A SEASONAL STUDY OF THE SILT-ALGÆ OF TWO PONDS[1]

BY C. B. RAO

Government Training College, Rajahmundry

(Received for publication on October 10, 1953)

DURING a twelve months' study[2] of the periodicity of algæ of five ponds on the Hadley Common, Hertfordshire, England, one idea gained prominence, namely that, some species noticed almost throughout the year—constant species as they are called—showed month after month striking changes in their frequency, apart from the "abundant species" becoming dominant at one time or other in the year to remain in traces or disappear at other times. The question arose as to what happened to the individuals of a species, when the abundance noticed one month declined in the next one or two months. Did the organisms pass into resting stages so as to be retained on the pond bottom till such time as the algæ reappeared in the cycle of periodicity? Lind (1940) in fact remarked that the resting period in life of most algæ would be spent in mud and that the growth of algæ in pond would depend largely on the extent to which resting stages germinate. Transeau (1913) likewise associated the periodical dominance of algæ with the germination of zygospores, oospores and aplanospores. To gain, however, a personal insight into the possible answer to the problem, the seasonal study of silt-algæ was undertaken. Through this study, it was also hoped to investigate whether any particular type of algal flora was confined to the silt as opposed to the general flora of the pond and if so, what relation such a flora holds to the nature of silt and to the seasonal variations.

EXPERIMENTAL PROCEDURE

Two ponds showing a wide contrast in the algal flora were chosen for the study. One was the Lemna pond (characterised by a relatively poor flora) with a thick sheet of *Lemna minor* over the entire pond surface and with water having negligible or very small concentration of oxygen (varying from "0" to 2 mg./l.) and high concentrations of hydrogen sulphide, carbon dioxide, phosphate and silica. As discussed in the paper dealing with the distribution of algæ of this pond, this pond could be regarded as having a "reducing bottom". The silt of this pond, therefore, was thought suitable for the present study because it would afford one of an uncommon type. The second pond chosen was the Brewery pond showing a rich algal flora; the water of this pond showed a normal concentration of oxygen (between 6–12 mg./l.) during the year and judging from the other chemical features,

1. Part of a thesis approved for the Ph.D. Degree of the University of London.
2. The results of this study have been recorded in a separate communication.

the pond could be regarded as a normal one providing for this study silt of a common or normal type.

Small amounts of fine silt occurring on the sides (about 3′ inside from the water edge) of each of the two ponds were collected from different spots by means of a wide-mouthed bottle fixed at the end of a collecting stick. The collection was made at the beginning of each of the four seasons of the year. A layer of silt about $\frac{1}{2}''$ thick was provided in each of two glass dishes ($2\frac{1}{2}''$ diameter and $1\frac{3}{4}''$ depth) with lids. To the silt in one dish about 50 c.c. of distilled water were added and to another, the same quantity of pond water. A fortnight after the cultures were set up, the first estimate of algæ was made and the further estimates were made once a month during the season concerned and once a season during the rest of the year. (*Method of estimation*: The algæ of the silt surface in each dish were pipetted out along with the medium to have one drop placed on each slide. Each estimation was the average of all algæ counted in three sets, of ten each, of high power fields of a microscope, ten fields chosen at random—five on each of two slides—corresponding to each of the three replicates).

Once a month the media in the dishes were drained off carefully without unduly disturbing the silt at the bottom and fresh supplies put in so as to keep the cultures fresh all the time.

The pH of the drained off media was determined at intervals so as to be able to judge from the variations in the values whether the silt was remaining without being subject to the effects of decomposition.

The algæ present on the silt treated with distilled water were compared with those present on the silt treated with pond water and the algæ of one season compared with those of another. Further the seasonal variations in the flora of the two ponds were compared and the general succession in the two ponds studied.

OBSERVATIONS

(1) *Silt from the Brewery Pond*

Winter silt (collected at the beginning of 1948).

In the winter silt treated with pond water, *Chlamydomonas* spp. were abundant at the start; so also *Synedra tabulata* (including *Nitzschia palea*) and *Fragilaria capucina*, which remained fresh till March to appear in smaller numbers later. By March, *Oscillatoria terebriformis* appeared in a larger number and by August *Nostoc paludosum* and *Os. pseudogeminata* were conspicuous; by November these algæ were unhealthy. *Achnanthes affinis* and *Cocconeis placentula* were the frequent diatoms along with *Oscillatoria splendida* during November.

The winter silt in distilled water showed algæ more or less on lines indicated for silt in pond water but the flora was always poorer. Though more or less the same species were noticed in both, the number of individuals of each species was always more in pond water medium. In place of *Oscillatoria terebriformis*, however, noticed in pond water silt in March, *Os. splendida* was there in distilled water silt at that time.

Spring silt (collected at the beginning of April 1948)

In the spring silt treated with pond water, the algal estimates of May, June and August were the highest compared to those of winter and summer silts. The flora of autumn silt was no doubt more abundant than that of spring but was mainly composed of diatoms unlike the spring flora which was more varied (Fig. 1). The spring

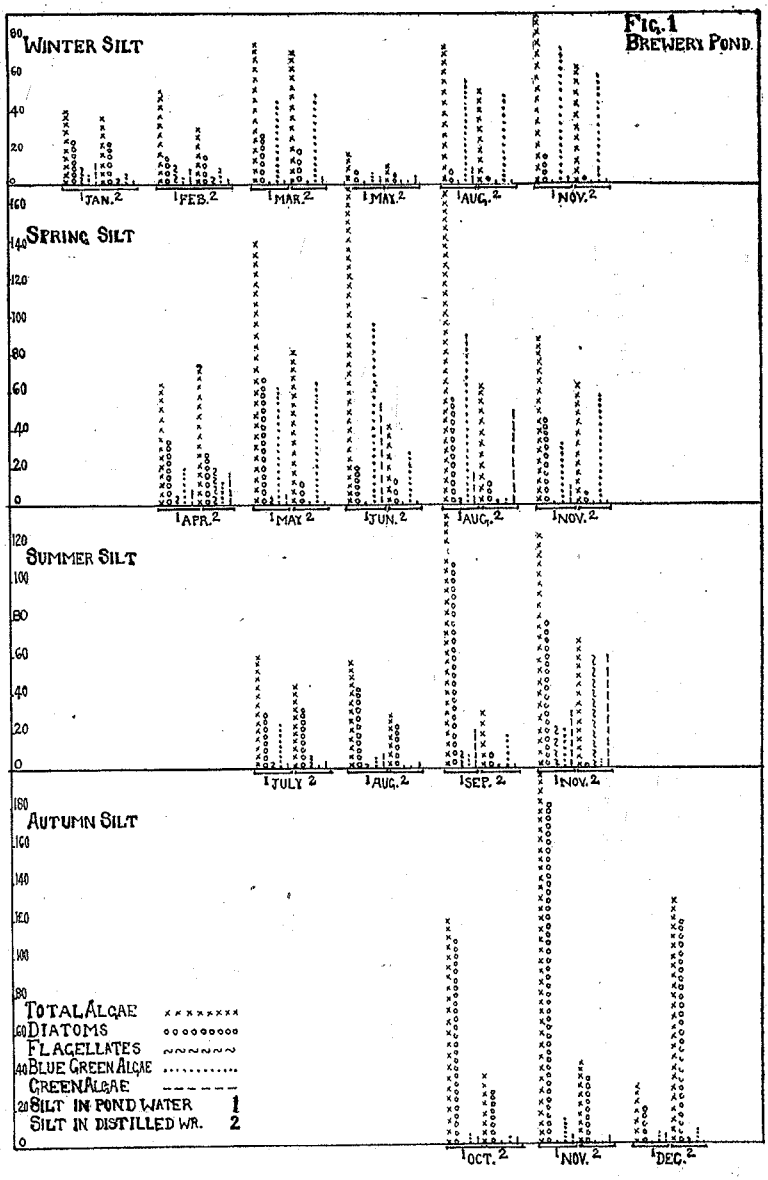


FIG. 1 BREWERY POND.

silt estimates were higher because of *Navicula cryptocephala* and *Oscillatoria terebriformis* (peaks in May) and *Anabæna* sp. (peak in June). By August *Synedra tabulata* and *Nostoc paludosum* were abundant. Of the three spring months' totals again, the total of algæ noticed in June was the highest, because of an additional green alga, *Scenedesmus quadricauda*. Of the diatoms prominent in November, along with *Nostoc paludosum, Navicula cryptocephala* and *Synedra tabulata* stood foremost.

In the spring silt treated with distilled water also, the flora was more conspicuous than the flora in winter, summer and autumn silts (Fig. 1). This was on account of *Oscillatoria terebriformis* (May) and *Anabæna variabilis* forma (June). *Nostoc paludosum* and *Nostoc spongiæforme* were abundant in August and November respectively. *Navicula cryptocephala* and *Synedra tabulata* were no doubt frequent in April but they did not fluourish thereafter. Even in spring, the flora of distilled water silt was poorer than that of pond water silt.

Summer silt (collected at the beginning of July 1948).

In the pond water summer silt the maximum dominance of algæ was noticed by September and this was due to *Synedra tabulata* and *Achnanthes affinis*. *Ankistrodesmus falcatus* and *Chlamydomonas* sp. too were present but in smaller numbers. The dominant diatoms by November were *Synedra tabulata* and *Achnanthes affinis*. *Cylindrospermum* sp. too was noticed at this stage.

Table I showing the pH variations of the two media on the silt of this pond shows a lowered pH by November in the case of "summer silt pond water medium". This lowered pH agreed with the appearance of a large number of *Chlamydomonas* spp. in November. This agreement threw some supporting light on the conclusions arrived at through field studies that abundance of *Chlamydomonas* and lowered pH could be associated.

The summer silt treated with distilled water showed a poorer flora again in comparison to that treated with pond water, just like the corresponding winter and spring silt. *Nostoc paludosum* was frequent in September and no other algæ appeared particularly conspicuous. But by November consistent with the lowered pH (see Table I) *Chalmydomonas* spp. became frequent just as in the summer silt treated with pond water.

Autumn silt (collected at the beginning of October 1948)

This silt treated with pond water showed a marked abundance of diatoms in October and November; *Achnanthes affinis* and *Cocconeis placentula* being the major ones. Excepting the sparsely present *Oscillatoria pseudogeminata* no other blue green algæ were frequent. In December the diatom total and the total algæ diminished.

The autumn silt in distilled water as usual was characterised by a smaller flora than that seen in pond water. In December, as an exception, *Achnanthes affinis* was noticed in rather large numbers and this accounts for the total of algæ being bigger than the corresponding total in pond water (Fig. 1—autumn silt).

TABLE I

Silt of the Brewery Pond—pH Variations of the Medium

		Jan.	Feb.	March	May	Aug.	Nov.
Winter silt :	P. W. ..	7·5	7·6	7·8	7·7	..	7·8
	D. W. ..	7·3	7·7	7·6	7·8	..	7·5
			April	May	June	Aug.	Nov.
Spring silt :	P. W. ..		7·7	8·0	7·0	..	7·2
	D. W. ..		7·7	7·9	7·0	..	6·5
				July	Aug.	Sept.	Nov.
Summer silt :	P. W. ..			6·4	..	..	5·5
	D. W. ..			5·9	..	..	5·1
					Oct.	Nov.	Dec.
Autumn silt :	P. W. ..				7·1	..	7·2
	D. W. ..				7·1	..	6·9

P. W. stands for Pond Water ; D. W. stands for Distilled Water.

(2) *Silt from the Lemna Pond*

The silt flora of this pond observed in the different seasons both in pond water and distilled water was always poorer than the flora of the Brewery pond silt (compare Figs. 1 and 2). But as noticed in the Brewery pond, more algæ were observed on the silt samples treated with pond water than on silt samples treated with distilled water considering all the four seasons.

Winter silt (collected at the beginning of January 1948)

In the winter silt treated with pond water, January counts were marked by *Cryptomonas ovata* and in March, *Euglena mutabilis* appeared in a large number. By May the bulk of algæ noticed was comprised of *Navicula pupula*, *Achnanthes linearis* and *Pinnularia subcapitata*, most of them however not being quite healthy. A large number of *Chlamydomonas* spp. and a few diatoms comprised the flora in November.

The winter silt treated with distilled water showed in January *Cryptomonas ovata* and *C. obovoides* and by March, an abundance of *Euglena mutabilis* was observed just like in pond water silt. The flora did not show any prominent changes later. Unlike in the pond-water silt, the diatoms in this silt did not significantly develop during the entire period of observation.

The pH of the "winter silt distilled water" had fallen from the January reading of 6·5 to 3·9 in November—*vide* Table II. The significant absence of algæ in the silt in November might be due to the very low pH. Lund (1942) reported a conspicuous fall in the algal flora in distilled water cultures (of bottom deposits of ponds) when the pH had fallen to 3·8.

TABLE II

Silt of the Lemna Pond—pH Variations of the Medium

			Jan.	Feb.	March	May	Aug.	Nov.
Winter silt :	P. W.	..	5·1	5·4	4·1	4·4	..	5·9
	D. W.	..	6·5	6·2	4·2	4·0	..	3·9
				April	May	June	Aug.	Nov.
Spring silt :	P. W.	..		7·7	8·3	6·9	..	6·5
	D. W.	..		7·7	8·3	6·4	..	6·1
					July	Aug.	Sept.	Nov.
Summer silt :	P. W.	..			6·0	..	..	5·9
	D. W.	..			5·3	..	..	4·8
						Oct.	Nov.	Dec.
Autumn silt :	P. W.	..				4·6	..	4·7
	D. W.	..				4·8	..	3·6

P. W. stands for Pond Water ; D. W. stands for Distilled Water.

Spring silt (collected at the beginning of April 1948)

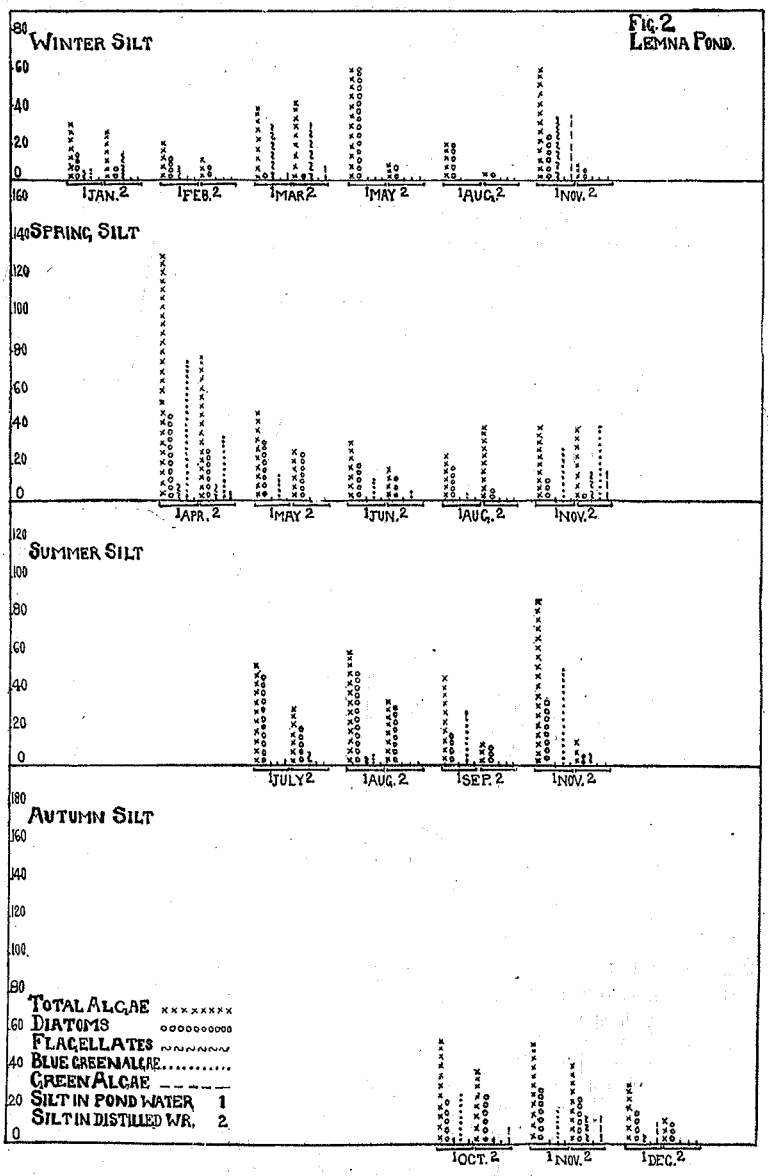
In the spring silt treated with pond water there was only an initial abundance of algæ and that was on account of *Navicula cryptocephala, Oscillatoria amphibia* and *Oscillatoria tenuis*. The only conspicuous alga in November was *Nostoc spongiæforme*.

This applied also to the spring silt treated with distilled water, though the bulk of its flora was much smaller than that of pond water silt of spring; the dominant algæ in November were *Chlamydomonas* (palmelloid), *Anabæna oscillarioides* and *Oscillatoria pseudogeminata*.

The flora of spring silt, whether in pond water or distilled water, was richer than that of winter, summer and autumn silts (Fig. 2).

Summer silt (collected at the beginning of July 1948)

This in pond water showed an initial diatom abundance in July consisting of *Synedra tabulata, Achnanthes affinis* and *Navicula cryptocephala*. By August, *Gomphonema parvulum* was in large numbers.



The rise of numbers in September was caused by *Nostoc spongiæforme*. In November, in addition to *Navicula cryptocephala* and *Synedra tabulata*, the flora was characterised by *Nostoc spongiæforme*, *Oscillatoria terebriformis* and *Os. pseudogeminata*.

No noticeable changes were there in the "distilled water treated silt" except that *Chlamydomonas* (palmelloid) was frequent in November. *Autumn silt* (collected at the beginning of October 1948.

In pond water, this silt showed a flora comprised of some diatoms (*e.g.*, *Synedra tabulata*, *Pinnularia mesolepta*, *Achnanthes affinis*) and some blue green algæ (*e.g.*, *Nostoc spongiæforme*, vegetative *Anabæna* and *Oscillatoria pseudogeminata*). This flora became very poor by December.

The autumn silt in distilled water showed *Pinnularia mesolepta*, *Pinnularia subcapitata* and palmelloid *Chlamydomonas* though in small numbers. No members of Myxophyceæ were noticed throughout. By December the already low pH fell to 3·6—*vide* Table II—and as explained earlier, the absence of flora at this stage was understandable.

All the same, whenever the pH was low, algæ like *Microthamnion kutzingianum* and *Ophiocytium arbuscula* and *O. cochleare* appeared to flourish. Lund (1942) described the first alga as one favouring markedly acidic conditions. In the Lemna pond silt, when the pH was 3·6 in December, this alga was quite frequently observed.

It might be observed at this stage, by comparing Tables I and II, that the pH of the media on the Lemna pond silt was in general lower in all the seasons than the pH of media on the Brewery pond silt. The possible explanation for these lower values might be that the Lemna pond had been a typical stagnant sheet of water with a reducing bottom and characterised by active decay of organic matter. The summer silt of the Brewery pond had shown pH values lower than those observed in the other seasons, the factor of greater decay in warmer months being a probable cause.

Summary

The algal flora noticed on the silt of the Lemna pond with a reducing bottom was in all seasons poorer than that of the Brewery pond which was regarded as having a normal (oxygen-rich) bottom.

The silt treated with pond water had shown a better growth of algæ in all the seasons concerned than the silt treated with distilled water, as seen in both the ponds.

As observed in both the ponds again, the silt collected in spring yielded a richer flora than the silts collected in winter, summer and autumn, though in the latter, obtained from the Brewery pond, diatoms were predominant.

Whenever the pH of the medium became low, a considerably diminished flora was observed.

The general succession of the different groups of algæ as noticed through field studies conducted on these ponds seemed to apply in a general way to the silt cultures also. Flagellates started the series in March, diatoms following by mid-spring, these in turn being followed by green algæ, blue-green algæ and some flagellates by summer. Finally autumn was characterised by diatoms.

The present study was undertaken mainly to find out whether algæ perennate on the pond bottom in any form thus accounting for the dominance at one time and the less frequent appearance or total

disappearance at other times but the results of the present study did not throw any light on the problem.

The algæ noticed in the silt cultures of both the ponds were the same as those observed in the field samples from near the surface of each pond, thereby suggesting that no special flora was confined to the silt as opposed to the general flora of the pond.

The writer is indebted to Professor F. W. Jane, Ph.D., D.Sc., for his guidance and criticism throughout the course of this work. He is also grateful to Professor W. H. Pearsall, D.Sc., F.R.S., for his interest in the work and for his helpful criticism.

Literature Cited

Lind, E. M. 1940. Experiments with pond muds. Jour. Ecol. 28 : 484–490.

Lund, J. W. G. 1942. The marginal algæ of certain ponds with special reference to the bottom deposits. *Ibid.* 30 : 245–283.

Transeau, E. N. 1913. The periodicity of freshwater algæ. Amer. Jour. Bot. 3 : 121–133.