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A Note on an Extreme Freshwater Habitat and its Biota

by

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THE small pool on the golf course at Malacca is very unusual amongst Malayan, and indeed S.E. Asian, freshwater habitats for three reasons : it is very alkaline ; its waters attain exceptionally high temperatures ; and it is regularly stratified, the stratification appearing to be semi-permanent. It is thus of some interest to know what sort of life it supports.

The pond has been visited on several occasions and its general characteristics noted. A rather thorough investigation was made on the afternoon of 24th October 1961. The results of this investigation are sufficiently characteristic to be taken as representative of the general conditions in this pool.

Situation and General Character

The pool occupies a shallow, grassy depression on the golf-course at a distance of about 50 ms. from the sea. Its area varies slightly with the incidence of dry and wet weather ; on the average it is about 30 ms. long and 15 ms. wide. The depth varies with season from 1 to 1½ ms.

The bottom consists of sand, silt, and decayed organic detritus. Macrovegetation is sparse but there is a fair quantity of the mudwort, *Ludwigia natans*, around the margins and floating stems of this may extend over the surface for between 1 and 2 ms.

Physical and chemical determinations made on 24.10.61, which show good agreement with those from other visits, were :—

Temperature of surface layer (to about 20 cms) ...	36.2° C
Temperature of bottom layer	32.2° C
pH	8.8
Methyl orange alkalinity ($CaCO_3$ equivalent) ...	29 p.p.m.
Salinity	Nil
Oxygen saturation of surface layer	100%

No trace of chloride has been found, using standard, routine, volumetric techniques, on any visit. Thus the locality is properly described as being freshwater. Oxygen in the bottom layer could not be determined on 24.10.61. Determinations on other visits showed either complete absence of oxygen or the merest trace.

The combination of high pH and relatively low alkalinity may result from the replacement of calcium by sodium as the chief cation. Unfortunately it was not possible to make any determinations of cations.

It will be evident that conditions in this pond are much more severe than is normal in shallow ponds in the equatorial tropics. This is apparent from the temperature figures alone. Vaas and Sachlan (1955) give a temperature range from 26°C to 32°C for a shallow fishpond in Indonesia. These figures correspond almost exactly with unpublished records we have made over a period of some ten years for two shallow ponds in Singapore. Any temperature above 32°C may be considered high for a Malayan freshwater if thermal springs are excluded. Temperatures of 35°C or over are almost unknown except for very small puddles, buffalo wallows and similar habitats fully exposed to the sun. I have also once encountered a temperature of 35.5°C in a shallow and fully insolated blackwater ditch. It is true that temperatures of up to 40°C have been recorded for shallow ponds in such monsoonal areas as Assam (Muirhead-Thomson, 1951); but, despite the views of Macan (1963, p. 139), such temperatures are not normal in ordinary freshwaters in areas close to the equator.

The waters of southern Malaya are dominantly soft waters and pH readings of above 7.0 are distinctly unusual whilst readings of above 8.0 are very rare indeed anywhere in Malaya. The almost complete or total absence of oxygen in the bottom layer must severely restrict its possible inhabitants as well as preventing many organisms from avoiding the heat of the surface layer by retreating into this deeper zone. Indeed, as we shall see, most of the bottom-living animals are restricted to the margins of the pond where the bottom lies within the surface zone. The pond is fully insolated in contrast to the shading which is usual in small, natural freshwaters in Malaya. The water is not turbid and not peaty so that absorbtion of light within the water cannot act as a protection from excessive insolation. It is clear that the conditions of this habitat are likely to be very unfavourable for most of the native plant and animal life of Malayan freshwaters. Nonetheless, as appears below, the biota, though unusual is quite diversified.

It may be noted that the two layers of the pool are separated by a sharply defined and presumably very stable thermocline. The thickness of this thermocline has been about 3 to 5 cms on different visits. On one visit alone, made in the early morning after a period of cool weather there appeared to be no thermocline and the surface layer had a temperature of 32°C. Birge (1897) defined a thermocline as the region where the temperature falls at the rate of 1° C per metre. The thermoclines reported by Rüttner (1931) for Indonesian lakes are much less well defined and yet must still be considered as true, functional thermoclines. Thus the thermocline of this pond, which shows a rate of fall in temperature of the order of 20°C per metre, is exceptionally well marked, especially by tropical standards. At most periods it must be effectively divided into two, functionally separate, water bodies.

The Biota

The following account of the biota is concerned especially with the biota of the surface layer. The only creatures which have been proved to inhabit the bottom layer are larvae of an unidentified tendipedid (chironomid) midge

and the climbing perch, *Anabas testudineus*. Neither has been collected within the shallow marginal zone. At least during the day the climbing-perch spends most of its time in the bottom-layer, though making short but frequent trips to the surface in order to breathe. No facilities were available for determining the bacteria of the bottom mud but presumably such bacteria were present.

It will be noted that the only fish living in the pond is the above-mentioned *A. testudineus*. This is also the major predatory organism. Since it does not venture into the marginal zone during the day this must result in greatly reduced predation pressure on those organisms inhabiting this zone.

The only other vertebrate recorded from the pond is the tadpole stages of a species of *Rana*, almost certainly *R. limnocharis* which have occurred in abundance ; but which were not present on 24.10.61.

Snails were absent, possibly surprisingly, though a similar absence of snails is shown by the very alkaline lake Tasek Dayang Bunting, in the Langkawi Islands.

Insects were abundant but restricted in variety. Dominants were anopheline larvae and the small water-bug, *Mesovelia orientalis*, which was abundant on the water surface. Also abundant were a species of the notonectid bug *Anisops*, probably *A. breddini*, and nymphs of the wandering dragon-fly, *Pantala flavescens*. Species of *Anisops* are micro-predators, whilst the *Pantala* nymphs are the largest predators living permanently in the surface zone. *Ranatra filiformis*, of the family Nepidae, is another predatory insect, which occured in small numbers amongst the vegetation.

Unidentified water-mites, an unidentified species of the copepod genus *Cyclops*, and a small ostracod were abundant on 24.10.61. The only cladoceran was *Alona verrucosa* Sars, present in moderate numbers. This last species is frequently found in small, extreme habitats.

The lower metazoans are of considerable interest. On 24.10.61 a species of the oligochaete *Nais* was abundant. Even more conspicuous was a flourishing population of the rare oligochaete, *Aelosoma variegatum*. I had not previously found any species of this genus in Malaya but I have more recently collected the same species in abundance in a grassy pool in Singapore. Rotifers including species of *Euchlanis* and *Collotheca*, and the unusual species *Brachionus angularis*, were numerous. In my experience the latter species is often found in slightly saline waters and in other habitats close to the sea. The only protozoan noted was a species of *Rhabdostyla ;* but doubtless other species were present.

Algae were both abundant and varied. They included : *Actinastrum* sp. ; several species of *Scenedesmus*; *Cosmarium* sp.; *Staurastrum* sp.; *Pleurotaenium* sp. ; *Oedogonium* sp. ; several species of *Phacus* ; *Trachelomonas similis* ; *Tribonema* sp. ; *Anabaena* sp. ; and *Oscillatoria* sp. The last was very abundant. In general these are common pond algae, though *Trachelomonas similis* is by no means the commonest pond species of the genus. The selection from the common pond flora is distinctly eclectic. One may note the apparent absence of both diatoms and the genus *Euglena*. Desmids were better represented than one might have expected in an alkaline water body.

General Comments

The biota of this pond seems to be determined in part by the peculiar ecological conditions and in part by difficulties of dispersal. The pond is an old one and has shown little change in 15 years. However it lies at a considerable distance from other similar pools and it is not connected with the general system of pools, swamps, and ditches of the neighbouring riceland area, even in times of flood. Thus the flora and fauna are restricted to those species which can be transported overland or can themselves cross land barriers. This is so even of the fish, *Anabas testudineus*. This fish commonly migrates overland, and it is one of the first fish to recolonize ponds and ditches after unusually severe and lengthy droughts. Inability to cross the land barrier probably explains the absence of the waterbug *Sphaerodema rusticum*, since this creature cannot fly and spreads only through water connections (Fernando, 1960). It may also account for the absence of such tolerant fish as *Aplocheilus panchax* and *Trichogaster trichopterus*. On available evidence (unpublished results, Zoology Department, Singapore) both could stand the physical and chemical conditions, including the high temperatures of the surface layer. The former is a surface feeder. The latter is an algal feeder (unpublished results, Zoology Department, University of Singapore students). Both should then find the food supply very satisfactory.

Dispersal restrictions can hardly account for all the peculiarities of this biota. The list gives the impression of an eclectic selection from those forms which could reach the habitat. Absence of many forms, together with unusual abundance of others, must reflect the ecological conditions. Striking absentees which could well have been expected to have reached the habitat include : the fish, *Clarias batrachus* ; the snail, *Lymnaea rubiginosa*, and possibly also the snail, *Gyraulus convexiusculus*, which commonly appears in more or less isolated habitats ; several hydrophilid and dytiscid beetles ; such cladocerans as *Moina dubia* and *Macrothrix squamosa* ; several species of *Euglena ;* and several other pond algae.

On the other hand there are a number of unusual species which occur in abundance. These include such forms as : *Alona verrucosa* ; *Brachionus angularis* ; and *Aeolosoma variegatum*. All are species found elsewhere in small habitats, often showing rather extreme physical and chemical conditions, and with an abundant algal flora.

Summary

Data are presented on the plants and animals of a small pond at Malacca which shows unusual physical and chemical conditions. The pond is thermally stratified and the two regions of the water are distinct in physics, chemistry and biology. The fauna of the deeper zone is very restricted presumably in response to oxygen shortage. The shallow zone contains a rich and varied association of animals and plants which appears to represent an eclectic selection of those easily dispersed species which can tolerate the unusual environmental conditions.

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