Pond at Shorne: background explanation
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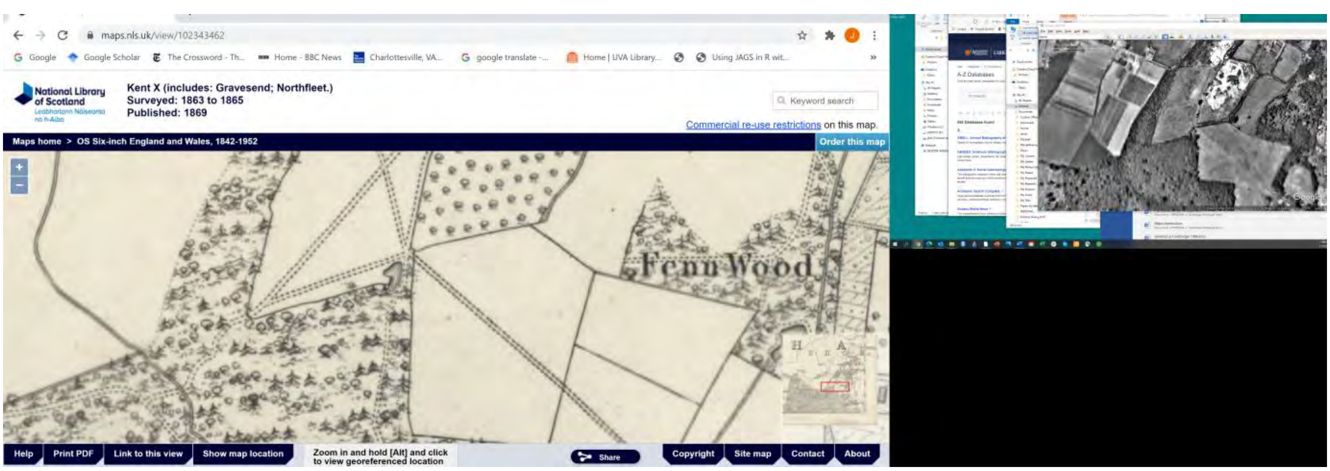
This is the write up of my 3rd Year Sixth Form (7th Form) Biology project which I did with two other students, Adrian Harris and N (Norman? Neil? I forget) Cocup at Gravesend Grammar School for Boys, in Kent, England. I think we shared much of the field work but the write up was largely mine, and the result of my family having purchased a brand new electric type-writer that I was keen and proud to try out. I was seventeen at the time.

The effort was not graded/marked but was encouraged by our biology teachers (Clive Jermy and another woman teacher whose name I forget, but who patiently introduced me to Mendelian genetics). Both were temporary teachers, standing in for Richard (Dick) Ellis, our biology teacher throughout grammar school, who had suffered a heart-attack and was bed-ridden. He passed away a year or so later. Clive Jermy was largely responsible for cementing my interest in plants and left soon the school soon after this for a job at the Natural History Museum, London, where he became head of the Fern Section.

I include this project account here because it is (now in retrospect) uncanny how many of the themes (transects, population numbers, community ecology, disease) are repeated later in my career. The one component that is not mentioned is Genetics, in which I eventually specialized (as the subject of my Natural Sciences Tripos Part II at Cambridge).

The pdf version is not great and the odd line has been cut from top or bottom, as the original is on A4 paper. Also, nearly all the stand-alone data tables and graphs, but for two, have been lost. I am not sure why, but they were in a loose leaf folder and may simply have fallen out at some time.

Shorne is a small village on a hill about 5 miles out from Gravesend.
The loction of the pond is below (Map from 1869 and from 1960 (Historical Google Earth Pro).
Its co-ordinates are 51.410452 N, 0.424849 E
More later Google Earth pictures show it covered by trees



A study was startedmthis year by J.A. and N.C., two members of the Third Year Sixth and by A.H. of the Upper Sixth, of a pond at Shorne near Gravesend, Kent. A preliminary investigation had been carried out by A.H. the year before (1959) and this formed a useful basis on which to form the present study. The pond was visited several times during the Autumn and Winter but extensive study was only begun in Feb. 1960.

The pond is situated towards the south side of Shorne hill and is accessible from Shorne by a path going in between the sand-pits (-1-). The hill is of sand and this has a marked effect on the vegetation, plants such as Oak (QUERCUS), Gorse (ULEX), Broom (CYTISUS) and Harebell (CAMPANULA ROTUNDIFOLIA) being found there. These plants are all characteristic of sandy acid soil.

The pond lies at the corner of a wood (Randall Wood) and two fields (-2-). The wood is of Sweet Chestnut (CASTANEA SATIVA) which is regularily coppiced. At the edge of the wood there are Oak trees and where the pond encroaches into the wood there is some Willow (SALIX). The field to the East had Barley in it while that to the North West was fallow. Here the soil was noticed to be of a pebbly or stony nature and not of high quality.

The pond was visited during the Autumn of 1959 when it was found to have dried up: there was no standing water but the grass was covered withh dew and the soil was waterlogged. The bottom was of Floating Sweet-grass (GLYCERIA FLUITANS) and Oak leaves. A soil profile (-3-) was made. The soil at the bottom was found to be distinctly acid in reaction which was to be expected in a leached infertile sandy soil. Growing on the bottom besides GLYCERIA was some POLYGONUM AMPHIBIUM. Under the logs and among dead leaves were found water-beetles and a newt - a clear indication that there was still enough moisture for many species to survive the dry period. Dead Caddis larva cases were also found.

The pond was revisited early in January when there was still no standing water there.

W When weekly visits were started in Feb. the pond was found to be filled with water. Since the pond is situated in a depression, water probably comes in as seepage from the surrounding land. A stream is present in the wood but no connection with this and the pond could be found. The water like the soil in the neighbaouring field was acid (pH. 6·5).

A plan for the study of the pond was drawn up (-4-) and the following were the important points in the programme:-

A. PRELIMINARY WORK
- a) Mapping of the area.
- b) Profile charts.
- c) Mapping regions of plants.
- d) Transects.
- e) Mark out stations.

B. WEEKLY WORK
- a) Conditions in pond, including depth; pH; temperature; wind; turbidity; weather conditions.
- b) Animals and plants in pond, including net sweeps to note fauna; concentration of LEMNA; concentration of plankton.

Not all these studies materialised or gave conclusive results!! Nevertheless they are included in the following results and conclusions.

A. PRELIMINARY WORK

a) MAPPING OF THE AREA

A base line was marked out along East edge of pond, its position being marked by stakes. It was 60ft. long and started at 3ft. from gatepost of "gate" to the wood. It extended along path at the side of the pomd. A perpendicular 50ft long was taken at 0ft. along the base line and this served to delimit the South side of the area to be studied. However owing to irregularities onm the North West side, the area to be studied was only partly decided.

Shape of the pond at water levelx was marked out by taking successive readings of the distance of the water's edge from the base line and at 3ft. intervals along it.

The results were plotted on a graph which was later modified to show position of edge at high-water. (-5-). This was 5ins. higher than when map was made. The water's edge was marked with stakes for future reference.

A compass reading was taken.

Made on 21/2/60. Taken perpendicular to base line and 25ft. along it (-6-) and in an arbitrary direction lengthways across pond (-7-). The exact positions are marked on -5-. Method was to use a travelling plumb line on a tape measure, depth soundings being taken every foot (see fig.).

At the same time inner limit of GLYCERIA marked out and seemed to come at about 3ft. depth. Otherwise not many conclusions from profiles.

c) MAPPING OF PLANT REGIONS.

A rough plan of the flora was obtained on 28/2/60 using quantitative as well as qualitative observation. Since this was made early in the yearmany of the grasses had to be identified by their vegetative characters while much of the vegetation could only be partly identified because flowers were not out.

A fuller map based on the one above was made in June (26/6/60) when a fuller identification could be made (-8-). Specific names were confirmed and mistakes (ALOPECURUS, for example, had been named as AGROSTIS) corrected. New species and regions (e.g. APERA SPICA-VENTI) were noted. From these observations the final map was produced. Other observations were made at other times of the year and these were incorporated in the map. (e.g. GALIUM PALUSTRE and inner limit of GLYCERIA).

Most of the species were identified in the field but some were brought back for identification.

Reference books used were Bentham and Hooker, Clapham, Tutin and Warburg, and for grasses, Hubbard.

d) TRANSECTS

These were made on 26/6/60 (East side: -9-) and on 3/7/60 (West and South side: -10- and -11-). Method used is shown in the fig. They were Line Transects.

Plants actually touching the string were included even if their roots did not arise from directly underneath it. In the case of grasses the flowering stalks, only, were included for the sake of simplicity but some allowance was made for flowers that were not fully out.

A full list of plants found was not made partly because the region for study was not exactly delimited and because it could not be determined which plants were influenced by the prescence of the water.

It is hoped that future workers will mark out a definite region despite various difficulties that may be encountered. The present region could also possibly be extended.

CONCLUSIONS DRAWN FROM THE ABOVE STUDY OF PLANTS:There was a definite zonation of plants round the pond. The dominant plant within the pond region itself (ie. within the high-water mark) was Floating Sweet-grass - GLYCERIA FLUITANS which extended right up to the high-water mark although here it was replaced by Marsh Foxtail - ALOPECURUS GENICULATUS.

The absence of the "accepted" pond weeds was noted and could probably be accounted for by the periodical drying up of the pond (and acidity?). The GLYCERIA it was concluded was able to resist dessication and also changes in the depth of water and ensuing mechanical problems.

It adapted itself to changing water level (and changes in Oxygen concentration??) by changing its growth form (-12-). Some of this was inevitable as the plant increased in size and the water level fell. Even if these changes were not the result or direct reaction of the plant to altering external conditions, they must have been the result of the peculiar growth and form of leaves and stem. For example, to go through the various stages from completely submerged to floating to aerial, the leaves had to be of a certain (and changing?) pliability otherwise they could not have ~~grow through~~ been able to grow underwater, float and stand upright in the air. Normally the different depths are taken by different plants e.g. pond-weed to water-lily to reeds but GLYCERIA was adapted to all these depths. The actual reactions of the plant to the enviroment need further investigation.

GLYCERIA was able to resist dessication because its leaves were unwetted by water. The stems or leaf-sheaths were, however. It appears then that it is not a truly aquatic plant like pond -weeds etc. whose leaves are wetted by water. Absorption of water and nutrients must take place through stems and roots. Again further investigation, esp. histological, would yield interesting results.

When the first flowers of GLYCERIA appeared a statistical analysis of the number of spikes in each panicle, was made. This was done more for the practice of statistical analysis (working out means, mean deviations, standard errors, etc.) than for any intrinsic value of the results themselves. Statistically significant results were that the number of spikes per panicle taken from the region around stations 4 and 5 was different from other regions of the pond. This may reflect certain differences in conditions around the pond but further investigation is needed. Reference book used was Dowdeswell's "Practical Animal Ecology".

ergot. The seeds were swollen into sausage shaped structures, glaucous or with dark violet tint. They were up to $\frac{3}{4}$ins. long, filled with white tissue. See fig. They first appeared on the plants on 10/7/60 but such structures had been noticed in thw water much earlier. Whether this is Ergot has to be confirmed (What else?). If it is the fungus the %age infection of seed and related problems should be studied.

Peculiar outgrowths from one of these suspected Ergotised seeds were seen and noted on 5/6/60. See fig. They may have been the club shaped structures which bear the perithecia.

No animals feeding directly on living GLYCERIA could be found although Weevils (BAGOUS) were present on it.

Around the high-water mark was found ALOPECURUES GENICULATUS Which therefore only received one short period of submergence during the spring. It was a plant of much lower growth than GLYCERIA and therefore probably uuable to get sufficient light where GLYCERIA was abundant. Early in the year its fine shoots and leaves formed an underwater sward round the edge.

The plants next to these, higher up on the banks were Clustered Rush - JUNCUS CONGLOMERATUS (absent from the East edge) and Perennial Rye-grass - LOLIUM PERENNE. The latter had a wide distribution and was found along the paths; appeared to be able to resist much trampling. The incursion of LOLIUM into the Yorkshire Fog - HOLCUS LANATUS is because this is the direction of a path.

Massh Bedstraw - GALIUM PALUSTRE appeared fairly late in the year on the West bank just below the high-water level. Apart from its late arrival its requirements seemed to be almost the same as that of A. GENICULATUS.

ABove the ALOPECURUS where the bank sloped gradually i.e. in North and Nosth West corners, there was a profusion of HOLCUS. However, this had avery wide distribution in general.

Higher up still Cocksfoot grass was more abundant and therefore requires drier conditions. In about the same region as Cocksfoot - DACTYLIS GLOMERATA but in the shaded spots e.g. by wood, on West bank among other tallpix plants, and by Rose (ROSA) and Hawthorn (CRATAEGUS OXYCANTHA) bushes, Loose Silky-bent grass - APERA SPICA-VENTI was prominent.

Creeping Buttercup - RANUNCULUS REPENS was abundant all round the pond but other spp. of RANUNCULUS were only found higher or further from the pond e.g. in neighbouring field.

Many more species than mentioned above were noted but their distribution was not clear cut and no firm conclusions as to their requirements could be drawn.

e) MARK OUT STATIONS

This was done at first by stakes, inserted with reference to some landmark e.g. by a tree-stump, log, or large clump of JUNCUS. Later on we became accustomed to the stations ~~were got used to, by us~~ and marking became unnecessary. When the water level got very low (mid. July), the stations had to be considerably modified so that plankton samples and net sweeps could be taken. The modifications, if possible, were mostly in a direction perpendicular to the edge of the pond so that the stations were kept spaced out evenly. Positions of stations marked on (-5-).

Unfortunately a station in the middle of the pond could not be made because boots were not big enough and the waders leaked.

B. WEEKLY WORK

a) CONDITIONS IN POND

DEPTH:

Weekly variations in depth were noted and plotted on a graph (-13-). This was done by inserting a stake at the existing water-level and noting the change to the new water-level the following week. An absolute dexpth measurer was not made but the deepest point in the pond was believed to be about 4ft. (at high-water).

The water level rose during Feb. March and April but gradually fell during the Summer months. As the level fell the extent of the pond also fell and many of the plants that were previously submerged became aerial.

pH:

This was at first measured every week but it was found to remain very constant (within the limits of accuracy of the comparator used which was 0.5). The constant value was approx. pH 6.5, despite changes in depth, smell, and amount of organic debris in the pond. The only noticeable change was on 10/7/60 when the pH was, surprisingly, found to be 7. This was contrary to expectation because decay in the pond should release acid products. That it was raining may have affected it, or the indicator solution may have become contaminated; it was taken from an almost empty bottle.

On the whole nothing conclusive could be drawn from the pH measurements exept that the pond-water was definitely acid in reaction and that it was well buffered against changes in acidity.

B.D.H. Soil Indicator and the Lovibond Comparator were used. More accurate measurement using a single indicator with a range of pH 6-7 is necessary. The Capillator method which measures to 0.2 units would be useful.

of platinum wire became invisible) were not done. It appeared to be important as regards the depth to which light penetrated and hence influenced the distribution of the organisms.

It was noticed that the water became tinted yellow to brown to black (decaying debris in fine suspension) as the year went on.

TEMPERATURE OF AIR, WATER (TOP AND BOTTOM):

At first regular temperature readings were taken. Temperature of the water from different regions of the pond was measured and was at times greater than the difference in temperature between top and bottom. Since the latter was never more than 2 or 3°C these readings from different depths were never done.

The readings were later totally discontinued due to the loss of a thermometer and only a qualitative idea of the temperature was got from the weather conditions.

What really needs to be done is an accurate daily record of temperature since the temperature over the previous week (e.g.) is more important than that of the water or air at the time of collecting. This temperature reading need not be done at the pond itself but can be done at school or at home. It should be done out of doors (in the sun?) using a max. and min. thermometer. If greater accuracy is required a study could be made on the correlation of air-temp with water-temp at different times of the day.

WIND DIRECTION AND FORCE:

These were started at first but later discontinued or only included in the general weather conditions (use??).

GENERAL WEATHER CONDITIONS:

A fairly complete record of these were kept (-14-) but some of the criteria used were rather vague. Since certain correlations between plankton number and distribution and the climatic conditions a fuller investigation of weather conditions (including temperature, wind, and light intensity) should be worth doing. Light intensity is of particular importance as regards distribution of animals. A light meter was, unknowingly to us, available at the school but an exposure meter (re-calibrated) would be equally ideal.

OTHER CONDITIONS

in the pond which should be recorded are oxygen concentration, concentration of dissolved substances and concentration of toxic substances. The former apparently had a profound effect on plankton distribution and should be definitely done so as to give relevance to the plankton readings. A good account, with experimental details is given in Dowdeswell's "Practical Animal Ecology".

b) ANIMALS AND PLANTS IN POND

SWEEP EVERY WEEK AT THREE DEPTHS:

This was not done every week but only at intervals, partly because of the length and difficulty of identification - although this got quicker and quicker as more and more species were recorded- and partly because of the time taken in sweeping 11 stations. Moreover only the middle and bottom were swept with a net (an ordinary dip-net was used), the animals on the surface being noted by observation. These were mainly spiders, GERRIS - the Lesser Waterboatman (esp. on sunny days), and Spring-tails - COLLEMBOLA (in July).

No attempt at accurate quantitative measurement was made.

A list of species (including those in the plankton samples) was made as a result of these sweeps. (-15-).

Nothing firmly conclusive about distribution of various species in the pond was found. The habits of the various species were noted (-15a-). However there were indications that:

*Water-lice - ASELLUS - more abundant on wood-side (because prefers rotting leaves?).

*The water-beetle HALIPLUS abundant in filamentous algae (because eats it?).

*The caddis-fly larva - LIMNOPHILUS - first appeared at station 1 where the water was overhung by bushes. (because eggs may have been laid on branches of overhanging bush?). These larvae were largely collected from the middle region, having crawled up the vegetation.

Various increases in number were noted, as well. Water-mites (HYDRACARINA SPPP.) on the 22/5/60; Caddis-fly larvae (LIMNOPHILUS SP.) on 8/5/60 ; The water-beetles HELOPHORUS and HYDROVATUS on 22/5/60 and 5/6/60, respectively; and mosquito larvae of the CULEXINE type on 10/7/60.

The distribution in time of the various species were noted (-16-).

From observations of the live animals brought home, by examination of gut-contents, and by inference from distribution (and by using reference books to complete the picture - but it was indicated where this was done) food chains of the various animals or main groups of animals were worked out and put together on one chart (-17-).

An interesting feature was the total absence of pond-snails. This was probably because of the acidity of the water (dissolving shell?). To confirm this an experiment was performed and in the account of which (-18-) the problem is more fully discussed. The acidity of the water may account for many of the peculiarities of the pond such as absence of Tubifex worms, planarians - only one individual of DENDROCOELUM sp. found. A green flatworm - DALYELLIA sp. - was abundant and frequently turned up in the plankton samples although it crawled about on the vegetation. The effect of the acidity needs investigation.

live animals themselves and for this purpose an aquarium, to be stocked species of animals and plants found in the pond (and pond water), should be kept.

Reference books used were;-

Needham and Needham - Guide to Study of Freshwater; Ward and Whipple - Fresh-water Biology; Mellanby - Animal life in Fresh-water; Dibb - Field Book of Beetles; and other lesser works!?

NUMBERS OF DUCKWEED:

A study of the numbers of duckweed (LEMNA spp) did not materialise because their numbers remained small and were swamped by GLYCERIA. Last year ivy-leaved (L. TRISCULA) as well as lesser duckweed (L. MINOR) were found but this year there was no sign of the former. This is an indication that considerable changes are taking place from year to year.

An interesting study could be made on how the duckweed survives the dry season.

NUMBERS OF PLANKTON:

A fairly complete study was made of numbers of plankton and of their vertical distribution in the pond. Not much was done as regards distribution at different stations.

Method of taking and measuring plankton samples. Plankton samples were taken from surface middle and bottom using a measuring cylinder (100c.c. capacity) attatched by string to a wooden rod, rectangular in cross section. See fig. Samples from the surface were taken by simply placing the lip of the cylinder just under the surface. Samples from middle and bottom were taken by placing the cylinder into the water upside down and tilting it at the appropriate depth. See fig. The middle sampling was at first standardised by attaching a table-tennis ball to a string of known length (1ft. 6ins.) which in turn was attatched to the cylinder. This was then tipped when the ball was pulled just under the water. However as the depth fell and the pond became clogged with GLYCERIA this became impracticable and instead an arbitrary depth was used depending on the prevailing conditions at each station. Samples were generally taken from stations 1 to 11 but where this interfered with net sweeps the order was modified. Surface samples were taken first and bottom ones last.

The water with plankton was then sieved through a plankton net of bolting silk and collected in a glass plankton bottle fixed to the bottom of the net by means of a strip of elastic cloth. This ensured that the net was tightly closed around the lip of the bottle, so preventing animals collecting in between the net and the lip of the bottle. See fig.

The water that was filtered through the net and was therefore free from plankton was collected in a jam-jar and used for washing down the sides of the net. This water was not examined for nannoplankton i.e. net passing plankton which may play an important role in the economy of the pond.

So, in this way 11 samples of 100c.c. each were taken from the surface middle and bottom layers of the water and each of these was concentrated to 27c.c. (capacity of the plankton bottle). This concentrate was then transferred to a larger screw top specimen tube (all specimen tubes were marked with waxed labels) and ten drops of strong formalin solution added as fixative.

The specimen tubes were then taken to the school where the counting was done.

Method of Counting. The sample of pond water was agitated to get a uniform distribution of plankton. Then an amount was removed using a wide necked squeese or dropping tube (it should have been graduated for greater accuracy but was not) and transferred to a home made rafter cell (2cm. x 5cm. x 0.1cm.) holding about 1c.c. The structure of this special slide is shown in the fig. Just excess liquid was put in so that when the coverslip (another slide) was put on some excess water was squeezed out so preventing the formation of air bubbles.

The rafter cell was marked by a "Chinograph" pencil into 1cm. squares to help positioning of the slide under the microscope. The slide with the cell was then moved so that the field of the microscope covered every part of it inturn. See fig.

All the animals seen were classified but only 8 or 9 groups or species were counted. They were: Naupilus larvae, Ostracods, SIMOCEPHALUS spp, CHYDORUS spp, CYCLOPS spp, Harpacticids, Diaptomus spp, and DAPHNIA spp. & VOLVOX spp. which were not fully done or abandoned. Only animals were included in the plankton counts; nor were all the plants identified mainly because a reliable reference book was not available in the earlier part of the year. Types of planktonic plant present included Diatoms - PINNULARIA spp. CYMBELLA spp. and others, Green Algae - Spirogyra, CHLORELLA spp. etc.(?), Flagellates - VOLVOX spp. EUGLENA spp. and probably others.

Living samples of plankton were also collected but no extensive studies were made. It was looked at under the microscope but mostly pretty pretty. All the three types of bacteria were noted, and fungal hyphae were common.

The counts were fully done from March till the end of July. The results were representted in tabular form and thence in the form of various types of graph.

Results from graphs and general observations:

1) Total plankton numbers (-19-).

The number of plankton showed an overall increase till a peak was reached at the end of May. It was calculated that at this time there were 20 plankton/c.c. or about 15 million in the pond all together. And this was counting 7 species or groups only. Thereafter the numbers decreased until they reached a steady level in July (and after?). This decrease in number activity could definitely be ascribed to the fact that the week before the taking of the samples had been exceptionally warm and sunny for the time of year. This showed that the limiting factor in their growth and reproduction early in the year was the cold weather. It also showed the importance of keeping a daily weather check. The second peak could not so obviously be accounted for.

2) %age plankton at the surface.

The results obtained from plotting a graph of %age plankton at the surface agaist weather conditions (as well as comparing it with other graphs) was most illuminating. In the early months of the year the %age plankton at the surface was very low (less than 20%) but during May the situation was reversed and the majority of the plankton (usually more than 50%) were at the surface later in the year. This reversal in plankton distribution could be accounted for as follows:- Early in the year most of the rotting material and algae on which the plankton feed was at the bottom and hence the plankton were also at the bottom. However as the year went on the amount of debris that was deposited at the bottom increased because of the death of plants, plankton, and larger animals. This and the increased temperature stimulated decay by fungi and bacteria thus tending to deplete the water near the bottom of oxygen. When oxygen became short anaerobic decay must have set in, releasing harmful products (methane, hydrogen sulphide and nitrites). Confirmed by increasing smell of the pond and definite smell of hydrogen sulphide in some of the specimen tubes which had not been opened for afeww days. Harmful products and oxygen deficiency would drive the animals to the surface where there was oxygen for their own needs and oxygen to destroy the harmful substances by oxidation. Note. GLYCERIA now mostly aerial or floating so, not only not supplying oxygen to the lower layers, but also cutting off light and preventing photosynthesis of algae underneath) An oxygen barrier would therefore be set up (cf. thermocline) or rather a decreasing oxygen conc. gradient from surface to bottom. Mineral salts, and food substances locked up in decaying animals and plants keep on falling to the bottom and are not available to the animals above because of the oxygen barrier. This would account for the general decrease in plankton number as well as the change in their vertical distribution.

This is of course speculative and needs to be confirmed by actual measurement of the oxygen conc. in the water at different levels.

Other evidence supports the above speculation. For example, by comparing the %age graph with the bar-chart of total number of plankton it is seen that the peaks of both graphs come at about the same time. This showed that as the oxygen was being removed there was still enough food etc. left for active multiplication to take place. But once these large numbers of plankton were concentrated at the surface food substances would be quickly used up without subsequent replacement, hence giving the observed, sudden fall in number.

The prescence of oxygen deficiency is"confirmed" by the larger species dying out e.g. DIAPTOMUS, SIMOCEPHALUS, before the smaller ones e.g. CHYDORUS? CYCLOPS. (See special case of the Ostracoda).

The slight evening out of distribution in later months may have been the result of adaptation to changing conditions or replacement of one species by another more suited to the new conditions. (see Ostracoda).

Comparing the %age graph with the weather conditions there is seen a direct correlation between the two at the beginning of the year. (i.e. more plankton near the surface when sunny and warm). Later in the year there was a more obvious inverse relationship (i.e. less plankton at the surface when sunny and warm or hot). This could be accounted for by assuming that the plankton have an optimum temperature or light intensity. They would then move towards light or the warmer water early in the year when these were still moderate and away from them later, when they were intense. Further investigation esp. with light-meter is again necessary to confirm these findings.

3) Numbers of NAUPILUS larvae. (-20-).

This is a collective term for the larvae of certain Crustacea, in particular CYCLOPS, Harpacticids, and DIAPTOMUS. These were most abundant early in the year and were presumed to have come from winter or resting eggs. Rate of metamorphosis could be studied using for apparatus, that shown in the fig.

4) Numbers of CHYDORUS. (-21-).

These were the most numerous sp. of water-flea probably on account of their small size. At their most numerous they reached a conc of 13/c.c. Remained quite numerous (together with CYCLOPS) after the other species died out. Small size therefore able to resist oxygen deficiency better. It forms conpicuously different winter and summer eggs. Although one of the most prominent species during the peak period did not greatly increase in number after warm week at the end of March and therefore may require even warmer water for full and rapid development. They formed the main diet of young newt tadpoles becaude found in their guts.

5) Numbers of Ostracoda. (-22-).

There were two interesting features of the bar-chart of the numbers of Ostracoda at different times of the year. Firstly, was their abundance early in the year (peak in April) and gradual decline in May (as other species increased). Secondly, there was their distinct recovery in June and July. This recovery was due to a change in the dominant species of Ostracoda: early in the year the dominant Ostracod was a large species with bristly 'shells' but these were the ones that declined only to be replaced by a much smaller species with reticulately marked 'shells'. The larger one seemed to be unable to resist lack of oxygen yet because of its large size was able to multiply in cold weather (larger size = relatively

The replacement with the smaller species seems to confirm that there was a shortage of Oxygen. Fuller identification (not easy) would have helped.

6) Numbers of Harpacticoida (-23-).

This group gradually increased in number and reached a peak in early May afterwhich they declined and completely disappeared at the beginning of July. From a study of their distribution they were distinctly bottom living yet seemed to be unable to withstand lack of oxygen or prescence of harmful substances. Probably the interaction of both these factors led to the early decline. In this respect they resembled the larger Ostracoda who also preferred the bottom layers (Debris feeding?) but unlike the Ostracoda were unable to multiply at low temps.

7) Numbers of CYCLOPS. (-24-).

There was an overall increase of CYCLOPS throughout the year but there were peaks in March and May. They were therefore comparatively resistant to low oxygen and deletrious substances and therefore able to proliferate when other species had died out. They were definitely bottom living as well. The various peaks were unaccounted for and a fuller investigation of the different species might be necessary.

8) Numbers of DIAPTOMUS. (-25-).

This was a large species which never reached great numbers and therefore the results cannot be regarded as being free from the element of chance. This genus appeared to require fairly warm conditions (peak in Mid-May) and a high oxygen conc. since it was surface living and since its numbers fell abruptly in late May. Increase in number of Filter-feeders near end of May may have been another important factor leading to its decline.

9) Numbers of SIMOCEPHALUS (-25-).

The number of SIMOCEPHALUS gradually increased from none in early March to a peak in late May. Thereafter they got less and less but some persisted into July. Were definitely surface lovers. From this it was inferred that despite their large size they could not multiply when it was cold and although reduced in numbers by oxygen deficiency, some were able to survive.

Another possible reason for their decline: an infection (apparently) by a fungus (see fig.) producing sporangia resembling those of MUCOR - Phycomycetes. In a Plankton sample taken on 12/6/60 almost a 100% infection was found. Whether this infection is fatal or not is not known and a study of the fungus itself, %age infection compared with number of hosts, and effect of fmg fungus on the host would be very rewarding.

Another interesting study on control of numbers would be to count the number of eggs in the brood pouch and plot this number against the actual number of the water-fleas. There should be an inverse relation since less eggs are supposed to be produced in an overcrowded situation.

One more point of study could be to try and find out why SIMOCEPHALUS was much more abundant than DAPHNIA (of which three distinct species were found). This may not be surprising in itself but when another nearby pond (only about 15ft. x 7ft.) was examined Daphnia was found to be more numerous than SIMOCEPHALUS.

Since these fleas are transparent examination of their feeding habits could be done as well as a study of their rate of metabolism in different conditions - measured by the rate of heart beat.

This water-flea could become the subject of an extensive type-study.

A summary of the requirements of the various groups or species of plankton was made:

CHYDORUS	MIDDLE	HOT	LITTLE OXYGEN
OSTRACODA	BOTTOM	COLD	MUCH OXYGEN
HARPACTICOIDA	BOTTOM	WARM	MUCH OXYGEN
CYCLOPS	BOTTOM	HOT	NO OXYGEN
DIAPTOMUS	SURFACE	WARM	MUCH OXYGEN
SOMOCEPHALUS	SURFACE	HOT	LITTLE OXYGEN

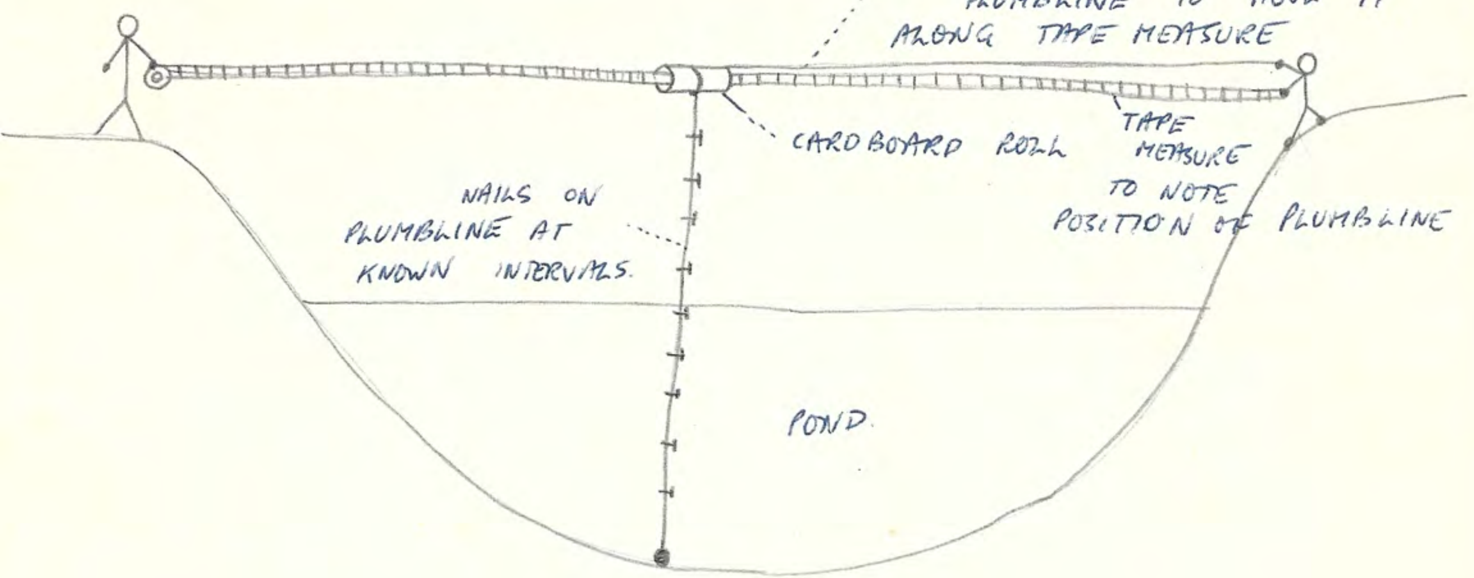
Note that they all have different requirements.

The above conclusions about the requirements of the variuos groups or species can only be regarded as indicative since many of the conditions of the pond were inferred from instead of being correlated with the numbers of plankton. Nevertheless many of the results were interesting and showed well the interelationships of the animals with themselves and with their enviroment.

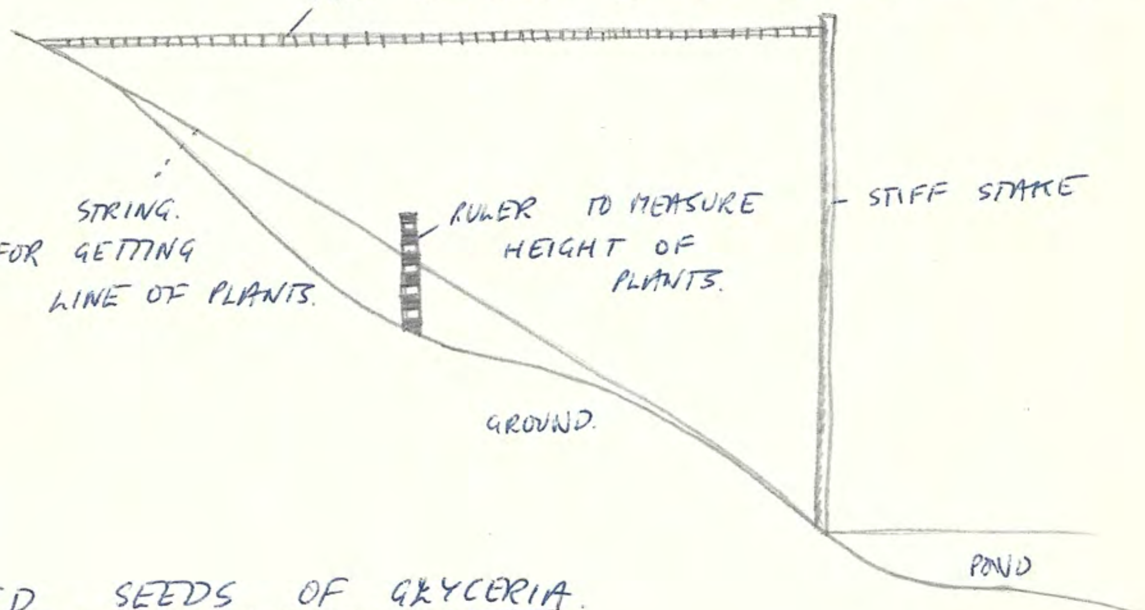
GENERAL CONCLUSION

THE STUDY OF THE POND FURNISHED MANY INTERESTING RESULTS? BUT UNFORTUNATELY NOT ALL OF THESE WERE CONCLUSIVE. THE VALUE OF THE STUDY LAY RATHER IN THE PRACTICE OF ECOLOGICAL WORK AND ALSO IN PAVING THE WAY FOR A FULLER STUDY OF THE POND IN FUTURE. THE ACCOUNT HAS IN FACT BEEN WRITTEN WITH THE ASSUMPTION THAT THE STUDY WILL BE CONTINUED NEXT YEAR AND EVEN AFTER. ALREADY IT IS SURPRISING WHAT INTERESTING RESULTS HAVE COME OUT OF THE RATHER INCOMPLETE STUDY OF A SMALL, OBSCURE POND. THE RESULTS OF FUTURE WORK ON THIS POND ARE AWAITED WITH INTEREST.

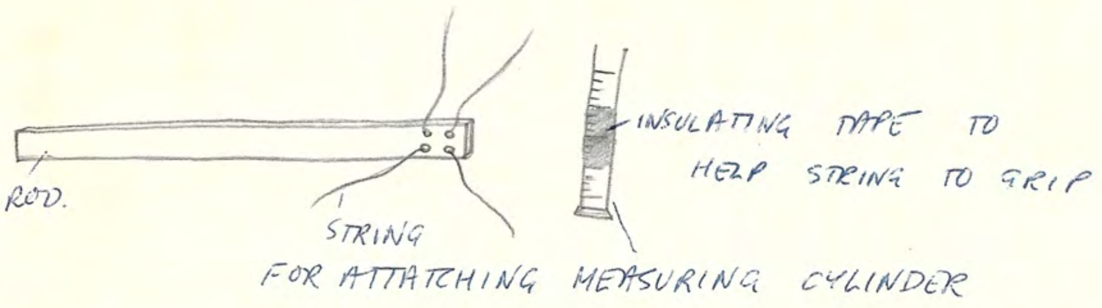
IETHOD OF MAKING PROFILES.



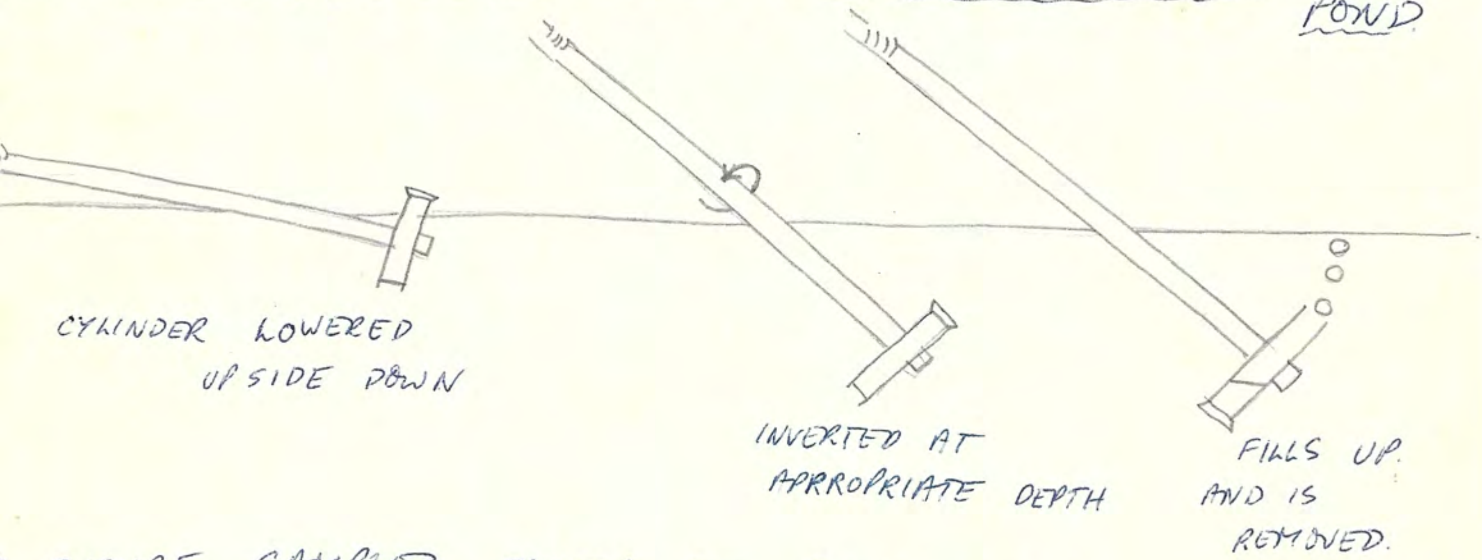
IETHOD OF MAKING LINE TRANSECTS.



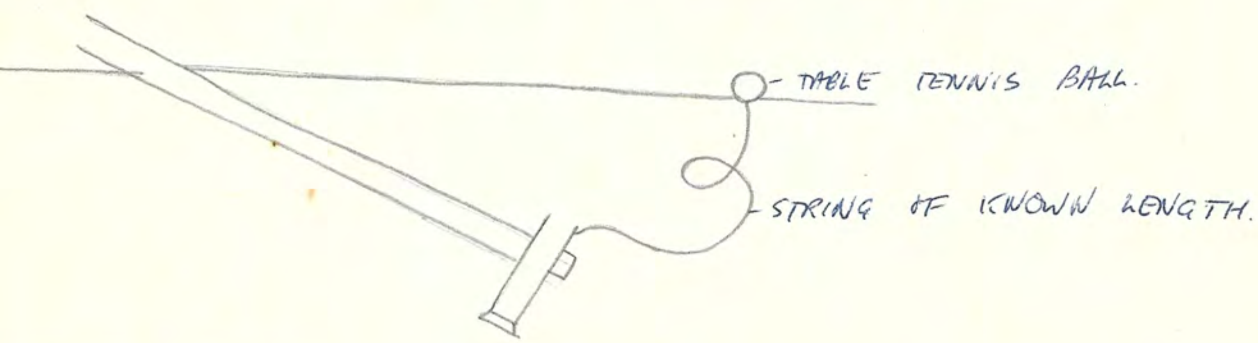
ERGOTISED SEEDS OF GLYCERIA.



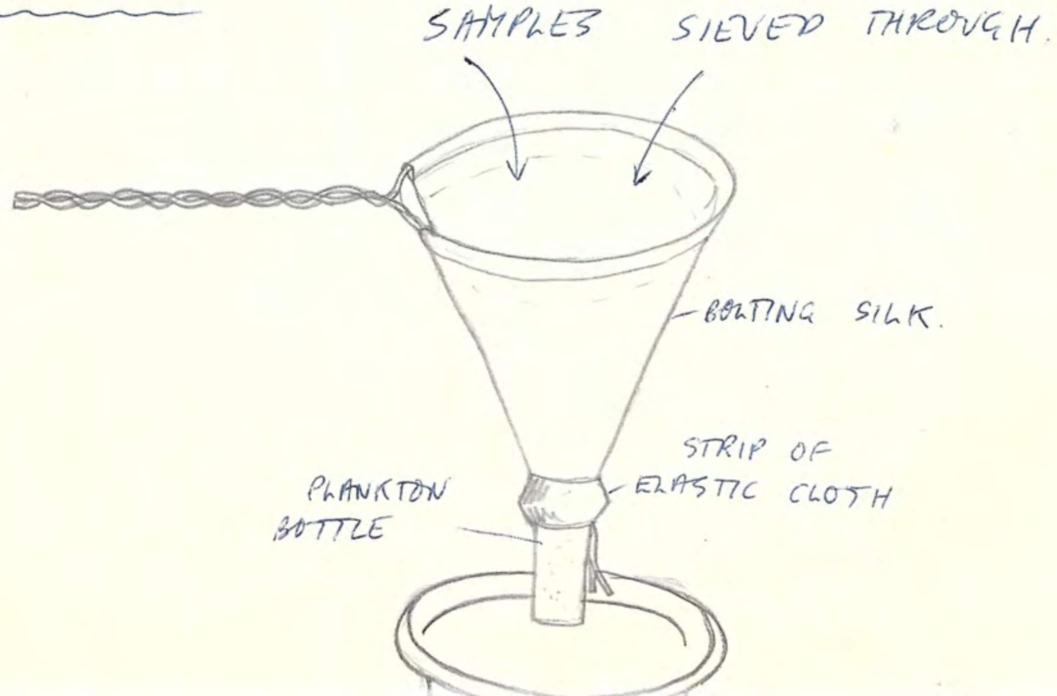
ETHOD OF TAKING SAMPLES FROM LOWER REGIONS OF POND.



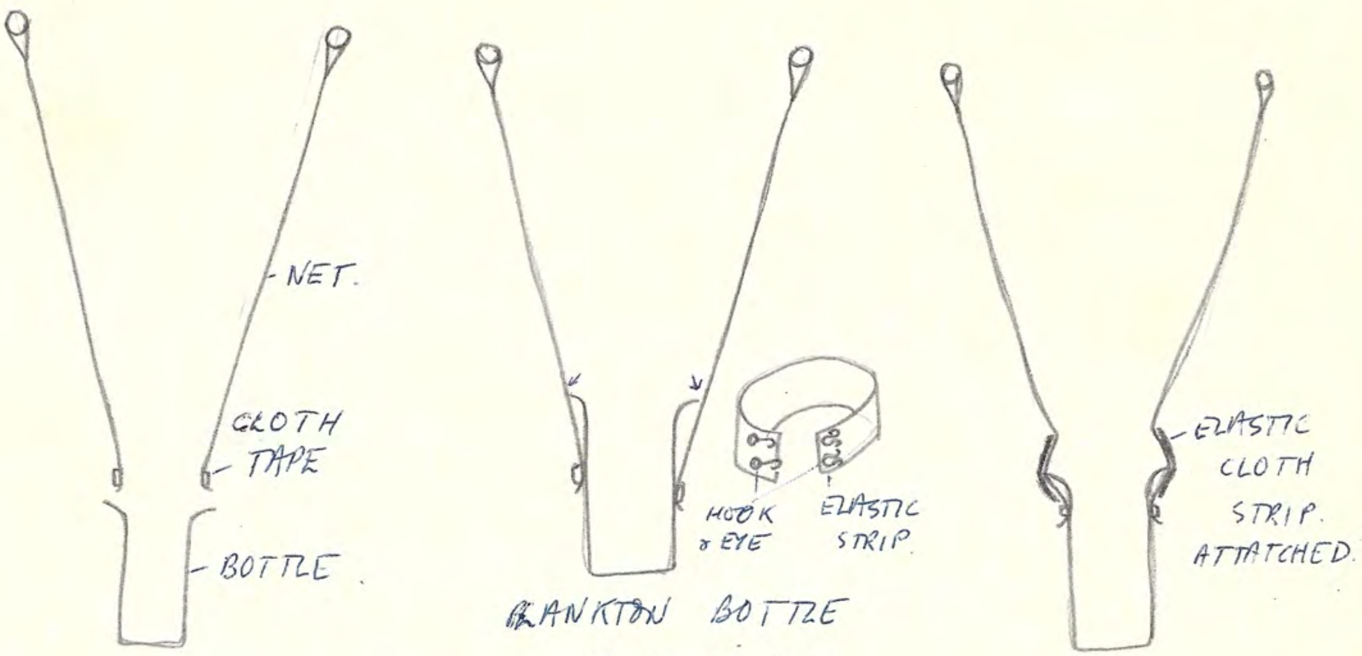
O ENSURE SAMPLES TAKEN AT RIGHT DEPTH



PLANKTON NET

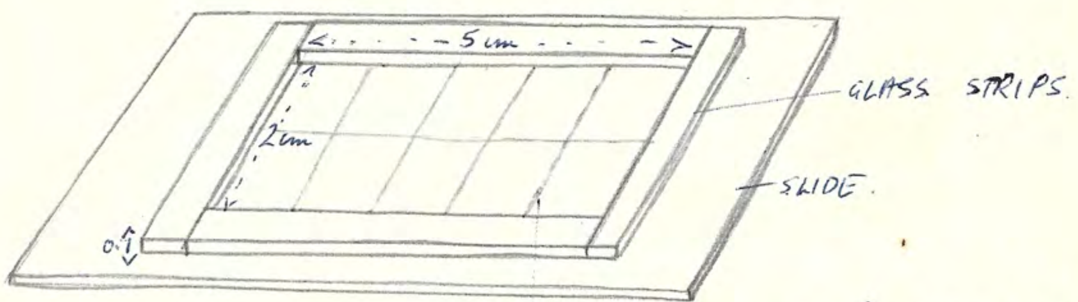


METHOD OF ATTATCHING PLANKTON BOTTLE TO NET.

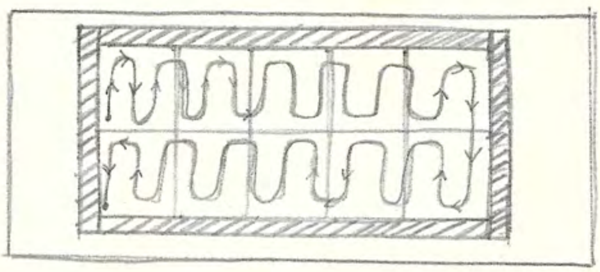


PLANKTON BOTTLE IN NECK OF NET

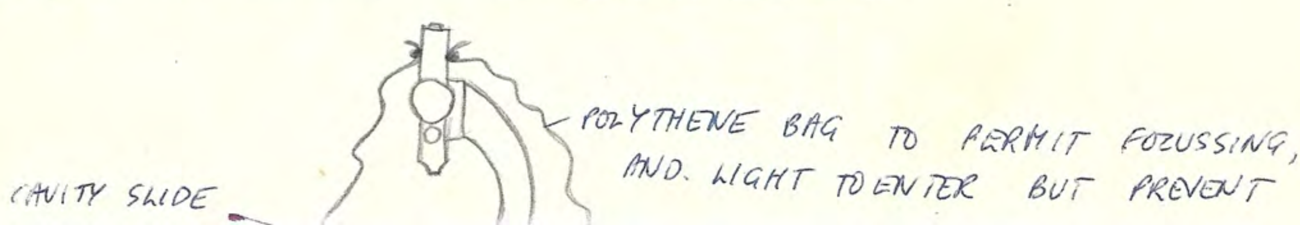
RAFTER · CELL



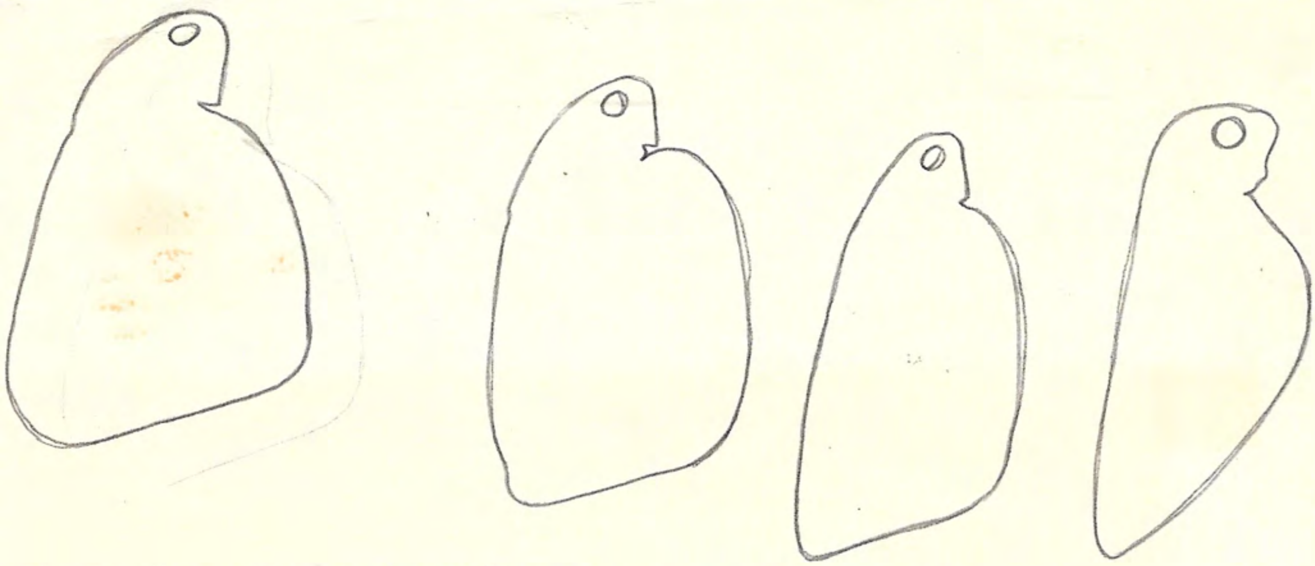
SHOWING DIRECTION OF SCANNING WITH MICROSCOPE.



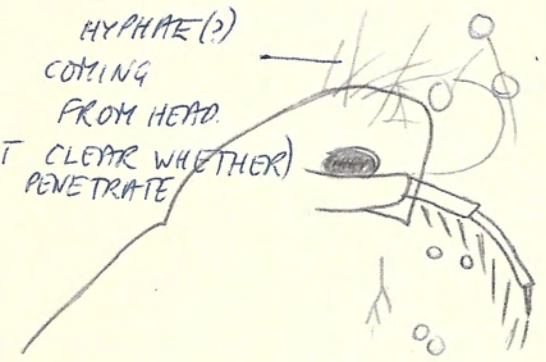
APPARATUS FOR STUDYING RATE OF METAMORPHOSIS ETC. OF AQUATIC ANIMALS OF MICROSCOPIC SIZE.



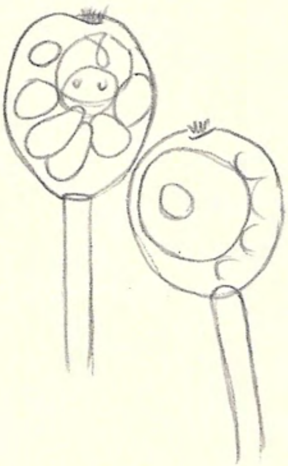
VARIATIONS IN FORM OF SIMOCEPHALUS



PARASITIC FUNGUS (?) ON SIMOCEPHALUS



LOW POWER.



STRUCTURES INSIDE ACTUALLY FAINTER.

HIGH POWER OF SPORANGIA (?).

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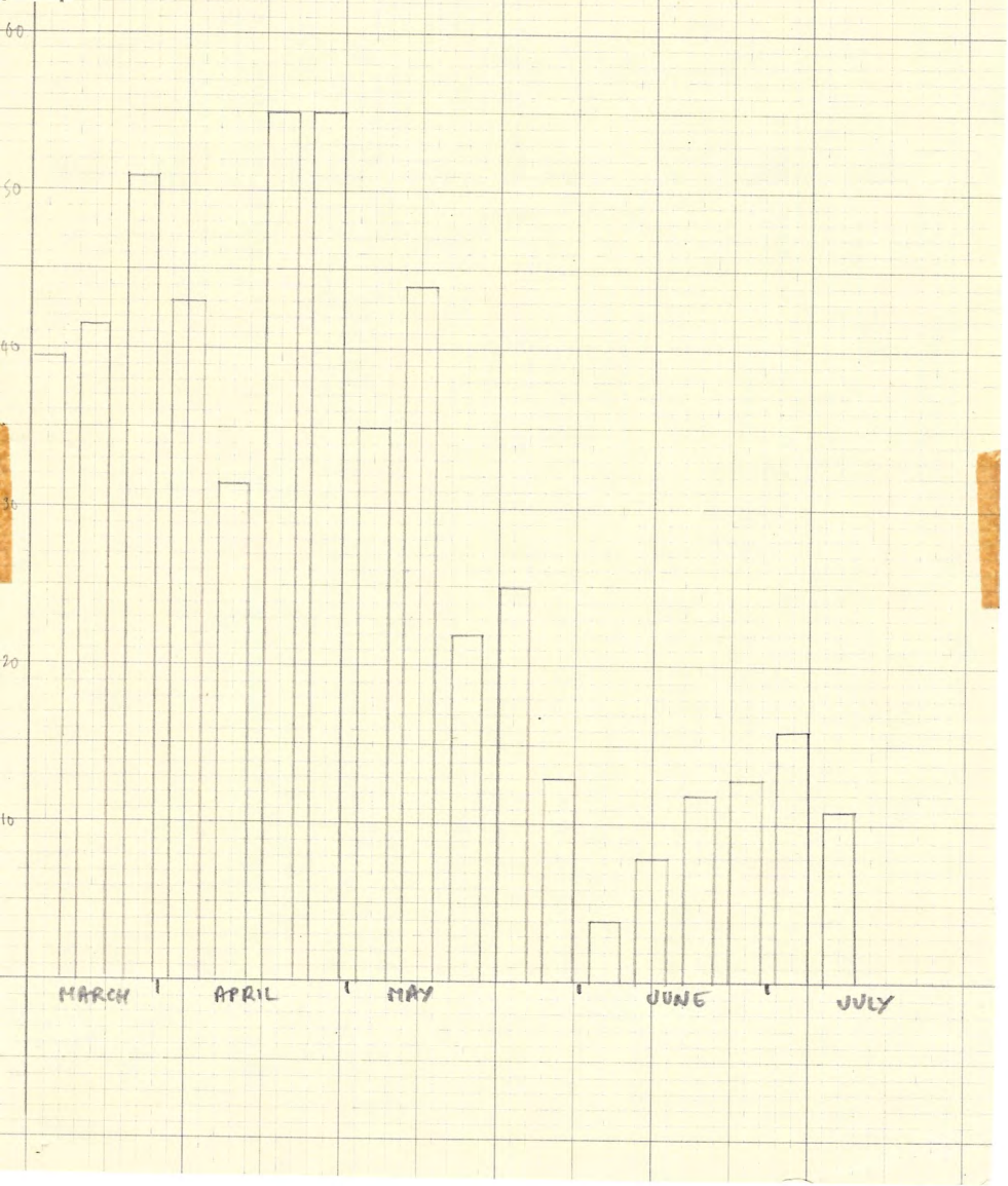
BAR-CHART OF NUMBERS OF OSTRACODA IN WEEKLY SAMPLES FROM POND



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BAR-CHART OF NUMBERS OF SIMOCEPHALUS IN WEEKLY SAMPLES FROM POND