SHORT ARTICLES AND REVIEWS

CHRYSOSPHAERELLA AND THE PHYTOPLANKTON OF THE LITTLE SEA, DORSET

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Preface

I am a physicist with some experience of microscopic assessment of airborne dust particles. Since retirement I have found scientific and aesthetic interest in the study of freshwater algae in local ponds and lakes. As I am on a learning curve (upwards - I hope!) I have restricted my identification of most algae to genera.

I chose the Little Sea (Fig. 1) for an extended study as there was no information on its microscopic flora. The flora and fauna of its surroundings was first documented by Captain C. Diver (see Merrett 1971).

Introduction

The Little Sea is an 80-acre, shallow freshwater lake, 1.6 km in length and 300 metres at its maximum width, with a maximum depth of 2 metres. It was formed about 100 years ago by sand-dunes cutting off a sea inlet at Studland Bay, near Swanage (Diver 1933 and Macan & Worthington 1972), and is now part of a reserve managed by English Nature for the National Trust. The lake water is acidic (pH ca. 6) as it is fed from a catchment (area 2-3 km^2) of dunes, heath and marshland. Close to the shore there are thick growths of birch *(Betula),* sallow *(Salix)* and bog myrtle *(Myrica gale).* There is no known input of any agricultural fertilizers or waste products but flocks of waterfowl may make a useful contribution to nutrients. Excess water runs to the sea via an artificial drainage channel.

Typical benthic flora are reeds, pondweeds *(Potamogeton),* water milfoil *(Myriophyllum),* bladderwort *(Utricularia),* quillwort *(Isoetes),* bogbean *(Menyantha)* and a stonewort *(Nitella* or *Tolypella?)* in deeper water. Benthic algae include *Spirogyra, Mougeotia, Zygnema, Bulbochaete, Oedogonium* and several genera each of desmids and diatoms.

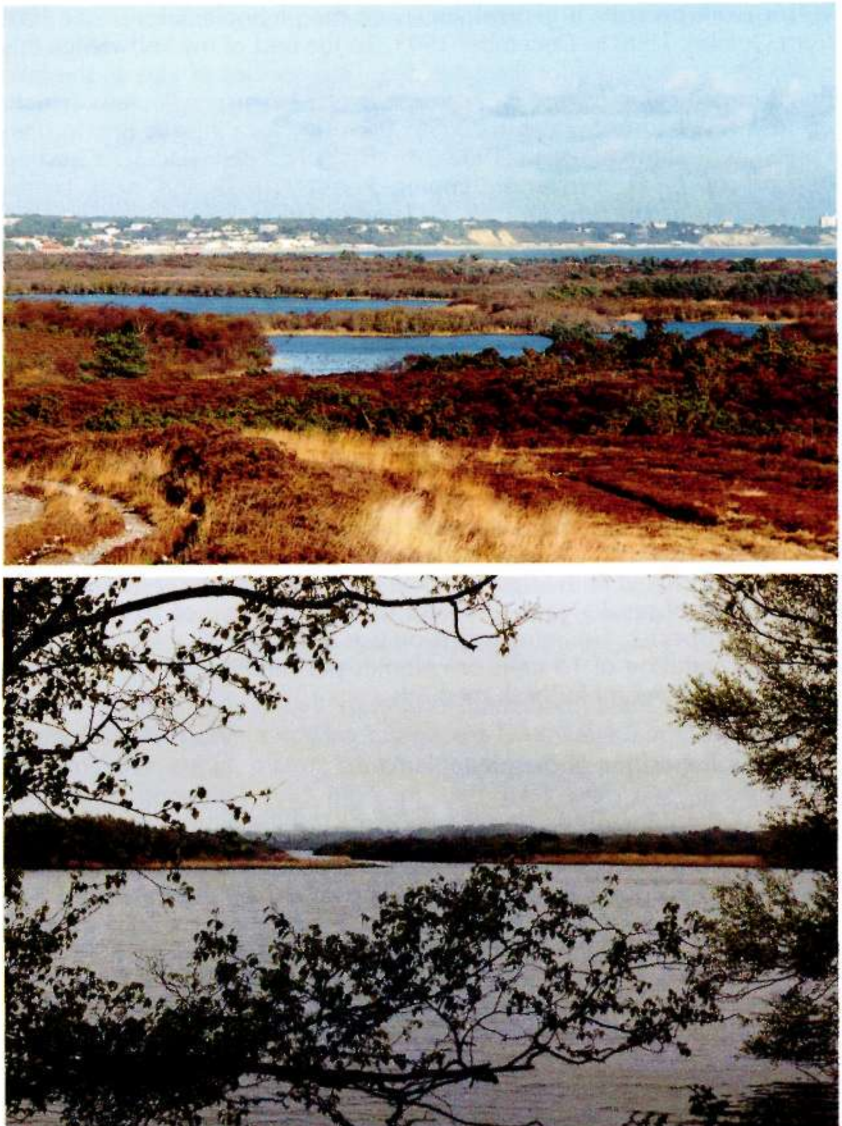

FIG. 1. The Little Sea, a coastal freshwater lake at Studland, Dorset. *Upper*: Southern end of the lake, with Bournemouth in the background. *Lower*: Northern end of the lake, looking south. (Photographs by D. C. Stevens).

This work presents a general survey of the phytoplankton in the lake from October 1990 to December 1993. To the best of my knowledge this is the first such record for the Little Sea. One species of alga in the lake that is of particular interest is *Chrysosphaerella longispina* Lauterb. which, up to 1991, had only been recorded from five localities in Britain (Pen Ponds in Richmond Park (1936-38), Faskally Loch (1953), Cheshire (records of E. G. Williams), Epping Forest (1983) and near Leeds) (information supplied by Dr J. W. G. Lund in 1991).

Sampling and analysis

Every month, surface water was sampled about 10 m from the bank at three points up to 1 km apart. Each sample was collected in the early afternoon on separate days during the middle two weeks of the month. Every 3 to 4 months, samples from the surface and at various depths were taken in the central parts of the lake, at the same time as one of the samples was collected from the bank.

Algae in all samples were observed and counted live after concentration by a hand centrifuge (about 1000 rpm for 1 minute). Colonies of algal cells were counted as single units. Also, many of the samples were fixed with Lugol's Iodine and counted after sedimentation. Comparison of results gave estimates of the efficiency of the centrifuge for various species. Counting precision was about ± 20% (standard error) at a concentration of 10 cells or colonies per millilitre and ± 50% at 1 cell or colony per ml for both methods.

General composition of the phytoplankton

About 50 genera have been noted in the phytoplankton of the Little Sea. In any month the species were the same at all sampling points and concentrations of algal cells were similar (usually within a factor of 2). The depth profiles supported this observation as did many ad-hoc samples from various parts of the lake which were qualitatively examined. In such a shallow lake, wind generated and transient thermal currents would contribute to mixing (Reynolds 1984).

In view of the uniformity of cell concentrations, the number of samples taken is sufficient to provide a "typical concentration" of a species for any month. To this end measured values of concentration were grouped within six ranges based on a logarithmic scale, as shown in Table 1. Each range covers a concentration span of a factor of 5, which accommodates variations between sampling points and errors arising from sample analysis. Table 1 shows the monthly concentration range of the most abundant algae over the period October 1990 to December

1993. Total rainfall and mean water temperature in each quarter are also included.

Many genera were present at low peak concentrations; *Euglena, Phacus* and *Pediastrum* at about 1 cell or colony per millilitre and *Cymnodinium (aeruginosuml),* a blue-green dinoflagellate, at 5 cells or colonies per ml. Others like *Gonium, Sphaerocystis, Kirchneriella, Coelastrum, Quadrigula, Uroglena, Ophiocytium* and the blue-green algae *Oscillatoria* and *Coelosphaerium* were seen occasionally («1 cell or colony per ml).

Many species of phytoplankton were present throughout the year; others showed seasonal variations (Table 1). Some peak concentrations may have been missed within the 2 to 3 week period between sample collections but the general impression, strengthened by ad-hoc samples, was that concentrations did not change rapidly.

Numerically, the diatoms, *Monoraphidium* and sometimes *Rhodomonas,* were the main constituents of the phytoplankton. Diatoms, mainly a species of *Synedra,* can exceed 5,000 cells or colonies per ml in the spring and summer (Table 1) - a concentration approaching that reported for the diatom *Asterionella* in Windermere, English Lake District (Reynolds 1984). Low diatom concentrations seem to occur after periods of low rainfall during the previous quarter. If land drainage is one source of nutrients there may have been a temporary shortage of available silica.

Calculation based on cell sizes and published values of cell density (Reynolds 1984) gave a maximum biomass (wet weight) in the range 2 to 4 grams per cubic metre, of which about 50% was diatoms. The calculation assumed that most of the mass was due to diatoms, *Peridinium, Cryptomonas, Trachelomonas* and *Monoraphidium.*

Hydraulic washout

An approximate estimate of washout can be calculated from the lake volume of 5×10^5 m^3, a catchment area of about 2.5 km^2, and by assuming a continuously mixed system. Using the rainfall values in Table 1, washout constants are in the range -0.02 per day (summer) to -0.07 per day (winter). These values correspond to mean retention times of 50 and 14 days. As no allowance has been made for losses by evapo-transpiration the washout constants will be overestimated. Comparison with published values of algal growth constants in the range 0.1 to 1.0 per day (Reynolds 1984) suggests that washout does not limit algal growth in the lake except perhaps for short periods in the winter.

Table 1. *Concentration ranges* (1 to 6) of phytoplankton in the Little Sea, Dorset. Concentrations of cells or colonies per millilitre are indicated thus: range 1 = ca. 0.5 to 2; range 2 = 3 to 10; range 3 = 11 to 50; range 4 = 51 to 250; range 5 = 251 to 1250; range 6 = 1251 to 6250; n = not noticed?; dashes indicate not seen.

	1990	1991				1992				1993			
Genus/group	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND
Trachelomonas (volvocina)	322	223	234	333	321	222	223	343	333	333	333	323	222
Cryptomonas[a]	533	333	344	455	444	333	333	244	434	343	343	233	333
Rhodomonas	nnn	nnn	nnn	nnn	nnn	554	34-	1--	546	454	543	333	455
Peridinium	223	434	24-	---	-33	342	332	343	333	344	444	---	233
Diatoms[b]	233	455	444	664	334	455	435	212	544	435	654	434	435
Desmids[c]	2--	-22	133	452	221	112	122	112	122	222	243	323	222
Scenedesmus	333	234	224	554	322	332	223	222	223	443	445	433	333
Monoraphidium	nnn	n4n	435	555	444	454	435	334	344	565	545	644	345
Tetraedron[d]	nnn	nnn	nn1	244	211	111	112	122	1--	-1-	134	423	2--
Botryococcus	22-	1--	1--	332	332	211	122	223	232	221	2--	334	312
Chrysosphaerella	n23	133	2--	---	121	1-1	1--	---	-1-	--2	1--	---	221
Synura	235	212	1-1	---	---	---	1--	---	-1-	-12	-1-	---	233
Mallomonas[e]	322	243	2--	---	-43	4-1	-3-	---	-44	235	3-1	-1-	422
Dinobryon	342	554	1--	11-	1-1	111	11-	---	---	--3	3--	-1-	-2-
Uroglena	112	111	---	---	---	---	---	---	---	---	---	1--	---
Oval/spherical cells[f]	322	334	444	554	432	233	354	432	332	334	444	433	332
Quarterly rainfall and average water temperature:-													
Total rain (mm)	266	227	169	119	186	113	133	260	344	172	206	225	427
Mean water temp. (°C)	10	5	16	22	10	8	18	20	9	7	15	15	7

a, two species? b, mainly *Synedra* with a few *Navicula, Gomphonema, Cymbella* and *Tabellaria*. c, species of *Euastrum, Staurastrum, Closterium, Cosmarium*. d, *T. minimum* and another species. e, *M. acrokomas* and another species. f, cells 10 to 20 microns in size, some motile, probably *Chlamydomonas, Chlorella* or similar.

Chrysosphaerella longispina Lauterb.

Fritsch (1935) describes and illustrates *Chrysosphaerella longispina,* a motile colonial member of the Chrysophyceae with a single flagellum and two long silica spines on each cell.

Chrysosphaerella was present in the autumn to early spring along with other genera from the same class; *Synura, Mallomonas, Dinobryon* and *Kephyrion.* Concentrations were low; a peak of about 50 per ml was recorded in the winter of 1990-1991, but since then there have been only 2 to 10 colonies per ml (Table 1). No positive explanation can be given for the higher concentration in 1990-1991, or for the disappearance of the genus every summer. Other Chrysophyceae show similar changes in concentration. Possibly a relevant factor is that some Chrysophyceae have to compete for silica with the large, growing population of diatoms in the spring. In the drought conditions of the summer of 1990 the diatom concentration in the plankton was low and large areas of the benthic community at the edges of the lake dried out (not repeated in subsequent years). The return of the water in the autumn would release a variety of nutrients. The cold winter of 1990-1991 (ice on the lake in February 1991 but not in other years) may have been another contributary factor.

Nichols (1981) lists some of the lakes where species of *Chrysosphaerella* have been found; for at least part of the year these are cold water-bodies in, for example, Greenland, Norway, Sweden, Canada, Switzerland and Japan. He suggests also, on evidence from the published records, that some species may be widely distributed geographically in lakes of different water qualities.

On live examination *Chrysosphaerella* can be overlooked if, as in the Little Sea, it occurs with *Synura,* an alga of superficially similar structure. At moderate magnifications the silica spines of *Chrysosphaerella* are not seen easily in bright-field illumination; the more compact structure of the colony and much slower motion are the more immediate recognition features. On fixing with Lugol's Iodine I have found that colonial Chrysophyceae tend to disintegrate; dilute formalin (2%) gives better results.

Conclusion and a call for help

In the Little Sea phytoplankton, genera from many of the major groups of algae were present, but generally at relatively low concentrations; no bloom of any species has been seen. This suggests that the lake is mesotrophic, neither rich nor poor in nutrients.

The Little Sea is a relatively large lake and help from any local algae or pond-life "enthusiasts" in continuing and extending these studies would be very welcome! For example the benthic algae would repay study and more extensive sampling and nutrient measurements are required.

The variety of species present in the lake has interested the staff of a Local Education Authority Field Study Centre (Leeson House near Swanage) who think that aspects of the lake ecology would be a suitable project for students at 6th form level. In future work it is hoped that the students can assist in making regular measurements of water quality such as nutrients, pH and conductivity.

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