dry weight vegetation.

the year closely followed the multiple population peaks (Fig. 5). If by contrast two of the most abundant species (*Cricotopus scottae* and *C. albitibia*) are considered separately, it appears that each of them showed a different type of population change. The first had two annual maxima whereas the second was characterized by several peaks distributed throughout the year (Fig. 5).

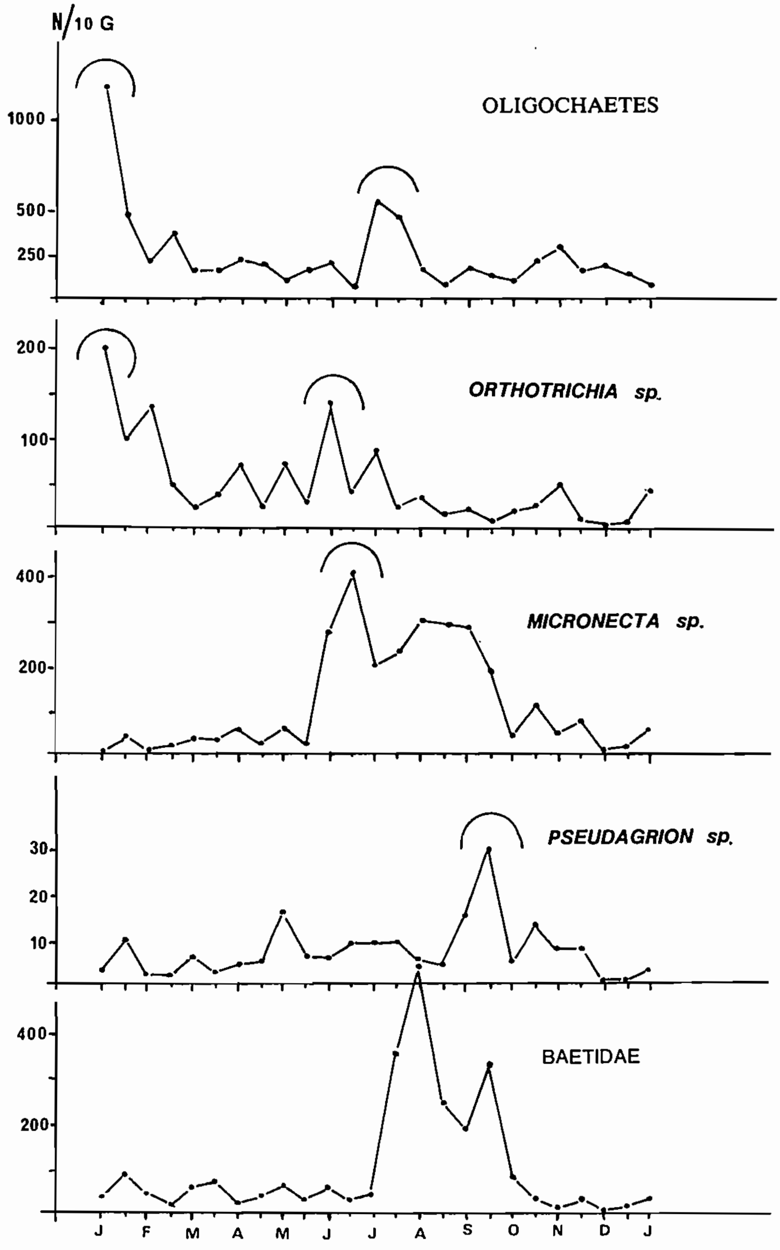



*Fig. 4* Annual variations density of some invertebrates living in *Potamogeton* banks of the delta region. $N/10$ G = number of individuals for 10 g of dry vegetation.

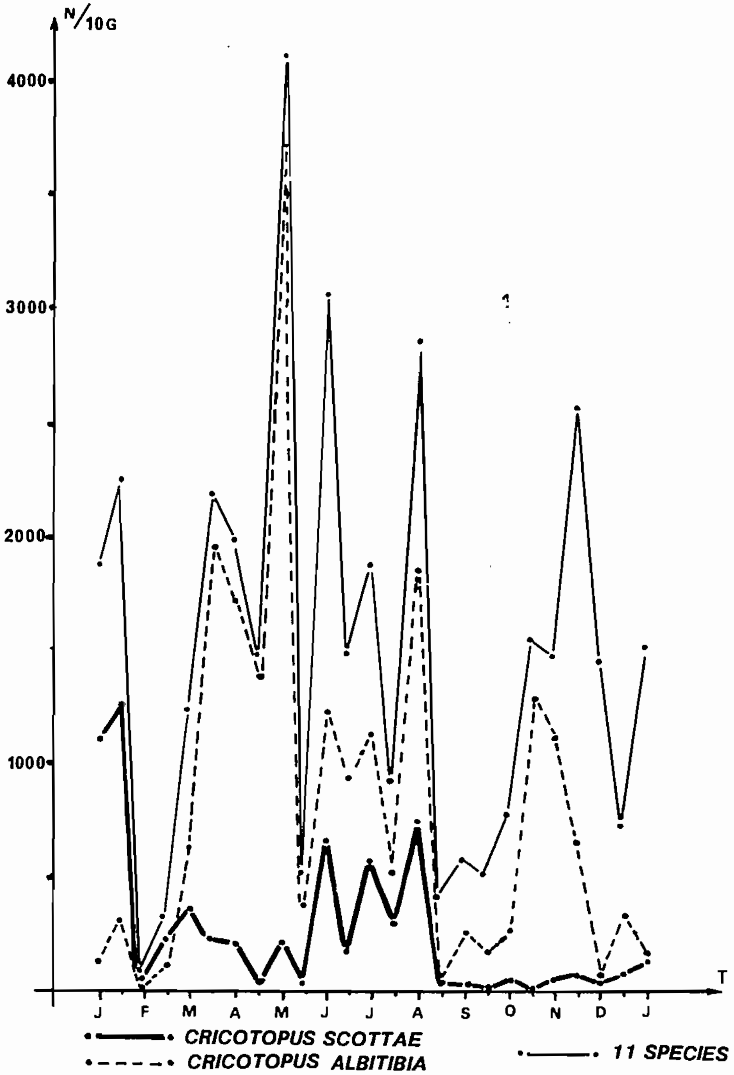



*Fig. 5* Seasonal fluctuations of Chironomid density in *Potamogeton* banks of the delta region. $N$=number of individuals in 10 g of dry vegetation.

## 9.3 Discussions and conclusions

Although represented by heterogenous facies, the aquatic and semi-aquatic vegetation constituted among the biotopes of Lake Chad, an original and well-individualized environment whose importance in area varied as a function of the lake level. It was considerable in some parts of the lake basin during the period of mean or low level, and reduced during the period of the reflooding during the 'Greater Chad'. In the last case only, the vegetation banks, such as the floating islands (kirtas) or vegetation belts, could be an obstacle to navigation, limiting access to the emerged zones.

The aquatic vegetation contributed largely to the mineral cycling in the lake. At the mean water level of 28.5, the semi-submerged macrophytes covered about 2400 km$^2$, or about 12% of the lake surface (Carmouze 1976). They represented a considerable biomass of organic matter as well as an extremely important stock of mineral salts and ions from the lacustrine environment. As indicated, the quantity of potassium ions thus stocked in the aerial parts of the plants was about 138 000 tons, thus much higher than the annual river supplies (cf. Chapter 5).

The rate of mineralization of plant organic matter was lower than its rate of production. This resulted in a considerable accumulation of slightly degraded vegetation debris, especially in the zones of reed islands, and each year considerable quantities of dissolved elements (calcium, magnesium, potassium) were thus accumulated and so definitely lost.

In addition to elements common with the other biotopes, the vegetation was populated by one particular and characteristic fauna. The depth of the lake was essentially made up of detrital material and it is certain that the biotopes colonizable by the fauna would have been less diversified without the presence of aquatic and semi-aquatic vegetation.

## References


Andrewartha, H. G. and Birch, L. C., 1964. The distribution and abundance of animal. University of Chicago Press, 785 pp.

Carmouze, J. P., 1976. La régulation hydrogéochimique du lac Tchad. Trav. Doc. ORSTOM, No. 58: 1–418.

Daget, J., Lecordier, C. and Lévêque, C., 1972. Notion de Nomocénose: ses applications en écologie. Bull. Soc. Ecol. 3: 448–462.

Dejoux, C., 1976. Synécologie des chironomides du lac Tchad. Trav. Doc. ORSTOM No. 56, 161 pp.

Dejoux, C. and Saint-Jean, L., 1972. Etude des communautés d'invertébrés d'herbiers du Lac Tchad: recherches préliminaires. Cah. ORSTOM Sér. Hydrobiol. 6: 67–83.

Hopson, A. J., 1972. A study of the nile perch (*Lates niloticus*, Pisces, Centropomidae) in Lake Chad. Overseas Research publication No. 19, London, 93 pp.

Leonard, J., 1969. Aperçu sur la végétation. In: Monographie hydrologique du lac Tchad, ORSTOM Paris, 11 pp., mimeo.

Lévêque, C., 1972. Mollusques benthiques du lac Tchad: Ecologie, production et bilans énergétiques. Thèse d'Etat, Univ. Paris VI, 225 pp.

Lévêque, C., 1975. Mollusques des herbiers à *Ceratophyllum* du lac Tchad: Biomasses et variations saisonnières de la densité. Cah. ORSTOM Sér. Hydrobiol. 9: 25–31.

Loubens, G., 1969. Etude de certains peuplements ichtyologiques par des pêches au poison (1ère note). Cah. ORSTOM Sér. Hydrobiol. 3: 45–73.

Loubens, G., 1970. Etude de certains peuplements ichtyologiques par des pêches au poison (2ème note). Cah. ORSTOM Sér. Hydrobiol. 4: 45–61.

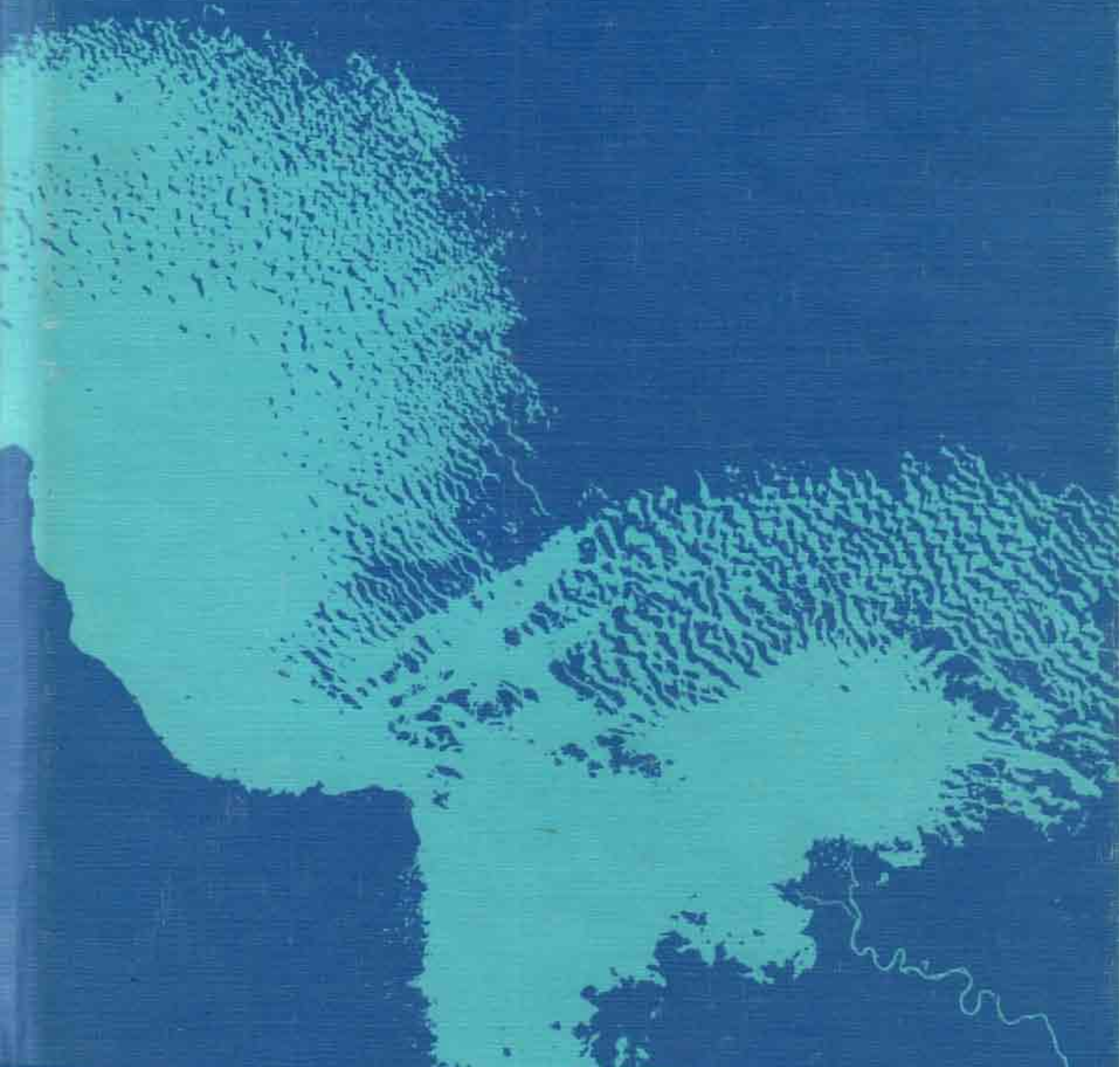
Petr, T., 1968. Populations changes in Aquatic invertebrates living on two Water plants in a tropical man-made Lake. Hydrobiologia 32: 449–485.

Troubat, J. J., 1975. Un échantillonnage de crevettes d'eau douce en milieu d'herbier. Cah. ORSTOM Sér. Hydrobiol. 9: 291–294.

# LAKE CHAD

ecology and productivity
of a shallow tropical ecosystem

edited by J.-P. Carmouze J.-R. Durand C. Lévêque



W. Junk Publishers

# LAKE CHAD

## Ecology and Productivity of a Shallow Tropical Ecosystem

*Edited by*

J.-P. CARMOUZE, J.-R. DURAND and C. LÉVÊQUE

1983 **Dr W. JUNK PUBLISHERS**
a member of the KLUWER ACADEMIC PUBLISHERS GROUP
THE HAGUE / BOSTON / LANCASTER

## Distributors

*for the United States and Canada*: Kluwer Boston, Inc., 190 Old Derby Street, Hingham, MA 02043, USA
*for all other countries*: Kluwer Academic Publishers Group, Distribution Center, P.O.Box 322, 3300 AH Dordrecht, The Netherlands

## Library of Congress Cataloging in Publication Data

Main entry under title:

Lake Chad.

(Monographiae biologicae ; v. 53)
Includes bibliographies and index.
1. Lake ecology--Chad, Lake. 2. Biological productivity--Chad, Lake. 3. Chad, Lake. I. Carmouze, Jean-Pierre. II. Durand, Jean René. III. Lévêque, C. IV. Series.
QP1.P37 vol.53 574s [574.5'26322'096743] 83-4288
[QH195.C46]
ISBN 90-6193-106-1

ISBN 90-6193-106-1 (this volume)

Cover design: Max Velthuijs

## Copyright



PRINTED IN THE NETHERLANDS