The effect of drought and position in the dam on the algal composition of two dams in New South Wales

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Abstract

May, V. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 1988. The effect of drought and position in the dam on the algal composition of two dams in New South Wales. Cunninghamia 2(1): 75–84. — The effect of drought and position in the dam on algal composition was investigated at two dams in New South Wales.

Introduction

Phytoplankton studies were carried out on two dams in the Hunter River Valley, New South Wales, to study the effects of drought and position in the dam on the algal composition. Water samples were made at 2–4 week intervals from five stations in Lostock Dam (32°10′S; 151°05′E) (Figure 1) between May 1979 and April 1983, and from five stations in Glenbawn Dam (32°04′S; 150°55′E) (Figure 2) between September 1978 and January 1982. The period of drought was 1980–1981, and the effects were more severe at Glenbawn. Methods are as for May & Powell (1986). Full data sets are held by the Library, National Herbarium of New South Wales, Royal Botanic Gardens, Sydney.

Results and Discusssion

Number and distribution of taxa[1]

Of the 68 algal taxa recorded from Lostock Dam, 36 were common, 27 rare and five were found only as drift material (Table 1, Frequency).

In Glenbawn Dam, 34 taxa were recorded as common, 20 as rare and four as drift material (a total of 58 algal taxa) (Table 1, Frequency).

Thirty of the common taxa were found in both dams though abundance data for these taxa varied greatly (Table 1, Abundance)[2]. It was particularly noticeable that the potentially toxic algae *Anacystis* and *Anabaina* were not prevalent in Lostock, though often abundant in Glenbawn. These differences in abundance are explained probably by the high rate of flow and low retention time shown by the water in Lostock, compared with Glenbawn and other dams (Chaffey, May & Powell, 1986, and Carcoar, May, 1988) which all show the same high abundance ratings of toxic algae, low rate of flow and high retention time.

Seasonal growth

Seasonal appearance of taxa in Lostock was variable from year to year. In Glenbawn, some taxa recurred annually, while others showed a seasonal

[1] Where only one species of a genus is reported, the generic name alone is used. A full list of species names and authorities is given in Table 1.

[2] This high number of taxa common in both dams is not surprising considering the wide distribution of many freshwater algae.

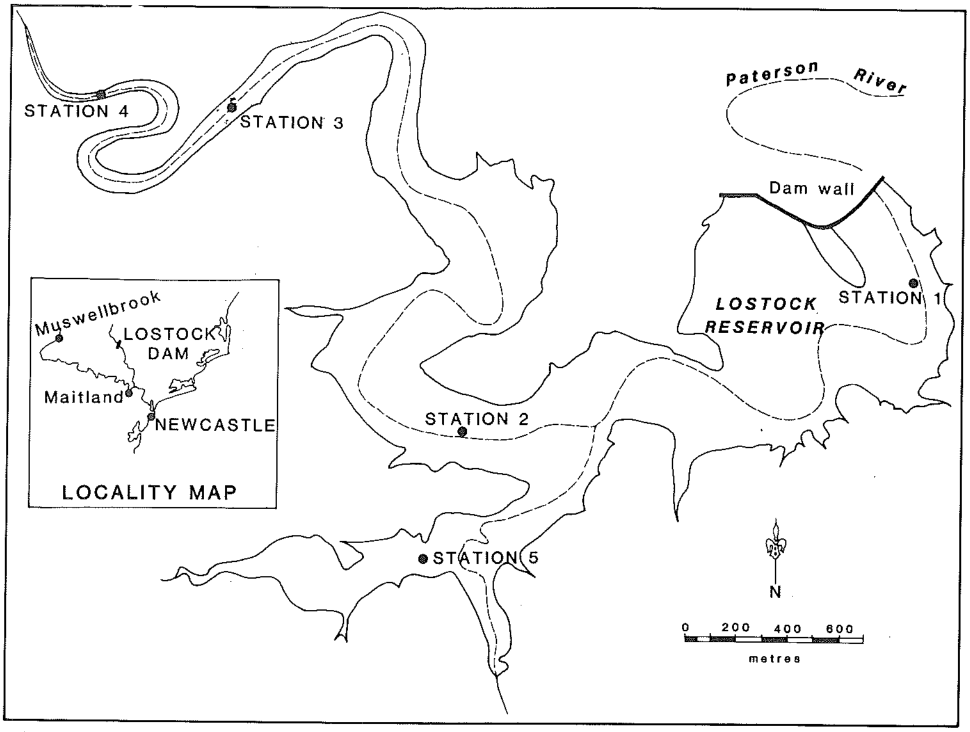

Figure 1. Location of Lostock Dam in Hunter River Valley, showing locations of collecting stations.

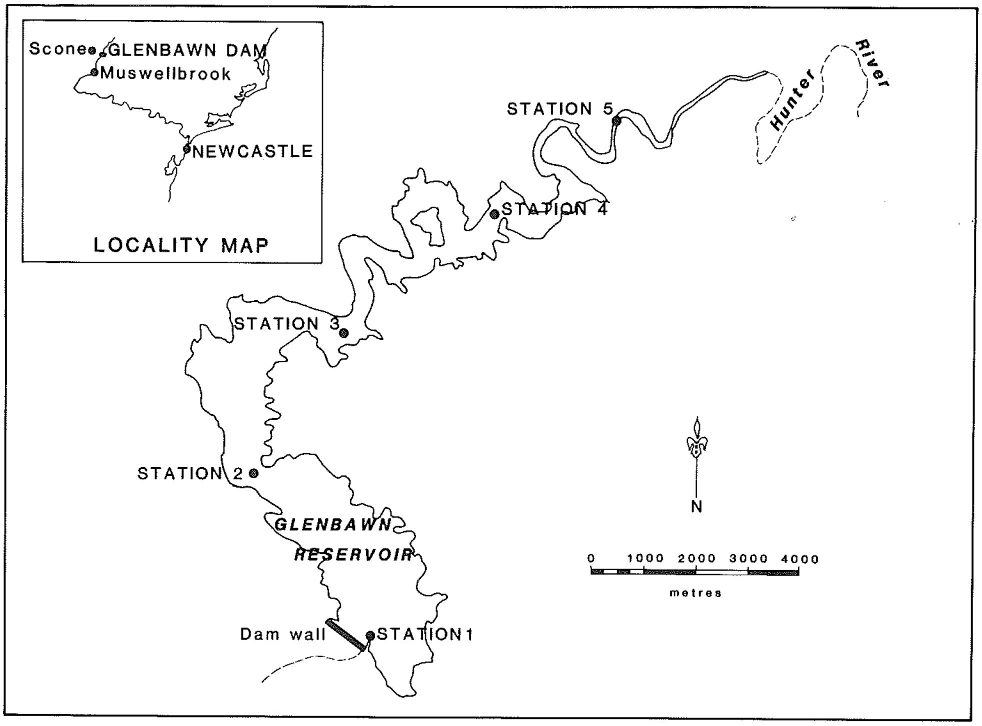

Figure 2. Location of Glenbawn Dam in Hunter River Valley, showing locations of collecting stations.

development in the first two years, but less so in the third (drought). This decreased seasonality in drought time was also recorded in the Peel River (May & Powell, 1986). The lack of precise seasonality in Glenbawn and Lostock is probably due to variations in year-to-year temperatures and inorganic nutrients, though many species tend to occur more often in summer (Table 1, Seasonal Effect).

Drought

The major effect of drought (1980–81) in Lostock (Table 1, Effect of drought) was immediately to increase the frequency of 22 common taxa, with a further three taxa remaining near their maximum frequency during the drought. Nine taxa continued to show increased frequency in the year following the drought. Those remaining of the original taxa showed a slight or marked reduction in frequency during the drought or were erratic.

In eight common taxa in Glenbawn, frequency stayed constant or increased with drought and continued at high or even increasing levels in the prolonged drought[3]. In another 10 species the frequency at first increased with drought, then decreased with prolonged drought (Table 1, Effect of drought). In contrast, 12 taxa decreased with drought and continued at low or even decreasing frequencies thereafter, while another two decreased in frequency with drought and later increased with prolonged drought. Two taxa showed less clear changes.

Fifteen of the 30 common taxa occurring in both dams increased in frequency of occurrence with the onset of drought, two others also increased, but, in Glenbawn, only after an initial decrease. Eight other taxa decreased in both dams and one showed no significant change (Table 1, Effect of drought). Thus, only four taxa showed contrasting behaviour, increasing in frequency at the onset of drought at Lostock, but decreasing at Glenbawn.

There appears to be little relationship between the after-effects of drought shown at Lostock and the response of various species to prolonged drought at Glenbawn (Table 1, Effect of drought). Although more taxa showed high abundance ratings more often in drought time, only two taxa (*Sphaerocystis* and *Peridinium*) became abundant in both dams during drought or prolonged drought. The number and occurrences of rare species increased with drought in both dams, but then decreased with prolonged drought at Glenbawn. Drift species were less frequent in times of poor water flow.

Comparing Carcoar (May, 1988), Lostock and Glenbawn, six common taxa (*Botryococcus, Closterium aciculare, Ceratium, Microcoleus, Pediastrum duplex* and *Trachelomonas armata*) increased or extended their range in some way with the onset of drought in all three dams; only *Melosira varians* decreased in all three.

Position of station

Some taxa were more frequent upstream and probably represent what have been termed 'fluvial' species, while those with lower frequency upstream are regarded as 'lacustrine' species[4].

Nine common taxa appeared as fluvial species in both dams while another eight were lacustrine (Table 1, Behaviour). Four taxa had contrasting behaviour; some species showed definite behaviour in one dam, indefinite in the other. A comparison of common lacustrine and fluvial taxa found in all or combinations of Chaffey, Carcoar, Lostock and Glenbawn Dams is shown in Table 2.

[3] *Anacystis* is included here; already very high in freqency, it increased progressively in abundance.

[4] *Anabaina* and *Euglena* sp. 2 are also considered as fluvial in Glenbawn dam, since they occurred in abundance or high abundance much more frequently in Stations 4 and 5.

Table 1: Frequency of occurrence, seasonality, abundance, fluvial or lacustrine behaviour and effect of drought on species recorded from Lostock (LO) and Glenbawn (GL) Dams.

Taxon	1 Frequency		2 Seasonal effect		3 Abundance		4 Behaviour		5 Effect of drought		
Dam:	LO	GL	LO	GL	LO	GL	LO	GL	LO	GL	Comp.
Actinastrum hantzschii Lag.	C	C	Jan	Nov, Jan, Feb	1	—	F	F	I+	D+	X
Agmenellum thermale (Kuetz.) Drouet & Daily	R	—	—	—	—	—	—	—	—	—	—
Anabaina circinalis Rabenh.	C	C	Jan–Apr, Oct	Jan	1	2	L	F	(D)	D+	D
Anacystis cyanea (Kuetz.) Drouet & Daily (= *Microcystis aeruginosa* Kuetz.)	C	C	Feb, Apr, May, Oct	Jan–Feb, Apr, Jun–Aug	—	2	L	L	I+	I+	I
Ankistrodesmus falcatus (Corda) Ralfs	C	C	May, Jul, Aug, Oct	Oct, Dec	—	1	F	L	(I)	i+	I
Aphanizomenon (ecophene of *Calothrix parietina* (Naeg.) Thuret)	R	C	—	Jan	—	1	—	L	—	D+	—
Asterionella sp.	C	—	Dec	—	2	—	L	—	(I)	—	—
Botryococcus braunii Kuetz.	C	C	Dec	Jan, Feb, Jun	2	—	L	L	(I)	I+	I
Ceratium hirundinella (O.F. Muell.) Dujardin	C	C	Apr, Jun	Apr, Jun	1	1	L	L	(I)	D+	X
Chlamydomonas sp.	—	R	—	—	—	—	—	—	—	—	—
Chodatella chodati (Bern.) Ley.	R	—	—	—	—	—	—	—	—	—	—
C. subsalsa Lemm. (*Lagerheimia*)	R	C	—	Jan, Dec	—	2	—	—	—	(I)	—
Cladophora crispata (Roth) Kuetz.	D	D	—	—	—	—	—	—	—	—	—
Closterium aciculare T. West	C	C	Oct, Dec	Mar, Apr, Jun, Sep, Oct	—	1	L	L	(I)	(i)	I
C. acutum (Lyngb.) de Bréb.	C	C	Aug, Oct	Nov	—	1	L	L	(I)	I+	I
C. parvulum Naeg.	R	C	—	Jul, Sep	—	—	—	—	—	d+	—

C. sp. 1	R	R	—	—	—	—	—	—	—	—	—
C. sp. 3	—	R	—	—	—	—	—	—	—	—	—
Cosmarium sp.	C	R	May	—	—	—	—	—	(I)	—	—
Crucigenia rectangularis (Braun) Gay	C	R	Feb	—	—	—	F	—	(i)	—	—
Cyclotella meneghiniana Kuetz.	C	C	Feb, Dec	Feb, Aug, Oct, Nov	—	1	F	F	(I)	D+	X
Diacanthos belenophorus Korch.	R	—	—	—	—	—	—	—	—	—	—
Diatoms (undetermined species)	C	C	Aug, Sep, Nov	Jan	1	1	F	F	d+	D+	D
Dictyosphaerium pulchellum Wood	—	R	—	—	—	—	—	—	—	—	—
Dinobryon sertularia Ehrenb.	C	—	Oct, Dec	—	2	—	F	—	(I)	—	—
Eudorina elegans Ehrenb.	R	R	—	—	—	—	—	—	—	—	—
Euglena acus Ehrenb.	—	R	—	—	—	—	—	—	—	—	—
E. polymorpha Dang.	C	C	May–Jul, Feb, Oct	Jan–Mar, Jun	1	1	F	F	d+	D+	D
E. aff. *tripteris* (Dujardin) Klebs	—	R	—	—	—	—	—	—	—	—	—
E. sp. 1	R	—	—	—	—	—	—	—	—	—	—
E. sp. 2	C	C	Jan, Aug	Dec	—	1	F	F	i+	i+	—
E. sp. 3	C	—	Jun, Aug	—	—	—	—	—	—	—	—
Glenodinium sp.	R	—	—	—	—	—	—	—	—	—	—
Golenkinia sp.	R	—	—	—	—	—	—	—	—	—	—
Gonium pectorale Muell.	R	R	—	—	—	—	—	—	—	—	—
Hydrodictyon reticulatum (L.) Lag.	R	R	—	—	—	—	—	—	—	—	—
Lepocinclis sp.	R	—	—	—	—	—	—	—	—	—	—
Melosira granulata (Ehrenb.) Ralfs	C	C	Jan	Nov–Jun	2	2	—	F	I+	(I)	I
M. variana Ag.	C	C	May, Oct	Feb	—	—	F	F	d+	D+	D
Micractinium pusillum Fres.	—	R	—	—	—	—	—	—	—	—	—
Microcoleus lyngbyaceus (Kuetz.) Crouan	C	C	Apr	Feb	—	—	—	F	(i)	I+	I
Mougeota sp.	—	D	—	—	—	—	—	—	—	—	—
Nephrocytium agardianum Naeg.	C	C	Jul, Aug, Oct, Nov	Feb	1	—	—	—	(I)	(I)	I
Nodularia sp.	R	—	—	—	—	—	—	—	—	—	—
Oedogonium sp.	D	—	—	—	—	—	—	—	—	—	—
Oocystis gigas Archer	C	C	Mar, Apr, Aug	Nov	1	1	L	L	I+	D+	X

		1 Frequency		2 Seasonal effect		3 Abundance		4 Behaviour		5 Effect of drought		
Taxon	Dam:	LO	GL	LO	GL	LO	GL	LO	GL	LO	GL	Comp.
O. parva West & West		C	C	Apr, Sep	Oct	—	—	L	L	I+	(I)	I
Oscillatoria ? *lutea* Ag.		C	C	Apr, Jun, Oct	Mar–May	—	—	—	F	D+	D+	D
Pandorina morum (Muell.) Bory		C	C	Dec	Jan	—	—	F	F	d+	(D)	D
Pediastrum boryanum (Turp.) Meneghini		R	R	—	—	—	—	—	—	—	—	—
P. duplex Meyen		C	C	Dec	Jan, Jul	—	—	F	F	(I)	(I)	I
Peridinium granulosum P'fair		C	C	Mar	Jan, Feb, Apr	1	1	L	L	(I)	(I)	I
Phacus caudatus Huebner		R	R	—	—	—	—	—	—	—	—	—
P. sp.		R	—	—	—	—	—	—	—	—	—	—
Pleurotaenium sp.		R	—	—	—	—	—	—	—	—	—	—
Scenedesmus abundans (Kirchner) Chodat		—	R	—	—	—	—	—	—	—	—	—
S. bijugus (Turp.) Kuetz.		C	C	Oct	Jan	—	—	—	—	(I)	(I)	I
S. obliquus (Turp.) Kuetz.		R	R	—	—	—	—	—	—	—	—	—
S. quadricaudus (Turp.) de Bréb.		R	C	—	Jan	—	—	—	F	—	—	—
Schizothrix calcicola (Ag.) Gomont		C	C	Dec	Jan	—	—	L	F	D+	D+	D
Schroederia judayi G. M. Smith		C	C	Apr–Jun, Aug	Dec	—	—	—	—	I+	See Text	
Sphaerocystis schroeteri Chodat		C	C	Dec	Jan	2	2	—	F	I+	See Text	
Spirogyra sp.		D	D	—	—	—	—	—	—	—	—	—
Spirulina subsalsa Oersted		R	—	—	—	—	—	—	—	—	—	—
Staurastrum pingue Teiling		C	C	Sep	Jun	2	1	—	L	I+	(I)	I
Stigeoclonium sp.		D	—	—	—	—	—	—	—	—	—	—
Synura adamsii G. M. Smith		C	R	Jul	—	1	—	F	—	D+	—	—
Tetraëdron hastatum (Reinsch.) Hansgirg		R	—	—	—	—	—	—	—	—	—	—

T. minimum (A. Braun) Hansgirg	—	R	—	—	—	—	—	—	—	—	—
T. trigonum (Naeg.) Hansgirg	R	—	—	—	—	—	—	—	—	—	—
Tetraspora lubrica (Roth) Ag.	R	R	—	—	—	—	—	—	—	—	—
Trachelomonas armata (Ehrenb.) Stein	C	C	Jan, Feb	Apr, Jul, Nov–Jan	1	—	F	L	(I)	I+	I
T. girardiana (P'fair) Deflandre	R	R	—	—	—	—	—	—	—	—	—
Trachelomonas hispida (Perty) Stein	C	C	Jan, Mar, Jun, Sep	Jun, Aug, Oct–Jan	1	1	L	—	(I)	(i)	I
T. sp.	R	—	—	—	—	—	—	—	—	—	—
Ulothrix sp.	D	—	—	—	—	—	—	—	—	—	—
Volvox globator L.	C	C	Mar, Oct	Sep	1	1	F	F	(D)	(D)	D
Zygnema sp.	—	D	—	—	—	—	—	—	—	—	—

1. Frequency (all species). C = common species (>5%). R = rare species (≤5%). D = drift species.

2. Seasonal Effect (common species). Showing months of occurrence at most stations.

3. Abundance (common species). 1 = medium abundance rating. 2 = high abundance rating.

4. Behaviour (common species). F = Fluvial (more common at upstream stations). L = Lacustrine (more common at downstream locations).

5. Effect of Drought (common species). A frequency change of over 5% is considered significant and is shown by a capital letter; lesser changes are shown in lower case. I = Frequency increased with drought or remained high during drought. (I) = Increase in frequency occurred only or mainly in year of drought. I+ = Increased frequency continued or became greater in year following drought. D = Frequency decreased with drought. (D) = Decrease in frequency occurred only or mainly in year of drought. D+ = Decreased frequency continued or became lower in year following drought.
   Comp. — Comparison between the response of species common to Glenbawn and Lostock Dams. I = Increase common to both dams. D = Decrease common to both dams. X = Responses of species differ between dams. A common result is accepted when the figures for one or both dams reach significance and the trend is the same in both dams.

Table 2: Number of common lacustrine and fluvial species found in four dams. (Figures from present paper, May & Powell 1986 and May 1988).

	Chaffey Carcoar Lostock Glenbawn	Carcoar Lostock Glenbawn	Chaffey Lostock Glenbawn	Chaffey Carcoar Glenbawn	Lostock Glenbawn
Lacustrine	3	6	4	4	8
Fluvial	0	1	2	0	9

Drift and rare species were found more often in mid- and upstream stations of both Lostock and Glenbawn Dams, but there were fewer occurrences of medium or high abundance ratings in other species and fewer taxa exhibiting this behaviour in the upstream stations.

Depth

Both dams showed greater frequency of occurrence and of abundance of most taxa at most times in surface water, as was found at Chaffey and Carcoar Dams (May & Powell, 1986; May, 1988). Only *Melosira granulata* showed greater frequency of occurrence (in both dams) and of abundance (in Glenbawn) in bottom collections. Bowen & Small (1980) describe *Melosira granulata* blooming after circulation of filaments from the hypolimnion.

In contrast with the importance of algae in top water, Wiederholm (1973) found bottom fauna provided indicator organisms of ecological significance.

Drought and position of station

Of the eight common lacustrine species found in both Lostock and Glenbawn, six increased in frequency with drought; of the nine common fluvial species found in both dams, five decreased in frequency with drought, while only one increased (Table 1, Effect of Position of Station and of Drought). This indicates that fluvial taxa are, in general, more adversely affected by drought. The four taxa that responded differently to drought in the two dams are probably affected more by some other, as yet undetermined, factor.

Physicochemical results

From surface water data obtained from Glenbawn Dam by the Water Resources Commission, it can be shown that turbidity, ammonia and iron, and possibly total phosphorus, increased with both position upstream and drought, while carbonate decreased correspondingly. Nitrate increased with prolonged drought (in both surface and bottom water), but not with progress upstream.

It has been shown above that the fluvial taxa tend to be more adversely affected by drought than do lacustrine taxa. Thus, with an apparently adequate annual nutrient supply, those physicochemical factors which act in the same way with both position in dam and drought do not determine which taxa thrive at each place. However, as nitrate increased with prolonged drought but not with position of station, it seems likely that this could be important in determining the changes in distribution of some taxa with prolonged drought.

At Glenbawn Dam, during the drought times *Anacystis* gradually replaced *Anabaina* as the toxic alga of greater occurrence and abundance. Since this time interval is associated with increasing nitrate content this observation supports the results reported from Carcoar Dam (May, 1988) showing that the concentration of oxidised nitrogen determines which of these blue-green algal species is likely to occur in quantity.

Acknowledgements

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Appendix 1
Species recorded from Lostock (marked L) and Glenbawn Dams (marked G)

LG *Actinastrum hantzschii* Lag.
L *Agmenellum thermale* (Kuetz.) Drouet & Daily
LG *Anabaina circinalis* Rabenh.
LG *Anacystis cyanea* (Kuetz.) Drouet & Daily (= *Microcystis aeruginosa* Kuetz.)
LG *Ankistrodesmus falcatus* (Corda) Ralfs
LG *Aphanizomenon* (ecophene of *Calothrix parietina* (Naeg.) Thuret)
L *Asterionella* sp.
LG *Botryococcus braunii* Kuetz.
LG *Ceratium hirundinella* (O.F. Muell.) Dujardin
G *Chlamydomonas* sp.
L *Chodatella chodati* (Bern.) Ley.
LG *C. subsalsa* Lemm. (*Lagerheimia*)
LG *Cladophora crispata* (Roth) Kuetz.
LG *Closterium aciculare* T. West
LG *C. acutum* (Lyngh.) de Bréb.
LG *C. parvulum* Naeg.
LG *C.* sp. 1
G *C.* sp. 3
LG *Cosmarium* sp.
LG *Crucigenia rectangularis* (Braun) Gay.
LG *Cyclotella meneghiniana* Kuetz.

L *Diacanthos belenophorus* Korch.
LG Diatoms (undetermined species)
G *Dictyosphaerium pulchellum* Wood
L *Dinobryon sertularia* Ehrenb.
LG *Eudorina elegans* Ehrenb.
G *Euglena acus* Ehrenb.
LG *E. polymorpha* Dang.
G *E.* aff. *tripteris* (Dujardin) Klebs
L *E.* sp. 1
LG *E.* sp. 2
L *E.* sp. 3
L *Glenodinium* sp.
L *Golenkinia* sp.
LG *Gonium pectorale* Muell.
LG *Hydrodictyon reticulatum* (L.) Lag.
L *Lepocinclis* sp.
LG *Melosira granulata* (Ehrenb.) Ralfs
LG *M. varians* Ag.
G *Micractinium pusillum* Fres.
LG *Microcoleus lyngbyaceus* (Kuetz.) Crouan
G *Mougeota* sp.
LG *Nephrocytium agardianum* Naeg.
L *Nodularia* sp.
L *Oedogonium* sp.
LG *Oocystis gigas* Archer
LG *O. parva* West & West
LG *Oscillatoria ? lutea* Ag.
LG *Pandorina morum* (Muell.) Bory
LG *Pediastrum boryanum* (Turp.) Meneghini
LG *P. duplex* Meyen
LG *Peridinium granulosum* P'fair
LG *Phacus caudatus* Huebner
L *P.* sp.
L *Pleurotaenium* sp.
G *Scenedesmus abundans* (Kirchner) Chodat
LG *S. bijugus* (Turp.) Kuetz.
LG *S. obliquus* (Turp.) Kuetz.
LG *S. quadricaudus* (Turp.) de Bréb.
LG *Schizothrix calcicola* (Ag.) Gomont
LG *Schroederia judayi* G. M. Smith
LG *Sphaerocystis schroeteri* Chodat
LG *Spirogyra* sp.
L *Spirulina subsalsa* Oersted
LG *Staurastrum pingue* Teiling
L *Stigeoclonium* sp.
LG *Synura adamsii* G. M. Smith
L *Tetraëdron hastatum* (Reinsch.) Hansgirg
G *T. minimum* (A. Braun) Hansgirg
L *T. trigonum* (Naeg.) Hansgirg
LG *Tetraspora lubrica* (Roth) Ag.
LG *Trachelomonas armata* (Ehrenb.) Stein
LG *T. girardiana* (P'fair) Deflandre
LG *Trachelomonas hispida* (Perty) Stein
L *T.* sp.
L *Ulothrix* sp.
LG *Volvox globator* L.
G *Zygnema* sp.