An investigation of the alga flora of the littoral sediments of South Hartley Farm pool Whitley Bay Northumberland

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by

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The object of the Investigation

The object of the following investigation is to determine the condition of the algal flora inhabiting the littoral sediments of a small pool where the water level varies considerably throughout the year, and alternately exposes the littoral sediments to dessication and re-irrigation.

There are the following possibilities regarding the state of the alga flora when the water level recedes:

(a) the algae may retreat from their original position in the sediments, and follow the receding water line, afterwards returning with the advancing water level.

(b) the algae may remain in the dessicated sediments when the water retreats. They may (i) perish entirely, and the re-appearance of the defunct species will, then be most probably due to re-invasion from the sediments, which have remained unexposed by the retreat of the water; or (ii) they may enter into a resting condition of some kind, such as a cyst, or aplanospore or other protected body; or (iii) they may persist in their original condition to all appearances, and resume their vegetative activity on re-irrigation. Fritsch has shown that certain algae can withstand periods of dessication without injury (Ref. Fritsch

It will be shown that the algae of the sediments of this particular

pool exhibit all the above possibilities. This will be shown particularly by the members of the Bacillaceae and Cyanophyceae, but the species of the Chlorophyceae in general showed a tendency to retreat with the water, though not invariably so.

The question of survival under conditions of dessication is of considerable importance in connection with the distribution of algae. Animals coming to drink at the pool, or birds coming to seek for food in the mud, must necessarily carry away on their feet appreciable quantities of sediment which, if it contains algae capable of surviving the temporary dessication, would inoculate the next pool which was visited by them.

SECTION I

bank. This pipe is in the bank about eighteen inches above water level. Any overflow is carried away by a drain situated in the extreme South East corner of the pool (Plate I outflow).

The pool is used for watering cattle which have free access to it. Owing to its shape they only use the North and South ends where the slope is gradual

SECTION 2

The Position of Stations and the Character of the Sediments of the Stations

Observations were taken at four stations which were named I, II, III and IV. Station I was situated in the extreme North East corner of the pool. Station II was situated on the North bank of the pool, twenty-five feet East of the West bank of the pool. This station was marked with a large red stone. Station III was in the South West corner of the pool. Station IV was near the South East corner of the pool, at a point on the South bank, four feet to the West of the Eastern bank. This was because the outlet of the pool was in the extreme South-East corner. (Plate I. The map of the pool). Each station was taken at Maximum water-level.

Samples of sediment were generally taken from positions in the pool, one foot in front of the water line at each station. These positions varied with the water level of the pool, and were therefore situated on lines, passing through the Stations, and roughly parallel to the East and West banks of the pool.

Another station, named III A was occasionally used for the taking of observations. This station was on the South side of the pool, forty feet in, from the West bank, (See Plate I Map) and ten feet in, from the Maximum level water line on the South bank. Samples of sediment were always taken from the same place at this Station. It was situated in a small depression which was separated.

from the rest of the pool (when the water level was at its minimum) by a low bank of sediment which protruded from the East bank of the pool, halfway across the South end. This bank was roughly parallel to the South bank. (Plate I Map and Section II)

The comparative, chemical, analysis of the sediments showed that they varied little in general composition. In all cases the sediments were mainly composed of sand, No clay was present in any of them.

The sediments of Station I contained more sand than those of the other stations, (88 parts per 100) (Plate VI). They contained average amounts of Carbonate of lime and. (3·7 parts per 100) of Carbonaceous matter. Station I was sheltered to some extent from the North and East winds by the bank which forms the East shore of the pool and by the cemetery wall (Sect I). It is exposed to the South and West winds, which are the prevailing winds in this district. These affect the water, which in turn affects the sediment, causing some of the organic matter to be washed out from it, The sediment at this station is generally lighter in colour after a West wind has been blowing.

The sediments of Station II contained least organic matter. Station II is situated on a comparatively exposed part of the North side of the pool, and not in a

Sheltered corner, hence the sediments were more exposed to movements of the water. The sediments of this station had only a poor Alga-flora.

The sediments of Station III contained a larger proportion of Carbonaceous matter, and Carbonate of lime, than those of Stations I and II. This was because Station III is commonly used by cattle as a drinking place. It was sheltered by the stone wall on the West, and by a portion of the South bank (Plate I Map) which protrudes into the pool on the East. The water here was generally calm, and the sediments were not so affected by its movement. This station's sediment contained a large number of Euglena and had a luxuriant Alga-flora.

Station IV was more exposed than Station III. The sediments of this station contained more organic matter than the sediments of the other three stations. This was because the current which flowed from the "Inlet" to the "outlet" of the pool, tended to carry organic matter with it. The general level of the sediment at Station IV was higher than the level of the sediment at the other stations (probably due to the influence of the current) and when the water retreated this sediment was always the first to be invaded by the Macroflora, and as the water level advanced, it was always the last to be re-irrigated

(Plate I Map and Section II)
(Plate II)

The Rainfall and Changes in Water Level.

The rainfall was obtained from the readings of a rain-gauge situated in an enclosed garden, about one mile from the pool. The rainfall there, would probably be slightly different from the actual rainfall at the pool which is situated in the open country, but in general the rainfall at the garden would be proportional to the rainfall at the pool. The readings of the rain-gauge were assessed monthly, and these results are expressed graphically on plates III IV and V.

As the pool is fed by the drainage of the pasture field in which it is situated, the rainfall has a direct bearing on the water level of the pool. The level of the water in the pool was taken from a mark made on the stone wall which supports the west bank. (see Plate I Map of pool) These readings were expressed graphically on Plates III IV and V.

The rainfall of 1923 was heavy in August and the latter part of November, and was comparatively low in June and September. The level of the pool was therefore high in August and the latter part of November and low in September. (see Plate III)

The rainfall of 1924 was heavy and was evenly distributed throughout the year; excepting during March which had a low rainfall.

The water of the pool remained near its maximum level in consequence, except in March when the water level fell two inches below maximum water level.

In 1925 the rainfall was not evenly distributed. Very little rain fell in June and in consequence the level of the pool fell to its minimum. The rainfall increased until September and the water in the pool gradually rose. The rainfall was low in October and the level of the pool again fell, but the level increased again until in December the pool was near to its maximum level. (Plate V)

The maximum level of the pool is only three inches above minimum water level, but as the depth of the basin is small compared with its radius of curvature when the water falls to its minimum level a considerable expanse of sediment is exposed. This is indicated on the Plan of the pool (Plate I)

SECTION 4.

The macroflora (bulk) of the sediments and of the ground adjoining the pool with special reference to the colonization of the sediment exposed by the shrinkage of the water.

The pool is surrounded on its North, West and South sides by meadow land. (Plate II) The dominant plants of the meadow are chiefly:-

Cura caespitosa Linn.

Agrostis alba Linn

Lolium perenne. Linn

Festuca ovina v rubra Linn

Ranunculus acris Linn.

Ranunculus repens Linn

Stellaria media Cyrill.

Trifolium repens Linn

Hieracium pilosella. Linn

Taraxacum dens-leonis Desf.

Bellis perennis Linn.

Plantago major Linn. and Plantago lanceolata Linn

Rumex acetosa Linn

The east bank of the pool is formed by a low mound surmounted by a hedge of Crataegus oxyacantha. Linn. The predominating plants present on this mound are the following:-

Rosa canina Linn.

Rubus fruticosus. Linn

Stellaria Holostea Linn

Lamium Album Linn

Potentilla anserina Linn.

Plantago lanceolata Linn.

Rumex obtusifolius Linn

Dactylis glomerata

The East bank of the pool is steep and at the water edge are found patches of Juncus conglomeratus. Scattered Patches of Alisma plantago are found near the west bank of the pool (Plate II). The middle of the pool is occupied by a profuse growth of Lamprichillea palustris. This is never seen above the level of the water ~~and~~ or rises to the surface of the water. It is often covered with an epiphytic growth of Characeum gracilepe

In June 1923 the water level of the pool was low (Plate III) and a considerable expanse of sediment was exposed. This sediment was at first covered by an algal film composed of Oscillatoria tenuis, Oscillatoria limosa and Anabaena inequalis. This film gradually became dessicated and disappeared (Section 8. P.), as the water content of the sediment became lower.

The exposed sediment at the South end of the pool was first invaded by Taraxicum dens-leonis, Plantago lanceolata, Plantago major and Stellaria media. It is probable that the sediment was inseminated with seeds of the above plants by the wind, or by birds coming to seek for food in the sediments of the pool. Shortly after this seedlings of grass (Festuca ovina v. rubra. and Lolium perenne) appeared. The flora of the surrounding meadow now invaded the edges of the exposed sediment; The grasses encroached more quickly than the other plants. Ultimately the sediments were covered with a growth of Macroflora composed chiefly of; Taraxicum - dens-leonis, Plantago - lanceolata, Plantago - major, Stellaria media, Ranunculus repens, Potentilla anserina, Rumex obtusifolius, Rumex acetosa, Lamium album, Dactylis glomerata.

Lamium Album and Potentilla anserina were found

chiefly near the hedge, which surmounts the East bank of the pool. These plants were not found in the meadow but only on the bank which forms its Eastern boundary.

The exposed sediments at the North end of the pool was only sparsely covered with macroflora which consisted chiefly of Plantago major Plantago lanceolata, and Lolium perenne. Plantago major grows nearest to the water line.

In 1924, the sediment was exposed for three weeks in October, and very little macrophytic vegetation appeared except a small amount of Lolium perenne and Festuca ovina: These grasses were only found near the edge of the exposed sediment.

In 1925 the water of the pool fell to its minimum level (Plate V) from June to September. The exposed sediment at the South end of the pool was again invaded first by Stellaria media, Plantago major and Plantago lanceolata. Seedlings of Polygonum aviculare (Linn) were also present. The exposed sediment had at first been covered with the algal film consisting chiefly of Oscillatoria tenuis, Oscillatoria limosa, and Anabaena inequalis. This film became desiccated and finally disintegrated. Ultimately the exposed sediment was covered with a growth of macroflora consisting chiefly of:-

Plantago major, Plantago lanceolata, Stellaria media, Polygonum aviculare, Trifolium repens, Ranunculus repens, Taraxacum dens-leonis, Bellis perennis, Rumex acetosa, Lolium perenne, Dactylis glomerata and Festuca ovina.

The exposed sediments at the North end of the pool were again only sparsely covered with macrophyte vegetation, which consisted chiefly of Plantago major, Plantago lanceolata and Lolium perenne.

From the above observations it appears that the sediments exposed by the shrinkage of the pool are first invaded by plants, whose seeds have been carried there by wind or by animals. They are then invaded by other plants which grow in the surrounding meadows. These spread inwards from the edge of the pool, the grasses spreading more quickly than the other plants.

As the water of the pool advances when the pool is rising, these plants are immersed. They become water logged and the grasses are generally covered with an epiphytic growth of Characeae gracilis. They finally decay and disappear.

SECTION 5

Methods of Collection

The sediment was collected with a small tin cylinder about two inches in diameter which was fastened onto the end of a stick. Over the lower end of the cylinder was lashed a piece of muslin. The upper end was left open. The sediment was collected by scraping the surface mud of the pond with the cylinder. The surplus water escaped through the muslin. The sediment was then placed in a specimen tube. Sediment was generally taken from points not more than one foot from the shoreline at the various stations.

Methods of Preservation

The material was preserved by adding enough 40% formaldehyde to ensure that the sediment was in a 2% solution of formaldehyde.

Experimental Methods of Observation

The material in 9% formaldehyde was examined in the following manner. The tube containing the material was thoroughly shaken and a small quantity of the material was taken from the tubes by means of a pipette at intervals of one, two and three minutes after shaking. This was to allow for sedimentation. This material was placed upon slides and examined microscopically.

The following scale was used to classify the numbers of organisms present in a sample of material:-

rrr	–	one organism present in a field at HP
rr	–	two organisms " " " " " "
r	–	three to five " " " " " "
m	–	five to ten " " " " " "
m m	–	ten to twenty " " " " " "
m m m	–	more than twenty " " " " " "

These results of the investigations were tabulated and are expressed in the sheets accompanying this Thesis.

The measurements needed to identify the organisms occurring in the sediments were made by means of the "Camera lucida"

When dessicated sediment was used, this was generally ~~dessamined~~ examined in water. When dessicated sediment was irrigated it was placed in a shallow dish and irrigated with distilled water. This dish was covered with a piece of muslin to prevent contaminates

SECTION 6.

The general microflora of the Sediments of the Pool Section

The microflora of the Littoral Sediments can be divided into two groups.

I These organisms which survive in the desiccated sediment. These remain in the Sediment through the any period and can be revived at any time by the addition of water to the dessicated sediment. This group can be subdivided into two divisions

(a) Organisms which occur in the dessicated sediment as cysts or aplanospores. chiefly:-

Amoebae sp.

Arcella vulgaris

Euglena sp.

Oscillatoria tenuis Ag.

Oscillatoria limosa Ag.

Spyrogyra crassa. Kutz. Eunotia pectinalis Kütz

(b) Organisms which occur in the dessicated sediments in an apparently unchanged condition or by thickening or mucilagenation of the cell wall. chiefly:-

Nitzschia Sigmoidea. Ehrenb.

Navicula Sphaerophora (Kützing).

Navicula platystoma (Ehren.)

Navicula exilis (Kützing)

Cocconema lanceolata (Ehrenberg).

Characium graciles. (Lambert)

6. Gyrosigma acuminatum var. curta (Grünow)

Oscillatoria tenuis Ag.

Cinabaena inequalis Kütz

II These organisms which are found in the submerged sediment but do not survive in the dessicated sediment. This group can be subdivided into two divisions

(a) Organisms which remain in the dessicated sediment only as dead and empty cells namely:-

Scenedesmus quadricauda (Turp) Bréb.

Closterium acerosum. (Shrank) Ehrenb.

Fragilaria capucina Desmazières

(b) Organisms not found in the dessicated sediment and which apparently retreat with the water namely:-

Lyngbya aeruginea-coerulea (Kutz) Gom.

Pteromonas angulosa (Carter) Lemm.

Scenedesmus obliquatus (Turp) Kütz

Scenedesmus bijugatus Kütz

Ankistrodesmus falcatus (Corda) Ralfs.

Largenheimia Wratislaviensis Schroeder

Closterium spetaicum (Näg)

Actinastrum Hantzschii (Lagerh)

Trachelemonas hispida

Tabellaria flocculosa. Kützing

SECTION 7.

Characteristics of the flora of the dessicated sediment.

The material used for observation was samples of sediment that had been exposed to the atmosphere for varying lengths of time, by the sinking in level of the water of the pool, and thus had become dessicated.

The samples of sediment were collected at Stations I, II, III and IV on the following dates.

September 25th 1923,

November 14th 1923.

June 9th 1924.

September 20th 1925.

On the first three occasions samples were taken at approximately three feet behind the water line at the four stations. On the last occasion samples were taken at four feet behind the water line and six feet behind it, as the moisture contents of the two sediments differed greatly. The sediment taken from four feet behind the water line at station I contained 8.6% of water, while that at six feet behind the water line contained 2.4% of moisture.

The dessicated sediment was mounted in sterile water and examined and the following

observations on organisms persisting in the dessicated sediment were made.

Amoebae sp. were found in all instances in the dessicated sediment and were fairly numerous. These were in an encysted condition and were surrounded by a very thick, rogae wall, which was brown in colour. The protoplast was shrunken and withdrawn from the cell wall.

On one occasion only, and that on September 20th 1925 has Arcella vulgaris been found in the dessicated sediment. It did not appear to diverge in any way from the normal organism found in the submerged sediment of the pool.

Resting stages of Euglena sp were found on November 17th 1923, and on September 20th 1925. The Euglena sp. were generally rounded and the cell wall was thickened. The cell contents were green and in some cases were filled with small granules. The sediment of Station I, on November 17th, 1923. contained more moisture than the sediment of the other three Stations, because a South-West wind had caused the water of the pool to irrigate the sediment at this station. Euglena sp were present in the sediment at this station in their

normal condition.

It appears that the organisms in the above section, during a period of dessication tend to surround themselves with a thick wall and the cell contents tend to concentrate and shrink from the cell wall. but are in contact with it at certain points. The cell contents also tend to become granular in the case of Euglena. These results agree with those of Fritsch. (Ref II P. 18).

BACILLAREAE

The Bacillareae are represented in the dessicated sediment by Nitzschia sigmoidea, Navicula sphaerophora, Navicula platystoma, Navicula exilis, Cocconema lanceolata Fragilaria capucina, Gyrosigma acuminatum, and Eunotia sp pectinalis Kutz

Nitzschia Sigmoidea was found in the dessicated sediment of September 25th 1923, and occurence here was comparatively rare. The protoplasts of the diatoms present were green in colour and were frequently moniliform in shape. The walls of the diatom appeared to be thickened with a mucilagenous exudation, yellow in colour, which was covered with adherent particles of sediment.

Navicula sphaerophora was found to be present in nearly all the material examined. The two platyform chloroplasts showed the following variations in the diatoms observed :-

1) They retained their normal shape and brown colour and in this case oil globules were generally observed to be present.

2) They retained their brown colour but appeared as two irregular masses, or were fused together to form one irregular mass. In many cases this mass was moniliform in shape.

3) They were green in colour and had assumed

the shapes referred to in the previous paragraph.

At the same time the cell wall appeared to be thickened with a yellow mucilagenous exudation which adhered in irregular masses to the wall of the diatom. To the mucilage itself adhered particles of sediment. In several cases, on September 20th 1925, the chloroplast was observed to be breaking up into brown, irregular granular fragments. (Plate VII Figs 2+3)

On March 15th 1925, several Navicula sphaerophora were observed with small, colourless, needle-shaped crystals adhering to the walls of the diatom.

Navicula platystoma occurs frequently in the dessicated sediments. The chloroplasts behave in the manner as those of Navicula sphaerophora. The [redacted] walls of the diatoms observed on September 20th 1925 were slightly thickened by a yellow mucilagenous exudation. No particles of sediment were observed adhering to the walls of the diatom. (Plate VII Figs. I)

Navicula exilis occurs frequently in the dessicated sediment. When examined they did not appear to differ from those found in the submerged sediments except that the chloroplast had changed from brown to green in colour and oil globules were frequently observed.

Cocconema lanceolata was present in

all dessicated sediments except those of September 25th 1923
The chloroplast was generally brown in colour but
occasionally as on Sept 20th 1925, was green. The
chloroplast was either in two irregular masses in the cell
or in one irregular mass which sometimes assumed
a moniliform shape. Oil globules occurred
frequently. In most cases the wall was thickened with
irregular masses of mucilage which adhered to it.
Particles of sediment in turn adhered to the mucilage.

Eunotia pectinalis appeared only in the
dessicated sediment of September 25th 1923. The diatom
contained a number of yellowish-brown, round
spore-like bodies. The walls appeared to have
a mucous investment. The appearance was
isolated and did not permit further investigation
(Plate VI Figs 5 & 6) (Ref 6. P. 111)

Gyrosigma acuminatum was found in the material
of September 20th 1925. The chloroplasts were green in
colour and the green colour had diffused throughout the
contents of the diatom. No noticeable thickening of
the cell wall was observed.

Fragilaria capucina was present in the dessicated
sediment of November 14th 1923, and September 20th 1925
when alive (death was assumed when the diatom was
devoid of contents), it did not appear to diverge
from the normal diatoms found in the submerged sediment.

From the above observations it appears that some members of the Bacillareae prepare for a period of dessication by thickening the wall of the diatom with an irregular layer of mucilaginous matter to which particles of sediment adhere. This may be a device to conserve the water supply in the diatoms and to absorb from the surrounding sediment what moisture is present.

The chloroplasts may retain their original colour and shape in which case oil globules are generally present. Often the chloroplasts change in colours, from brown to green and they may assume various shapes of which the navicular form appears to be the commonest.

CYANOPHYCEAE.

The Cyanophyceae are represented in the dessicated sediment by Oscillatoria limosa, Oscillatoria tenuis, and Anabaena inequalis.

Oscillatoria tenuis was observed in the dessicated sediment of. November 17th 1923, July 9th 1924 and. September 20th 1925. Oscillatoria tenuis occurs in the dessicated sediment, and also in the submerged sediment. more frequently, and in greater profusion than either Oscillatoria limosa and Anabaena inequalis

Oscillatoria limosa was found in the dessicated sediment of September 25th 1923, and September 20th 1925. Single nesting spores were found in the dessicated sediments of. November 17th 1923.

Anabaena inequalis was found in the dessicated sediments of November 17th 1923. and September 20th 1925.

Oscillatoria tenuis and Oscillatoria limosa ~~and~~ are found in the dessicated sediment in two forms:-

1) The outer walls of the filament are coated with an irregular layer of mucilage. The protoplasts ~~have~~. have changed in colour from blue-green to a brownish-green. When supplied with

Sufficient moisture the filament apparently resumes its normal condition after twenty-four hours.

2). Each cell in the filament enters into a resting condition. The cell contents change from a blue-green to a brown-green colour and the cell walls are considerably thickened It is probable that some of the specially adapted cells break away from the filament In samples of dessicated sediment taken at Stations I and III on September 20th 1925 filaments of Oscillatoria tenuis, about twenty cells in length were observed, and four or five adjoining cells in each filament were empty. The transverse septa were absent but parts of the outer walls remained. The cells adjoining the absent cells, were rounded and protruded into the spaces once occupied by the contents of the empty cells. In one case concave cells between the septa were seen. The cells in the remainder of the filament had brownish green contents and the cell walls were considerably thickened (Plate VII Fig 4). (Ref. P41)

It is probable that these resting cells when supplied with sufficient moisture, germinate, and grow into short filaments about six cells in length. In most cases when dessicated sediment had been resubmerged for about

three days, many short filaments of both Oscillatoria tenuis and Oscillatoria limosa were observed. These filaments were generally six to eight cells in length.

When dessicated sediment was placed in water under experimental conditions on November 17th 1923 and September 30th 1925 many ~~short~~ filaments of Oscillatoria tenuis and Oscillatoria limosa were observed after the sediment had been immersed for three days. These filaments were about six cells in length and are probably hormogines as described by Crow (Ref. P. 120)

It is probable that resting cells of Oscillatoria tenuis and Oscillatoria limosa had germinated and grown into these short filaments.

Anabaena inequalis was found in the dessicated sediment. It did not appear to differ from the normal filaments found in the submerged ~~filaments~~ sediment.

CHLOROPHYCEAE

Scenedesmus Quadricauda was found in the dessicated sediment of September 20th 1925. The cells present contained a number of brown granules, in addition to the protoplast which was generally much shrunken. The protoplast generally remained in contact with the cell wall at some point. In some cases the protoplast appeared to be in a state of division.

Spyrogyra Crassa was not found in the filamentous condition in the dessicated sediment except on September 25th 1923, at Station II, when a short filament of six cells in length was found. The contents of the cells had broken up into small fragments, and were probably in the process of disintegration. Zygospores of Spyrogyra Crassa have been found in the dessicated sediment. When samples of dessicated sediment were placed in water on November 17th 1923, a germinating zygospore was observed after three days had elapsed. A germinating zygospore was observed in sediment taken from three feet behind the water line at Station IV on September 20th 1925. The sediment was moist

SECTION 8

Variations in water level and the condition of organisms and the sediment as the water recedes.

The variation in level is only about three inches, but as the depth of the basin is small compared with its radius of curvature, a considerable expanse of sediment is exposed when the water falls to its minimum level. This expanse of sediment is indicated on the "Plan of the pool" (Plate I)

In June and September 1923 the pool was very low and the water fell 2·5 inches below the maximum level point. (see Plate III)

In 1924. the rainfall was heavier than in 1923 and was more evenly distributed throughout the year. As a result the pool showed very little variation in water level except towards the end of September when it fell 0·75" below Maximum water level. (Plate IV)

In 1925 the rainfall was much less than in the two preceding years. In June the pool sank to its minimum level and varied little from that level until September when it began to fill and the Maximum water level was reached in January 1926 (Plate V)

As the water of the pool was subsiding, samples of sediment were taken from the following places:-

(a) points in the pool. six feet from the water edge. at Stations I, II III and IV.

(b) positions at the water edge at Stations I II III and IV

(c) positions one foot behind the water edge. at Stations I, II III and IV.

Samples were taken on three occasions, June 9th 1923, Sept 18th 1923, and May 20th 1925.

In the Sediments taken from the positions in the pool. six feet from the water edge, the following organisms were found to be common to the sets of Sediments examined.

Amoebae. SP

Euglena. SP

Nitzschia Sigmoidea

Amphora ovales (var. pediculus) on Nitzschia Sigmoidea

Navicula sptaeroptera.

Navicula exilis

Tabellaria flocculosa.

Coccenema lanceolata

Gyrosigma acuminatum. v. curta.

Characium gracilips

Csallatoria lenuis

Cspallatoria lemosa

Scenedesmus quadricauda

Scenedesmus bijugatus

Scenedesmus obliquus.

Largenheimia wratislaviensis

Coelastrum sphaericum

Actinastrum Hantzschii

Spyrogyra crassa.

Closterium acerosum.

In the Sediments taken from the water edge the following organisms were found to be common to all:-

Amoebae.

Navicula Sphaeroptora.

Nitzschia Sigmoideae

Navicula exilis

Tabellaria flocculosa.

Gyrosigma acuminatum v. curta.

Scenedesmus quadricauda (rare)

Scenedesmus bijugatus (rare)

Oscillatoria limosa

Oscillatoria tenuis

In the Sediments one foot behind the water line the following organisms were common to all:-

Amoebae (in an encysted condition)

Nitzschia Sigmoidea
Navicula Sphaerophora.
Navicula exilis
Cocconema lanceolata
Gyrosigma acuminatum
Oscillatoria limosa.
Oscillatoria tenuis.

} In the resting stages described in Section 7.

Two Scenedesmus quadricauda were found on September 20th 1926 in the dessicated sediment. One of the organisms was empty and therefore assumed to be dead. The protoplast of the other had broken up into brown irregular granular fragments, as if about to disintegrate

On June 9th 1923, two specimens of Closterium acerosum were present in the dessicated sediment one foot behind the water line. The protoplast of one was much shrunken and was granular. The protoplast of the other had broken up into granular fragments, possibly a state in the process of disintegration

From these observations the organisms present in the sediments one foot behind the water line, with the exception of Scenedesmus quadricauda and Closterium acerosum, remain in situ when the water recedes and then enter into some form of resting stage.

to withstand the period of dessication

Other organisms are seldom found in very shallow water or in dessicated sediment. These include -

Scenedesmus quadricauda

Scenedesmus obliquus

Scenedesmus bijugatus

Largenheimia wratislavensis

Coelastrum sphaericum

Actinastrum Hantzschii

Closterium acerosum.

It appears probable that these organisms are unable to persist through a considerable period of dessication. When left in situ in the dessicated sediment they disintegrate and perish. They occur more frequently in relatively deep water (from two to five inches in depth) than in shallow water (from one half to two inches in depth) Apparently they drift in some way from shallow water to deeper water as the level of the pool varies. In this way they probably minimise the chance of exposure to dessication

The Cyanophyceae behave in a characteristic manner as the water in the pool subsides. As the water recedes, the newly exposed sediment becomes covered with a green film composed of Oscillatoria tenuis, Oscillatoria limosa and Anabaena inequalis. Oscillatoria tenuis appears in much greater profusion than the other two algae.

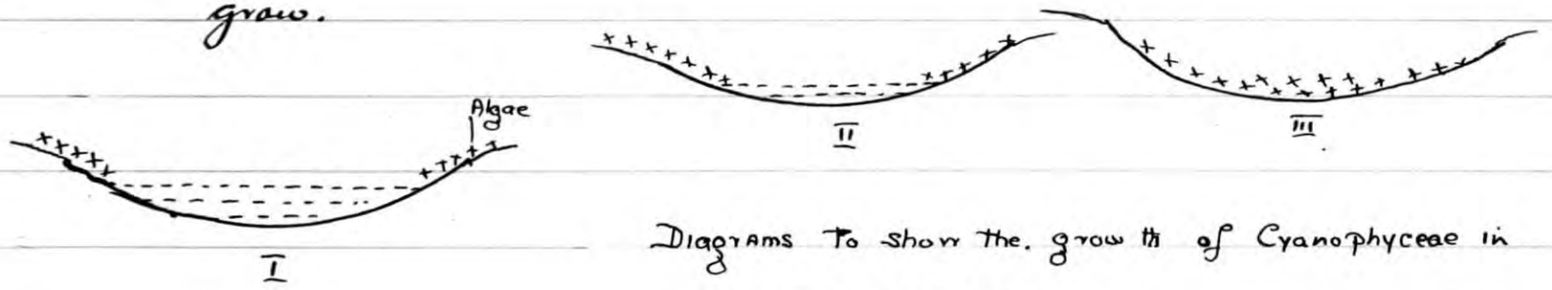
The floor of the pool is very uneven when seen through the shallow water near the shore owing to ripple marks. At the North and South ends it is still more uneven and contains numerous small depressions which are in most cases caused by the trampling of the feet of animals which come to drink at the pool.

The algae form a film over the whole of the sediment which is exposed to the atmosphere as the water recedes, but in the depressions, which contain water, algal growth is more luxuriant than elsewhere.

At first in each small depression, only the drying sides of the depression are covered with the algal film. Gradually, as the water evaporates, the exposed sediment is covered by the algae so that by the time the water level in the depression is very low, a thick green mat is formed at the bottom of the depression.

Should the water return at this stage (as it frequently did in 1924), the film generally floats on the surface of the water and is blown to one side of the pond. The film does not persist, but apparently disintegrates rapidly into individual filaments, and disappears from view.

Should the water not return for a long period, the film gradually dessicates, becomes brown and brittle and disappears. The algae enter into the resting stages described in Section 2, the sediment dries and cracks and the macroflora begins to grow.



Diagrams to show the growth of Cyanophyceae in small depressions

In May 1925 at Stations I and II it was observed that several masses of Spyrogyra crassa, which had been blown to the edge of the pool by wind, entered into a state of conjugation and formed Zygospores. These Zygospores were probably left in 'situ' by the water as it receded, and germinated when the ground was resubmerged.

SECTION. 9A.

Variations in water level and the behaviour of organisms as the water advances. (a) Observational.

The water in the pool sank to its minimum level several times during the years 1923-5. On three occasions namely, in September 1923, in November 1923 and in September 1925 the floors of the sediments, throughout the periods of inundation which followed the dry periods, were observed.

In each case organisms common to the sediments of the four stations were noted. Samples of sediments were taken at the four stations at the following times, and at the following positions, namely:-

(1) Samples were taken at the water edge several days before the period of inundation

(2) Samples were taken behind the water edge, at several days before the period of inundation,

(3) Samples were taken at the water edge from three to five days after the beginning of the inundation period.

(4) Samples were taken at the water edge, two weeks after the beginning of the period of inundation

(5) Samples were taken at the water edge, three weeks after the beginning of the period of inundation

The results were arranged in the following tables.

The Table of organisms in sediments from Sept 18th - Oct 20th 1928

Organism	At water edge. Sept. 18th	At water edge Sept 25th	4' behind water edge Sept 25th	At water edge. Oct. 3rd.	At water edge Oct 13th	At water edge. Oct 26th
Amoebae.	m.	m	—	—	m R.	—
Euglena.	vv	v v	-	m.	v	m
Nitzschia Sigmoideae.	—	v	v v R.		m	—
Nitzschia Sigmoideae + Amphora Ovalis	m	v	v R.	m	m	—
Navicula Sphaerophora.	—	—	m R	v	—	m m
Navicula exilis	v	m	m R	—	v v	m m
Gyrosigma acuminatum	v	v v	—	m	m	
Oscillatoria limosa	—	—	v R.	m Short lengths	m Short lengths	v
Anabaena inequalis	—	—	—	—	—	v
Scenedesmus quadricauda Nannochloris sp	m m	m m		m m	m m	v
Scenedesmus bijugatus	m	m		m	v	v
Actinastrum Hantzschii		v				
Largutiemia wratislaviensis		v				
Coelastrum sphaericum					m.	v
Spyrogyra Crassa	v	m m			v v	m m
Oscillatoria Tenuis	v ~~m~~	v ~~m~~		Short lengths m m	Short lengths m m	—
Characium gracilis	v	v	—	—	—	—
	Before Inundation.			Period of inundation		

R = Resting condition as in Section I

Table of organisms common to sediments of the four stations Nov 3rd a - Dec 5th 1923

	Nov 3rd a.	Nov 17th 1yd. behind waterline	Nov 17th 12 yds. behind water edge	Dec 5th
Amoeba.	m	m R	m R	m R
Euglena	m	m R	r r r	—
Nitzschia Sigmoideae	m	—	r r r	—
Nitzschia Sigmoideae + Amphora Cocks.	r	—	r	—
Navicula Sphaeroptera.	m	m R	r	m.
Navicula exilis	m	r R	m	m
Cocconema lanceolata	r	r R	—	—
Bacillaria lineus	—	m R	m short length	m short length
Bacillaria linea	—	—	m short length	m short length
Scenedesmus quadricauda	r	r	r	—
Gyrosigma acuminatum	m	=	r r R	=
Characum graciles	m	—	—	—
Anabaena inequalis	—	r	—	m short length

before Inundation

Period of Inundation

R = Resting condition as described in Section 5

September 1925.

Organism	Sept 18th	At lateral waterline Sept 20th	Alkali edge Sept 20th	Sept 27th	Oct 3rd.
Amoebae.	r R.	r R.	r R.	—	—
Euglena.	m.	r R	m	—	m.
Trachelomonas hispida	rr.	rr.	—	—	m.
Nitzschia Sigmoidea	—	rr R.	—	r	r
Navicula Sptaroptera	r	r R	r	r	m.
Navicula platystoma	r	r R.	r	r	r
Navicula exilis	r	r R	r	r	m.
Cocconeis lanceolata	r	rr R	r	r	m.
Gyrosigma acuminatum	r	r R	r	—	m m.
Bacillaria tenuis	- r	rrr R.	m Short lengths r	m Short filaments	m.
Bacillaria tenuis	—	—	m	m Short filaments	r
Lyngbya.	—	—	r	r	—
Surirella inequalis	r	—	r	m Short filaments	—
Scenedesmus quadricauda	Mm	—	m.	M m	Mm.
Scenedesmus obliquatus	Mm	—	m	m m	m m
Scenedesmus obliquus	-	r	r	m	—
Pleuromonas angulosa.	—	—	—	r	m m.
Ankistrodesmus falcatus	—	—	—	r	r
Spyrogyra crassa	—	R.	Germinating Zygospor.		
Characium graciles	—	—	—	m	m m
	Before inundation			Period of inundation	

R. Resting condition as described in Section 2

September 1925.

Organisms	Sept 18th	Sept 20th	Sept 20th	Sept 27th	Oct 3rd.
		Inundation water fine	Inundation water edged		
Amoebae.	r R.	r R.	r R.	—	—
Euglena.	m.	r R	m	—	m.
Trachelomonas hispida	rr.	rr.	—	—	m.
Nitzschia Sigmoidea	—	rr R.	—	r	r
Navicula Sp[h]enoptera	r	r R	r	r	m.
Navicula platystoma	r	r R.	r	r	r
Navicula exilis	r	r R	r	r	m.
Cocconeis lanceolata	r	rr R	r	r	m.
Gyrosigma acuminatum	r	r R	r	—	m m.
Bacillaria tenuis	- r	rrr R.	m Short lengths	m Short filaments	m.
Bacillaria tenuis	—	—	r	m short filaments	r
Lyngbya.	—	—	r	r	—
Tabellaria inequalis	r	—	r	m short filaments	—
Scenedesmus quadricauda	m m	—	m.	m m	m m.
Scenedesmus obliquatus	m m	—	m	m m	m m
Scenedesmus obliquus	—	r	r	m	—
Pleromonas angulosa.	—	—	—	r	m m.
Ankistrodesmus falcatus	—	—	—	r	r
Spyrogyra crassa	—	R.	Germinating Zygospores.		
Characium graciles	—	—	—	m	m m
	Before Inundation			Period of Inundation	

R = Resting condition as described in Section 2

From the three tables of results the following organisms are found to be present in the dessicated sediments behind the water line. The were all found in the nesting conditions described in Section 3

The organisms were chiefly:-

Limoebae. sp

Euglena. sp

Nitzschia sigmoidea

Navicula sptaeroptera.

Naviculs platystoma.

Navicula exilis

Cocconema lanceolata

Gyrosigma acuminatum

Oscillatoria tenuis

Oscillatoria limosa

Anabaena inequalis

Zygospores of Spyrogyra crassa.

As the water level rises and the water reinvigates the dessicated sediment, the following organisms return with it:- Scenedesmus quadricauda.

Scenedesmus bejugatus.

Scenedesmus obliquus

Coelastrum sphaericum

Pteromonas angulosa.

Characium gracilipes

These organisms continue to multiply rapidly and are very flourishing for a period. The organisms which have been present in the desiccated sediment take several days to recover their normal condition. At the end of five days the Amoebae are still encysted; the Bacillariae present are recovering, but the chloroplasts had still not returned to their normal shapes; the resting cells of Oscillatoria tenuis and Oscillatoria limosa are germinating and many short filaments of both these algae are present. Germinating zygospores of Spyrogyra crassa were found on ground that had been inundated for three days.

The grass present on the newly inundated sediment either floated to the surface of the water, and was blown to the side of the pool where it disintegrated or became covered with a profuse epiphytic growth of Characium gracilipes (Sect 4 P.14). This growth was particularly luxuriant at Station IV, and it is probable that this was because the current of the pool tended to run between the entry pipe in the west bank to the outlet-drain in the South-east corner. The macroflora (Zannichella Palustris) which occupied the central portion of pool, was covered with the

epiphyte Characium graciles. Any detached organisms of Characium graciles would be carried towards Station IV and attach themselves to the grass there. The organisms which return with the water, continue to multiply rapidly for about two weeks after the ground has been inundated and then through the water of the pool. The floor of the pool was observed to become covered with a reddish-brown film. This was apparent first in the bottom of the small hollows, formed by the movement of the water. Gradually it spread until the whole of the floor of the pool was covered with the film. At this period the Bacillareae present increased in numbers rapidly, and it is probable that this film was composed of the members of the Bacillareae. namely:- Navicula Sphaeroptera

Navicula platystoma

Navicula exilis

Bacillaria lanceolata

Gyrosigma acuminatum.

Navicula Sphaeroptera appeared more frequently than the other members of the Bacillareae.

As the members of the Bacillareae increased the other organisms which return with the water declined in number and until their occurrence was comparatively rare.

After three weeks the films changed from brown to green in colour, and disappeared.

As the films disappeared bacillaria tenuis, bacillaria lineata, Anabaena inequalis, and Spyrogyra crassa began to appear. These algae had been dormant during the period of luxuriant growth of the Bacillaceae but they now showed luxuriant growth in their turn and then they in turn died off.

SECTION 9B

Section 9.B.

Experemental irrigation of the dessicated Sediment.

On September 25th 1923, samples of dessicated sediments were taken at Stations I, II III and IV. The samples were taken at approximately six feet behind the water line and the sediment contained very little moisture. The ground from which the sediment was taken was covered with a growth of Macroflora at Stations I, III and IV

On September 20th 1925 samples of surface dessicated sediment were taken at Stations I II III and IV. Two samples were taken at each station; the first at four feet behind the water line and the second six feet behind the water line. The sediments at III and IV, four feet behind the water line contained more moisture (8.6% compared with less than 2%) than those at six feet behind the water line. This was due to a North wind pushing the water towards Stations III and IV as the previous week.

In each case a note was made of the organisms found in the dessicated sediments after examination. The sediment was placed in a shallow dish and irrigated with Sterile water.

This dish was covered with a piece of muslin to exclude any foreign matter.

The unagaled sediments of September 20th 1925 were examined:-

(a) After ~~four~~ one hour's immersion in water.
(b) After three hours' immersion in water.
(c) After three days' immersion in water.

The sediment of September 25th 1923 was examined after three days' immersion in water.

The sediments of Stations I., II., III and IV taken six feet behind the water-line on September 20th 1925 yielded the following:-

Amoebae sp in an encysted condition
Trachelemonas hispida
Euglena sp in an encysted condition
Navicula sphaerophora. } These organisms were in the
Navicula platystraa } resting stages described in
Navicula exilis } Section I.
Cocconema lanceolata }

Oscillatoria limnus } These algae were in the resting stages
Oscillatoria limosa } described in Section II

Free resting spores were also observed.

Anabaena inaequalis - showing hormogones.

Zygospores of Spyrogyra crassa.

Scenedesmus quadricauda - two specimens were observed. One was devoid of contents and the contents of the other were very much broken up into irregular-shaped granules.

After immersion in water for one hour practically no change was observed in the organisms.

After three hours immersion in water very little change was observed in the organisms, except that the Navicula exilis showed movement. The other members of the Bacillaneae were shedding the particles of sediment that adhered to the mucilaginous exudation covering them.

In sediment that had been immersed for three days in water the Amoebae had not altered but the Euglena had regained their normal appearance and showed movement.

Navicula sphaeroptera, Navicula platystoma and Cocconema lanceolata had lost all traces of the adherent particles of sediment and the irregular covering of mucilage present in the dessicated sediment.

The chloroplasts however had not assumed their normal platiform shapes but still retained

the shapes they had assumed when exposed to dessication

This material yielded a profusion of short filaments of Oscillatoria tenuis and Oscillatoria limosa. These filaments were about five to six cells in length and the terminal cells of each filament were rounded. No none of the single resting cells of these Algae, which were present in the dessicated sediment, appeared to be present after three days immersion in water, it is probable that these resting cells germinated and formed these new filaments.

Many short filaments of Anabaena inequalis about twelve cells in length were observed.

Two germinating zygospores of Spyrogyra crassa were present and in each case the filament issuing from the zygospore was two cells in length.

The samples of sediment taken from four feet behind the water line on September 20th 1925 at Station I and II were very dry, and the flora of the sediments was very similar to the flora present in sediment six feet behind the water line. The sediments taken from four feet behind the water line at Stations III and IV contained more moisture than the sediments at Stations I and II

The amoebae were in an encysted condition and Trachelemonas hispida was in a normal condition Euglena sp were not in an encysted condition but were in their normal state

Navicula sphaerophora, Navicula platystoma, Navicula exilis and Lyrocnema lanceolata were not covered with irregular masses of mucilage, but were normal in appearance except that the chloroplasts had not assumed their normal shapes.

Many short filaments of Bacillaria tenuis and Bacillaria lemisa were present. These filaments were generally about eight cells in length. Short filaments of Anabaena inequalis were also present.

When samples of sediments from four feet behind the water line were irrigated, the diatoms present showed movement almost immediately

The desiccated sediments taken on September 25th 1923 from six feet behind the water line contained the following organisms:-

Navicula Sphaeroptera.

Navicula platystoma

Navicula exilis

Nitzschia Sigmoidea

Gyrosigma acuminatum

These were also in resting stages as described in Section 7.

After the sediment had been immersed in sterile water for three days, the diatoms had assumed their normal appearance except that the chloroplasts had not re-assumed their usual shapes. Many short filaments of Oscillatoria tenuis and Oscillatoria limosa were present and a germinating zygospore of Spyrogyra Crassa was observed.

From these observations, apparently the Amoebae do not easily and quickly leave their encysted condition and resume their normal form after a period of dessication. Euglena sp however quickly returns to its normal condition when the available water supply is increased.

When an increased amount of water is available, the diatoms which had been present in the dessicated soil return to their normal condition The smallest diatom present, Navicula exilis, shows the first signs of recovery. Probably the irregular mucilaginous exudation to which particles of sediment adhere helps to conserve the water supply of the diatoms and also aids in the absorbtion of water from the surrounding sediment. The chloroplasts however, eventually take a longer

time to ~~eventually~~ recover their normal shape and colour.

The resting cells of the Cyanophyceae require only a small quantity of moisture before they germinate and produce the short filaments which are found, and apparently take about three days to form these filaments.

The zygospores of Spyrogyra crassa take longer to germinate and require more moisture to germinate than the Cyanophyceae.

Scenedesmus quadricauda does not survive the period of desiccation but perishes and finally disintegrates

SUMMARY

Summary.

The chief conclusions drawn from these observations on the flora of the sediments of South. Hartley. Farm Pool. may be summarised as follows:

1/ Certain of the organisms which form the microflora of the sediments of the pool. (Amoebae sp. Euglena sp. Trachelomonas hispida, Spirogyra crassa) remain in situ as the water recedes, and these persist in the dessicated sediments as cysts or aplanospores until the water level rises and the sediments are resubmerged. They then resume their vegetative life but take a considerable period varying from three days to several weeks to do so. In Euglena the cell contents contract, become granular but remain in contact with the cell wall. This agrees with the statements made by Fritsch (Ref 3. P 18).

2/ Members of the Cyanophyceae also remain in situ as the water recedes and develope resting cells. As the water recedes, the newly exposed sediment is covered with a film - comprised mainly of Oscillatoria tenuis, O. limosa, and Anabaena inaequalis. This film becomes dessicated & brittle & separates into filaments. Oscillatoria tenuis and Oscillatoria limosa develope thick walled resting cells in their trichomes. (These persist in the dessicated sediment) When the ground is resubmerged, either

by the rising in water level. or by experimental means numbers of short hormogones, six to eight cells in length appear. while the resting cells disappear. Hence it is probable that the resting cells have germinated and formed these hormogones

3/ Other organisms, which do not enter into any definite resting stage are also capable of persisting in 'situ' throughout the period of dessication. This applies chiefly to the Bacillaceae (Navicula sphaerophora, Navicula platystoma, Navicula exilis, Gyrosigma acuminatum and Cocconema lanceolata). These secrete an irregular layer of mucilage upon their cell walls, and to this adheres particles of sediment. This device is probably to conserve the moisture in the dealin and also to help in the rapid absorbtion of any moisture in the surrounding sediments. The chloroplasts change in colour from brown to green and assume various irregular shapes of which the moniliform one is the commonest. On re-irrigation the smallest dealin Navicula exilis recovers its normal state. First.

4/ Other organisms belonging chiefly to the Chlorophyceae. (Scenedesmus Quadricauda, Scenedesmus bijugatus, Scenedesmus obliquus, Pleurococcus angulosa, Actinastrum Hantzschii, Cyclostrium Sphaericum, Ankistrodesmus falcatus) are apparently incapable of withstanding

dessication and in some manner not actually observed, they advance and retreat with the water line. Any organisms left in "situ" by the retreating water, perish

b) As the water in the pool rises and the dessicated sediment is resubmerged, the organisms which invade the sediment with the advancing water, at first are dominant. These then show luxuriant growth and then gradually decrease in numbers and are replaced by those organisms which have persisted in situ in the dessicated sediment. These in turn have a period of maximum growth and then decrease numerically and are replaced by other organisms. This process is subject to constant repetition

b) The sediment exposed by the shrinkage of the water of the pool was first covered by an algal film composed of members of the Cyanophyceae. This film became dessicated and brittle and disappeared. The sediment was then invaded by the Macroflora. It was first invaded by plants whose seeds had been carried there by the wind or by animals or birds. It was then invaded by plants growing on the surrounding grounds which encroach inwards. The rhizomatous plants (grasses) encroach more quickly than the other plants

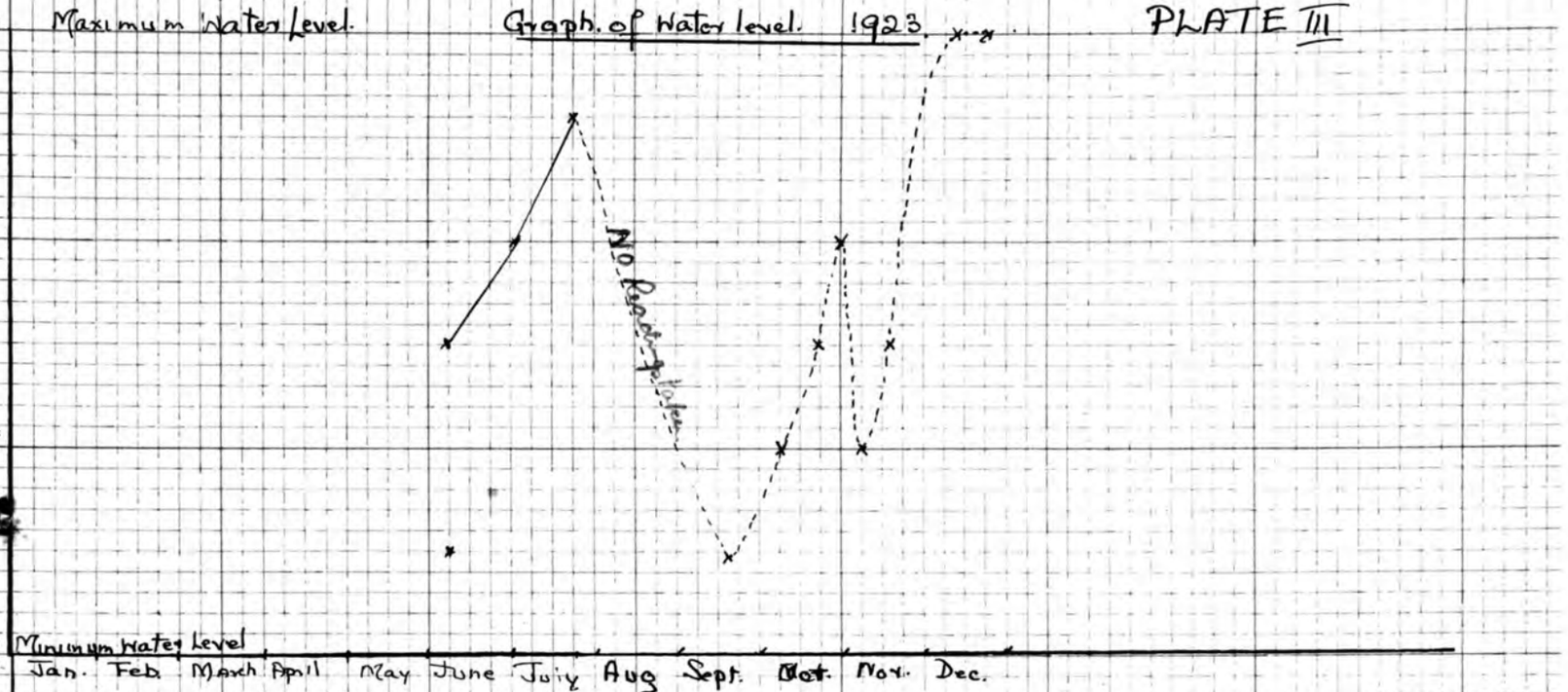
It thus appears that many of the algae, namely the Bacillareae, Cyanophyceae and a few species of the Chlorophyceae are well equipped to withstand a considerable period of dessication. These algae apparently will be capable of surviving in the sediments of pools which completely dry up at some period of the year. They also will be able to survive a period of dessication during the transmission of sediment from one pool to another, by wind and animals. This will be of considerable importance to their distribution.

The majority of the members of the Chlorophyceae found in the sediments of the pool, show a tendency to advance and retreat with the water. They will therefore be at a considerable disadvantage in comparison to the other algae, and apparently will be unable to persist in sediments which are exposed to a considerable period of dessication, as would be experienced by the sediments of a pool which dries up for long periods, or by sediment carried on the feet of animals and birds in going from one pool to another.

This investigation was suggested by Dr. B. Millard Griffiths Head of the University Department of Botany at Durham, and the work has been carried out under his advice and criticism.

PLATE III

Graph of Water level 1923.



Graph of Rain-fall 1923

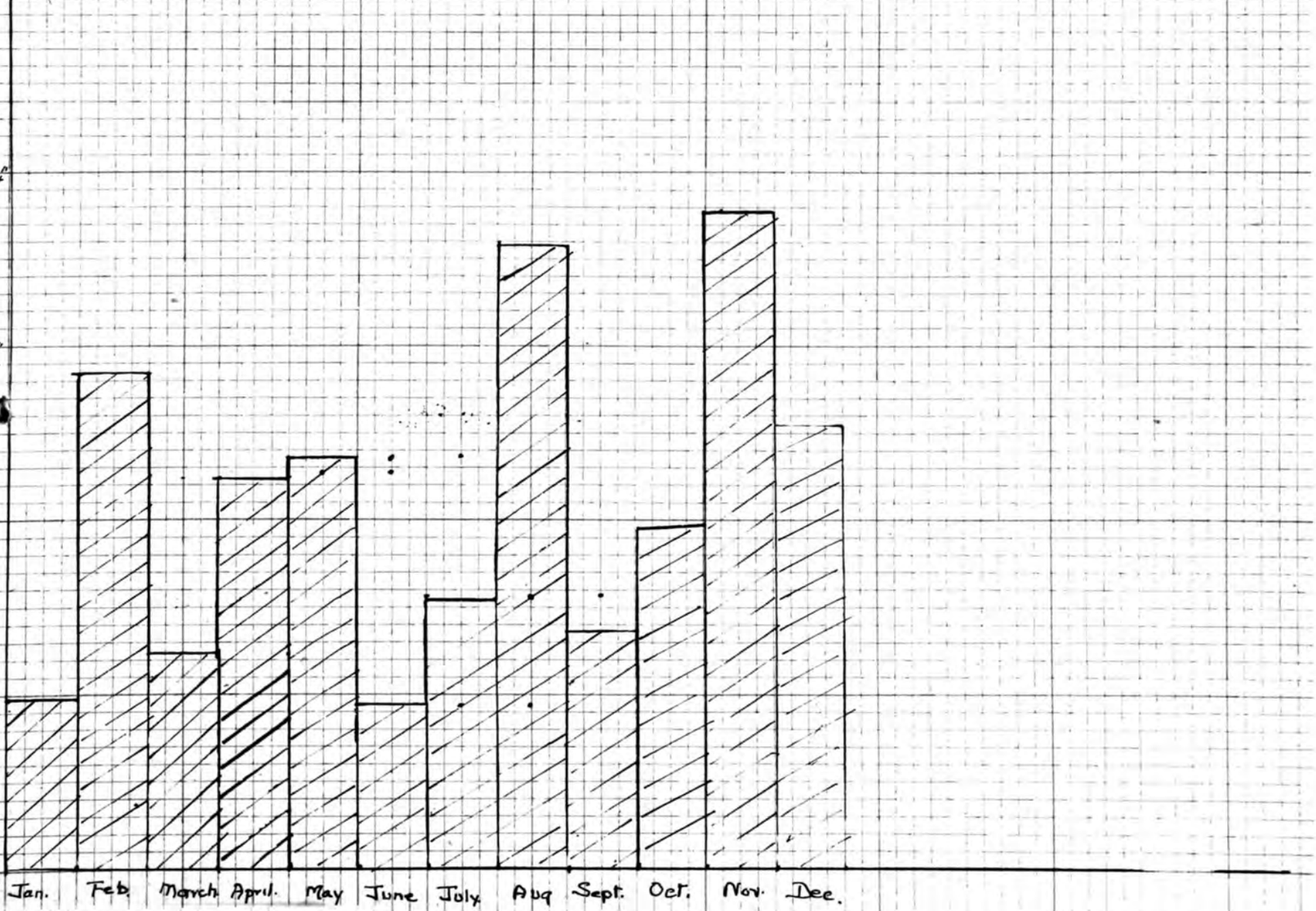
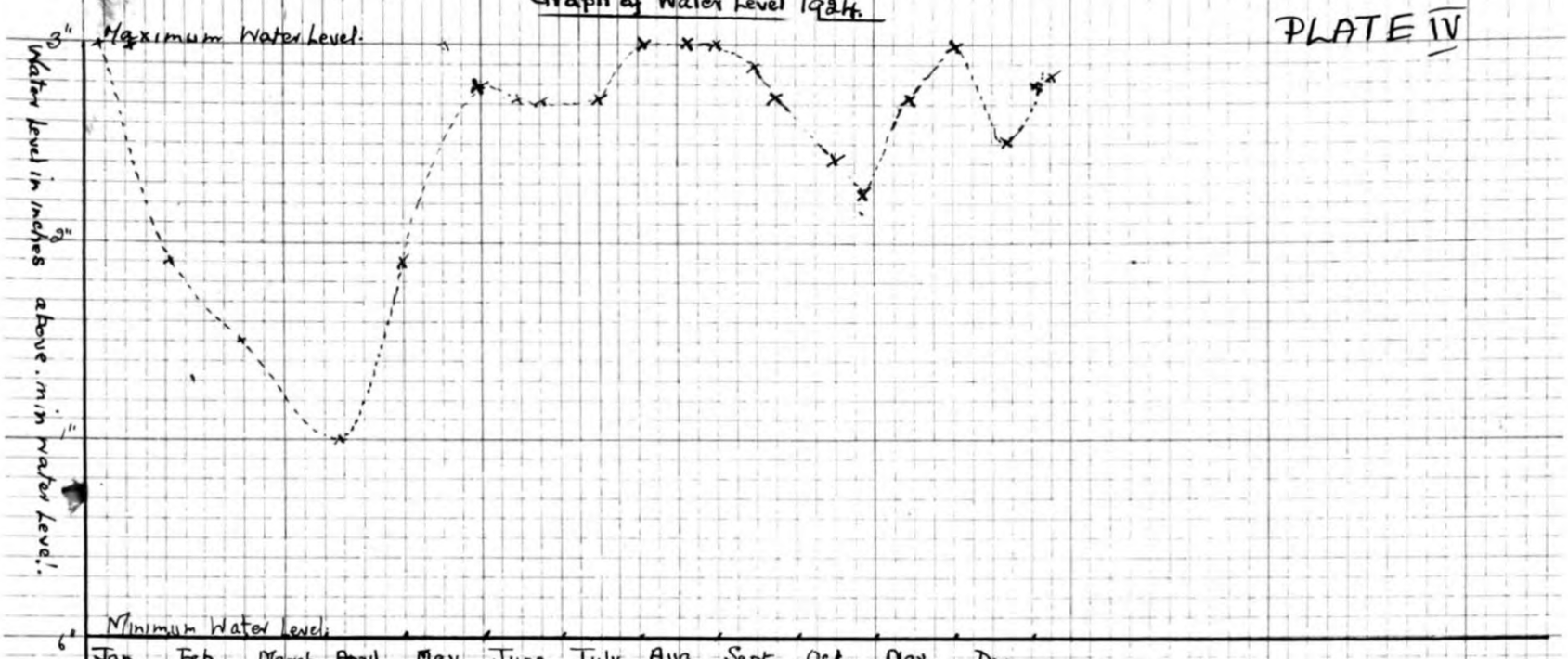


PLATE IV

Graph of Water Level 1924.



Graph of Rainfall 1924.

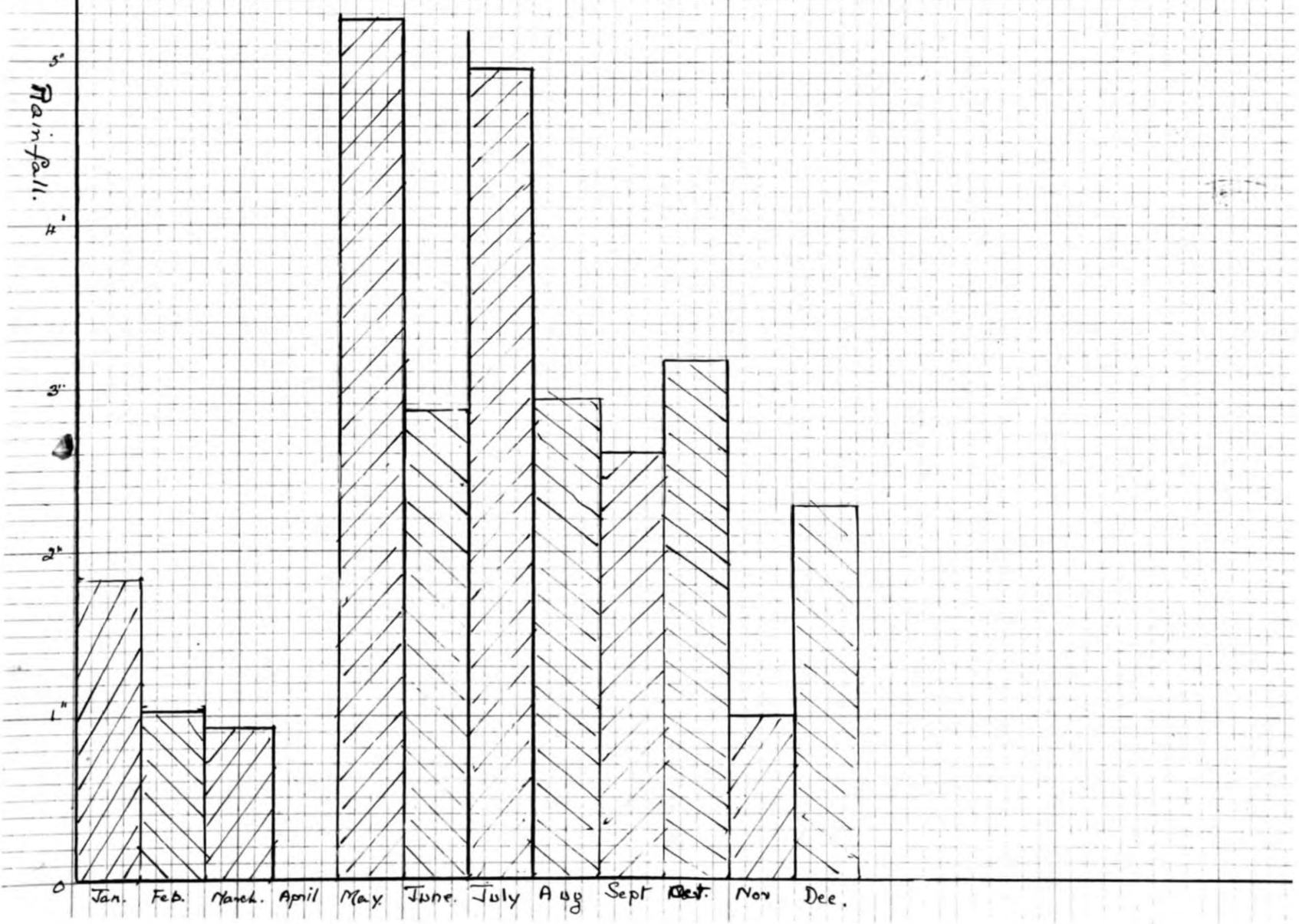
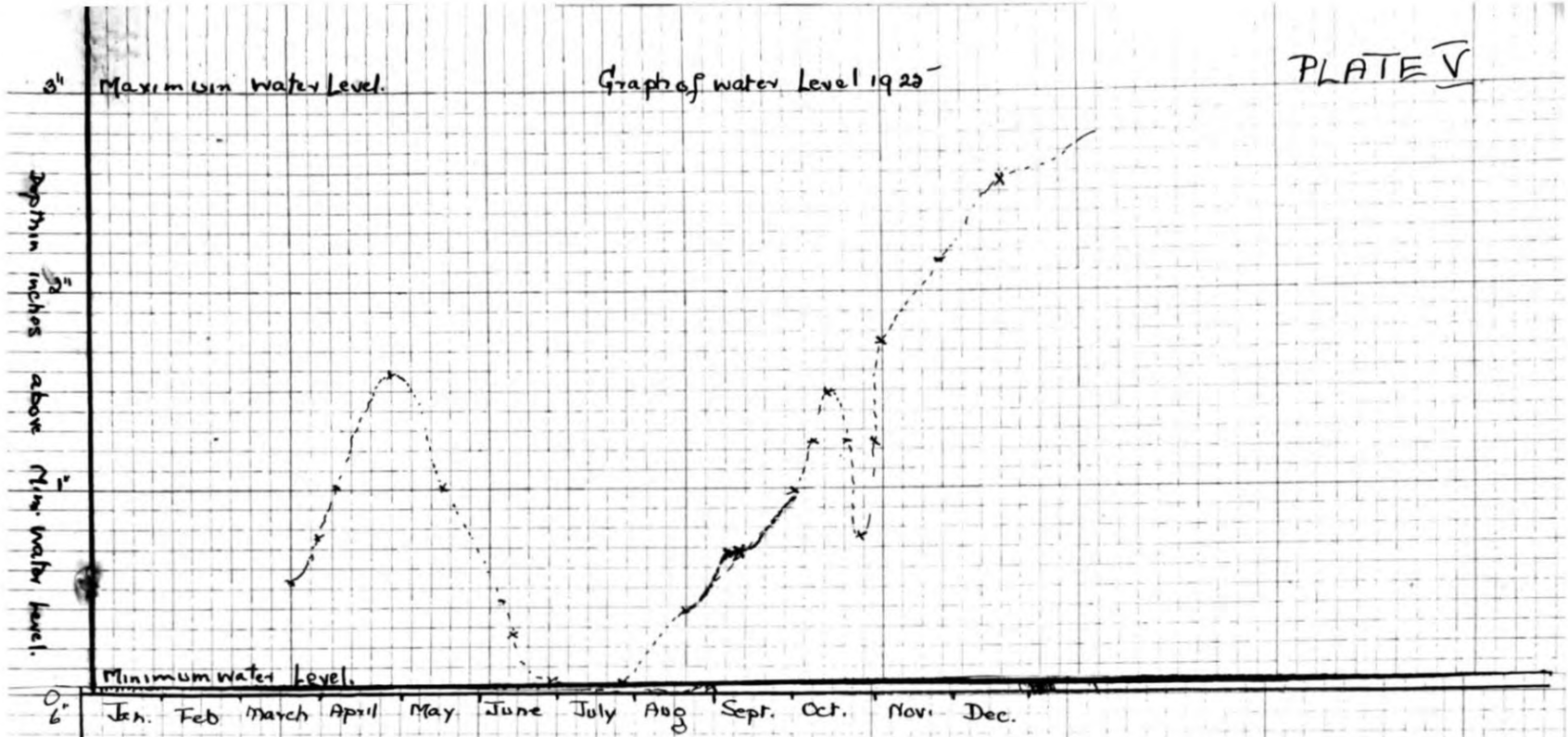


PLATE V


Graph of water Level 1925
3" Maximum water Level.
Depth in inches above Min. water level.
2"
1"
0
Minimum water Level.
Jan. Feb March April May June July Aug Sept. Oct. Nov. Dec.

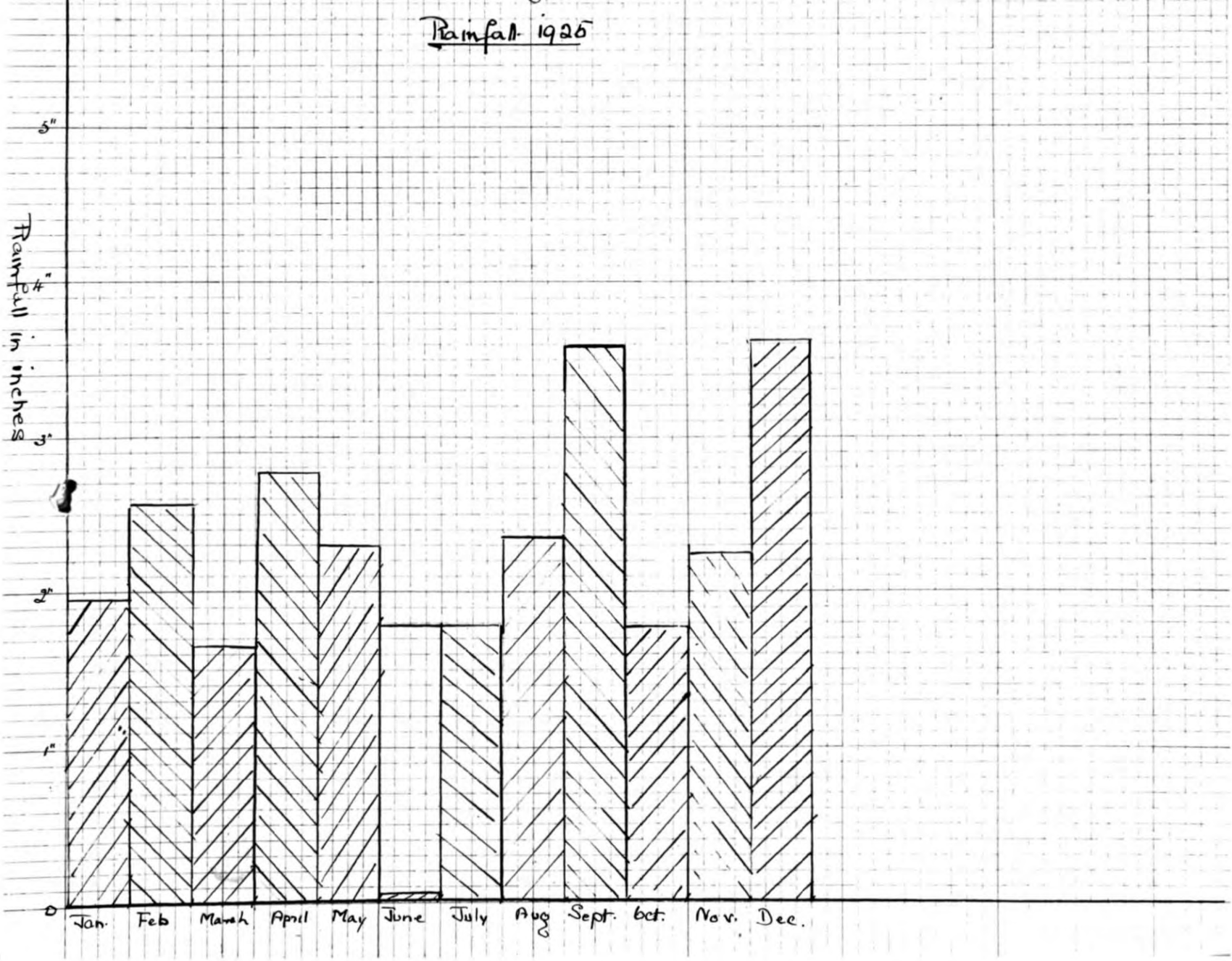

Rainfall 1925
6"
5"
4"
3"
2"
1"
0
Rainfall in inches
Jan. Feb March April May June July Aug Sept. Oct. Nov. Dec.

PLATE VI

Comparative Rough Analysis of the Sediments

	STATION 1	STATION 2	STATION 3	STATION 4
Sand.	88	84.	82	82.
Carbonate of Lime	2nd Most.	Least.	most.	3rd Most
Iron hydrate.	Least.	most.	3rd most	2nd Most
Clay.	—	—	—	—
Carbonaceous matter.	3.7	3.4	4.0	6.0.

Water – 6 parts carbonaceous matter per 10,000.

Description of Plate 7

1/ Navicula platystoma. Ehrenb. Taken from dessicated (valve view) sediment, showing adherent particles of sediment and mucilage ×1000.

2/ Oscillatoria tenuis Ag. Taken from dessicated sediment. showing a gap from which resting cells have escaped.

3/ Navicula sphaerophora (valve view) Kutzing taken from dessicated sediment, showing adherent particles of sediment and mucilage. ×1000

4/ Navicula sphaerophora. (girdle view) of 3. ×1000

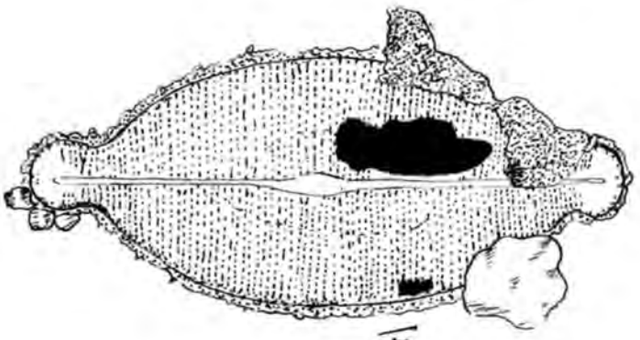
5/ Eunotia pectinalis. Kutz. (girdle view) taken from dessicated sediment, Shows twenty spore-like bodies

6/ Eunotia pectinalis Kutz (Valve view of same).

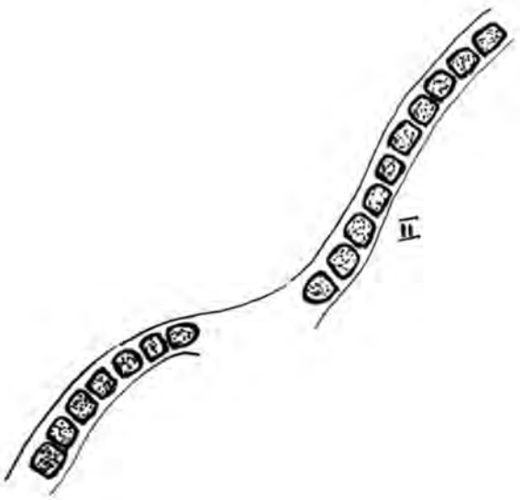
7/ Germinating zygospore of Spirogyra crassa.

PLATE 7.

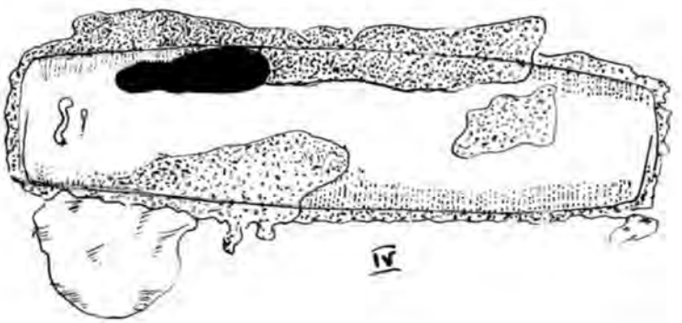
I



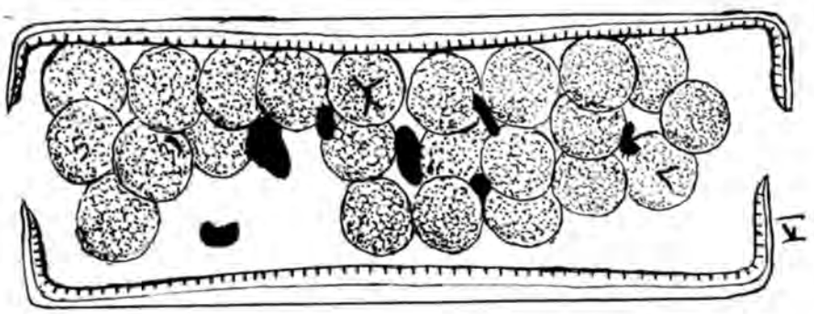
III



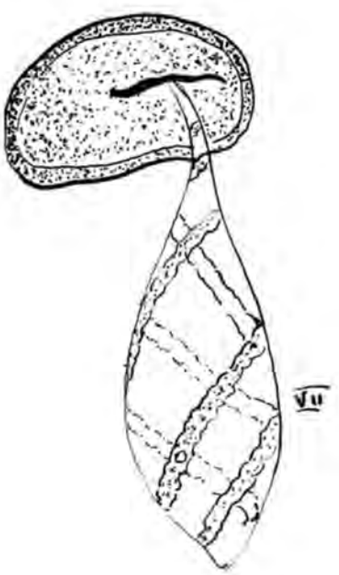
II



IV



V



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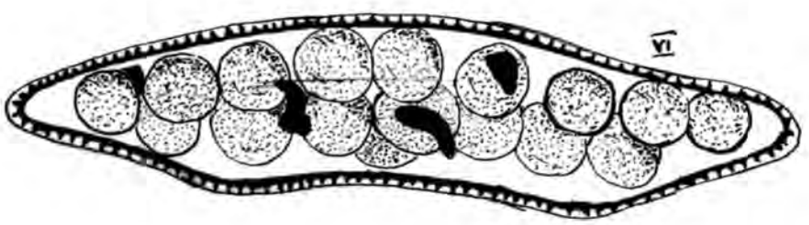
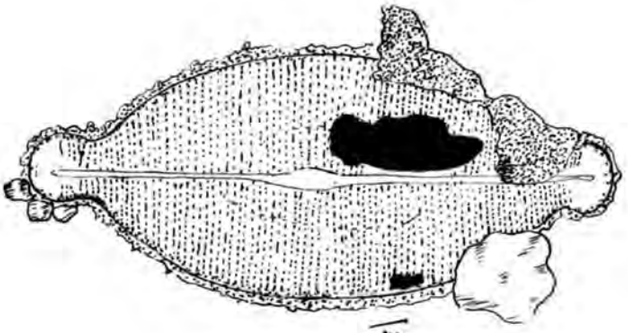


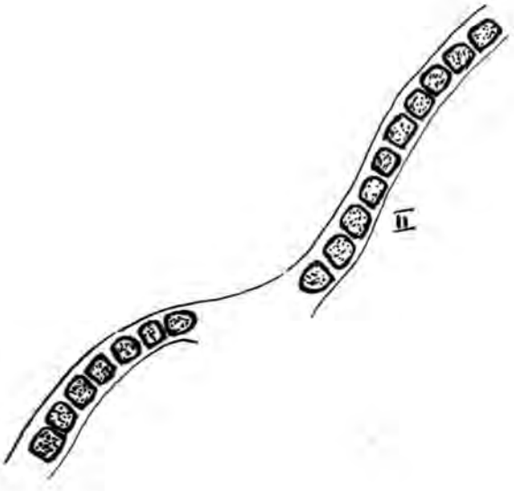
VI

PLATE 7.

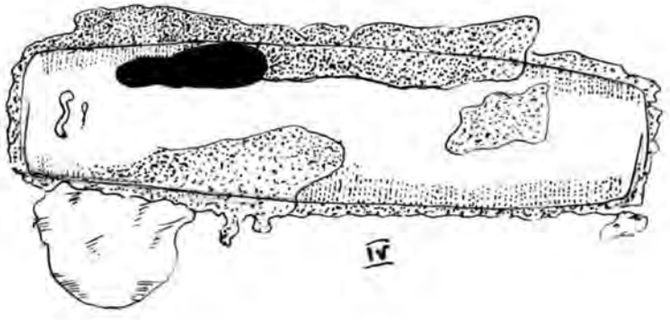
I



III



II



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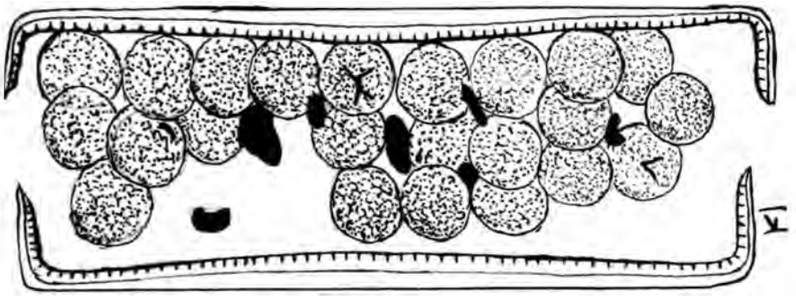

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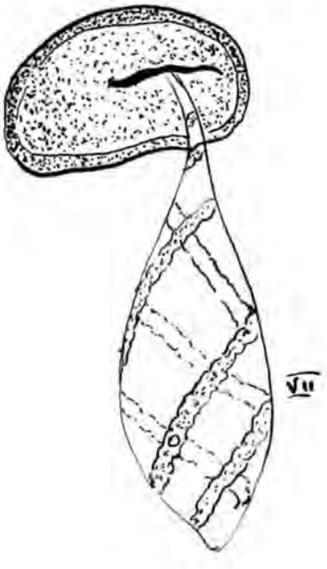

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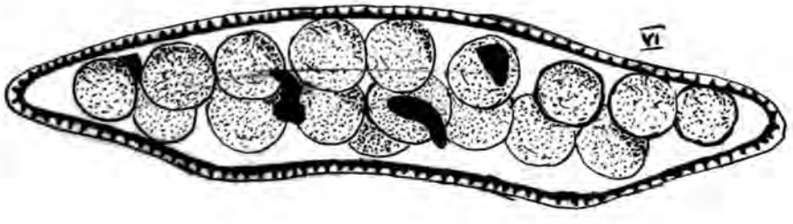

VI

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1923 - 1925.

Detailed Records of the Occurrence
of Species in the Sediments of -
South Hartley Farm Pool, nr Whitley Bay
Northumberland

Winifred Sloe B.Sc.

1925

STATION I 1926

	March 1st	March 17th	April 19th	April 29th	June 3rd	June 26th	Sept 13th	Sept 20th [illegible] water's edge	Sept 20th 4 [illegible] water line	Sept 20th 1' in front of [illegible]	Sept 27th	Oct 3rd	Oct 11th	Oct 18th	Oct 23rd	Nov 1st
Amoebae sp					mR		rR.									
Trachelomonas hispida					r		r.		r							
Arcella vulgaris				r						r			m.			
Euglena sp	rrr			m.		mm.	r			r	r			r		
Gymnodinium sp.																
Nitzschia sigmoidea																
Amphora ovalis v. pediculus on Nitzschia sigmoidea																
Navicula sphaeroptera	rm.	m		m.		mm	m		mR	rr	r	r		r		
Navicula platystoma	mm	rm		mm.		r.	m.		mR		mm	r	m.	r		
Navicula exilis.				rrr		r	r.					mm.	m.	✓		
Characium gracilipes	rrr	rr		rr.	r	r	rr					r	m.			
Cocconema lanceolata	mmm.	m.		mm.	m.	r					m.					
Fragilaria capucina	m	r		r		r										
Tabellaria flocculosa.	m.	r														
Gyrosigma acuminatum	m.	r		m.		r								rr		
Oscillatoria tenuis		r					r		rR	r	m.					
Oscillatoria limosa.		mm.														
Lyngbya aeruginea	rrr	r														
Anabaena inequalis		r					rr			r	m.					
Pteromonas angulosa.												m	mm	mmm		
Chlamydomonas sp.				rr.								m	mm.	mm		
Scenedesmus quadricauda		rrr					mmm		rr D	mmm	m	r	m	mm		
Scenedesmus bijugatus.							mmm			mmm	r	r	m.	mm.		
Scenedesmus obliquus										rr		rr		r		
Ankistrodesmus falcatus													m.			
Actinastrum Hantzschii																
Coelastrum sphaericum																
Lagerheimia wratislaviensis																
Spirogyra crassa.										rR.						
Closterium acerosum.		rr												rrr		

STATION 2 1925

	March 15th	March 17th	April 19th	April 29th	June 3rd	June 26th	Sept 13th	Sept 20th below water level	Sept 20th 4' before water line	Sept 20th 1' in front of weir level	Sept 27th	Oct 3rd	Oct 11th	Oct 18th	Oct 23rd	Nov 1st
Amoebae sp																
Trachelomonas hispida						r	rr			r	r					
Arcella vulgaris	r												r			
Euglena sp.						m	r	hrrr		m.	rrr	R. rrr	m	m		
Gymnodinium sp.												rrr				
Nitzschia sigmoidea							rr.						rr			
Amphora ovalis v pediculus on Nitzschia sigmoidea						m.										
Navicula sphaerophora	m	r			r	r	rr		Rr	r				rr		
Navicula platystoma	m.	r		m.		r	rr							m		
Navicula exilis	r				m									mm		
Characium gracilipes	rrr	r		rR		r						m.				
Cocconema lanceolata	m.	r		rR		mm	rr.			rr	m		rr			
Fragilaria capucina				rr.		mm.										
Tabellaria flocculosa							rrr									
Gyrosigma acuminatum	rr	r		r		r				r				m		
Oscillatoria tenuis	rrr					r	rrr		rR.							
Oscillatoria limosa						r						r	rrr			
Lyngbya aeruginea	rrr	rrr								rr.						
Anabaena inequalis						rr.	rr.			r		r				
Pteromonas angulosa													mmm	mm		
Chlamydomonas sp													mm.	m		
Scenedesmus quadricauda						r	mmm			mmm	m	mmm	mm	mmm		
Scenedesmus bijugatus							mmm			mm	m	mmm	mm	mmm.		
Scenedesmus obliquus														r		
Ankistrodesmus falcatus														m.		
Actinastrum Hantzschii																
Coelastrum sphaericum																
Lagerheimia wratislaviensis																
Spirogyra crassa						m										
Closterium acerosum														m		

STATION 3 1925

	March 15th	March 17th	April 19th	April 29th	June 3rd	June 26th	Sept 13th	Sept 20th [illegible]	Sept 20th 4' [illegible]	Sept 20th 1' [illegible]	Sept 27th	Oct 3rd	Oct 11th	Oct. 18th	Oct. 23rd	Nov 1st
Amoebae sp.	r	rr							rR.							
Trachelomonas hispida							r					[illegible]		r		
Arcella vulgaris		rrr		rrr	m											
Euglena sp	rr			r	r	r	r				r	r		r		
Gymnodinium sp																
Nitzschia sigmoidea	rr															
Amphora ovalis v. pediculus on Nitzschia sp.							rrr					rr				
Navicula sphaerophora.	mm.	mm.		mm	m	mm				r		rr	rr			
Navicula platystoma		r		mmm.	m	r	r			r	r		rrr			
Navicula exilis	rrr	r		m.			m				rr	r	rrr			
Characium gracilipes		r		r			m			r	r			m r		
Cocconema lanceolata	mm			r	m	r	rr		rR	r		rr		[illegible]		
Fragilaria capucina		rr		rr		rr				r						
Tabellaria flocculosa.		r					m			r						
Gyrosigma acuminatum	m	r		r	m.	mm	rr			mm						
Oscillatoria tenuis									rR							
Oscillatoria limosa		rR.														
Lyngbya aeruginea		mm		rr												
Anabaena inaequalis		r					mm		rR.							
Pleuromonas jaculans.							m.				m.	m	mm	m		
Chlamydomonas sp.		rr		r	r									m.		
Scenedesmus quadricauda		rr			r	rr	mmm		rD	mm	mm.	mmm	mmm	mm		
Scenedesmus bijugatus		rrr					mmm		rD	mm	m.	mmm	mmm	mm		
Scenedesmus obliquus										r		mmm	mm.	r		
Ankistrodesmus falcatus												r		rr		
Actinastrum Hantzschii																
Coelastrum sphaericum																
Lagerheimia wratislaviensis																
Spirogyra crassa.																
Closterium acerosum.						m								r		

STATION IV. 1925

Group	Species	March 15th	March 17th	April 19th	April 29th	June 3rd	June 26th	Sept 13th	Sept 20th [illegible]	Sept 20th [illegible]	Sept 20th [illegible]	Sept 27th	Oct 3rd	Oct 11th	Oct 18th	Oct 23rd	Nov 1st
[illegible]	Amoebae sp.	m	r														
	Trachelimonas hispida	rrr	rrr			rr		rr		r							
	Arcella vulgaris		rr														
Flagellatae	Euglena. sp.				m.		r			rR.	m.		r	r	m		
Peridineae	Gymnodenium sp.																
Bacillariaceae	Nitschia sigmoidea				rrr	rrr											
	Amphora ovalis v. pediculus. or Nitschia sig.moidea.													m			
	Navicula sphaerophora.	mmm.			mmm	m	mm.			rR	r	r	r	m	m		
	Navicula platystoma	mmm.	r		mmm		mm.			mR	rr.	r		m	m		
	Navicula exilis	m	r.		r					m			r	m	m		
	Characium gracilipes	rr			r		r	rr				r	r	m	mm		
	Cocconema lanceolata	mmm			m.	rr		r		rR	rr			r			
	Fragilaria capucina				rr		r										
	Tabellaria flocculosa.		r														
	Gyrosigma acuminatum	mmm	m			r											
Cyanophyceae	Oscillatoria tenuis		mm.		rrr.	m.	mm.			r	r	m.	rrr	r	m		
	Oscillatoria limosa		mm.				r										
	Lyngbya aeruginea		r				rr.	rr				r					
	Anabaena inequalis							m.						r.			
	Pleuromonas angulosa.							mm.					mm.	mmm	m		
	Chlamydomonas sp.	m			r			m.						r			
Isokontae	Scenedesmus quadricauda	rrr					r	mm			mmm	m.	mmm	mm	m		
	Scenedesmus bijugatus.							mm.			mm		mmm	mm	m.		
	Scenedesmus obliquus												r	r			
	Ankistrodesmus falcatus.	rr															
	Actinastrum Hantzschii												r				
	Coelastrum sphaericum.																
	Lagerheimia wratislaviensis																
AKONTAE	Spyrogyra crassa.																
	Closterium acerosum.		r.								r				rr		
											r						

Summary 1926

	March 16th	March 17th	April 19th	April 29th	June 3rd	June 26th	Sept 18th	Sept. 20th 6 hibernaculum	Sept 20th 4 Hibernaculum	Sept 20th 1 imperfect	Sept 27th	Oct 3	Oct 11	Oct 18	Oct 23rd	Nov 1st
Arnoldia sp.	rr	rrr			rr R		rrr R		rrr R							
Trachelinnas hospida	rrr				rr	rr	r		r	rr	rrr					
Corella vulgaris	rr	rrr		rr		rr				rrr		r	m	rr		
Euglena sp.	rr			m	r	m			rrr	m	rr	rR	m	m		
Nitzschia sigmoidea	rrr				rrr		rrr						rrr			
Amphora ovalis v. pediculus.						rrr	–									
on N. Sigmoidea.																
Navicula sphaeroptera	m m m	m m		m m	r	m	r		r R	r	rr	m	m	r		
Navicula platystoma	m m	r		m m	rr	r	m		r R	rr	r	r	m	m		
Navicula exilis	r	rrr		rr	rrr	rr	r		r r		r r	r	m	m m		
Characium gracilipes	rr	r r		rr	rrr	rr	rr		–	rrr	rr	rr	m	m m		
Nocenima lanceolata	m m m	r		rr	rrr	r	rr		r R	r		rr	m	m		
Fragilaria capucina	r r	rr		rr	rrr	r	rrr			rr			rr	–		
Tabellaria flocculosa	r r	r		rrr	—	—	rr			rr				–		
Gyrosigma acuminatum	m m	m		rr	rr	r	rrr			m			m	m		
Cocillatoria tenuis	rrr	r		rrr		m	rrr		r R	rr	m		rr	m		
Cocillatoria limosa	–	m m		–		rrr	w			r			rrr	–		
Hyngbya aerugineä	r r	m		rrr		rrr	rr			rrr	r r	rrr	rrr	–		
Anabaena inequalis				–		–	–			–	–		rrr	rr		
Pleurotaenias angulosa	–	–		–		–	m			r	r	m	m m	m m		
Chlamydomonas sp.	rrr	rrr		rrr	rrr	–	r					r	r			
Scenedesmus quadricauda	rrr	r r		–	rrr	rr	m m		Dead rrr	m m m	m m m	m m	m m	m m		
Scenedesmus bijugatus							m m			m r	m m	m m	m m	m m		
Scenedesmus obliquus										r	rrr	r r	m	m		
Ankistrodesmus falcatus	rrr											rr	m	m		
Cretmastrum Hantzschii																
Cuelastrum Sphaericum																
Largenheimia wratislawensis																
Spirogyra crassa.		r		r		m										
Closterium acerosum.		rrr														

South Hartley Farm Pool.

Northumberland.

1923

STATION I 1923.

	June 9th Wet	June 9th Dry	June 20th	Sept 18th	Sept 25th 2" in pool	Sept 25th Edge of pool	Oct 6th	Oct 18th	Oct 20th	Nov 3rd	Nov 17th wet	Nov 17th wash 1" from lump	Dec 15th
Amoebae		r		m		m			m	mm			mR
Trachelomonas hispida		r										m	
Arcella vulgaris					m			m					
Euglena sp					m	rr	m		r	r	rrr	m	
Gymnodinium sp													
Nitzschia sigmoidea	·			r		rrr		rrm		m	Dead r		
Amphora ovalis v. pediculus on N. sigmoidea		r		r			·	mm					
Navicula sphaerophora		r		·	r	r	rrr		m	m			
Navicula platystoma													
Navicula exilis		r		·	m	r							
Characium gracilipes	mm	r		mm	m ·	· r				m			
Cocconema lanceolata	r						r						
Fragilaria capucina	r								m				
Tabellaria flocculosa	r							mm					
Gyrosigma acuminatum	mm		r	m			mm	mR	m				
Oscillatoria tenuis	r					rr		m	m.				
Oscillatoria limosa													
Lyngbya aeruginea													m
Anabaena inequalis													
Pteromonas angulosa													
Chlamydomonas sp.													
Scenedesmus quadricauda	r		m	mm	mmm	mm	mm	m.					
Scenedesmus bijugatus	r			r	mm	mm							
Scenedesmus obliquus	r				m			m					
Ankistrodesmus falcatus													
Actinastrum Hantzschii	r			r	r								
Coelastrum sphaericum	·r												
Lagerheimia wratislaviensis													
Spirogyra crassa				r	mm	mm			mmm				
Closterium acerosum					r		r		m	r	rr		

STATION 2 1923

	June 9 1k net	June 9 1k Dry	June 29 1k	Sept 18 1k	Sept 25 1k 2' in pool	Sept. 25 1k Edge of Pool	Oct 6 1k	Oct 18 1k	Oct 20 1k	Nov 3 1k	Nov 12 1k net	Nov 17 1k 1' further back	Dec 5 1k
Amoebae.									r r	r R	r R	r R	r R
Trachelomonas hispida											m		m
Arcella vulgaris													
Euglena sp.				mm	-			.	m	m	mm	m	
Gymnodinium sp.													
Nitzschia sigmoidea		r											
Amphora ovalis v. pediculus or N. Sigmoidea										rr		r	m
Navicula Splanoptera													
Navicula Platystoma.													
Navicula exilis		r				r		m	m	m		r	
Characium gracilipes	r		.	mm		mm				r			
Cocconema lanciolata.													
Fragilaria capucina	r												
Tabellaria flocculosa													
Gyrosigma acuminatum	r	.		.	m	r	r	r					
Oscillatoria tenuis						.	m	m					m
Oscillatoria limosa								m		rrr			
Lyngbya aerugineo													
Anabaena inequalis													
Pleromonas angulosa.													
Chlamydomonas													
Scenedesmus quadricauda.	r	r		mm		mm	mm	.	rrr	rr	rr	m	
Scenedesmus bijugatis	r												
Scenedesmus obliquus													
Ankistrodesmus falcatus													
Cicinastrum Hantzschii	r												
Coelastrum Splaericum													
Langerheimia Wratislawensis													
Spyrogyra crassa.				rr	mm	rr							
Closterium acerosum				r	m		m	r	r				

STATION 3. 1923

	June 9th Wet	June 9th Dry	June 29th	Sept 18th	Sept 25th 2' in pool	Sept 28th Edge of Pool	Oct 6th	Oct 16th	Oct 25th	Nov 3rd	Nov 17th Wet	Nov 17th 1' Bottom bank	Dec 5th
Cimarbae				r	m	m m			m m	r	R R		R R
Trachelomonas hispida								r					m
Dinella vulgaris													
Euglena sp							m m	r		m	r	r	
Gymnodinium sp.													
Nitzschia Sigmoidea		r r r			r r	r	r	m	r				
Cymbella arabica var. N. Sigmoidea				r		r			r r r		r r r		
Navicula Sphaeroplea	r	r r r										r r	
Navicules platystoma													
Navicula exilis			m		m m		m	r	r	m			
Characium gracilipes							r r r						
Cocconema lanceolata		r r				r	r			r	r		
Tragillaria capucina													
Tabellaria flocculosa	r											r r	
Gyrosigma acuminatus	r							m m		m r			
Bacillaria tenuis							r		r r			r	
Bacillaria paxillifera								m m	m m	r r r	r r r	m r	
Hyalotheca dissiliens								m	m				
Anabaena inaequalis													
Pleurotaenium angulosum												m	
Chlamydomonas sp.												h	
Scenedesmus quadricauda	r			m m	m m	m	m m	m m	m	r r			
Scenedesmus bijugatus				m		m	r	r	m				
Scenedesmus obliquus								m m	m				
Ankistrodesmus falcatus		r r											
Elakatothrix Gelatinosa	r												
Closterium Ehrenbergii													
Staurastrum gracile													
Spirogyra crassa													
Closterium acerosum						m m							

STATION 4. 1923.

	June 9th Wet	June 9th Dry	June 29th	Sept 18th	Sept 25th 2' in pool	Sept 25th 1 yd from the bed	Oct 6th	Oct 18th	Oct 25th	Nov 3rd	Nov 17th Wet	Nov 17th 1 ft behind	Dec 5th
Amoebae													m
Trachelomonas hispida							m						
Arcella vulgaris													
Euglena sp							mm						m
Gymnodinium sp													
Nitzschia sigmoidea				r			r						
Amphora ovalis v pediculus or N sigmoidea													
Navicula sphaerophora						r							
Navicula exilis					mm								m
Characium gracilipes						r		rr					
Cocconema lanceolata								r					
Fragillaria capucina						r							
Tabellaria floculosa													
Gyrosigma acuminatum						mm	mm	~~mm~~	rr				
Oscillatoria tenuis									r	rrr			
Oscillatoria limosa													
Lyngbya aerugnea													
Anabaena inequalis													
Pteromonas angulosa													
Chlamydomonas sp													
Scenedesmus quadricauda			mm		mm		m	m					
Scenedesmus bijugatus			m		m		m	m					
Scenedesmus obliquus								m					
Ankistrodesmus falcatus								m.					
Actinastrum Hantzschii													
Coelastrum sphaericum													
Lagerheimia wratislaviensis													
Spirogyra crassa							mm	mm					
Closterium acerosum								r					

Summary 1923

	June 9 '12 Wet	June 9 '12 Dry	June 29 '12	Sept 18 '12	Sept 25 '12 2 in pool	Sept 25 '12 Edge of pool	Oct 6 '12	Oct 18 '12	Oct 30 '12	Nov 13 '12	Nov 17 '12 Wet	Nov 17 '12 Further back	Dec 5 '12
Amoeba sp		rr		r	r	m			m	r	rR	rR	rR
Trachelomonas hispida		rr					r	rr			rr		m
Arcella vulgaris													
Euglena sp					rr	rrr	mm	rrr	r	r	mm	r	r
Gymnodinium													
Nitzschia Sigmoidea		rr		rrr	rrr	rrr	rrr	m	rr	rr	r	rrr	r
Amphora ovalis v. pediculus on N. Sigmoidea		rrr		r	r	rrr		r	rrr	rr	rrr		
Navicula Sphaerophora	rr	rr			rr	rr	rrr		r	r		rr	r
Navicula platystoma													
Navicula exilis		rr			r	m		m	r	m	m		m
Characium gracilipes	m	r		mm	rr	m			rrr	m	r		
Eccanema lanceolata	rr	rrr			rrr		rr		r r	rrr	rr	r	rr
Tragillaria capucina	r								rrr			rrr	
Tabellaria flocculosa	rr												
Gyrosigma acuminatum	m		rr	m	r	m	mm	m	r				
Oscillatoria tenuis						rr	r	m	.	m	m	r	r
Oscillatoria limosa	r							m	r	rrr	rrr		
Lyngbya aerugina													
Anabaena inaequalis								rr	rr		rr		
Pteromonas angulosa													
Chlamydomonas sp										.	m		
Scenedesmus quadricauda	r	rrr		mm.	m	m m	mm	m	mm	rrr	rr	rrr	rrr
Scenedesmus bijugatus	r			m	r	r	rr	r	r	-			
Scenedesmus obliquus	rr				r			rrr					
Ankistrodesmus falcatus		r											
Actinastrum Hantzschii	m	r			rr								rr
Golenkinia Schroeteri	rr												
Lagerheimia wratislawiensis	rr												
Spirogyra crassa			-	m	mm	mm	r	r	mm				
Closterium acerosum				rr	r		rm	r	r	rr	rrr	rrr	-

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	May 26th.	June 3rd.	June 14th	June 22nd.	June 27th	July 6th	Aug 31st	Sept 6th	Sept 20th	Sept 27th	Oct 4th	Oct 11th	Oct 19th	Oct 26th	Oct 29th	Nov 2nd.	Nov 11th	Nov 28th	Dec 6th	Dec 14th.	Dec 22nd.
Amoebae sp.	m R	m R									m R			m	m			m			m.
Trachelomonas hispida		m.	r				r			m	m	m		r			m	m			
Arcella vulgaris							r														r
Euglena sp.	m.		rr.	m.			r		m	m	m	m.		m	m		m				
Gymnodinium																					
Nitzschia sigmoidea														m.							
Amphora ovalis v. pediculus nr N. sigmoidea.																					
Navicula sphaeroptera.	m n		m.	m.			m m	r	m	m m	m m.	m m		m.	m		m m m	r			m
Navicula platystoma	m			r							m	m		m	m		m.				
Navicula exilis	m.						m.	n	m	m		m		m	m						m
Characium gracilipes	r.	r.	m.	r			m			m		r		m.	m.			r			m.
Cocconeis lanceolata		m.	r	r.			m	m	m.	m	m	m.			m.		m.				in.
Fragillaria capucina				m.																	
Tabellaria flocculosa.																	r				
Gyrosigma acuminatum.			r	r			m	m		m	m	m		m.							
														r r			m				
Bacillaria tenuis			r.				r r	r r r	r	r	r r	r		r	m						m.
Bacillaria limosa.																	m.	r			
Lyngbya aeruginea																		r			
Anabaena inequalis							r r			r											
Pteromonas angulosa.			r r.												m						
Chlamydomonas sp.	m																				
Scenedesmus quadricauda	m.		m.				m	r		m			l	m.							
Scenedesmus bijugatus														r							
Scenedesmus obliquatus.														r							
Ankistrodesmus falcatus																					
Actinastrum Hantzschii																					
Coelastrum sphaericum																					
Harpenkeimia inaequalis																					
Spyrogyra crassa.																					
Closterium acerosum.							r	m				r									

STATION 2 1924

	May 26th	June 2nd	June 14th	June 23rd	June 27th	July 5th	Aug 8th	Sept 6th	Sept 20th	Sept 27th	Oct 4th	Oct 11th	Oct 19th	Oct 26th	Oct 29th	Nov 2nd	Nov 11th	Nov 23rd	Dec 6th	Dec 14th	Dec 23rd
Amoeba.			h								vR										
Trachelomonas hispida	m.	m.	m.	m			m		m												
Bralla vulgaris	m																				
Euglena sp.			v.				m		v	m	m/m	m m		m/m	m.		m.	m			
Gymnodinium Sp.																					
Nitzschia Sigmoidea				v				v	rm												
Amphora ovalis v. pediculosa																					
av Nitzschia Sigmoidea																					
Navicula sphaerophora.		m.	m.	m.				m m		m.	h/m/m.	m m m		m/m	h m			m m.		h m	h m
Navicula platystoma				m								m		m.	m			m.		m m	m m
Navicula exilis	m m.	m m.		m					ho		m/m	m									
Characium gracilipes			v.	m.			m	v		m	v	m.		v	m						
Cocconeis lanceolata			m.					m		m	m	m		v			m m.	m.			m
Fragilaria capucina			m.					v			v										
Fatellaria flocculosa.																					
Gyrosigma acuminatum	m		v.				m	m m	v	m.	m m	m m m	m m.	m/m	m.		m m.	m			m.
Oscillatoria limosa	m R.		m.	m.			m m m			m.	v		m.	m				m.			
Oscillatoria limosa	v		m.	m.			m m														
Lyngbya aerugineo			m.																		
Anabaena inaequalis				v.																	v
Peridinium angulosa.																					
Chlamydomonas sp.																					
Scenedesmus quadricauda.			v.	v				m.		m.	v			v							
Scenedesmus bijugatus.								m													
Scenedesmus obliquus.																					
Ankistrodesmus falcatus			m.																		
Actinastrum Hantzschii																					
Lovelastrum Sphaericum																					
Lagerheimia wratislaviensis																					
Spirogyra crassa	m.		m.																		
Closterium acerosum.								m	m						m						

STATION 3 1924

	May 26th	June 3rd	June 11th	June 22nd	June 27th	July 5th	Aug 31st	Sept 6th	Sept 20th	Sept 24th	Oct 4th	Oct 11th	Oct 19th	Oct 26th	Oct 29th	Nov 2nd	Nov 11th	Nov 23rd	Dec 6th	Dec 14th	Dec 22nd
Amoebas.																					m.
Trachelomonas Hispida		m.								mm	hm	mm			mm			m			
Arcella vulgaris	m.						r														
Euglena sp.		m		√			mm	mm	mm	mm	mm	m	m		m		m				mm.
Gymnodinium sp.																					
Nitschia Signoidea													r								
Amphora ovalis v. pediculus Gr N. Signoidea				r																	
Navicula Sphaerophora.		m.	m.	mm			mm.	mm.	mm	hm	hm	hm.	mm		m.		mm	hm.			mm m.
Navicula platystoma.		m.		hm.						hm	m m.	m	m m		m		m	·			m.
Navicula exilis	m.	m.	m.					m	mm	hm	m	m m	hm		m.		m	m.			
Characium gracilipes		·	r	r			m	r	mm	m	m	m m	m				r	m.			
Coccinema lanceolata		m.	r	r.			m	m	m		m	r	r		m.		r	m			
Fragilaria capucina											m	r	r		r		r				r r
Tabellaria flocculosa													m								
Gyrosigma acuminatum		m.	r	r			r		r	m	m	m	m		m.		r	m.			mm.
Bacillaria tenuis	m.		mR.				r	r	mm	mm							r	r			r
Bacillaria limosa	m						r.	rr							r		.	r			
Synedra aerugina			r																		
Amphora aequalis							r	rr					r				r				
Pleurosigma angulosa.		m.																			
Chlamydomonas Sp.		m.																			
Scenedesmus quadricauda.		m.	r					rrr	m				r				rr				
Scenedesmus bijugatus																	r				
Scenedesmus obliquus															m.		r				r
Ankistrodesmus falcatus																					
Actinastrum Hantzschii																					
Coelastrum sphaericum								r													
Hargenheimia Wratislawiensis																					
Spirogyra crassa.			mR.	m.	r																
Closterium acerosum.			r					mR									r				r
										m	mm										

STATION IV 24.

	May 26th	June 3rd	June 14th	June 28th	June 29th	July 5th	Aug 31st	Sept 6th	Sept 20th	Sept 27th	Oct 4th	Oct 11th	Oct 19th	Oct 26th	Oct 29th	Nov 9th	Nov 11th	Nov 23rd	Dec 6th	Dec 14th	Dec 22nd
Amoeba	mR.											rR.									
Trachelomonas hispida		m.					r			r	r	m.									
Bodo vulgaris																					
Euglena sp		m.		m.				r	rrrr	rr	r	m.		m.							
Gymnodinium sp.																					
Nitzschia sigmoidea		r.					rr	r		r											
Amphora ovalis v pediculus on N. Sigmoidea																					
Navicula Splaeroptera	r.	m.		m			r	r	m	mm	m	mmm.		m.	m.						mmm
Navicula platystoma									m	m	m	m		m	m						m
Navicula exilis	r							m	mmm	m		m			m						mm.
Characium gracilipes				r.					m	r		r									
Surirella lanceolata		r									r			m							
Fragilaria capucina				m.																	
Tabellaria flocculosa										r				rm							
Gyrosigma acuminatum	m.	m.		m.			mm	m	r	mm	rr	m.		m.	r						mm.
Bacillaria tenuis	m.	m.		m.			m	m.	m	mmm	m.	mm		mm	m	m-					
Bacillaria tenuissima	m						m		rrr												
Synedra ulna				r.																	
Cymbella inaequalis								r		r											
Pleurosigma angulosa.														m							
Cheilomonas sp.																					m
Scenedesmus quadricauda.	r							r	rr	rr		m.		r							
Scenedesmus bijugatus												m.		m							
Scenedesmus obliquus																					
Cymbella cuspidata																					
Closterium Ehrenbergii																					
Closterium Moniliferum																					
Largenheimia wratislawiensis																					
Spirogyra crassa.							r	r						m.							
Closterium acerosum																					