A STUDY OF THE SOIL ALGÆ OF A JUST DRIED UP POND*

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(Received for publication on October 10, 1953)

With a view to study† the distribution and periodicity of algæ of 6 ponds on the Hadley Common, Hertfordshire, England, the writer started work in January 1947. The 6 ponds referred to were: Fish pond, Shallow pond, Brewery pond, Horse pond, Railings pond and Lemna pond. Of these, however, the Shallow pond dried up towards the beginning of August 1947. By about the middle of the third week of July the water level was very low. It was felt at this stage that a study of the algæ present in and grown from this soil, on being treated differently, would be worth-while, especially after having studied the periodicity of the algæ of the pond during the first 6 months of the year.

Experimental Procedure

The dry soil was collected on 11–8–1947 from three different spots in the pond about 3 feet from the edge and at approximately equal distances. At each spot, a cube of soil, about 10 cm. in edge was lifted. The 3 portions were mixed and dried in the laboratory in a paper-covered glass trough for 2 days.

Nine portions of this dry soil were taken (50 gm. each roughly) and treated, in triplicate, with distilled water, Knop's solution and Molisch's solution—100 c.c. to each portion. The containers used were jam jars with glass lids. The algæ that came up in these cultures were estimated after 12, 28, 70, 130 and 191 days. Each estimate was the average of all algæ counted in 30 high power fields of the microscope, each set of 10 fields chosen at random on two slides corresponding to each of the three replicates. The pH of the culture media was determined on the days when counts were made.

When the soil in the pond was still wet, *i.e.*, on 6–8–1947, a portion of the soil obtained by mixing three equal portions collected at three spots in the pond was brought to the laboratory and each of the three 50 gm. portions was kept in 100 c.c. of distilled water on the same day. The objects of studying the wet soil, in addition to the dry one, were two: (1) to find whether the wet soil would show any algæ different in form, especially as regards perennation, or in numbers from those grown from the dry soil and (2) to compare the pH of the 'wet-soil medium' with that of the 'dry-soil media' mentioned above and determine the effect on algæ of the difference in pH, if any. The algæ growing in these 'wet soil' cultures were estimated periodically. The first

* Part of a thesis approved for the Ph.D. degree of the University of London.

† The results of this study have been recorded in a separate communication.

estimate was made 6 hours after treating the soil and the further counts were made after 3, 6, 19, 35, 77, 137 and 198 days. Here also the pH of the medium was determined periodically.

During the earlier part of the observations the cultures were kept on a table in the room and during this period (August to October 1947) the days were warm and bright. In November 1947 the cultures were removed to the illuminated window box in the laboratory. Barring the difference in the nature of illumination, the cultures were in bright light all the time.

Observations

The dry soil in distilled water showed an increase in the 'total algæ' upto 70 days, there being no significant change later. This increase was mainly due to *Euglena mutabilis*, *E. intermedia* and other Euglenineæ. The green algæ and diatoms were in the same small numbers throughout. The medium was all the time acidic and showed no great variation—the values ranging from 6·7 to 6·95 (Fig. 1, A).

The dry soil in Knop's solution showed more or less the same 'total algæ' upto 130 days but after 191 days the number was high. The diatoms, specially *Synedra tabulata*, were on the increase while Euglenineæ decreased in number. The green algæ, however, like in distilled water, showed no great change during the time. The medium which was acidic—5·9—to start with turned alkaline (7·4) as noticed after 191 days (Fig. 1, B).

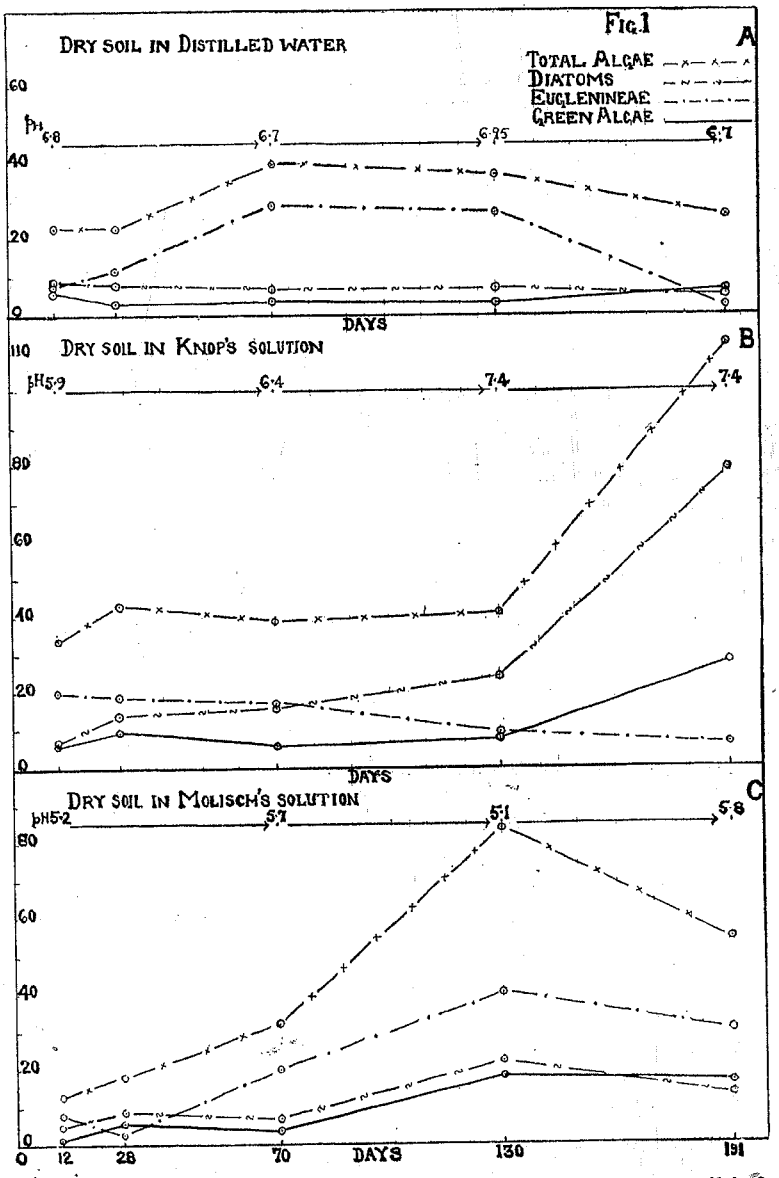
In Molisch's solution, the total of algæ steadily increased upto 130 days and there was a fall towards the end. All the three groups of algæ—Euglenineæ, Diatoms and Green Algæ increased in numbers, especially the first. The pH of the medium was distinctly acidic all the time, ranging from 5·1 to 5·8 (Fig. 1, C).

The wet soil in distilled water showed an abrupt rise of total algæ on the 3rd day and after the 19th day the numbers were more or less steady (Fig. 2). This abrupt rise was on account of *Chlamydomonas* spp. As seen in dry soil treated with distilled water and Molisch's, here also the Euglenineæ were on the increase all the time, though not to the same significant degree. Barring the *Chalmydomonas* spp. referred to, the green algæ and diatoms remained more or less steady all the time. The medium was distinctly acidic upto the 137th day, the range being 4·1 to 4·8 and towards the end, the reading was 5·9.

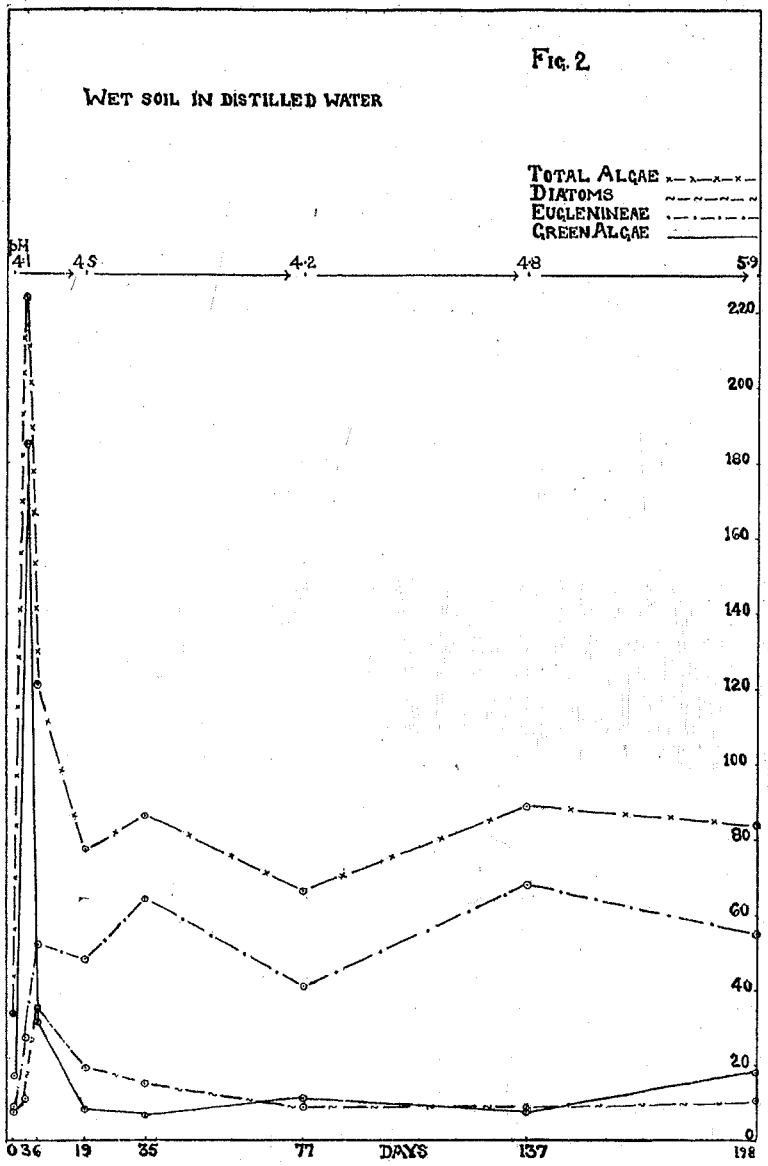
Either in this medium or in those referred to above no resting stages of algæ were observed.

Conclusions

The average pH (6 months' average) of the water of this pond was 6·5 and the water was relatively rich in iron throughout. From the field data, it was inferred that this pond harboured a large bulk of Euglenineæ on account of the water being acidic and rich in iron. The



indoor observations on the soil of this pond supported the detail inferred from nature. The acidic culture medium encouraged an abundance of Euglenineæ (Fig. 1, A & C) especially *Euglena mutabilis*. In nature this alga was conspicuous in this pond and also in the other acidic ponds. Lund (1942) described *Euglena mutabilis* as fovouring acidic conditions both in field and cultures. Species of *Euglena*, in fact, thrive best in acidic conditions. Harris (1941) noted a purer growth



of *Euglena viridis* when pH was between 4 and 6. Jahn (1931) and Alexander (1931) found *Euglena gracilis* growing best under acidic conditions.

A change in the culture medium from acidity to alkalinity as noticed in Knop's (from 5·9 to 7·4) appeared to have an effect on the algæ growing therein. Diatoms specially *Synedra tabulata* and *Pinnularia*

subcapitata showed an increase while Euglenineæ fell in numbers. This was in accordance with the conclusion drawn through the field data that diatoms were more numerous and Euglenineæ fewer in alkaline ponds than in acidic ones. It could not be explained why the Knop's medium alone should show a change from acidity to alkalinity along with time although Hopkins and Wann (1926) say that in unbuffered nutrient solutions marked changes in H-ion concentration may be brought about by unequal absorption of ions. The pH values of the untreated Knop's solution and Molisch's were 7·4 and 7·1 respectively as determined 200 days after their being prepared. The initial pH values were not determined because a change in pH on being treated with soil was not anticipated.

Of the three media—distilled water, Knop's and Molisch's—the last one showed greater acidity and it was in this medium that Euglenineæ were noted to be most predominant. This was in accordance with the inference from field data that a distinctly acidic water harboured a predominantly flagellate flora. Some green algæ also were comparatively abundant in this medium. It was of interest to note that those green algæ that were dominant in distinctly acidic waters in nature, *e.g.*, *Microthamnion kutzingianum*, *Closterium kutzingii* and species of *Characium*, contributed to this richness. Lund (1942) too observed in cultures *Microthamnion kutzingianum* and *Characium Pringsheimii* favouring very acidic conditions, *e.g.*, pH 4·0 to 5·0.

The wet soil in distilled water, besides showing the initial sharp rise in "total algæ", was richer in algal content than the dry soil treated with the three media (Fig. 2). This could obviously be due to there being more algæ in a vegetative state in wet soil than in a dry one. In an attempt to resist drying, it could reasonably be expected that only some algæ survive.

The pH of the "wet-soil distilled water medium" was much less through the period of observation than that of the three media treated with dry soil. Just before the pond dried up, the pH of the water was 4·9 and pH of the "wet-soil distilled water" medium was ranging from 4·1 to 4·8. The conditions did not very much alter the degree of acidity at which algæ in nature were thriving just before the pond dried up and the greater abundance of algæ in this medium therefore could be attributed to the maintenance of more or less the same degree of acidity in the laboratory medium as in nature. Thus in respect of this medium being comparatively rich in algæ, two features become relevant: (1) continuity of life facilitated by the soil being wet and (2) the degree of acidity of the pond water just before the pond dried up and that of the laboratory medium being more or less the same.

Blue green algæ were not observed in any of these cultures during the period when the other algæ were present and this must be due to the fact that the soil was highly acidic before being cultured. But when the cultures finally dried up after nearly 10 months the surface of the soil was closely examined. Soil surfaces which had been bathed by Knop's solution and distilled water showed signs of algal growth. A thin greenish coat on the surface of the soil in the Knop's cultures

was composed of pure *Oscillatoria splendida*. The reddish brown growth observed at the same time on the surface of the soil in the "dry-soil distilled water cultures" was due to *Phormidium laminosum* and colonies of *Nostoc*. The species was not identified as the colonies were without spores. At this time the soil in the other two cultures was not dry.

A month later, however, the soil surface of these two cultures, *i.e.*, Molisch's and "wet-soil distilled water" cultures—was exposed, but no visible growth of any alga was noticed. Even a microscope examination of the soil surface did not show any algæ.

It has been pointed out already that the pH of the Molisch's medium and the "wet-soil distilled water" medium was lower throughout than that of the two others (Knop's culture and "dry-soil distilled water" culture). The higher acidity of these two media might not have encouraged the growth of blue-green algæ which again would support the conclusion arrived at through field observations that blue-green algæ did not favour highly acidic waters.

SUMMARY

The relative numbers of algæ, that came up in the laboratory cultures set up by treating the dry soil of a just dried up pond with distilled water, Knop's solution and Molisch's solution showed variations and an attempt was made to explain these variations on the basis of field observations on this pond and the other ponds in the area.

A change of pH in the Knop's medium from acidity to alkalinity reduced the number of Euglenineæ and increased the number of diatoms; this being in accordance with the conclusion drawn through the field data that diatoms were more abundant in alkaline water than in acidic ones.

The dry-soil treated with Molisch's solution was more acidic than the other "dry-soil media" and the greater abundance of Euglenineæ in this medium was again in agreement with the field observation that a distinctly acidic water and an abundance of flagellates went together.

The algæ that appeared on the wet-soil of the drying pond after distilled water had been added were comparatively more numerous than those observed in dry soil similarly treated.

Blue-green algæ were not noticed in any of the cultures, during the period of observation, and the field observation that blue-green algæ were frequent in highly acidic waters was given as a reason for this absence. When the cultures finally dried up, however, blue-green algæ appeared on the soil previously present in Knop's solution and distilled water (dry soil treated with distilled water).

The author is indebted to Professor F. W. Jane, Ph.D., D.Sc., for his guidance and criticism during 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.

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