Handwillen Manuscript No-2-

A map of Worthern Indian showing distribution of Ultorichales lescribed in this paper. The numbers shown in the map refer to pecies as given below.

1. Binucleari Tatrana
2. Cylindrocajsa oedogonioide
3. C. scytonengides
4. Enteromorpla intestinalis
5. Geminella interrupta
6. Hormiaium Flaccidum
7. Microspora indica
8. M. Terrestris

9. Pearsoniella Kashmiriensis
10. Prasiola Fluviatilis
11. Schizomeris Irregularis
12. Ulothrix Oscillarina
13. U. Subtilissima
14. U. Tennerima
15. U. Tennuissima
16. U. Zonata

Besides the above mentioned species, Rao and Singh have described a number of "formas" of Spiropyra and Zygnema. While some of these are merely described as "formas", there are others which are described as 'forma nov. As their names, such as megaspora, inflata, maxima, crassa and tenuis show, these algae differ from the type only in larger dimensions of zygospores and vegetative cells, or in having narrower cells and zygospores, or greater or lesser inflation of fructifying cells, or slight differences in the shape of zygospores varying from ellipsoidal to subspherical. As has been already discussed these differences are of no great value or importance and in most cases are merely of physiclopical nature. In fact the dimensions of the vegetative cells and zyggospores of the same species collected from two different ponds seldom agree. The present author is of opinion that these so-called 'formas are of little taxonomic value, and

(and merely ecological variants)

al ress any special names. Some workers who have "Onol- Deserve pickled unabiend along sail to turn from obsirvation smiling insted of these curlingical variants aventing and not unusual li fino habitat . forms , and it is truss elevater into in rough species.

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Collection and Preservation and Morotechnic House of Frishwale Algae. Algae and universally distributes of " are found over floating or attached to aquatic plante in ponde, preshwater streams, and owing growing rubarrally on moist soil and in bank of Thes. of all the groups of prestwater Algae, rynophyceae are the comments and The most familiar, and we see them nearly all un year round in drains, ponde, and walls of houses. Most of our ancient historical buildings present a dank and dismid appearance, due to the thick . could ap Campylmena, Scylmena, and Tolypollinia, which grow upon their domes and walls.

Collection of Algae: - For collecting Algae a my sumple outjit is required A tim. box containing a rack with about two dozen holes accomodating :24 willes wouldes & glass tubes about 2 inches in length and 1 wich in diameter, is recessory. The hotim of the holes should be will padded with cotton wool to prevent upung to the glass tubes. These should also be some space provided for a shorp kinge, a havi Joursons and and I dogen envelops unide the box. In me of the small Tubes commercial Formalin iphould be stones. A wooden. sod, made of. mall pieces about 12 foot in kyin which could be renewed on to cach atur, and with a muslim net attucked on one side

Besides the above mentioned species, Rao and Singh have described a number of "formas" of Spiropyra and Zygnema. While some of these are merely described as "formas", there are others which are described as 'forma nov. As their names, such as megaspora, inflata, maxima, crassa and tenuis show, these algae differ from the type only in larger dimensions of zygospores and vegetative cells, or in having narrower cells and zygospores, or greater or lesser inflation of fructifying cells, or slight differences in the shape of zygospores varying from ellipsoidal to subspherical. As has been already discussed these differences are of no great value or importance and in most cases are merely of physiclopical nature. In fact the dimensions of the vegetative cells and zyggospores of the same species collected from two different ponds seldom agree. The present author is of opinion that these so-called 'formas are of little taxonomic value, and

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i. Subarrial and soil Alfread Back Spylyto -The stalgar growing on soil should be revapes from the surface of the soil with a short knige. These may be stoned in an envelope a in a glas tule with 4% Formalin colution . On reaching the lateratory they should the places in a glass trough and placende a water top and herroughly washed till the costra attached is as impletily removed as provible. The bank algae and betty stones niside minvelops, for may are capable of standing dessication. a. Freshwater Algae - meso and usually found free floating or iteached to water plants. Free- floating from my de hest collected with ones hands. On holding The mass of filaments modes sunlight in one hand, hollowed dorow in up. shaped mannes, one can easily detect if in filaments are fertile or merely regulations. In the case of spirogyra, zygnema, and Oclogmum on can see the zygospones or Oospons in in form og small blackiste specks. The colour og the alga, also is an inder of its reproductive a vegetative stage. Dark green sheets of algae are always in a segretation stage of growth, and when they became hale gellow & brownsh yclow in wlour they show blenty of 2ygospones & orpmes as the care may he. So care should be taken 5 calledmly time formes which may be learnably

reproductives stage. In the case of algae which good epipergreatly on writer plants, small pices of. teaves i tems of in plant may be art with a pair of sursis, when they are mall in size, but when they are big and cannot be but miside a Tube, me should scrape the algae with a shalp knife, from their surface and store them maise a glass. When. Care should be taken to keep The links may 3 full. Then a drop of Formalin should be attiched, and usually it is form to be quite sufficient to keep two Algas in good and tim for a comple of day. Flagellats and attin planklow forms and sometimes found is lorge unders visite mall pont a lake. Sometime when The water is wholly prear with them, one can collect a grant quantity en merely dipling a tube visite un water. In some casas a silk net is found useful and are should drag it for a distance of a few paces inside the water and collect a large number of view formes. Preservation of Algae :- thost of in Kick walles Chlorophycere and nearly all tyrophyceae one best preserved in a 4% solution of Formalin (Formalselyde 40%). In the case of some delicate from like the Flagellats and Culorococcals 2% adulim of Formalin is sufficient. A lettle copper sulphate may be added to 2% solution of Formalin, when it is descried to preserve their natural when it is descried to preserve their natural

Staining - First wash The Alga in walk 4. for about 10 minutes. Then stain with theleylene Blue. I found Relugten Blue to be in last stain for differentiation of the cell details. However when mounted in relycerine jelly tie whole bigment is suched out and after some unters the cell stracture becomes transforent. Rounting - I found Glycerine Jelly return to be the cleanest and most ratigating in En core of filamenton Algre. The filament should be light with a fine needle and placed in a & watch-glass in 10% Calgarine (1 hart- glalguarine mixed aports of water). and should be council under a hell-jos to present particle of dust fran muning mide. The 10% Glycermi solution should be just sufficient to cover in filment, and the watch-glass should be left alme for it bad 24 hours to allow in water is Jully evaporate. Then a drop of metted glycernic Jelly should be placed in me middle of the slide, taking are but a air bubbles dung to the rides of the book , and the filament should be transferred at the point of a needle to it. Then it should be covered with a coveredlip. The slide should be the places 'made a hell gor for at least 8 hours, and the glycerine felly will set in a way books way. Then The constitute should be placed on a turn. table and a thick mig of Black Varrisie rhould be painted on the sides of the coverslip. Give the temtable a strong Prefantion of Gigernie Jelly :-

- due alle, maning man transportunte it abstracts all The above and of nu and syed with gyreans is wind are in a abale of haged museriation. seven year yo, uning Eilycome. Ally release melle in a very for use in mounting. entiming boulding water no getting torues mull Tule and places in a beaker testing , siller his gelig wiele warm. A hurtune for allower 15 minutes and string bearing und row Corrobic aus. stend the whole Le viel province of the maximum out 1 der. of have a contraction of the goal 2 to be for mone 2 hours. Here and i with by weight of work and allowed I have any weight of Firende gelatin w - lost . indone of advance . Jeans not wine were two-coats third. 10 wide on the cover. Put a medeum any windly and extend the any with it is my to extend, then grade all officer and in non mel is work my merel pro rel co afine, and buck The slide will a true tosure

Occurrence and Distribution of the Prospects Freshwater Algae of North India".

I made a collection of the Panjah freshwater Algae from July 1929 to April 1930, and February 1934 to October 1951. Jam Lahme, Jullimder and Holiarpur districto og til Paujab. Then I had another apportunity of meking a collection of the preshoates Algae is Salaran pur district y the united Provinces from December 1934 to January 1936. In all about 420 samples were collected Comprising 122 species which have been worked out and malute two new genera and sixteen new species. Archiespur and Jullim sur districts are situated between sutly and Beas rivers, and contains two perennial streams the sich and the sufed Ballow mere two districts provide unique apportunities for Algal collections, and it is no exaggration if I call Them an Algologist's Paradise. Hoshingpup and Sakarapas districts contain a chain of ponds in the submontance areas, as well as swamps which are called Chhambs, locally. Salearanpur district is retualed behoven the Ganges on the east and Jumona on the West with two big canals, and himson mall streams meandering in Them. The ewamps in these districts are annually replenished by rain. water from in hills brought by the choes, which are seasonal torrential rivers which sweep

Geographically these districts are very much similar being bound by The Suitalik sange in the North, and have practically the same cost of climatic anditions, The

There are numerous big tanks also made by religiously & distably - Diport people which goe afford ample apportunities for algal collections. In addition there are ponds which are from in practically every village for The use of cattle, and these are also very interesting from the algot point of oried. The ponds and detabes found on both rides of The valuary lines in many districts are also Juli og Algne durning and after tin raing clasm.

Climatic Cuditins ____ Hoshisopur is a sabmontane district lynig helwen 30.59' and 32°.5'N, and 75.3° and 76:38E. The annual average ranifall is 36, of which 3° fall in the summer months and 5 in the winter windths. Jullimber and Lahore recemble each atter very much and as compared with Hostingfors they are more dry and hot. The hottest months are May mi June, with a mean maximum tanjurature of 106°F. ; we highest temperature recorded being 120°F. The coldest wonths are December and January, with a mean minimum temperature of 48F. me ramfall selvan exceeds 25 miches per annum. Saharanpre vescubles Hoshiaspur in very every way, only difference being that the rainfull is greater in Salaranpone.

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Occurrence and Report duction of treshwater Algae: - The main groups of Algue VB. Diatoms, Hypophycene, and Isokontae, Heterokontae, and Rhadophyceae, have been studied as for by Tr. Aladal Myred, Dr.S.L. Chine and the author in Northern India. Diatoms are very abundant during the winter months from the middle og vovember to ten end og February, and my own observations fully corroborate the conclusions veaches by Mr. Ale and Rajas in this unrestigations og un Paujale Dialons. Forms like Navicula, Cyclotelle Surivella, synedra, mit Nitzechia are from in longe numbers an the moist soil of fuiles after sames and the orying rites of ponds and ditches. Synessa, Navicula, Cyclotella, Councis, and Comphonene and also found in large numbers along in stagnant or altached to the rothing branches of water plants. Hyxophyceae are met all in year vound, hut are very alumdant after the October and November. Fembers of Mysophyceae are note subserial as well as aquatic, and in un latter case and found wine commenty in stagnant-sheets of water. Our knowledge of this group of Algae is mainly hand on two work of Dr. S. L. Chose. According to Dr. Cohose the Mysophycere in Kalime show great vegetating activity between August and February, and the fruiting season is from February to April. The study af spore bearing forms like Anabaena

Rivulania, Auloria, and Kodulania is very uiteresting from this point of view. According to Dr. Ghose Anabaena Versalilio and Revuleria nations produce spones in the highling of March and April. My own abservations show that forms like Anabaena aghindrica, Anabaena monififorme, Anabacuotinix epipliptua, and Noduloria spunigura produce numerous Apres in the unites of February and March. in the Reproduction of Frashwater Algae," That The spore bearing them Algae like Sprogyna, Zygnema, ahorilla, Shhaeroplica, and Ocdogmium in March and April, The spire bearing ryrophycene the the species mentioned allove, also, and leg behind in this respect. In fact there typophycene are as well prepared to meet the drought of May, June and July in the form of thick . walled spores is the Green Algae. I have already dealt with at quest length in a reporte paper with the peniting moren by The sport hearing Comen Algae in their reproduction. However Jomes which unlipty vegetatively by fragmentation and zoospores continue their cycle of reproduction intermittently. mese algae are found in artificial reservoirs of water, and perennial streams, and show a great huxuriance is growthe from October to March .

Ecological Survey of Two Freshwater Algae of Northern India-The following is in brief an ecological carry ay un Algae og Norturn India, which I have ome airos during my investigations. 1. Subarrial Associations - Under This her suij we shall deal with Algae which grow upm vil in the form of patches or in some cases in the form of mats. Subarial forms also include Algae growing upon pieces of moist timber and walls of houses. So we may divide the Subaenal Associations into two main groups; firstly the soil Algae and secondly The Algan growing on Word and Walls. A. Soil Algae. - The soil Algae nicludes ture kniss of Amatinis in this country. country. i. Vaucheria Formation - Mus is equivalent to 29 gogonium errictorum Armation of Europe. From the beginning of December to the last-week of February, Vancheria semilies and V. geminata are seen writing large areas in lawns and granzy filler in the form og bright green felt her mats. Ogsmå and Anthritia hegin to appear in in first week of January, and by the last week ytebruary most og tin filaments become sontile. It is arrives that Vanderia sersitis collected from ponts at about the same time is from the lawns proved to be and fortile, each filament being loaded

which has a great liking for worst want work trick line covered walls of houses, and carthen Versels like gharas and Surnhis. After the ranis this alga may be commonly rear on smooth pièces of word, from which hark her been venoved and the walls of houses. This alga may be found toronghout the year on the most word work of Risian wheels, accompanies by Horses. i. Bark Epiplugtes - Afterwoodfes. Mis grønp og Algae resembles in many features The formation discussed above, but differs is showing on almost exclusive preference In a moist logs of wood and trunks of trees. Aphanocapsa untana appears in the from og light. blue green patches on smooth trunks of thes from July to August, and the truchs burne drie, un alza bernes saplurieblue ni colour. Awording to Dr. J. L. Charc Phonnidium transicolum, dyngluga transicole and Tolypothing campylonemoids may commonly be seen on the trucks of Acacia modeste in the from of a bluich green layer, which becomes very sling and confirmous after the rains In the wet reason homogones are plentifully formed, and these forduce uncitagenois sheath which become thick formi, and coloured , When it becomes dry and warm in straking becomes them and papery, and beels off this

I Aquatic Associationis -

we include all the Algae which are found growing in water, free. Hoaling or attached to after water plants. This includes a large number of forms and we shall deal with may the commonest and unst important species. According to their habitat, we duide this group into two man rubynanps, viz - Algal associations of Howing Water and Algal Associations of standing water. 1. Algol Associations of Flowing Water_ This group may be further subsivides into two mult subgroups according to the velocity of the amount of water in which were Algae graw. a. Algal Associations of Swiftly Rumming water - mis group of Algae is chracting by the possision of strong basal cells which very after remete a rost of cement like material of abration. I found a number of Rhodophycen in the siah Bacen hear Dasuya in Hortispur detruit, where it flows very rapidly. Attached to black of rushes, in midament, and found thankruisia chalypen, compropogon, Batrachopernum umiliforme, and Sligeodonum variable - in the worth of August Schlember O loter ~ November. In December, due

perhaps, to excernic cold, mere Algae disappear Cladaphona glomerata also belongs to tins group and may be seen in hig tassels boking the fox-tails attached to fallen branches of water plants and these in most streams and canals. Mis group also includes a mumber of unicellular and colonial bypoplycea growing at stores, which are well works investigating. By developing strong basal cells and likenens for plenty of Oxygen, these Algae excluse atter impetitors and hold their own against all atur Algae. (4) - Algal Association of slowly Running Streams _ These Algal and also chructures by Induers for plenty of oxygen, but not so huch is in the best mentioned group, and at the same time basal cells are not - 20 well seveloped. As compared with in former group, it is a much more numerous group. Chadophora glomerata, Mongcotia gunglina, Draparnaldia plumora, Chartomorpha aerea, Vedogmun op, and accomptanente, and ceptain attached spenis of Sturiggora, are very chora tenstii aj unis group. Here we may also mention the interesting case of cladophora glomerate, which grows on the shells ay tanks in the anon the shells ay astropads in the chalamar the Garden Laline, and in the still water of the tanks secures its and in the still water of the tanks secures its and in the still water of the tanks secures its

Cladaphora glomerala also accurs li tuo vesenois of wells fitted with Persian Wheels, where two alga is constantly being arated by two How y water from the well. Chartonopha area which generally accurs in prestwater streams mag also die grute after reen growing under water taps, where twere is a constant-flow of water.

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11. Algal Association of Ponds, Tanks, and Ditches. - This group contains by for the divided into three subgroups according to their habit.

a. Plankton forms - These are very ting algae, which are formed floating in lakes ponds and tanks. Some of these Algae have evolved special structures like bristles Stattining of in boy, and in recretion og muilage, for keeping afloat ni wales. Such brittes and flattened chape may be ceen in Rediestrum Borganum, Scenedestrus abliques S. quadricanda. Mucilage helps Valoox aureus and and Pandomia unrum in beckning aftent. Missocystis acraymenta, sine samply flat in shape and has is alles special structure. Arthrospira spiralinoides and A. platenzis have a spiral like a look screw which helps me Alya in traping affort. In this group of algae me may also mention the different spens

an forme free floating is ponds and lake og tin blankton form have excepting un secretion og muilage. His group als comprises numerous Desmids which are practically untonded by any Algologist in this country, and Dictors which have been pratty worked and by Tr. Abdul Rayced.

b. Benthic and Free. Hoating froms_ Under this heading we shall tise consider three Algae hear hear when you to the the thanks of ponds, lakes, and tanks or sumply entangled in branches og waler. plants, for they have as special organs in the form og hapterophines. For attachment, Zygnemiles are very well represented with about nineteen specie desorties by the outer alme, and there are sundy many ume. Spirogyra i til mumest form J these, and then come Cihosella, Zygnema, Debarya, and Rougestin, Modularia fertilissemi op. nov. may aks bee nen mixed werter Ghadla midica. gen. nov. Octogmin is very well representing by about Justice species tearters by in another. Sphereples annulina mayales be commonly reen after February, and in April it becomes featule in much mass that it guis a brick, ned.

colouration to many ponds. Hydrodictym reticulations occurs in most of the big ponds and small slowly flowing prestivate streams from the middle of July to nist of the preshwater streams are full of glistening daughter - colonies of this alga. There are very four Myrophyceae which are found pre floating. Oscillatoria princeps may he seen in very muddy and stinking puddles found rear most of our village wills or in drains. Appanocapsa serpentina is found in an shape of light the gelations cylindrical marses filling many hands in Fergepore district. Inen there are certain species of Anabaena Rivalana' and Cylindes spermum which may he found that to pre. floating in Houlent masses in some ponds and tanks. C. Altached Forms - Under Turs group we shall consider the the algae which are formed allached to the bottom of ponds, toto submerged walls of tanks and water reservoirs, and submerged the voots, stenes, and leaves of water. plants, According to the substration and aleject to which they are attached, we subsivide This moup into following subgroups. i. Algae attached to Submerged soil of Ponds: ____ In this sub-group we include that small granp of algae which are formed attached

verg shallow and seldom being deeper than · 12. two fut. The So far I have seen only Times two mentions of rypophyceae which can be dealt with under the subgroup. Of these Lyngbya penelegans grows in the form of dirty - brown cylinistical columns attached to the bottom of tanks, and Anabaenoturia aplinidrica in tim form y blue green irregular cylinders attached to the relation of publies. As there is no specialisés ryan ay attachment, even a slight disturbance in water causes these cylinders to get detached from the bottom, and the alga beimes free. floating. I It is my the method of growth which has given in alga an attached helit. The alga firstly grows on the submerges soil, and then the distal part of the colony grows up towards light, and the mucus. Jan colony annues a gludnial shape. The time Jalga is Wodalaria spinigena which grows in deep blue coralline masses on gran untraged moved with grass in the shallow water of Budha sale at Ludnime. With grass in the shallow water of Budha side of Water. reservice II. Algae attached to the side of Water. reservice and Steps of Tanks _ tonder This group includes many members of Myxophyceae and some Green Algae which are friend attached to the brick. work og tu walls og water. reservoirs og wills, and the steps of tanks. If These Schozothorix mexicana may he seen in deep blush - green velvet. Whi bunches an The side, of water reservoirs, used In wabring calle in villages; adjacent to wells. Another common alga " Rhizo donum hieroglyplicum which i found on brid. work

under water. tops. Other important members of this 14 proup are four species of Stiger diminum, S. tubricum, S. amoonum S. tenne, and S. Subuligerum which here from 1 iii. Algae found attached to Sticks and Stones _ The algae which are included in this mb group show have developed definite mb group show have developed definite ognus of attachment in the form of religoids organis of attachment in the form of men may or flattenes basal cello. Some of them may he four growing attached to are rikes of the submerger steps of tanks, but wist of the submerger steps of tanks, but wist of them are from stackers to stones & dried sticks and branches of trees. Styerclonium with its frair species is a typical S. lut S. 24 s. ano representative og tis granf. and Next innes 6. ten Ulotinx with Jour species a. Zonata, U. tenuissima, U. tennerima, and U. subtilissima. IV. Epiphytes - Propundy speaking it is a mirapplication of the term to call most of the algae - epiphytes. by his term however we wear those algae which good upon living water plants and algae. This sub-group may be roughly divided into two sections, the difference mainly hering that members of the seins section and microscopic in size and are not aborrows to the nakes eye as the members og in frist section are. Section 1. Hajor Epriptlytes - Host og time epiphyts have well. I wedoped bosal cells for attachment. Desagonium is the commonent of twee with 14 species of which Ol. condiacum

De . urbium. De merme, De souile au . De. Hirrii ane fainly common on leaves of water. plants, and in the month of April They produce a multi-coloured harvest of orspores. Other common numbers of this section and Schizomeris inegularis, Aloturix oscillarine, Pithophora kewensis, Cladaphora glomerate chutmingha anea, and attached species of Spirogyna. It may be marked that most of these algae, which have agains of attachment, are the same of these found in Howing water, and have developed these organs even in a still water environment. Section R. - Minine Epiphytes - These are algre which are usually microcapic in nige, and grow as epipeligte not may no common phaneragamic waterfe plants, but abo on other algae like Swogonium, Chadoplana and Pathophona, which donot produce any muilage and hence become loaded with epipeligte. Hr. Abdul Mayers has studied the epipequipe Diatons of the Painale and according to him most of the filamenton algae, and specially him most of the filamenton algae, and specially him mentioned above are toaded with species og Synedra, Achnanthes hungarica, Councis placentula, Gomphonema intricatum, G. subapicatum G. constriction and Epithemia argus. That of mere Dialous have mucilizinois hyaline stalks by means of which they are attached stalks by means of which they are attached to alway algae and water plants. Other common to alway algae and water plants. Other common which have to one. Appenarchaete repens, Coler chute solute

C. suitala, Chartosphainidium globosum, and species og Characium. Hypoplycere are represented by Chamaciphon filamentosa, Anabacnoturix epiplytica, and Cylinderspermum Michaelovskoense. Literature. 1. Ghose . S.L. - A systematic and ecological account og a collection og Blue Green Algar form Lahme and Simla, Journ. Linn. Soc. Bat. XLVI. 1920. ii. See Ghore S.L. _ Presidenteal Address. Ske. Batany Robi. Indian Sucice Engress 1933. iii Jyengar. M.O.P. -Presidential Allows. Le. Boliny 15th . Indian Serena Congress. IV. Mayced. M. A. -A short Nate on Occumence and Distribution of Diatons in the Paryale

Marked Perioditity in Reproduction in here I made a vegular collection of the Panjale Freshwater Algae Jean July 1929 to May 1930, and and then I have been collecting Algae from December 1934 to December 1935 in Sahoranper district, which is on the boundary line of Eartin Paryale on the boundary line of the Provinces and muching hast of in thirtes provinces and hes a climate not very different from in erten submentance districts of in Panjab, erten submentance districts of in Panjab, two the Andrio pur and cardospur. Hy two that the inder the shown we that there is a marked periodially in an reproduction of Spore forming Chlorophysee which is donly connected with temporation and rainfall and itims. A passing regerence may also be make about Chlorophycener which donot form openes with hard walls . of these Hy srodictym retuculatum is an immonst m ponde and slow. Howing preshwater stream. Its glistennig daughter colonies may be four in nearly all months of the year when water is found in the ponds and streams, and I have collected it in all stages of sweldpinent ni all montes from July to February. I An excluding form anniberation have all algae

which are found allached to artificial h. water-reservoirs and only three are discussed which are found in habiral ponds and streams. Seasons of Northern India :- I have divided a gear in Northern Ondia into five scarme; A Ho a gear in Northern Ondia into five scarme; A Ho Start may be made with the Hot summer Months Autum units which begins from about 15the. May and tominates and s by the middle of July. These untits are characterised by dry heat - which in grows June is the hotest work of the wholeyer with a mean temperature of 89.7°, while The maximum near the a high as hands dry up and only a few streams show a slow tridle of water. Due to absance of water us algae can be seen in any ponds while in mue perenneal streams Dedogmum may be found in a vegetative andition. Heret og tur algae tide over uten hot-andry umtils perennetters. in un form og tuick. walled spors. II Ramy Season - This may vouguly he taken a beginning from the uniddle of July and ending they the second week of september. Due to the Ronsons his men Temperature falls to 85. About 7 inches of ram falls in these two weeks, and the ponds and streams become family full with water. The maximum amount of sam talls in Augustic. about & 5 wiches and all The water of un two bonds and stream, overflow with waters, in ponds is usually

The ramy scann finishes by un secondweek of september, in ramfall in time two weeks ho uldme exceeding two inches and watty falling is in chowers. This is the season for Hyxophyceae J On logs of wood light bluich patches of Aplanocaps untina meg he commenty seen. Campylonema dalimense 1tot 5, 6 is found mixed with grass in book brown patches abunt engwhere. In water trouger & bleush-green umn Sh Jasuich of schizolivir mexicana may be commonly reen internixed with Cladaphora and Rhizochnum. On moist pièces of wood green covering of fleurorours way des be seen. In some streams, & young filaments of schuzonins and comprobojn may be seen, un latter benjg purple colour, altached to reeds submerged in flowing water. young filaments of spirogge are also seen and in the unit the chloroplato donot show full waterity. The same way be said about various spece of zygneme nille Arsonant and de sagmium. It is with insidenble and de sagmium algae may enfound fin bet mintimes algae may enfound aport mat, even in vegetative in Sition. II Autumn Timtes - more may letaken as beginning with the Tind wich of September and Jinisting they the wildle ag November. In the letter part of september the sides of parts begin to dry up. On the sides of drying ponds Botry dium and unt

Protosiphin appear in a trick green carpet. In the unth of November Protosifhin grows in large numbers on fields which have been lying fallow r. Eyst. formation & in in The subtommean dizoidal portion takes place pal in a week mit then we Alga disphenos ui from view. Spiragyna is also seen in a featile endition in most prode. I recorded four spenis of sproggin in this worth viz. Spurgyra undeusate, S. rivularis, S. crassa and s. milida.

IV Winter Months-

By the middle of November it becomes fairly cold in Northern India, and the temperature drops to 50.0. The ponds are usually half full at this time, and the streams and rivers have a regular flow of clear sparking, and ice. cold water of in Hunalayan snows. In some cold preshwale streams like The Siah ballen, with a swift arrent of water, Chantransia chalybea, Batra chorpermum unitiforme, Stegeo lorium Variable and compropogn Tane found attached to blades of Typha in the mid current. These \$\$ members of Rhodoplyceae and Stigeo Inium variable are provided with well-developed besal alls for attachment. These algae disappear in December, perhaps due to excessive cold for the temperature may be as low as 45.

In slowly running streams Cladophone glomerals may he seen in hig tarsels looking like fox-tails attached to water. plants. All these algae require a good deal of aeratim, and I have notices that where the stream of water becomes very slow these algae town to disappear. Here we may mention the peculias case of cladophora glourate which may be seen in the tanks of the Shalimar Gardens Lahone growing on shells og Gastropods, whet more about in the m tanks and thus wrate the alga. However in this case the growth of the alga is not here she dow of the alga Cladophra glomerala which grows in running streams. One to slow locomotion of the Gastropod, the alga becomes thickly envirted with Diatoms and dust particles. Cladophora glomerate also ours in the waty. reservoirs of wells filled with Persian wheels, where it is constantly analed by in flow of wals from the well. In December we see usually have a rainfall of 1.5 to 2 wiches especially in the last two weeks. After the dry honting of October and November, This is very welcome and gives a new leave,

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of bright green felt. like mass mats in lawns gardens and atter moist places. Dogonia and Anthendia begin to appear in the first week of January, where and day in last week of February nearly all the filaments became fertile hening heardy laden with agmia, auturidia and orspores. Usually it is Turyet Jaucheria essilis is found hatte in produced by aquatic and terrestrial habitat, and it is unious That specimens of it collected June ponds at about the same time as a line twons, proved to be some fertile, each filment being loaded with luge woles aj aggoria and antieridia, while in the case of terrestrial specimens very far sex organs were seen . V Spring Months _ Spring season may he

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I spring reason my he spring reason my he taken as beginning with the first week of Horth. A compared with February here is a marked rise in temperature, the hean temperature in Horde henj 62.0° the hean temperature in Horde henj 62.0° or compared with 49.7° in tebruary. just as in spring a young man's tancy is supposed to term to lightly turn to

By the uniddle of April, Coursella is all fertiles and conjugation canals bulge out with nips zygogmes of an orange. yellow colour. Singmium sticticum also produces zygopmes in April. Periodicity in Reproduces zygopmes in April. By the end of May want of the begin to begints hourse is no rain fall and ponds, dry up, as mire is no rain fall and the Algan ten temperature risis to 81.0°. Now the Algan + Z have to face the hot dry spell of thence A umblies beguning with they and ending with nu middle of July. To meet this contingancy in r t O species of Oedagnium, Springyra, Vancheria, Zygnema, Guosella, Swognium, and Spharoplea have produced thick walled a orpons while are capable of surviving in high temperatures of June and July. When the ×. rains start in the uniddle of July these oospones begin to germinate and produce young filaments. Then for the next tour to five months unt of them algae show a great vegetative growth with very little reproductive activity. The unter of March provides optimum moiting for their reproduction, and probably this may be due to risi of temperaturne in March after un cost

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months of January and February. Thus there is a marked periodicity in reproduction shown by the Algae in Northern India which is connected with mume or less districtly marked seasons. This is a vemarkable phenomenn which is not 7 E hoticable in England or other temperate 1A countres where the reasons are not at so will montes; as we have in Northum rt e India.

Reproduction in Green Algae. - (Marked periodicity).

	Hydrodictyon reticulatum - small daughter colonies from April to July.
	Cylindrocapsa conferva - July.
	Sphaeroplea annulina - April.
zoclonium	Coleochaete scutata - End of March.
EUROCOCCUS	VOedogonium sp April.
cunococcus	Ghosella indica - CHLOROPHYCEAE Zvgnema sp. GHALYBEOSFORUM - APHANOCAPSA MONTANA
PSOPOGON	Zygnema sp. GHALYBEOSPORGHT - APHANOCAPSA HOMPENSE
TRYDIUM	Spirogyra sp CAMPYLONEMA LANDLAND
	CLADOPHOKA GLOMERATH
TOSIPHON	A remarkable fact about the algae noted above is that
	though these are found in a vegetative state for most pert

NTRANSIA CHALY & A of the year especially in the winter months, they produce their sex organs with great regularity from the last week RAC HOSPERMUM of March and by the middle of April they are all fertile. MonvillFoRME Various species of Oedogonium produce heavy crops of Oogonia and antheridia by the last week of March and are GEOGLONIUM VARIABLEII in a fertile stage by the second week of April. The same periodicity may be noted in the case of Sphaeroplea, DUGEDTIA Ghosella and the various species of Spirogyra and Zygnemax. GENUFLEXA This is most probably connected with the rise of temperatur DIROGONIUM in March after the cool months of January and February. sticticum. As our seasons are distinctly marked, this also affects the sex organs of these Algae, and by April when the temperature rises to 106°F these begin to produce their sex organs. By the month of May most of our ponds begin to dry up and the above Algae are prepared to face this contingency for most of them have broduced thick-walled cospores which are capable of resisting the high temperatures of June and July. Most probably when rains start in July these cospores begin to germinate and produce young filaments. This is a remarkable phenomenon which is a noticeable in England or other temperate countries where the seasons are not so well marked as we have in India.

Rainfall in Norther Deale 1934 to detatur /20 outting Dasuha ana Gattahanker Kosher An Janda Thail Jahoil Town Jahril In kercen lown. lobor /3 4 . 04 revely /3 enter / 1.49 1.74 1.28 1.34 . 20 maty /35 4.36 1.54 5.13 4.12 3.50 1.83 5-32 ling 1935 1-08 1.57 1:20 1-23 .35 1.67 atch/35 . 38 . 44 .16 - 34 1.05-. 84 cul/35 2.71 2.78 1. -3-3-39 1:78 ny/35. 2.58 . 09 - 27 ne/35--.17 - 79 1 /35 -. 20 7.45-3.96 4-31 6.14 8.56 13.88 ugh / 35-11-41 6.05 5.5% 5.10 5.96 pti /35 9.49 .. 78 3.66 1.76 2-83 tolux/35 - 57 - 23 . 1) June • 11 . 06 10-06 11.68 9.0) 10-86 5-71 uperley ! 12-55-

Hostinopa all. 26.11.35 · Ser, In compliance with Verbal order ay S. Kaper 9. c. s. I respectfully beg give the information past year's rainfall achober 13 4/6 Oct : 135 descred by your in you dated 20 = 11.35° attrind Kind Sardar Salut. The information regarding " temperature for the who year is not available Owing to some indispar Sardar Sahile has got letter witten by me. will write you near sound health. any service ? Jour most abs Sertrant { home see .] Juli Run R

lyhidricepose cipita 15th November × chlorilla . _ tambis a chrige. IV Winke Minis January Hysradictym returnletting - insteines , 1.5 mich Greenich - tile man , Anabana . sp. (15 m. Nounde Skiregyra crossa Desnymuni rivulsae × grunde pra, Straling 4.5 mile I December Winter Month January February 1. 5 wiches Aleadrins milice q. us - entrugled as two rate of Azalla. February . leo cui che. 4.5 inches Analiaenotiena yundris quemito pres. Hoaling Vanchesia unimata gilatinta mass. 1.0 inch I Spring Montino. (sh. They Rarch × Octogmin Kedyapii atterned is shine of × Spring A first 2.5 m th 2.5 mich (is in Mary . X X

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Algai Collecter Henry Tempertin Ranifall Habitat # Fahrenheit Consistin og Ponds 86-4 F: Streams hemanks . 17 miles No. 15 tu. May -89.7 F Au junde orgup. Hot June found attached to reader. stream A wate trage gawell Ocdagmin sp. Undeploor glower to 15th guly 87.1 F. - young colonies for I . 86.0.F 7.5 87-1 Synches - Hydrochidym retrailating Taulas and stocaus Taula . - young filowarts attached to rade. Posple calour. - Ocdogram of -I Istr. july Frenwate stream - combischogn - appears in light believe patches on log of word. On log of ward Free firsting is a prove Valoor aurens Sn a grany lawn Caulus delimens 85.2 F Tondes Jul - Grows in the form of brown patches Kanig August. Canjuglorina dationense side of water tranges in a drif pond war a well. - Schrizolomix medicana Streamswith plenting water - Osultatoria formuls me forting with pros of dama. Tank. - yhudesspermen stegnale -Serson Tente under a water ligh sound strached 5 stein of Nelumburn . - schuzemens imiguton - alounn automa 15 hi. september 81.8 F 1.5inch 15 E. Schlanber 80.0 F ×

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Genus Anabaeno Turix and Parallelism of in Evolution in Freshwater Algae." During my investigations of the Paujab Freshwater Algre I came across two Anabaena- like affer species og Blue aren Algae, which however digges prom tu typical specimens of Anabaena in having a number of tritiones suclosed in a suigle multipinon rheath. Recently Dr. F.E. Fritsch described a spews of Anabalna with a mucus sheath , from South Africa, which he calls Anabalma seguida sp. nov. (Troms. Roy. soc. JS Africa Vol XVIII Post 1~2) This 20. called Anabaena reginicola. Fritich resembles Anabaena aylindrica. Lemmer in essential features and the only vital defirma is the accurrence of a number of trichmes within a single rhater. me two species which I discovered dijjer from Anabaena Vaginicola Frittich in the roje og tre filaments, tre shape and roje 7 The vegetative cells, and the form and ryce of spores and heterocysto. Following is a description of these unce species of Anabalna. like Blue. green Algae i - Insal A.

So here and time species of Anabaena. le She Green Algar which have acquired in his course of Their evolutionary progress, the same charactér og en dosune og a number og toichomes a ruigle check. This case clearly clustrates, as neggestes by Tiss Agnes Arber in her excellent monograph on Monocrificons, that a trenus o an evalutionary platform on which species of ligerent origin are essembled together. In the case of these Algae, these different species of Anabacua independently acquired the hab of grouping of numerous trichomes in a single sheath. Abriously we are justified in establishing a new Genus, which I call Anabaenotivix, for the same reasons as we have is establishing Schizothing as a reporte genes from Lyngliga or Lyngliga from Oscillatoria. This genus Anabaeno turix is an expression of a tendency parallel to that of schizotunia viz. The endowne of a number of tribmes within a common sheath. This parallelism in evolution is Very interesting and shows how in habit of secretion of a common nucus sheats leg a number of filaments, seveloped in different families of Myxophycen, by Schizotion in Oscillatorneae, and Anabaenolumen in Nostoiscere. Members y temos Lynglys and noting but Oscillatorias endored in a

nucus sheath. Here The individual filamento developes we halvet of scineting individ seporate mucus sheathers around themselves, possibly as a protection against drought and dessication. In Schization's which marks the west stage, possibly higher, in the ground programs we see a number of filaments scinting a common sheath, the which this, means a greats economy of material. This tendency towards collectives remeting of a sheath has also expressed they ni Anabacurtuni, Two species of which seveloped from sypicant species of Anabacua. shough Anabaena is structurally on a higher scale wan Dsullatona or dyngbyn, we find it to ending the sume coolutions pairs some species of the later Too genera of Typophycene. Dypoint species of Osullationa and Lyngby developed into schizolwork and sygnent spens of Anabalna vite Anabaenotirix, but how follows independent vorde in reaching the same goal. Following is the possible cooletimary course anny these Algae. Anabaensturix Schrige thirix wild funder of a Schrige thirix wild funder of a Sugar third of the second of the s 118 Anabaena

We also note similar parallelism in wolntim and dichotomously divided spene of Galagdian, calles Golaydian division. denorthed by Dr. M. O. P. Igengar some years i ago man times, and Dichotmistiphin The dichot mous 'nature Jik hi branching of 6. divien suggested to Dr. Symper some distant innection with Dichotomorphin, a number of Isolontee. Som However These resemblances of former and novely superficial helivien Bobry siem divisium - Typuga and Dichotomonthon are purchy superficial and imporable to recentlances discon by whain there of Englishing Englishing the physical of the second of the sec # Euphrobia royleana to Cereus triangularis a member of Castaceae. As a result of similar Sry and hot environment wien plants, Mylogenetically for apart, have developed similar physical donatorstus the suculence of stem and reduction of leaves. Dicholomorphin, a member of Sochontas is characterised by stard metabolion , presence of hyperoids and presence of carotan and xanthophyll in the same proportion as in higher plants, while BotryJuim a member og Heterokontae, is characteried by absince of pyrenoids, coupled with oil metabolism and excess of tranthophyllmine with the

hold that Isokontal and Heterokontal had an uidependent nigin anny in primitive Flagellats. Tost probably the ancestos of botry sum were some didiotomously branches filamentous coenocyte Heterokontie, prochly some comocytic Tribmemacene. Such structures in his hypothetical member of Tribonemeccae and Dichotomsight developed quite uidepersently due to a similar response to some unknown invironmental inditions and does not wear my phylogenetic relationshiphetwien the two for their differences and fundamental then their recemblances. Another striking mistance of parallelism in evolution is seen in the case of Protosiphon, a globular member y crokontie and the common roundiste speus of botry limm, which belong to Heter kontal. In This case the resemblance, is so great that species of Botrydium are given mistehen for time of Protocyphon and the versa, specially when the chloroplasts have disappeared. The spherical form his been independently evolved in these two Algae to reduce evaporation of water, specially as they subsist on dry mus and They have to economise their water content. These two terrest scal Algae Juis their parallel in globular of Mexico and South America. Caitaceae

5.

Species have a tendency to evolve along possibil times when they are subjected & miles environmentel etimeti e.g. The same degree of liemperature, milar hyprosopic motions and minder zort constituents. This is clearly seen in the cose og sobrydimm in Protoseptoon. However in some cases the resemblance may he purely fortuitors and may he ROMO-HERES chromemene of two dromines of the muclei of alls taking bears independently ni defend spenis of different guera but resulting in similar external pupical appearance of the plant - X. new for The discovery of the fast that species have a tensury to evolve along porallel his his made it aboundantly clear that external physical apperance is no index of physicatic PHYLOGENER velationship and use should avoid in Jullary of deducing pedignees and velationships menely on the accumence of a few common external characteristics. The realization of the fact of parallelism in walution dis also influenced our incept of Genus. The species of Anabaensturn's clearly illustrate That Genus is an evolutioning platform on which species which have wolved independently form different levels gather together for

"Some Attached Forms of Spirogyra form the langale." Some species og spirogyna have been described, which are known to produce organs y attachment in the form of hapterophines, but so for there is as record from India feature from ______ producing rhigoids. During my investigations of the Parijah freshwater Alance I cause across a humber of sheers of Algue, I cance across, a number of species of Spirogyra growing, both in stagnant water of tanks and rapidly flowing preshwater streams, which produce vhizoids for altachment. Delf hes described spinggyra adnata and S. Huvitilis as forms accomially producing rhizoids, and according to kny Spirogyra setiformis also produces rhizoids. I have prequently abserved that spirrgyra affinis kutz. whose usual and af reproduction is by lateral enjugation (tig ia) quite often produces vhizoids from its alls. These thisoids become closely attached to thick and rough filaments of Oedagonium on whom This alga is found as a common epiplyte in parts. These haptersphares of spiragina officia (jig i . le) are bijvæates, and their ends are fraged. In fact were me not very different from tusse described by Delf in spiringyraadnate and by Gyungar in a sterile checis of spirgyra. Their size and control position indicates that quite possibly they are merely modified conjugation canals, though it is difficult to guess as to why The organs which are parely reproductive in function should subserve the function of fixation

and support.

I have also come across some filaments og skirogyra dubia Kutz. prødung vhizails, which are very dyperent form the haptiophones of Sprogyra affinis. Fig " a shows a conjugating filament og S. dubia with rife zygospones. The verizoids in this Case are not short and stimpy as in S. yjinis, but are long filler. like hodes (fig I to) which expand laterally and beinne fraged when they get attached to some other aquatic plant. The chloroplasto in the vhizoids are rever in the from of a spiral, but are in the form of palish a. not. D. green stretched out tureed - like filenteties. This algo is found in slowly flowing proshwate storeins. Another interesting species of Sprrogyra was found attached to the radial stan of a water plant in the beg tank at Daruga District Holioppe. In This case it is noticeable that the attached habit has been developed m a distinctly still water environment , where The alga is no danger of being worked away by a rapid current of water. The upper cells of the filament are 30 H broad and about 4. times as long. The chloroplasts in the upper cells, and

very douby packed (Jig III a), so close in fact, that they donot present the appearance of a spiral at all. It was with anside the difficulty that the alga was identified as a spenie of spirogyra, The doubts about its identity being strengtmenes by its fixed talit. I came across a specimien of Spirtogyn in a sheet of water at Dhanour' Tehsil Rowher District Saharappe, which rescubles The form I have described above in The condensed nature of its chloroplasts. It would be interesting to find out the physiological factors which affect the form of the debroplant in three attached formor y sprogyn. The vhizoids of This alga are very highly developed. Some og tu vluzoids are long and dichotomously divided (Fig III t. c). Some of them show degenerated theread. like chloroplasts (fig iii th) while attress and absolutely hystic (tig ind.). Some of in filaments show a dichotomously - prayed disi at the bottom (Jij II e). Rhizoids like the above, have been described by lascher in a spenis of trongertia, but so far they have not been reported in such a complex stage of developmentin any species of spiriggra. Here we annot regard - un rhizoids as modifications of

enjugation tules as in Spirity on adnata for They are not lateral in portion os in the alere forms or S. affinis, the In this alga they are definite organs by Themselves, The upper alls of the alga also show onjugation in some case with wife zygospones (figs. II f and g) . The zygospons and wat makape 284 to Due 6 The condenses nature of the chloroplats it is definit to find out men number and spirits. Possibly it is a new spens of sprogyon My experience has shown mat fixed habit is quite common in The above species of spirogyra both in prode and streams in worthern India, and especially in the last mentiones from, where it is found as a constant and fixed feature af tin alga, rather than is a freak and a uniosity. A fixed habit with vhizoids is a distinct advance as imprened with a free. Hosting habit, and the species og spiragyra which show this feature must he regarded as structurally on a plan. Byme doning I must convey my heartfelt tranks To my esteemed tracher been

Algae.

Dr. S. L. Ghose of Latione, who has my main inspiration in my work m

i. Dely - / Refer types hahr.

Genus. Ghosella. Randhaun.

1. Ghosella midica. Kandhawa. Cells Vegelative filoments 10-15 P. brad, and colleger 4-5 time as long. Each cell with two stillate or une or less rounded chloroplasts surrounding a autrally retuales nucleus. (Fig). Conjugation scalarifrom, Conjugation could are very wide, henning 18- 4. 1 in width . Deposition of shining mucilagenous lamellae take place during tur process of injugation as in Debarga americana . Transcar (54) Marked genuglexis of filaments takes blace during anjugation as in atam species of Rougeotra. (Fig) Conjugation between 5-7 filaments at the same time is grinte common. The zygospores are rounded, or oval, and calend into hoter the gametangia. The zygospones commonly retain the horn. like arms of the gametangia, and joints of the repend alls get loosened, resulting in detachment af zygopones as in Debarya desmidioides West The gygospines are the 36 - 45 1 broad excluding their mulilagenois coats, and inclusive of these may be as broad as 56 P. 2. hipe zygospores and deep gellow in colour, and show a considerable varcely is shape. The zygospore. wall i composed of time layers, the exospone is this and light there in colour, in mesospore 5 Thick, chocolate

brown in colour, and the endospore is yellowski ui vlour. Fig. The zygospone wall shows hundalion (fig) ni de surface. in tie form og minute availa depressions (fig). Azygospres are also plentifully seen, and there are usually spuidle shaped i abbearance (fig). some ay the zygospores have liner anny and it seems as if then have resulted from the conjugation of a terminal all of a fil ament with an intercalary cell of another filament (fig) Such Sygrapheres are also seen in Delivorge américana Transcan (). Delimitation of Genersthosella : --There are there other members of Conjugalar, which have been variously described by deperent authors as helminging to trenus Debarya or Zygnema. All ghorn Mere are as follows :-1. Debarya americana. Transeau. from Norte America. Czurda () regards it as a species of Lygneme as has named it 2. americanum. 2. Debaya decumata Transcan fran Studo" Mortin America, and has been nameda doarsalie deussation by Gurda (). 3. 2 Jebarya spirale (Fritsch) Transera has been alles 2. Sprink Fritsch by ypuns peudodeurralin

A New Species og cylindricapsa from Onaci by M.S. Randhawa, Cylindrocapsa Oedogonioides. sp. nov. This very rare alga was found entangled in the filaments of a species of Octogromm, which was growing epiplytically on un blades og Typba blants in Skahniwala Tenk at Dasaya, Panjale, Surving the unter of Tarch, and April, 1930, and 1931. During March my sterile filaments were even, but by the last was of April, some filaments developed organia, anthenidia, and orspores. So for , there as a the The auter knows have has been no record of any spears of the rates ancomen genes Cylidrocupra from India. Possibly this s due to the habit of in alga, for even where it accurs it is found in such a realtered emplition. That after a long scarle under the microscope one may be lucky monya 5 shot a filament or 20. The filaments are unbranched and insist of a singletow of more or less A vertangular cells, which are enclosed with a lamellou sheath, as in Cyludrocapsa conferte. West. But the cells of this alga lifter from theme of C. conjecte west in having two small syrenoids at the appointe and y the cells (Figs 1 and 2), instead of Stringle massive hypenoid to in of C. angete west. There is a migle messive chlooplast, which is parcital in bostin. and presents a more or les granules appearance

In work y he was a man was maped nacces way be seen in the middle surrounded by two pyrenois at the sides (Fip. 2 and 4). Celle all det tim. Vegstalive all de services une 18 Hbroad being insiderably namower man wire of C. confeta wie and 12 - 28 V long fefrødudem. This alga is than closed by the presence as a well. deacloped organy. of the species so for known, sexual uproduction the been womber and only in C. involuta Reinsch. In the present from the method of reproduction deffers form that y cylindro capira involute Remain in many details, but antheridia and organia develop in The same Filament, as in C. modula Remith. Antheridia: - me autheridia ane produced by division of certain cells, and rach cells may be distinguished from the normal vegelative cells by their much maller sige (Fip 2a, and 5a). In me Felament Dogonia - me orgonia develop from ordinary vegetative cells, which because oval in shape, and primerse in size inviderably. Sometimes, rows of alls in: upda som filmellecome converted uits adjonia (Fig 3), and such filaments show constructions in The sheath , fin which makes the alga-look like an enlaged Anabaena.

nos of antity empty the week seen Winding with mos y enlarged allo (Fig 4). Probably here represent withal allo out.

The size of the regimen is . The organis one - 4 broad and 36 play. No lateral fre was abserved in any of the agginia. He of mere is a single over un erch oggonium, which is produced by tie enbraction og tie protoplarm, and ties vesults in a considerable empty space in tu agnia. The oospaces are 28 N ui diameter, benj muiteably malleras impored with more of C. involute Remisch, and are unounded with a thick lyaling wall (Figs 6 and 7). In one miglance the oosfme was seen divided into two alls (Fig 7.0.). The matrice filaments with mature agonia, cartaning ospores port. Donot look very much siggerentfrom the filaments of Ocdagmium, and hence un specific nume desagonistes. The sides of the mature agonia donat show any landlation as in C. involute Remak. Cyluidro capsa Oedogoniodes Sp. nov. Vegetative cello 18-20 4 broad, 12-28 1 long

rectangular av subrectangular in shape suches in a lamellar sheath. A single massive chlosoplasepercital in borition, with his small hypersoids in percital in borition of the states of the states with as lamellare at The sides. Oospores 28 y brows with a touch unuclugations hyperine sheath.

Habit - Found mixed with filament his species of Dedogmin growing chefey to welly blades in Strahniwela Taup Danuya, District Hospierfore Paryale, Durning March and April (180 and 1831. Literature Cited. i. Fritsch F.E. _ me structure and heproduction og Un Algae. Val. I. Camb. Univ. Press. - Ine British Ereshwali Algae. 1 2. Canh. Unio. Ivers - in Paschers' Die Susswasserglone 3. Hearing W. Vm. Deutschlands, Osterreichs und der Schweiz. Chlorophyceae III Hegt-6. Explanation of Figures. Cylindro capira Ocdogomioides. Sp. nov. Fig i. A vegetative filament showing all with two hypenoids in each. Fig 2. - A filament showing active division og some alles developing leter into antion die (a) and enlargement of alues cells developing inte aggonie (0). Fig 3 . - A filament showing a chain · of famale all which lats Swelop into agonia.

A filament showing some unply Fig 4: -A portion of a filament showing ulls. Fig 5. authoridial cells (a), and two oogmia. A mature filavent- showing Fig 6. an organium with an

oospme.

Fig 7. -

A filament- showing

tine ognia with ooppres.

Zygnema gigenteum

L

" in) Agardhy and his Explanation menny - ty Plate ho. I " in diameters · ~ () Zygnema Czurdae. Fig 1 . - A vegetative filament deloroplasts. Figh - A filament showing alls with onjugation processes. X 660 A filament showing alls giving Fig 3 aut injugation processes, no both rides. X 660 Fig 4. -A filament chowing a hear. shoped 39goohme cut of they walls from the remaining but of the cells . X 660 Fig 5 A filament showing sygospines filling are entire cells . X 660 Ruy 6 -A filament showing destind geniculation and rife 8790 pmes. X660 Turce filaments conjugating ai a Fý7 realiniform way. X 660 Zygnema Jungari. Fig 8. A filament showing chloroplasto X 660 Fig 9 A filament showing squaresto azygospines. X 660 Fig 10 A filament showing 3yzospres with a instruction in the widdle. X. 660 Zygnema giganteum

Fig 19 - Two conjugating fil aments showing hear. shaped 37 grapmes. X 660

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A Short- Note on an Indian Varety of Spharoples annuline (Roth) Agardh. Var. Multiseriata. Var. nov.

A veniety of Shhaeroplea annulina (Rothe) Agash was calleded by the aution from poinds during the months of Rarch and April in 1930 from Horbianpur, Jullunder and Amritsan. During". Rorch The Filaments become yellowish green in olow, and a examination under un green minscope numerous ava may be seen in most of them. By the end of April nearly all the filaments show red oospmes, and They occur in such large numbers that drying banks of most ponds present a comission red appearance. = 111149 m... Under lui microscope a number aj annulas chloroplaste may be zeen in each

whole presuling the seen array of hyperode way the scen in the second in a product in the second of a set allow the contractions (Fig i), the second of a set allow and the second of a set allow and the second of the second of

filaments of S. annulina (Roter) Agardley and two coarocytes donot intercommunicate by means y any pones. The conocytes and 60 - 80 1 in diand being amendat brader than those & reported from Europe . Sexual Reproduction. The remarkable teature of the alga are its organia, which are formed from h Ninny comocytes without any change of from. The protoplasm of the coursey's because cleft uits une ous green ova, arbids in the present variety may be seen arranged in time longitudinal rows (ty 3 It is due to this that the auter has named this variety of S. annulia (Rotin) Agarda a var nor. builtiseriate. Such a multiserial arrangement of ova and orfores 5 seen anly in S. africana Fritsch, and klebahn's figure of an on a segment of an oogonium og S. annulina (Rolin) Agardh as reproduced by Fritsch in his He Stouching and Reproductions of an Algar," shows only a single wow of ova. The ova in the present variety are deep green in colour and have , 1-3 byneworth in ench (Fig 3) .. Apertures for the entry of the sporms may be seen in the walls of the regence. (Fog 40.). We the

Litwature lited. i. Fritsch F.E -The British Treshwater Algae Cande Univ. Press "my Structure and Leproduction of Algae" Vol. I d 2. Cambo Umi. Pren. 8. Fritsch F.E and Rich F. - "Contructions to au Knowledge og in Frederalis Algaen Africa." " 1929 4. Alering Vm. W. - in Paschers' Susswarser Jena Dentschlands, Osterneich and der Schen Schweiz". Chlorophyceae II. Hyp. b. Explanation y Figures. shows a host of a comocyte Fig i. with chloroplasts, hynauoids (h) and anclei (h.). X 420 thrus a septem. X420 Fig 2 shows a part of an agonium Fig 3. with luna nows of ora. X420 Shows a part- of a mature agonuin Fig. 4 - with oospones, discarded membranes Jospones (m), and an apermy (o) in the wall of the aground for the entry of sports . X das thows a young oospore enclosed in a pring Fys membrane (m). X 1260 Show orpones enclosed in promising membranes. Show it is the Kings. Figs 6 and 7 chang whe sophone it and the letter

Genus Spirogyra. Link.

redale Section. I.

Species with Replicate Septa.

-4-

m joudata Spirosvra inflata (Vauch) Rab, op. cit. Borge Nameau) Gunda Sussesser flora lister of the Clunck Summass of the Nov. nom. Wegetative cells 14-18 u thick, 7-10 times as long, septa swollen and replicate, chloroplast single with 3-61 spirals, Sometimes almost straight(Fig) X Fruiting cells clearly swollen, 28-36 u broad. In fertile stages replication of septa becomes very clear. 370 for the stages replication of septa becomes very clear. Iong as broad 26-30 u in diameter. 11 to 2 times as actu, words that myagatin is also there is in a point at V. Shahpur, Distt. Hoshiarpur, in the second week of April 1930. Also collected from Saharanpur in April 1935. A very common form.

> 2. <u>Spirogyra quadrate</u> (Hass) Petit. op. cit. Borge Susswasser flora Heft 9.

Vegetative cells 28-32 u in diameter, 3-4 times as long. A single chloroplast in each cell with two to six spirals, 2 Septa replicate, fertile cells clearly swollen, 44-48 u br., and flattened near the middle. Zygospores ellipsoid-elongated, 32-42 u in diameter, 2-24 times as long. (Fig.). Habit:- Free-floating in a greenish mass of filaments

in a fresh-water stream near V. Kiri, Distt. Gurdaspur. Produces zygospores in the middle of December. Rather rare.

Spirigyra Hasallii (Jenn) Petit. op. at at. Gunda. Sussewaner Hera Ritheleur opa Heft- 9 -

Vegetation alls 30 - 32 p broad, 6-8 him as long. Two abbroplasts dimmatophines, Septe y alls replie Only lateral anyngation is known in this & Species. alls antaning the sygraphies are any very I a sightly swallen, while typical specimens of the openies & zygospores diproi ellipsoid, and very much elmyale JE Erospine dear, mirorti, light. blue in colour. Merospine Emooli, a brownik yellow in colour (Fig). - 1 (bit og un zygospones untain chytmidiaceous fungi (tig). Zygospines 34-38 V brock, and 64-1 Habit _ Found free. Hoating in a pond at E ' Manglaur Telisil Korrher District Salaraupme dure

in S. and Murd war of telemany 1435.

Section II.

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Species with septa not swollen. One chromatophore in each cell.

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3. Spirogyra affinis (Hass) Kutz. op. cit. Borge Susswasser flora Heft 9.

Both lateral and scalariform conjugation are seen in this species. Vegetative cells 22-30 u broad. Septa not swollen. Chromatophore single with 2½ to 4 spirals. Fruiting cells swollen on both sides. Zygospores ellipsoid 25-32 u br., 36-46 u long. Placed obliquely in the gametangium, yellowish in colour. Spore-walls smooth. Another interesting feature of the Alga is that many cells give out rhizoids (LXXIII, fig. c.) like those described by Delf by means of which the filaments are attached to coarser filaments of <u>Oedogonium</u>.

Filaments showing lateral conjugation are attacked by rounded endophytic <u>Chytridiaceous Fungi</u>, 2-4 of which are invariably found in each cell which does not contain a zygospore.

Habit:- Found free-floating in a brownish mass in ponds.Gollected in the second week of March 1930 at Hamira, and mixed with <u>Oedogonium</u> <u>urbicum</u> at V. Jhingran Distt. Hoshiarpur about the same time. Fairly common.

4. <u>Spirogyra durgensii</u> Kutz. op. cit. Borge Susswasser flora Heft 9.

Vegetative cells, 25-30 u thick, 2½ to 5 times as long. Septa occasionally swollen but not replicate. Cells with one chromatophore of two to four spirals. Fruiting cells not swollen on either side. Zygospores ellipsoid elongated 30-32 u thick, twice as long. Zygospore membrane smooth.

Habit:-Collected from Badami Bagh Tanks Lahore free-

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Spiragyra Sahnii. Sp. nov.

This alga was found mixed with filaments ay Sphaeroplea annulina, in Siah Bacon, a preshwalt stream hear Darwya about The middle og Marche 1931. 48-72 V 40 1- 74 V Ball 14 Vegetative cells are for the broad and 804 -1454 long. Usually They are broader than longs and are very much swallen, and me harrel. like m appearance. Mene is a single chloroplast- which is une or les coiles in an inigular fashino (t and may in me cell it showed a spiral and a hay The septe of the cells are plane. The septe of the cells are plane. Street heproduction - Only interal conjug has iblen noticed in this alga, and this is a very uiteresting type. We reighbouring cells use gnie out- tent- like protuberances ni the usual way, a the cell containing the 37graphies almost always adjoint male allo (Figs). The Janale cells containing the gypt become very much swallen and hulge out - curiderably sme cases (fig) giving his alga an inigula outline. The male and funale cells are usually of same size, but in are case the support male all was an wollen and much higger in size. It gave out - a du Tube which was continuous with a similar structure gu by in famale all, and appeared like a vetort used by In distillation purposes. Such conjugation tubes thave been m thy de bary in Zygnema migne (Hanal) kutz. (Fig). hi lage numbers surrout Jung tog 37grspmes and also ovala in shape ide in zygspme, but and day

Smaller uisize, being 404-444 broad, and 22-364 444 - 744 long. In some cases then and spherical ui shape (Fig). Some of the cells are infested with a fungul parasite, smister to a speui ay Myzocitium denviled on a material aj spirogyra affinis by Chrathari (). Some og tin zygospores also are tall of the cells og the paramete (Fig). It is a arrivis consident- heat hote the opens. og spirogyra fran which this form of Rysatium has been described, reproduce tremselves by lateral injugation. 24 - 36 V 29 oppmes are # - 72+ boad, 68 V and the 126th long. The Sygospone wall a a thick bluei green mesospre, and a smooth endospre. endospre. In me filament, hie alls were holiced to produce conical protuberances, which grie them a bear shaped appearance (Fig.). Probably these are abortion injergation much. There are four specie of spirogyra which rescuble the present from in some teatures, and especially in the prosession of a single aloroflest and dateral onjugation. of There it differs from S. longate (Vauch.) Gurda. and S. Lagerheimie Wittrock in the syst and shape

) 4 .n° h no (fiz half to nyugal n' a usually , and ris enfl zygospa bly " ular 77 m 5 anzili e distri growa by chan seen repr 20 24

and the

sy ment

of vegetation cells and zygspores. S. From S. condensate (Vanch.) Gurda emend. it differs in the shape and size of vegetative cells, the size of gygosports and in the presence og parthenospors. In fin species is S. asiahia. Georda from achich the atta differs in the shape of vegetative cells, presence of partnewspors, and the absence of any functation from the hurspine as well as its blush green alour, af spiragina after Dr. Birbal Sahni og Luchnow University, who has done so much to raise the prestige Indian Botany. Spirogyna Sahnii: Sp. nov. Vegetative cells 48- >2 & broad, 40-74 Hay barrel-shaped in appearance, with a migle ineqularly coiled chloroplast, septe of alls plane. Only - lateral injugation known, 399 ospons val 22-364 brow, 44-684 long, with a This mesti, hyalini eroppe, a tick blush green norospore, and a smooti nyaline me endospore. Parthenospons also reen. Hab. Free - floating in Sich breen a freshweter stream wined with Spharspher amulina, ver Dasaya, Dist. Hostienstran Penjale, about his second of week of Rach (931,

0 .

Spinogyra paludosa Gurda. op. cit. Die Susswoneglone Rétteleurope. Hegt 9. Nage 167-Vegetative alls the stop brand and 5-8 times as long. There is a single deloroplat in each all (tig). Septe og tu cells plane. Conjugation scalariform. Female cells entanning zygospores slightly wollen. zyjospore ellipsoid, much inger man broad, being w 24 - 264 broad and 44 - 464 lay. Exopore cleared on ooth, merospore light the torrior in colour. Habit - Found fra. Hoating is a fond it V. Bodal Diste. Hostiaspore in the first week of April 1931,

Spirigyra indensata (Vauch). Grunda-emend. Sussiwasserflow Titteleurope wige 9 hoge 178.

Vegetation cells 28 - 45 1 broad

2-3 huns as long. Schla og tre alls klaven mere is a single chlosoflast og 1 to 21 spirols mi each cell.

Conjugation laboral my. 24popme usually in pairs. 24gospones oval 32-364bs. W 60-70 V long. Famale alls antaning 34gospone are not swallen. Exospone bystim, tink, morosport brown, and caroppone wet swow. bystim, tink, morosport brown, and caroppone wet swow. bystim, tink, morosport brown, and caroppone wet swow. bystim owellar that those by the hype. Agggospones may also be seen plentegully, and one rounded in aberna , and 24-26 N in diameter. 7

Habit - ma-floahing in a prestuvater opring it Tahli Saluts Dist. Arshiarpore is fort week y larch 1931.

Nougeotia viridis (Kutzing) Wiltroch 1872 - Good of . it. Czurda. Susswasserflora Mitteleuropas Heyr. 9.

Vegetative cells 6- 8 V broad, Chloroplast plate. shaped, with 3- 4 hyrenoids in each. (Fig.) Cnyugatim scalarifrim. Zygapmes

hime v les squarish ashini. shaped in Aplannie, aus may be seen free. Hoating with this four torm like remains of the gametangia attached to them at the corners. Thespere clear ad smooth. 24 gosperes darkish in colour, 222-264 X 22-264. (Fig).

Distribution .- mis alga has been reported from Germany, Austria, Gechoslovakia France, Russia, Roumania aut. North America, Almost a cosmopolitan alga.

Habit. - Formed pres. floating mixed with 2yppema Gundas. Randhawa. and a specie og Oedogonum deirig wie second week of Mach 1981 in Seah Basen, a freshwalt dream Work 1981 in Seah Basen, a freshwalt dream in jullimeder deit nit, Panjab. Ratur a rane alga.

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Collection, Preservation and Microtechnic of Freshwater Algae. Algae are universally distributed and are found free-floating or attached to aquatic plants in ponds, freshwater streams, and rivers, growing subaerially on moist soil and the bark of trees. Of all the groups of freshwater Algae, Myxophyceae are the commonest and the most familiar, and we see them nearly all the year round in drains, ponde, and walls of houses. Most of our ancient historical buildings present a dark and dismal appearance, due to the thick coats of Gampylonema, Scytonema, and Tolypothrix, which grow upon their domes and walls.

Collection of Algae:-

For collecting Algae a very simple outfit is required. A tin-bex containing a rack with about two dozen holes accmmodating 24 wide-mouthed glass tubes about 2 inches in length and 2 inch in diameter, is necessary. The bottom of the holes should be well-padded with cotton-wool to prevent injury to the glass tubes. There should also be some space provided for a sharp knife, a pair of scissors and 1 dozen envelopes inside the box. In one of the small tubes commercial Formalin (40 % Formaldenyde) should be stored. A wooden rod, made of small pieces about 12 foot in length which could be screwed on to each other, and with a muslin net attached on one side may also be carried if possible. The method of collection differs with the type of habitat.

i. Subaerial soil Algae and Bark Epiphytes-

The algae growing on soil should be scraped from the surface of the soil with a sharp knife. These may be stored in an envelope or in glass tube in 4% Formalin solution. On reaching the laboratory they should be placed in a glass though under a water-tap and thoroughly washed till the earth attached is as completely removed as possible. The bark algae are better stored inside paper envelopes, for they are emable of standing dessication.

2. Freshwater Algae- These are usually found free floating or attached to water-plants. Free-floating forms may be best collected with ones hands. On holding the mass of filements under sunlight in one hand, hollowed down in cup-shaped manner, one can easily detect if the illements are fertile or merely vegetative. In the case of Spirogyra, ygnema, and Oedogonium one can see the Zygospores or Oospores in the form of small blackish specks. The colour of the alga, also is an index

of its reproductive of vegetative stage. Dark green sheets of algae slways in a vegetative stage of growth, and when they become pale yellow or brownish yellow in colour they show plenty of zygospores or Cospores as the case may be. So care should be taken to collect only those forms which may be reasonably expected from their colour to be in a reproductive stege.

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In the case of algae which grow epiphytically on water-plants, small pieces of leaves or stems of the plant may be cut with a pair of scissors, when they are small in size, but when they are big and cannot be put inside a tube, one should scrape the algae with a sharp knife, from their surface and store them inside a glass-tube.

Care should be taken to keep the tubes only 2 full. Then a drop of Formalin should be added, and usually it is found to be quite suffitient to keep the Algae in good condition for a couple of days.

Flagellates and other plankton forms are sometimes found in large numbers inside small ponds and lakes. Sometimes when the water is wholly green with them, one can collect a good quantity by merely dipping a tube inside the water. In some cases a silk net is found useful and are one should drag it for a distance of a few paces inside the water and collect a large number of these forms.

Preservation of Algae-

Most of the thick-walled Chlorophyceae and nearly all Myxophyceae are best preserved in a 4% solution of Formalin (Formaldehyde 40%). In the case of more delicate forms like the Flagellates and Chlorococcales H solution of Formalin is sufficient. A little copper sulphate may be added to 2% solution of Formalin, when it is desired to preserve their natural colour to as great an extent as possible

Staining-

First wash the Alga in water for about 10 minutes. Then stain with Methylene Blue. I found Methylene Blue to be the best stain for differentiation for and of the cell details. However when mounted in Blycerine jealy the whole pigment is sucked out and after some months the cell-structure becomes transparent. 1% whitin of Magista had in water and playing home for the cell details. In the some months is sucked out and after some months is sucked out and after

I found Glycerine Jealy Method to be the cleanest and most satis-

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satisfactory in the case of filamentous Algae. The filament should lifted with a fine meedle and placed in a watch-glass in 10% Glycerine (1 part of Glycerine mixed,9 parts of water), and should be covered under a bell-jar to prevent particles of dust from coming inside. The 10% Glycerine solution should be just sufficient to cover the filament, and the watch-glass should be left alone for at least 24 hours to allow the water to fully evaporate. Then a drop of melted glycerine jelly should be placed in the middle of the slide, taking care that no airbubbles cling to the sides of the drop, and the filament should be transferred at the point of a needle to it. Then it should be covered with a cover-slip. The slide should be placed under a bell-jar for at least 8 hours, and the glycerine jelly will set in a very proper way. Then the slide should be placed on a turn-table and a thick ring of Black Varnish should be painted on the sides of the coverslip. Give the turntable a strong spin, and touch the slide with a fine brush as far out from the cover as you wish the ring to extend, then gradually appread the coverslip and extend the ring until it is 1/16 " wide on the cover. Put a medium ring not more than two-coats thick.

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Preparation of Glycerine-jelly-

Put 1 part by weight afxantanxantanxitatexate of French gelatin in 6 parts by weight of water and allow it to be for about 2 hours. Then add 7 parts by weight of Glycerine. For every 100 gramms of the mixture, add 1 gm. of concentrated Carbolic acid. Heat the whole mixture for about 15 minutes and stir during heating. Filter the Jelly while warm. A little of the Jelly should be taken in a small tube and placed in a beaker containing boiling water. The jelly would melt and is ready for use in mounting.

The slides which I prepared about seven years ago, using Glycerine jelly Method are in a state of perfect preservation. The only defect with glycerine is that it abstracts all the stain out of the cells, making them transparent.

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(comminicated by Dr. S.L. Ghose, Lakore).

Occurrence and Distribution of the Freshwater Algae of North India.

> M.S. Randhawa, M.Sc., I.C.S. Saharanpur.

(with a map and a photograph)

"Occurrence and Distribution of the Freshwater Algae of North India." By M.S. Randhama, M.Sc., S.C.S.

(Communicates & ar. S.C. Shore, M.S., PL.S) I made a collection of the Panjab freshwater algae from July 1929 to April 1930, and February 1931 to October 1931, from Lahore, Juliunder and Hoshiarpur districts of the Panjab. Then I had another opportunity of making a collection of the freshwater Algae in Saharanpur district of the United Provinces from December 1934 to January 1936. In all about 420 samples were collected comprising 122 species which have been worked out and these include two new genera and sixteen new species. Hoshiarpur and Jullunder districts are situated between the Sutlej and Beas rivers, and contain two perennial streams the Siah and the Sufed Bacens. These two districts provide unique opportunities for elgal collections, and it is no exaggeration if I call them an Algalogist's Paradise. Hoshiarpur and Saharanpur districts contain a chain of ponds in the submontane areas, as well as swamps which are called Chhambs, locally. district is situated between the Ganges on the east and 1- Jumma on the west with two big canals, and numerous small streams meandering across the district. The swamps in these districts are annually replenished by rain-water from the hills brought by the 'choes', which are seasonal torrential rivers which sweep down the plains during the rainy season. Geographically these districts are very much similar being bound by the Siwalik range in the North, and have practically the same sort of climatic

There are numerous big tanks also made by religiously or charitably-disposed people which afford ample opportunities for algal collections. In addition there are ponds which are found in practically every village for the use of cattle, and these are also very interesting from the algal point of view. The ponds and ditches found on both sides of the railway lines in many districts are also full of Algae during and after the rainy season. Climatic Conditions: - Hoshiarpur is a submontane district lying between 30.59° and 32.5°N and 73.30° and 76.38°E. The annual average rainfall is 36°, of which 30"fall in the summer months and 6" in the winter months. Jullunder and Lahore resemble each other very much and as compared with Hoshiarpur they are more dry and hot. The hottest months are May and June, with a mean maximum temperature of 106°F., the highest temperature recorded being 120°F. The coldest months are December and January, with a mean minimum temperature of 40°F. The rainfall seldom exceeds 25 inches per annum. Saharanpur resembles Hoshiarpur in nearly every way, the only difference being that the rainfall is greater in Saharanpur.

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Occurrence and Reproduction of Freshwater Algae:-Five main groups of Algae, viz., Diatoms, Myxophyceae, Isokontae, Heterokontae and Rhodophyceae, have been 19 Corr. & studied so far by Mr. Abdul Majid, Dr. S.L. Ghose and the author in Northern India. Diatoms are very abundant during the winter months from the middle of November to the end of February, and my own observations fully corroborate the conclusions reached by Mr. Abdul Majeed Con. Sp in his investigations of the Panjab Diatoms. Forms like Navicula, Cyclotella, Surirella, Synedra, and Nitzschia are found in large numbers in the moist soil of fields after rains and in the drying sides of ponds and ditches. Synedra, Navicula, Cyclotella, Cocconeis, and Gomphonema are also found in large numbers on the moist soil of fields after rains and on the drying sides of ponds and ditches. Synedra, Navicula, Cyclotella, Cocconeis, and Gomphonema are also found in large numbers in stagnant or slowly-flowing sheets of water, freefloating, or attached to the rotting branches of water plants.

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Myxophyceae are met all the year round, but are very abundant after the close of the rainy season, in the months of October and November. Members of Myxophyceae are both subaerial as well as aquatic, and in the latter case are found more commonly in stagnant sheets of water. Our knowledge of this group of Algae is mainly based on the work of Dr. S.L. Ghose. According to Dr. Ghose the Myxophyceae in Lahore show great vegetative activity between August and February, and the fruiting season is from February to April. The study of spores-bearing forms like Anabaena, Rivularia, Aulosira, and Nodularia is very interesting from this point of view. According to Dr. Ghose, Anabaena variabilis and Rivularia natans produce spores in the months of March and April. My own observations show that forms like Anabaena cylindrica, Anabaena moniliforme, Anabaenothrix epiphytica, and Nodularia spumigena produce numerous spores in the months of February and March. As I have shown in my paper on "Periodicity in the Reproduction of Freshwater Algae, " that the spore-bearing Green Algae, like Spirogyra Zvgnema, Ghosella, Sphaeroplea, and Oedogonium produce huge crops of Zygospores and Oospores in March and April the spore-bearing Myxophyceae like the species mentioned above, also, do not lag behind in this respect. In fact these Myxophyceae are as well prepared to meet the drought of May, June, and July in the form of thick-walled spores, as the Green Algae.

I have already dealt at great length in a separate paper with the periodicity shown by the spore-bearing Green Algae in their reproduction, However, forms which multiply vegetatively by fragmentation, and zoospores, continue their cycle of reproduction intermittently. These algae are found in artificial reservoirs of water, and perennial streams, and show a great luxuriance in growth from October to March.

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Ecological Survey of the Freshwater Algae of Northern India:-

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The following is in brief an ecological survey of the Algae of Northern India, which I have come across during my investigations.

1. Subaerial Associations - Under this heading we shall deal with Algae which grow upon soil, in the form of patches, or in some cases in the form of mats. Subaerial forms also include Algae growing upon pieces of moist timber and walls of houses. So we may divide the subaerial Associations intwo two main groups; firstly the soil Algae and secondly the Algae growing on wood and walls.

A. Soil Algae. - The group of soil Algae includes three kinds of formations in this country.

1. <u>Vaucheria</u> community - This is equivalent to <u>Zvgogonium ericetorum</u> formation of Europe. From the beginning of December to the last week of February, <u>Vaucheria sessilis</u> and <u>V. geminata</u> are seen covering large areas in lawns and grassy fields, in the form of bright-green felt-like mats. Oogonia and **A**ntheridia begin to appear in the first week of January, and by the last week of February most of the filaments become fertile. It is curious that <u>Vaucheria sessilis</u> collected from ponds at about the same time, as from the lawns, proved to be more fertile, each filament being loaded with huge crops of cogonia and antheridia, while in the case of terrestrial specimens, very few sex organs were seen.

2. <u>Botrydium-Protosiphon</u> Community. Usually <u>Botrydium</u> and <u>Protosiphon</u> occur together on the sides of drying ponds after the close of rainy season. In fields which are left fallow, one may quite often see almost pure formations of <u>Protosiphon botryoides</u>, in the month of November after rains. Cyst-formation takes place in a week and then the elga disappears. Bright green patches of <u>Protosiphon</u> 2-8 yards in diameter can be seen growing in the hollow parts of fields.

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3. <u>Cylinderospermum</u> Community. Black patches of <u>Cylinderospermum muscicola</u>, accompanied by a species of <u>Riccia</u>, occupy huge areas under the shade of wheat plants in the month of March. Bacteria may also be seen in the mucous sheaths of this Alga.

4. <u>Campylonema</u> Community. <u>Campylonema Lahorense</u> appears in the form of woolly circular patches of a dark chocolate brown colour on the surface of lawns, and these patches expand laterally and form thick brownish sheets. species of <u>Gloeocapsa</u> and <u>Anabaena</u>, may often be found intermingled with the filaments of <u>Campylonema Lahorense</u>.

B. Timber Algae and Wall Algae:-

(1) <u>Pleurococus</u> community - This consists of yellowish-green incrustation of <u>Pleurococcus vulgaris</u> which has a great liking for moist woodwork, lime-covered walls of houses, and earthen vessels like 'gharas' and 'surahis'. After the rains this alga may be commonly seen on smooth pieces of wood, from which bark has been removed, and the walls of houses. This alga may be found throughout the year on the moist wood-work of Persian wheels, accompanied by Mosses.

(2) Bark Epiphytes - This group of Algae resembles in many features the formation discussed above, but differs in showing an almost exclusive preference for moist logs of wood and trunks of trees. <u>Abhanocapsa montana</u> appears in the form of light-blue-green patches on smooth trunks of trees from July to August, and as the trunks become drier, the alga becomes saphire-blue in colour. According to Ghose (5) <u>Phormidium truncicolum</u>, <u>Lyngbva truncicola</u> and <u>Tolycothrix campylonemoides</u>, may commonly be seen on the trunks of <u>Acacia modesta</u> in the form of a bluish-green layer, which becomes very slimy and conspicuous after the rains. In the wet season Hormogones are plentifully formed, and these produce mucilaginous sheaths which become thick, firm and coloured. When it becomes dry and warm,

the stream becomes thin and papery, and peels off trunk of the tree in bits.

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II Aquatic Associations - Under this heading we include all the Algae which are found growing in water, free-floating or attached to other water plants. includes a large number of forms and we shall deal with This only the commonest and most important species. to their habitat, we divide this group into two main According subgroups viz., Algal Associations of Flowing Water and Algal Associations of Standing Water. X

A. Algal Associations of Flowing Water - This group may be further subdivided into two subgroups according to the velocity of the current of water in which these Algae grow.

1. Algae from Swiftly Running Water - This group of Algae is characterised by the possession of strong basal cells which very often secrete a sort of cement-like material for fixation to other water-plants, and require plenty of aeration. I found a number of Rhodophyceae in the Siah Baeen near Dasuya in Hoshiarpur district, where it flows very rapidly. Attached to blades of rushes, in médcurrent, are found Chantransia chalybea, Compsopogon, Batrachospermum moniliforme, and Stigeoclonium variable -, in the months of August, September, October and November. In December due to excessive cold perhaps, these Algae disappear. Cladophora glomerata also belongs to this group and may be seen in big tassels looking like fox-tails attached to fallen branches of water plants in most streams and canals(Fig. 1). This group also includes a number of unicellular and colonial Myxophyceae growing on stones, which are well worth investigating. By developing strong basal cells and an account of their likeness for plenty of oxygen] these Algae exclude other competitors, and hold their own against all other algae.

2. Algae from Slowly Running Streams - These algae are also characterised by fondness for plenty of oxygen but

not so mewh as in the last mentioned group, and at the same time basal cells are not so well developed. As compared with the former one, it is a much more numerous group. Cladophora glomerata, Mougeotia genuflexa, Draparnaldia plumosa, Chaetomorpha aerea, Oedogonium sp., and certain attached species of Spirogyra, are very characteristic of this group. Here we may also mention the interesting case of <u>Cladophora glomerata</u>, which grows on the shells of Gastropods in tanks in Shalamar Gardens Lahore, and in the still water of the tanks secures its aeration through the help of these animals(Fig. 1). Cladophora glomerata also occurs in the reservoirs of wells fitted with Persian Wheels, where the alga is constantly being aerated by the flow of water from the well. Chaetonor -pha aerea which generally occurs in freshwater streams may also be quite often seen growing under water-taps where there is a constant flow of water.

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B. Algal Associations of Stagnant Water - This group contains by far the largest number of Algae. This group may be divided into four sub-groups according to their habit.

1. Plankton-forms - These are very tiny Algae, which are found floating in lakes, ponds, and tanks. Some of these Algae have evolved special structures like bristles, flattening of the body, and the secretion of mucilage, for keeping afloat in water. Such bristles and flattened shape may be seen in <u>Pediastrum</u> <u>Borvanum</u>, <u>Scenedesmus</u> <u>obliqus</u> and <u>S. quadricauda</u>. Mucilage helps <u>Volvox aureus</u> and <u>Pandorina m rum</u> in keeping afloat. <u>Microcystis aeruginosa</u> is simply i at in shape and has no other special structure. <u>Arthrospira spirulinoides</u> and <u>A. platensis</u> have a spiral like a cork-screw which helps the Alga in keeping afloat. In this group of algae we may also mention the different species of <u>Anabaena</u>, <u>Rivularia</u>, and <u>Cylinderospermum</u> which are found free-floating in ponds and lakes through they have submerged roots, stems, and leaves of water-plants. According to the substratum and object to which they are attached, we subdivide this group into following subgroups:

1. Algae attached to Submerged Soil of Ponds:-

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In this sub-group we include that small group of algae which are found attached to the bottom of ponds where the water is very shallow, and seldom being deeper than two feet. So far I have seen only three members of Myxophyceae which can be dealt with under this subgroup. Of these Lyngbya perelegans grows in the form of dirtybrown cylindrical columns attached to the bottom of tanks, and Anabaenothrix cylindrica in the form of blue-green irregular cylinders attached to the submerged soil of puddles. As there is no specialised organ of attachment, even a slight disturbance in water causes these cylinders to get detached from the bottom, and the alga becomes free-floating. It is only its method of growth which has given the alga an attached habit. The alga firstly grows on the submerged soil, and then the distal part of the colony grows up towards light, and the mucus of the colony assumes a cylindrical shape The third alga is Nodularia spumigena which grows in deep blue coralline masses, mixed with grass, in the shallow water of Budha Nala at Ludhiana.

2. Algae attached to the Sides of Water-reservoirs. and Steps of Tanks: - This group includes many members of Myxophyceae and some Green Algae which are found attached to the brickwork of the walls of water-reservoirs of wells, and the steps of tanks. Of these <u>Schizothrix mexicana</u> may be seen in deep bluish-green velvet-like bunches in the sides of water-reservoirs, used for watering cattle in villages, adjacent to wells. Another common alga is <u>Rhizoclonium hieroglyphicum</u> which is found on brick-work under water taps.

3. Algae attached to Twigs and Water-plants. - This subgroup is further subdivided into two sections, according to the nature of the substratum.

(a). Algae attached to Twigs and Dead Branches of Plants:-

The algae which are included in this subgroup have developed definite organs of attachment in the form of rhizoids or flattened basal cells. Some of them may be found growing attached to the sides of the submerged steps of tanks, but most of them are found attached to stones or dried sticks and branches of trees. It has been noticed that these forms show a decided preference for nonliving substratum and it is very rarely that they may be seen attached to living aquatic plants. These forms are totally submerged for the most part of their existence. Stigeoclonium, with its four common species, S. lubricum, S. subuligerum, S. amoenum and S. tenue, is a typical representative of this group. Next comes <u>Ulothrix</u> with four species, U. Zonata, U. tenuissima, U. tennerima, and U. subtilissima.

(b) Algae attached to Living Plants.- In this subgroup those algae have been dealt with which usually grow on living leaves, stems, and roots of water plants or living filaments of big algae like <u>Cladophora</u> and <u>Sirogonium</u>. This sub-group may be rough ly divided into two sections, the difference mainly being that members of the second section are microscopic in size, and are not obvious to the naked eye, while the members of the first section are big in **si**ze and conspicuous.

Section 1. Macroscopic Forms. - Most of these Epiphytes have well-developed basal cells for attachment. Oedogonium is the commonest of these with 14 species of which <u>Oe</u>. cardiacum, <u>Oe</u>. urbicum, <u>Oe</u>. inerme, <u>Oe</u>. Sociale and <u>Oe</u>. Hirnii, are fairly common on leaves of water-plants and in the month of April they produce a multi-coloured harvest of oospores. Other common members of this section are <u>Schizomeris irregularis</u>, <u>Ulothrix oscillarina</u>, <u>Pithophora Kewensis</u>, <u>Cladophora glomerata</u>, <u>Chaetomorpha</u> aerea, and attached species of <u>Spirogyra</u>. It may be marked, that most of these algae, which have organs for attachment

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are the same as those found in flowing water, and have developed these organs even in a still water environment.

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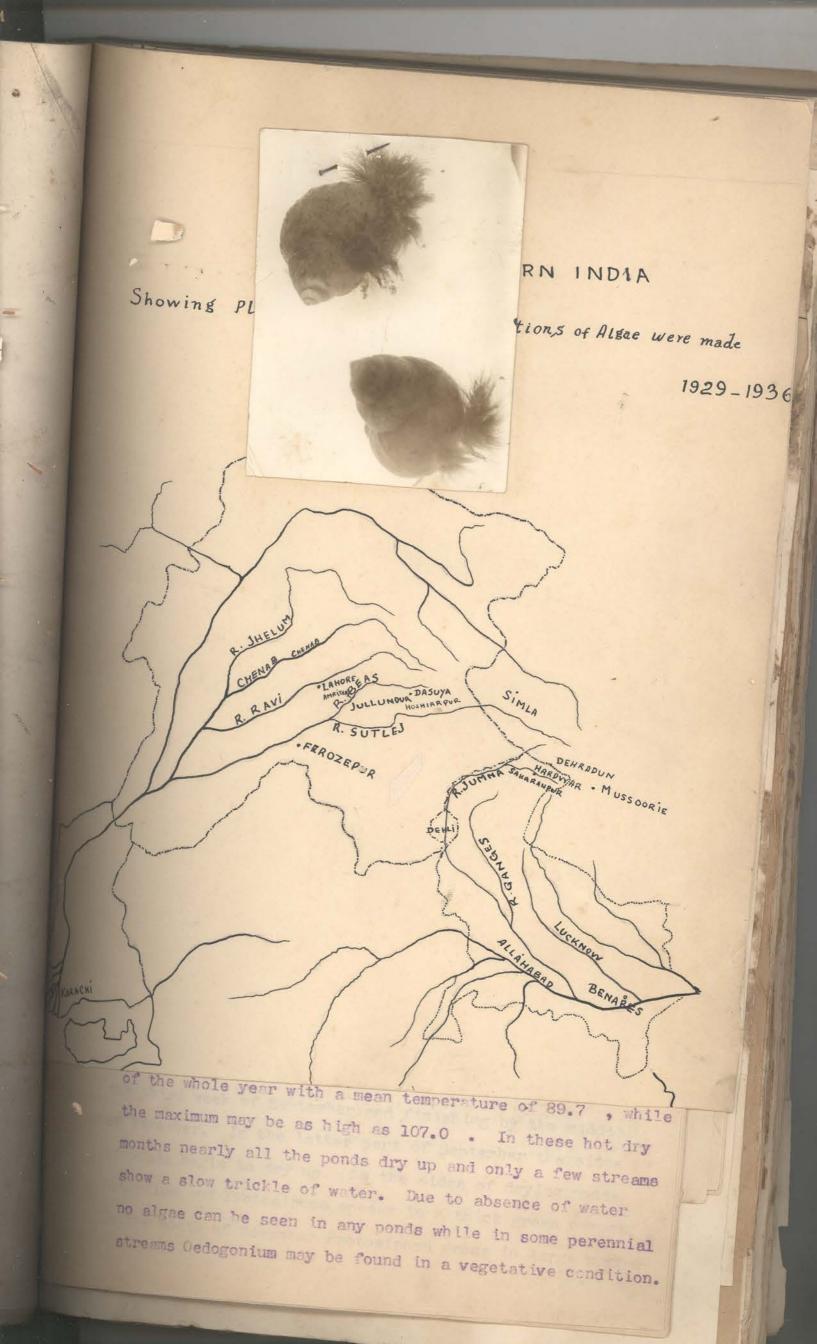
Section ii. Microscopic Forms .- These are algae which are usually microscopic in size, and grow as epiphytes not only on common phanerogamic water plants, but also on other algae like Sirogonium, Cladophora, and Pithophora, which do not produce any mucilage and hence become loaded with epiphytes. Abdul Majeed has studied the epiphytic Diatoms of the Panjab and according to him most of the filamentous algae, and especially those mentioned above are found loaded with species of Synedra, Achnanthes hungarica, Cocconeis placentula, Gomphonema intricatum, G. subapicatum, G. Constrictum and Epithemic arcus. Most of these Diatoms have mucilaginous hyaline stalks by means of which they are attached to other algae and water plants. Other common epiphytes are Aphanochaete repens, Coleochaete soluta, C. scutata, Chaetosphaeridium globosum, Bulbochaete and species of Characium. Myxophyceae are represented by Chamaesiphon filamentosa, Anabaenothrix epiphytica, and Cylinderospermur Michailovskoense.

Conclusion.

Very little work has been done on the ecology of the. the fireshwater algae of North India, and this is a pioneer attempt in this field. Under such circumstances, it may be expected that considerable variety of opinion be entertained by various algologists as to the best method of arranging the various forms in Groups, Subgroups, Sections and Subsections. The author realises that more intensive work is required in this field, and his conclusions in some cases may not be all what is desired. However, he hopes that his efforts, will stimulate the workers, who have better facilities than he has for this sort of work.

The writer sincerely thanks Doctors S.L. Ghose, H. Chaudhuri and P.L. <u>Ananad of the Panjab University for</u> their advice and criticism.

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Larked Periodicity in Reproduction of the Panjab Freshwater Algae.

I made a regul r collection of the Anajab Preshwater Algae from July 1929 to May 1930, and since then we been collecting Algae from December 1934 to December 1935 in cabaranpur district, which is on the boundary line of Bastern Panjab and Western part of the United Provinces and has a climate not very different from the eastern submontane districts of the Panjab, like Hoshiarpur and Gurdaspur. My two years experience has shown me that there is a marked periodicity in the reproduction of Spore-forming Chlorophyceae which is closely connected with temperature and rainfall conditions.

A passing reference may also be made about those Chlorophyceae which do not form spores with hard walls. If these Hydrodictyon reticulatum is the commonest in ponds and slow-flowing freshwater streams. Its glistening daughter colonies may be found in nearly all months of the year when water is found in the ponds and streams, and I have collected it in all stages of development in all months from July to February. I am excluding from consideration here all algae which are found attached to artificial water-reservoirs and only those are discussed which are found in natural ponds and streams.

Seasons of Northern India. I have divided a year in Northern India intofive seasons; Hot Summer Months, Rainy Season, Autumn, Winter and Spring. Start may be made with the Hot Summer Months which begins from about 15th May and terminates by the middle of July. These months are characterised by dry heat. June is the hottest month of the whole year with a mean temperature of 89.7 , while the maximum may be as high as 107.0 . In these hot dry months nearly all the ponds dry up and only a few streams show a slow trickle of water. Due to absence of water no algae can be seen in any ponds while in some perennial streams Oedogonium may be found in a vegetative condition. on fields which have been lying fallow, in bright green patches 2-8 yards in diameter. Cyst-formation in the subterranean rhizoidal portion takes place in a week, and then the Alga diappears from view. Spirogyra is also seen in a fertile condition in most ponds. I recorded four species of Spirogyra in this month viz. Spirogyra Condensata, S. Hivularis, S. Crassa and S. Nitida.

IV Winter Months. By the middle of November it becomes fairly cold in Northern India, and the mean temperature drops to 50.0. The ponds are usually half full at this time, and the streams and rivers have a regular flow of clear, sparkling, and ice-cold water of the Himalayan snows. In some cold freshwater streams like the Siah Baeen near Jullundar with a swift current of water, Chantransia Chalybea, Batrachospermum Moniliforme, Sti-Geoglonium Variable and Comsopogon sp. are found attached to blades of Typha in the mid-current. These members of Rhodophyceae and Stigeoglonium Variable are provided with well-developed besal cells for attachment. These algae disappear in December, perhaps due to excessive cold, for the mean temperature may be as low as 45 . In slowly running streams Cladophora Glomerata may be seen in big tassels, looking like fox-tails attached to water-plants. All these algae require a good deal of aeration, and I have noticed that where the current of water becomes very slow these algae tend to disappear. "ere we may mention the peculiar case of Cladophora glomerata which may be seen in the tanks of the Shalimar Gardens Lahore growing on shells of Gastropods, which move about in the tanks and thus aerate the alga. However in this case the growth of the alga is not luxuriant and it appears to be a mere shadow of the Cladophora Glomerata which grows in running streams. Due to slow locomotion of Gastropod, the alga becomes thickly encrusted with Diatoms and dust particles. Cladophora Glomerata also occurs in the waterreservoirs of wells fitted with Persian wheels, where it

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is constantly scrated by the flow of water from the well.

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In December we usually have a rainfall of 1.5 to 2 inches especially in the last two weeks. After the dry months of October and November, this is very welcome and gives a new lease of life to the algae growing in ponds. In January the rainfall is more copious and is seldom less than 4.0 inches, and as the temperature is low and evaporation is less, the ponds become fairly full. The months of January and February / are ideal for the growth of algae. Along with the species of Spirogyra already mentioned I also found nine other species of the genus Zygnema which henceforth is usually seen only in a vegetative condition, can be found in a fertile condition. The commonest species of Zygnema is Z. Chalyheosporum which is seen with plenty of zygospores. Mougeotia Genuflexa may also be found at this time. Species of Oedogronium which I never noticed with ripe cospores in any of the above-mentioned months, produces sex organs with great regularity in the month of February and most of the filaments show green oogonia and antheridia in the case of Macrandrous forms, while the Nannandrous forms show numerous Androsporanfia and Nannandria growing on the walls of oogonia.

With the coming of winter-rains in December Vaucheria Sessilis and V. Geminata may also be seen in the form of bright green felt-like mats in lawns, gardens and other moist places. Oognia and Anteridia begin to appear in the first week of January, and by the last week of February nearly all the filaments become fertile being heavily laden with oogonia, anteridia and oospores. Vaucheria Sessilis is found both in aquatic and terrestrial habitat, and it is curious that specimens of it collected from ronds at about the same time as from the lawns, proved to be more fertile, each fibament being loaded with huge crops of oogonia and antheridia, while in the case of terrestrial specimens very few sex organs were seen.

V Spring Months. Spring season may be taken as beginning with the first week of March. As compared with February there is a marked rise in temperature, the mean temperature in March being 62.0 as compared with im 49.7 in February. Just as in Spring a young Man's fancy is supposed to lightly turn to thoughts of love, most of the Algae also show great reproductive activity. Various species of Oedogonium produce heavy crops of Co/gonia and anteridia, and by the end of March their filaments are laden with red, yellow, and chocolate. coloured cospores. By the middle of April nearly all species of Oedogonium bear ripe cospores. I recorded fourteen species of Cedogonium in these months all in a fertile condition. Sphaeroples annulina also shows numerous green ova in its oogonia in the beginning of March. By the end of March the ova become fertilised and young cospores, green in colour, enclosed in a thin membrane, may be commonly seen. In April the Oospores become brick red in colour with a thick hyaline wall produced into 10.15 spines, and arranged in three alternate rows in the Godonia. This alga shows such an abundance of red Oospores in April that many ponds appear deep red in colour. Ghosella indica, a new member of conjugatae described by me as combining the characters of Debarya and Zygnema, with certain peculiarities of its own, is also found free-floating in dark green masses in the month of March. By the middle of April, Ghsella is all fertile and conjugation canals bulge out with ripe Zygospores of an orange-yellow colour. Sirogonium Sticticum also produces Zygospores in April.

Periodicity in Reproduction:- By the end of May most of the ponds begin to dry up, as there is no rainfall

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and the mean temperature rises to 81.0 . Now the Algae have to face the hot dry spell of three months beginning with May and ending with the middle of July. To meet this contingency species of Oedogonium, Spirogyra, Vaucheria, Zygnema, Ghosella, Sirogonium, and Sphueroples have produced thick-walled cospores which are capable of surviving the high temperatures of June and July. When the rains start in the middle of July, these ocspores begin to germinate and produce young filaments. Then for the next four to five months most of these algae show a great vegetative growth with very little reproductive activity. The month of March provides optimum conditions for their reproduction, and probably this may be due to rise of temperature in March after the cool months of January and February. Thus there is a marked periodicity in reproduction shown by these Algae in Northern India which is connected with more or less distinctly marked seasons. This is a remarkable phenomenon which is not noticeable in England or other temperate countries where the seasons are not so well-marked, as we have in Northern India.

6.

"Genus" Anabaenothrix and parallelism in Evolution in Freshwater Algae." 1 .

During my investigations of the Panjab Freshwater Algae I came across two Ana-baena-like species of Blue Green Algae, which however differ from the typical specimens of Anabaena in having a number of trichomes enclosed in a single mucilaginous sheath. Recently Dr. F.E. Fritsch described a species of Anabaena with a mucus sheath, from South Africa, which he calls Anabaena vaginicola. sp. nov. (Trans. Roy. Soc. of S. Africa Vol. XVIII. Parts 1 and 2). This so-called Anabaena vaginicola Fritsch resembles Anabaena cylindrica . Lemmer in essential features and the only vistal difference is the occurrence of a number of trichomes within a single sheath. The two species which I discovered differ from Anabaena Vaginicola Fritsch in the size of the filaments, the shape and size of the vegetative cells, and the form and size of spores and heterocysts. Following is a detailed description of these three species of Anabaena-like Blue-green Algae. 1. Anabaenothrix vaginicola.Fritsch- numerous trichomes in a single sheath rapely a single one in single sheath. Cells elongate cylindrical or sub-cylindrical 4 to 4.5 u br, granular, heterocysts cylindrical 4 to 5 u br, 6 to 10 u long. Spores oblong, barrel-shaped, contiguous to the heterocysts in series of 4-5, 6.5 to 10 u br and 12 to 17.5 u long.

II. Anabaenothrix cylindrica Randhawa.

Numerous trichomes enclosed in a single sheath, breadth of filaments 60-75 U inclusive of the sheath, cells rounded or constricted, dumb-bell-shaped, 5 u br, 6-7 u long with homogeneous contents. heterocysts rounded 9 to 10 u diam. Spores in pairs contiguous to the hetercysts cylindrical in shape 4 to 5 u br, 18-20 u

long. Found attached in mud of a pond in long cylindrical columns of blue green colour, which later on become detached, and the Algas becomes free floating. 1A shows .: III Anabaenothrix epiphytica Randhawa and Ghose : filament of Numerous trichomes enclosed in a single sheeth or baccolum & aylund rica a single one in a single sheath. Cells rounded with ny ucher : homogeneous contents. 3.5 / in diam. Heterocysts acheater, ellipsoid-rounded, always away from the spores. 5-6 44 TIQ RB 5 in diampter. Spores barrel-shaped in chains of 2-5, 5-11 4 a hast y my highly broad u br. 14-18 long. Always found epiphytic on other Algae especially Sirogonium. rought they day

Fu .

So here are three species of Anabaena-like Blue Green Algae which have acquired in the course of their y yimes in sides . evolutionary progress, the same character of enclosure of a number of trichomes in a single sheath. This case Fig. 3 B clearly illustrates, as suggested by Miss Agnes Arber an a typical in her excellent monograph on Monocotyledons, that a -2 Genus is an evolutionary platform on which species of where childle ters different origin are essembled together. In the case my munch of these Algae, three different species of Anabaena y ducty, independently acquired the habit of grouping of numerous trichomes in a single sheath. Obviously we are justified in establishing a new Genus, which I call Hereis Anabaenothrix, for the same reasons as we have in 7 a cungle andred Westablishing Schizothrix as a separate genus from heating any Lyngbya or Lyngbya from Oscillatoria. This genus A. Jos Anabaenothrix is an expression of a tendency parallel In shown to that of Schizothrix viz. the enclosure of a number 1 pres of trichomes within a common sheath. This parallelism 4 wette in evolution is very interesting and shows how the habit of secretion of a common mucus sheath by a number of filaments, developed in different families of Myxophyceae; by Schizothrix in Oscillatoriaceae and

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Anabaenothrix in Nostocaceae. Members of Genus Lyngbya

" Genus" Anabaenothrix and parallelism in Evolution in Kreshwater Algae."

During my investigations of the Panjab Fresh-water Algae I came across two Anabaena-like species of Blue Green Algae, which however differ from the typical specimens of Anabaena in having a number of trichomes enclosed in a single mucilaginous sheath. Recently Dr. F.E. Fritsch described a species of Anabaena with a mucus sheath, from South Africa which he calls Anabaena vaginicola. sp. nov. (Trans. Roy. Soc. of S. Africa Vol. XVIII Parts 1 and 2). This so-called Anabaena vaginicola Fritsch resembles Anabaena cylindrica Lemmer in esential features and the only vital difference is the occurrence of a number of trichomes within a single sheath. The two species which I discovered differ from Anabaena vaginicola Fritsch in the size of the filaments, the shape and size of the vegetative cells, and the form and size of spores and heterocysts. Following is a detailed description of these three species of Anabaena. Like Blue-green Algae.

1. Anabaenothrix vaginicola. Fritsch (nov. comb)-numerous trichomes in a single sheath rarely a single one in single sheath Cells elongate cylindrical or sub-cylindrical 4 to 5 u broad 6 to 10 u long. Spores oblong, barrel-shaped, contiguous to the heterocysts in series 4-5, 6.5 to 10 u broad and 12 to 17.5 u long.

II. Anabaenothrix cylindrica Randhawa and Ghose.

Numerous trichomes enclosed in a single sheath, breadth of filaments 60-75 u inclusive of the sheath, cells rounded or constricted, dumb-bell-shaped, 5 broad 6-7 u long with homogeneous contents. Heterocysts rounded 9 to 10 im u in dhameter. Spores in pairs contiguous to the heterocysts cylindrical in shape 4 to 5 u broad, 18-20 u long. Found attached in mud of a pond in long cyli ndrical columns of blue green colour, which later on become detached, and the Alga becomes free floating. Fig I A shows af filament of Anabaenothrix cylindrica with numerous trichomes enclosed in a single sheath. In fig. 2 B is shown a part of a trichome highly enlarged with a heterocyst surrounded by a chain of spores on both sides.

III. Anabaenothrix epiphytica Randhawa and Ghose.

Numerous trichomes enclosed in a single sheath or a single one in a single sheath. Cells rounded with homogeneous contents. 3.5 u in diam. Heterocysts ellipsoidrounded, always away from the spores. 5-6 u broad 14-18 u 1 long. Always found epiphytic on other Algae especially Sirogonium. In Fig. 3 B is shown a typical filament of Anabaenothrix epiphytica with a number of trichomes enclosed ing a single sheath. Sometimes we come across filaments of this species, showing a single trichome enclosed in a sheath as in Fig 4 A. In Fig 5 C is shown a part of a trichome with a spore and a beterocyst.

So here are three species of Anabaena-like Blue Green Algae which have acquired in the course of their evolutionary progress, the same character of enclosure of a number of trichomes in a single sheath. This case clearly illustrates, as suggested by Miss Agnes Arber in her excellent monograph on Monocotyledons, that a Genus is a evolutionary platform on which species of a different origin are essembled together. In the case of these Algae, three different species of Anabaena independently accuired the habit of grouping of numerous trichomes in a single sheath. Obviously we are justified in establishing a new Genus, wk (which I call Anabaenothrix, for the same reasons as we have in establishing Schizothrix as a separate genus from Lyngby. or Lungbya from Oscillatoria. This genus Anabaenothrix is an expression of a tendency parallel to that of Schizothrix viz. the enclosure of a number of trichomes within a common sheath. This parallelism in evolution is very interesting and shows how the habit of secretion of a common mucus sheath by a number of filaments, developed in different families of Myxophyceae; by Schizothrix in Oscill latoriaceae and Anabaenothrix in Nostecaceae. Members of

Genus Lyngbya

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"Three New Species of Zygnema" from Northern India.

The Writer came across three remarkable species of genus Zygmus, during his investigations of the Zygnemales of Northern India. The reproductive phase of these algae shows many peculiarities. Following is a detailed description of these three new species of Wygnema.

1.

I.

Zygnema Czurdae- Sp. Nev.

Vegetative cells are 20-27 U bread, and $\frac{1}{2}$ to 4 times as long. No more or less rounded chloroplasts with a conspicuous pyrenoid in tech, are seen in each cell. When stained with iodine, some of the discoplasts show the typical zygnemaceous stellate structure (Fig) Reproduction.

The reproductive phase of this new member, Zygnemales is most murkable. Both lateral and scalariform conjugation have been noticed in this alga.

i. Lateral Conjugation:-

Lateral conjugation is the commonest mode of reproduction in this alga. The neighbouring cells give out tent-like protuberances [Mg]). In most filaments, it is seen, that such protuberances regiven out on one side of the filament only (Fig), while in there these are given out on both sides in an alternate feshion (Mg)). The protoplasm with the chloroplasts shows a dislocation (Mg)). The protoplasm with the chloroplasts shows a dislocation (Mg)). The protoplasm with the chloroplasts shows a dislocation (Mg)). The protoplasm in the region of the protuberances (Fig)). Itimately the cell-wall separating the two gametes ruptures, the motoplasm and nuclei coalesce, but the chloroplasts with their pyremids remain distinct even in the zygospore.

Both the gametes are momphologically as well as physiologically isogenous. In one filament, I noticed that the upper part, which untains a kidney-shaped zygospore, is cut off from the remaining conjugation, geniculation is noticeable. (Fig) Sometimes three or more filaments may be seen conjugating together (Fig).

Affinities:-

The species of genus Zygnema, which come nearest to the present from, are Zygnema Heydrichii schmidle, and Z. Carteri Gzurda. However it differs from both these in that the zygospore is not confined to the conjugation canal, but encroaches upon the whole of middle part of the conjugating cells, when it reproduces by lateral conjugation. From Z.Carteri it differs in the size of vegetative cells and zygospores. Another related form is Z. gedeanum Czurda, which differs from the present form, in that the zygopores produced by lateral conjugation are confined to the upper part of the conjugation canal area only though they are not cut off by any cell-wall from the remaining part of the conjugating cells.

I have named this species after Dr. V.Czurda of Prag who has done such a memorable work in advancing our knowledge of Zygnemals.

Habit: -- This alga was found free floating in a bluish green mass, only with a species of Spirogyra during the third week of February, 1931, in a fresh-water spring at Tahli Sahib, Tehsil Dasuya, District Hoshiarpore, Punjab.

contd.

Zygnema Iyengari Sp. Nov. Randhawa. Vegetative cells are 18-20 U broad and five to eight times as Fach cell has two rounded chloroplasts (Fig)

Reproduction.

Sexual reproduction is not known so far, and the alga reproduces will by means of squarish or cushion shaped azygospores. The azygosand are of various shapes (Fig Fig) and have a consriction the middle part when fully mature (Fig). The cells assume a indis-shaped appearance due to the peculiar structure of the azygosand are shining white in appearance, possibly due to mucilage.

The azygospores are 26-30 U long and just as broad in some cases My). Three layers are clearly noticeable in the wall of the azymyores, a bluish extosporium, a dark brown, cringkled and sinuous

Minities:- This alga takes its place in the small group IV Reticuda of Genus Zygnema, as classified by Caurda in Heftfof Die Susswasmilora Mitteleuropas, due to the absence of sexual reproduction. Mrs are three species in this group viz Zygnema reticulatum Hallas iertile Fritsch and Rich, and Z. Cylindricum Transeau. From all use this alga differs in the shape and size and structure of the WEOSPORES.

Mitt- This alga was found free-floating in the form of a bluish the of filaments at Shahniwala Tank at Dasuya District Hoshiarpore mjab during the second week of April 1931. Zygnema giganteum Sp. Nov. Randhawa.

Vegetative cells are 38-48 U broad and 12 to 22 times as long. In thinner filaments, the chloroplasts show a typically stellate structure each with a conspicuous pyrenoid. (Fig). In bigger filaments the chloroplasts are loaded with starch granules, and the stellate structure of the chloroplasts is obscured, and they uppear to be more or less rounded in appearance. Cell wall is fairly thick as compared with other species of Zygnema. In most filaments protoplasm with chloroplasts and nucleus is restricted to the middle part, the peripheral part being full of shining mucilage, mereted by the retreating protoplasm which forms a homogeneous mass (Fig).

Reproduction- Both sexual and asexual modes of reproduction have been noticed in this alga.

1. Asexual Reproduction: -

Asexual reproduction takes place by means of brick-shaped parthenospores. Inearly stages, the filaments develop very thick cellsalls, and their chloroplasts become enormously expanded filling merly the whole of the cell interior. When stained with iodine the chloroplasts become purple, due to the heavy load of starch granules, which envelopes them, and the surrounding parts taken up a yellow tain. The parthenospores develop orange-coloured to lick walls, which constimes show two pyrenoids in the middle part (Fig.) The parthenospores are 36-45 U broad and 54-96 U in length, and may be rectangular or squarish in shape even in the same filament (Fig.). The parthenospores may be seen singly, or in rows of twos or threes, and in later stages whole filaments are converted into chains of parthenospores (Fig.).

II. Sexual Reproduction- The sexual mode of reproduction shown by this alga is also of a very interesting type. Material

sellected from the same habitat shows that in some filaments zygospores are found in the conjugation canals, and in others in the conlugating cells. the conjugation canals, and in others in the conlugating cells. The conjugation canals, and in others in the conlugating cells. The conjugation canals, and in others in the conlugating cells. The conjugation canals, and this type of conjugation has been seen in the case of Zygnema peliosporum Witte. by Writech, but even in that case the two different types of conjugation were seen in material cellected in different years from the mate habitat. In the present case both types of reproduction were term in the same material, and also transitional stages.

a. Anisogrmous conjugation.

This type of reproduction is quite common in most filaments. The conjugation canals do not from a continuous tube but present a mptured appearance in the middle, surrounded by a granular matter. (Ng). The male filaments manntam sometimes show an alternation of cells which produce male gametes, and xgx vegetative cells, in mich the chloroblasts are surrounded by a shining mucilaginous merial and thick walls (Fig) In later stage these sterile alls become loaded with starch granules, and these lso produce partive conjugation canals (Fig). This shows that these cells use are potentially male, though their activity is very much reunded by the development of thick walls. In other cases no cells an left out as purely vegetative in the male filaments, all of them (metioning as males (Fig).

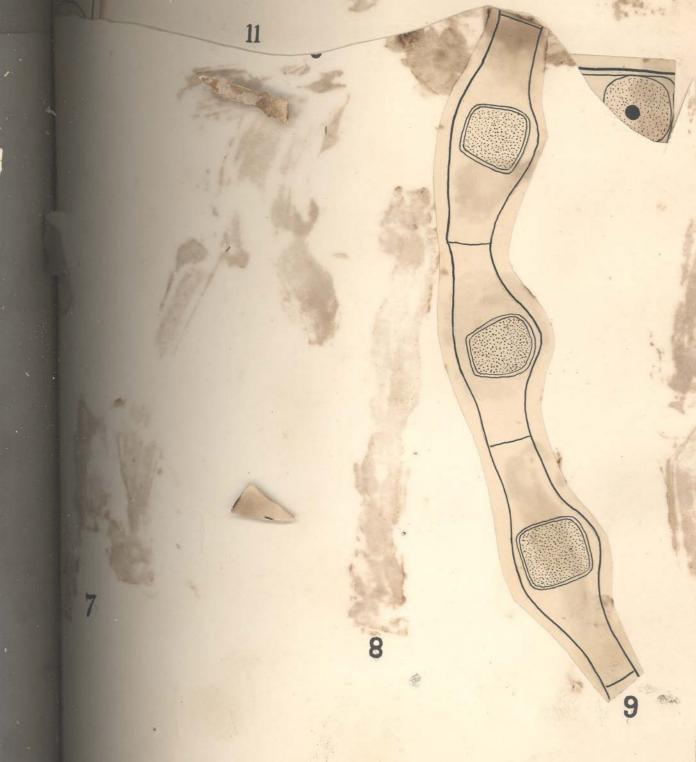
The zygospores are 42-46 U and 50-58 U long, and are oval in hape. The zygospore wall is composed of two layers only, a thick value and smooth exospore, and a thin, light blue, and smooth missoore. Mesospore is obviously missing. The ripe zygospores re orange-coloured in appearance like the parthenospores

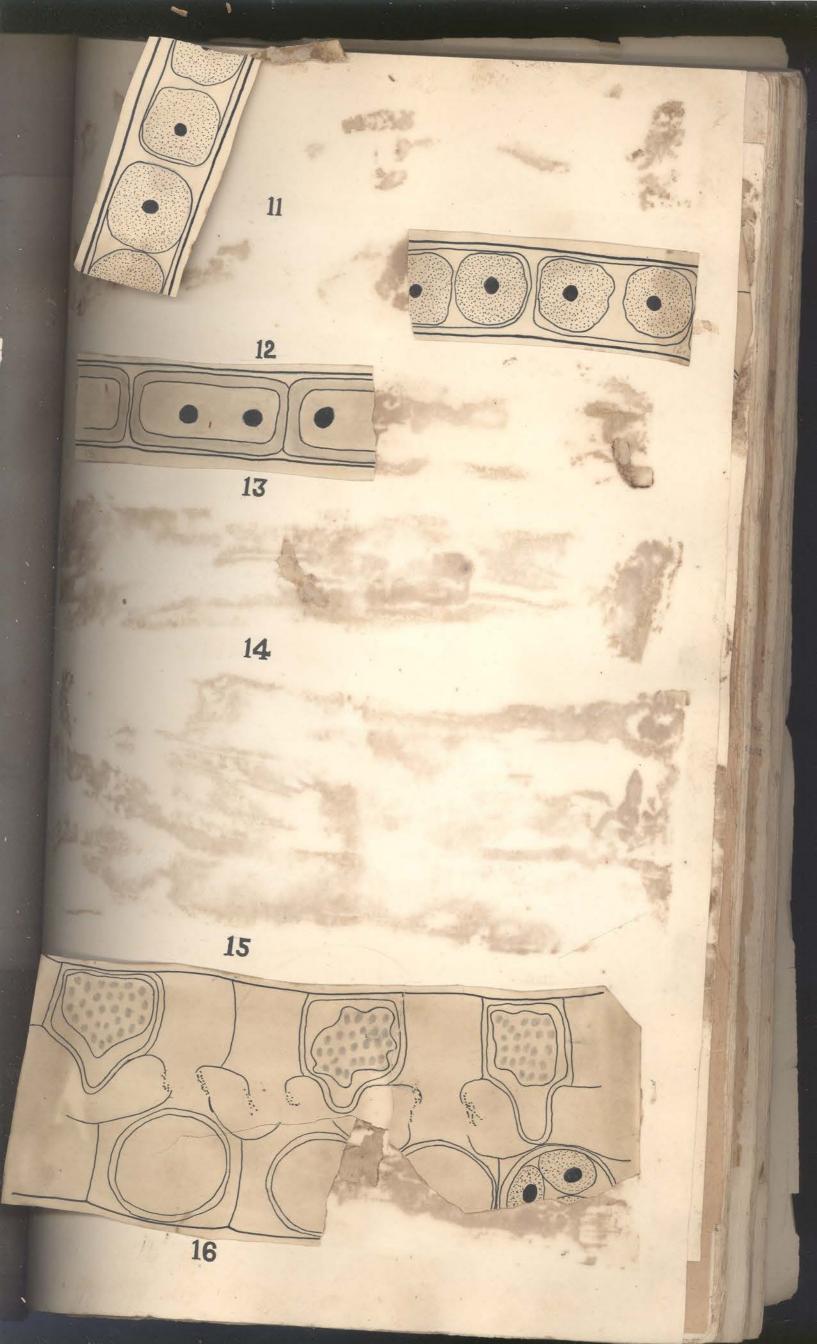
b. Isogamous conjugation.

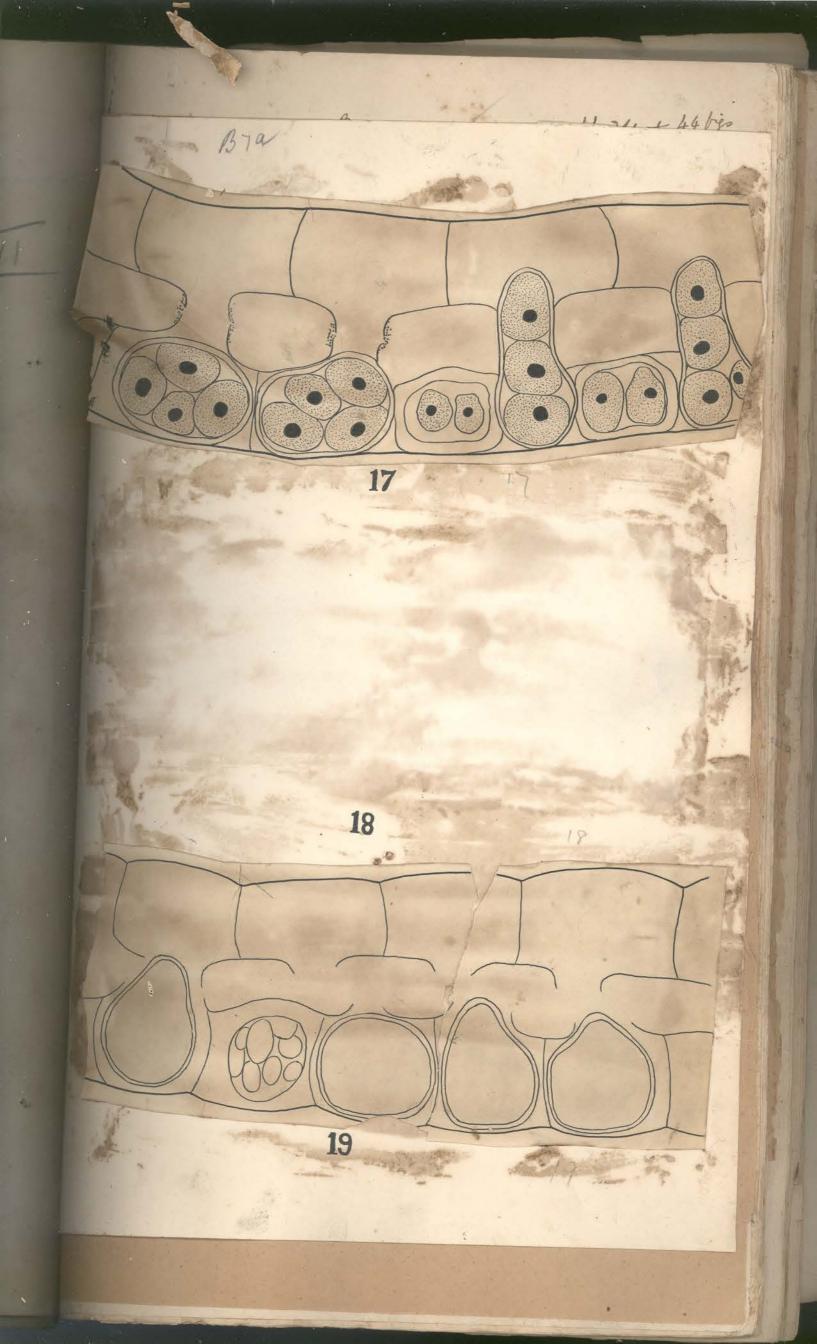
This is the commons mode of reproduction, in this alga. Zyg-

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ation in this species is very much unsettled; isogamy found side by side. In one filament isogamy, anisogamy and many intermediate stages between these both were seen (Fig. 17). While majority of the zygospores were clearly produced by anisogamous conjugation, is apparent from their being entirely confined to the female gametangium. here are some zygospores which are partly formed in the conjugation canal and narthy in the fan

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H. S. 26-8-1936.

A.S.-Vol. IV, No. 3, (B 7A)-1 H. S. 25-0-1936 THREE NEW SPECIES OF ZYGNEMA FROM NORTHERN INDIA.

By M. S. RANDHAWA, M.Sc., I.C.S.

Saharanpur. (Communicated by Dr. H. Chaudhuri, M.A., Ph.D.)

Received 1936.

The writer came across three remarkable species of genus Zygnema, during his investigations of the Zygnemales of Northern India. The reproductive hase of these algæ shows many peculiarities. Following is a detailed description of these three new species of Zygnema. I. Zygnema Czurdæ Sp. Nov.

Vegetative cells are $20-27 \mu$ broad, and $1\frac{1}{2}$ to 4 times as long. more or less rounded chloroplasts with a conspicuous pyrenoid in each, are seen in each cell. When stained with iodine, some of the chloroplasts show the typical zygnemaceous stellate structure (Fig. 1.) Reproduction.—The reproductive phase of this new member Zygnemales

is most remarkable. Both lateral and scalariform conjugation have been

 i) Lateral conjugation.—Lateral conjugation is the commonest mode
 (i) Lateral conjugation.—Lateral conjugation is the commonest mode
 of reproduction in this alga. The neighbouring cells give out tent-like
 (ii) Lateral conjugation. protuberances (Fig. 2). In most filaments, it is seen, that such protuberances are given out on one side of the filament only (Fig. 2), while in others these are given out on both sides in an alternate fashion (Fig. 3). The protoplasm with the chloroplasts shows a dislocation from its horizontal position, and it has been noticed, that in some cases, it accumulates in the region of the protuberances (Fig. 3). Ultimately the cell-wall separating the two gametes mptures, the protoplasm and nuclei coalesce, but the chloroplasts with their pyrenoids remain distinct even in the zygospore.

Both the gametes are morphologically as well as physiologically isogamous. In one filament, I noticed that the upper part, which contains a kidneyshaped zygospore, is cut off from the remaining part of the conjugating cells by means of distinct walls, as in Zygnema Heydrichii (Fig. 4). However in most of the filaments the zygospore is seen filling the whole of the conjugation canal area, as well as the lower part of the conjugating cells (Fig 5.). Probably the zygospore enlarges, presses down the lower arched part of the cell-wall, while the lateral parts are torn away partly by the pressure of the aygospore, and partly by the forces exerted by the movement of the filaments

The zygospores are $30-40\,\mu$ in diameter, and are oval in shape in early stages (Fig. 5), but later on become rounded. Four chloroplasts with a conspicuous pyrenoid in each, and nucleus in the central part may be observed nearly in all the zygospores (Fig. 5). The zygospore wall is composed of three thin layers, all of which are light blue in colour. The exospore and mesospore are smooth, while the endospore is slightly sinuous. When fully mature the zygospores are perfectly round in shape, and the peripheral area surrounding the chloroplasts is full of granular matter (Fig. 6). The middle-basal part of the conjugating cells becomes flattened and the upper part becomes rounded like a dome (Figs. 5, 6). In some filaments, which become more mature, distinct geniculation may be seen, the flattened basal part ruptures, and the zygospore is liberated into water (Fig. 6). The zygospores thus produced by lateral conjugation look very much like azygospores produced asexually in forms like Zygnema reticulatum Hallas and Z. fertile Fritsch. If the early stages showing cells with conjugation processes were not seen, and also the four chloroplasts in some zygospores, these might have been easily mistaken for azygospores.

-xual differentiation in this species is very much unsettled; isogamy inisogamy being found side by side. In one filament isogamy, anisogamy muny intermediate stages between these both were seen (Fig. 17). While must of the zygospores were clearly produced by anisogamous conjugation, apparent from their being entirely confined to the female gametangium, and are some zygospores which are partly formed in the conjugation canal

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111. Zygnema giganteum Sp. Nov. Vegetative cells are $38-48 \mu$ broad and $1\frac{1}{2}$ to $2\frac{1}{2}$ times as long. In timer filaments, the chloroplasts show a typically stellate structure each of a conspicuous pyrenoid (Fig. 11). In bigger filaments the chloroplasts is loaded with starch granules, and the stellate structure of the chloroplasts is obscured, and they appear to be more or less rounded in appearance. Cellnul is fairly thick as compared with other species of Zygnema. In most imments protoplasm with chloroplasts and nucleus is restricted to the middle X art, the peripheral part being full of shining mucilage, secreted by the retreating protoplasm which forms a homogeneous mass (Fig. 11).

Reproduction.—Both sexual and asexual modes of reproduction have noticed in this alga.

(i) Asexual reproduction.—Asexual reproduction takes place by means of buck-shaped parthenospores. In early stages, the filaments develop very thick cell-walls, and their chloroplasts become enormously expanded filling rearly the whole of the cell interior. When stained with iodine the chloroplasts become purple, due to the heavy load of starch granules, which enveupes them, and the surrounding parts take up a yellow stain (Fig. 12). The puttenospores develop orange-coloured thick walls, which sometimes show two pyrenoids in the middle part (Fig. 13). The parthenospores are $36-45 \mu$ moad and $54-96 \mu$ in length, and may be rectangular or squarish in shape oven in the same filament. The parthenospores may be seen singly, or in rows of two or threes, and in later stages whole filaments are converted into thans of parthenospores (Fig. 14).

(ii) Sexual reproduction.—The sexual mode of reproduction shown by this alga is also of a very interesting type. Material collected from the same habitat shows that in some filaments zygospores are found in the conjugation canals, and in others in the conjugating cells; the conjugation being isogamous and anisogamous in the same alga. The only parallel instance of this type of conjugation has been seen in the case of Zygnema pelioporum Witt. by Fritsch, but even in that case the two different types of conjugation were seen in material collected in different years from the same habitat. In the present case both types of reproduction were seen in the same material and also transitional stages.

(a) Anisogamous conjugation.—This type of reproduction is quite common in most filaments. The conjugation canals do not form a continuous the but present a ruptured appearance in the middle, surrounded by a granular matter (Fig. 15). The male filaments sometimes show an alternation of cells which produce male gametes, and vegetative cells, in which the chloroplasts are surrounded by a shining mucilaginous material and thick walls (Fig. 15). In later stages these sterile cells become loaded with starch granules, and these also produce abortive conjugation canals (Fig. 16). This shows that these cells also are potentially male, though their activity is very much retarded by the development of thick walls. In other cases no cells are left out as purely vegetative in the male filaments, all of them functioning as males (Fig. 19).

The zygospores are $42-46 \mu$ and $50-58 \mu$ long, and are oval in shape. The zygospore wall is composed of two layers only, a thick hyaline and smooth exospore, and a thin, light blue, and smooth endospore. Mesospore is obviously missing. The ripe zygospores are orange-coloured in appearance like the parthenospores.

(b) Isogamous conjugation.—This is the commoner mode of reproduction, in this alga. Zygospores are typically egg-shaped in appearance, and project partly into the gametangia, completely filling the conjugation canals at the same time. Zygospores produced by isogamous conjugation are longer than those produced by anisogamous conjugation, being 70-75 μ long. This is probably due to the fact that in this position more space is available for the lengthwise development of the zygospores (Fig. 18).

In some instances I noticed that male and female gametes instead of meeting and fusing to form zygospores, develop independently into azygospores (Fig. 18).

11024 + 44 bigs Sexual differentiation in this species is very much unsettled; isogamy and anisogamy being found side by side. In one filament isogamy, anisogamy al many intermediate stages between these both were seen (Fig. 17). While jointy of the zygospores were clearly produced by anisogamous conjugation, apparent from their being entirely confined to the female gametangium, are some zygospores which are partly formed in the conjugation canal and partly in the female gametangium (Fig. 19). In some only a small part the zygospore is found projecting into the conjugation canal. The pearaped appearance of some zygospores with their pointed ends towards the inal stage and in these and both the male as well as the female gametes low a certain amount of activity

This species combines all the four forms of reproduction known in different ecies of genus Zygnema.

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(i) Asexual reproduction by the development of parthenospores. (ii) Sexual reproduction.

(a) By means of development of zygospores produced isogamously. By means of zygospores produced anisogamously.

(c) By means of zygospores developed from isogamous gametes. Affinities .- There are two conspicuous peculiarities of this alga. Firstly modes of reproduction, and secondly its gigantic size.

As regards the combination of isogamous and anisogamous modes of mugation, it resembles Zygnema peliosporum Witt. as recorded by Fritsch X m South Africa. But it differs from that species in the shape and size of suspores and vegetative filaments, as well as in the presence of partheno-

As regards its size Z, inconspicuum Czurfla with its filaments as broad as "papproaches it, but differences in the shape of zygospores, occurrence of isogamy with isogamy and presence of parthenospores keep these two s wide apart. I have named this form as Zygnema giganteum, due to comparatively big size.

Habit.-This alga was found free-floating along with Zygnema cæruleum Stah Baeen, a perennial freshwater stream in Kapurthala State, Panjab, using the second week of March 1931.

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Irengar, M. O. P., "Studies on Indian Zygnemales," Rev. Algol, 1932, 6. EXPLANATION OF FIGURES.

PLATE I.

Zygnema Csurdæ sp. nov. 1 – A vegetative filament showing chloroplasts. \times 660. 2 – A filament showing cells with conjugation processes. \times 660.

3-A filament showing cells giving out conjugation processes on both sides.

4.-A filament showing a bean-shaped zygospore cut off by walls from the remaining 5.—A filament showing zygospores filling the entire cells. \times 660.

6-A filament showing distinct geniculation and ripe zygospores. \times 660. in 7.-Three filaments conjugating in a scalariform way. × 660.

Zygnema Iyengari sp. nov. 8. A filament showing chloroplasts. \times 660. 9. A filament showing squarish azygospores.

= 10.—A filament showing zygospores with a constriction in the middle. \times 660. PLATE II.

Zygnema giganteum sp. nov.

m II.-A filament showing chloroplasts. X 660.

12-A filament showing enlargement of chloroplasts and secretion of mucilage prior to formation of parthenospores. \times 660. 13-A-Slament showing a chain of brick-shaped parthenospores with two pyrenoids

14-A filament converted into a chain of orange-coloured parthenospores.

× 660.

in 15.-Two filaments showing anisogamous conjugation. The male filament alternation of male cells, and vegetative cells full of mucilage. \times 660. shows an

in the male filament. \times 660.

17—Two filaments showing transitional stages between isogamy and anisogamy. \times 660. u. 18.-Two filaments showing zygospores produced by isogamous conjugation and two

PLATE III.

Zygnema giganteum sp. nov. Fig. 19.—Two conjugating filaments showing pear-shaped zygospores. \times 660.

Contributions to our knowledge of the Freshwater Algae of Northern India.

1. Oedogoniales.

By

M.S. Randhawa, M.Sc., I.C.S Saharanpur.

1 to 24 + 44 bigs m Three sheets.

Received July 21, 1936

Communicated by Dr. S.L.Ghose, Ph.D. Botany Department, Government College, Lahore. Group 5. Oedogoniales. Genus Oedogonium. Link.

Genus Oedogonium.

This alga is found in freshwater ponds, lakes, and streams, nearly all over the world. The filaments have a well-developed basal cell by means of which they get attached to sticks and stones. The filaments are unbranched, and the cells are usually cylindrical or barrel-like in appearance. The genus was described by Link in 1820. A. Section Dioca nannandria.-

1. Oedogonium striatum sp. nov. Idioandrosporous nannandrous. Ogonia intercalary or terminal in position occurring singly or in pairs, also in threes, , pro-Figo toyanthe 2 + 3 nouncedly oval or oval-ellipsoid in shape. Oospore chocolate in colour, oval, almost completely filling the oogonium Oospore wall very thick bearing obliquely arranged or a raight hyaline striations, 10-15 in number which often mose (Fig Basal cells flattened 45-50 1 br. (Fig Wegetative anar cells swollen with starch. Androsporangia in rows of 3-6 Nannandria 2-6 on the basal cells and the walls of the oogonium. Antheridia always internal. Oospores germinating, to produce 4 pospores oval in shape, 10 u br., 18 u long, dig &) This alga very much resembles Oe. Wolleanum Wittrock in dimensions of cells and oospores but differs from that form in having an internal antheridium and in having no pore in the wall of the oogonium, and opening taking place by a superior lid, and its headiar strictions.

Oospores75 # br., 85 # long.

Androsporangia 23-1 br., 20-27 W long.

Nannandria, 18 N br., 72 No long.

Habit.- This alga was found epiphytic on submerged radifal stems of water-plants, in Shahniwala Tank at Dasuya during the second week of March 1930. 2. <u>Oedogonium multisporum</u>. Wood - Tiffny 1930, p. 131. Dioecious nannandrous, oogonia 1-3, sub-ovoid

-2-

or subglobose, pores superior, oospore globose nearly filling oogonia, spore-walls smooth, dwarf male a little curved near or on the oogonium, antheridium exterior 1-4. (Fig.).

Distribution .- U.S.A., England.

Vegetative cell of the female 14-18 w broad, 2-3 times long Oogonia 32-40 & broad, 28-34 & long,

Oospore 32 p broad, 28 p long.

Nannandria 14-18 14 broad, 2-3 times as long.

Habit.-

Reported by Mr. Prem Lal from ponds in Lahore The and Gujranwala in this first week of December 1933.

B. Section Dioca macrandria,

3. <u>Oedogonium capilliforme</u> Kutz. var. nov. Manum. Bandhawa. op. cit. Heering. Susswasser flora Heft.6.

Dioecious macrandrous, oogonia single or in pairs. Ovoid to sub-ovoid or even slightly ellipsoid in shape with a superior pore. Oospore globose or ovoid globose completely filling the oogonium. Spore walls smooth. Antheridia 2-4 celled usually alternating with the vegetative cells, two sperms in each division horizontal. This differs from the type in the smaller dimensions of its vegetative cells, oogonia, oospores and antheridia.

Distribution. So far this species has only been reported from Europe and United States of America. Diam. of female veget. cells 18-20 14, 2-3 & as long. " male " 10-12 14, 2-4 * " " Oogonia, 30-36 14 br., 32-40 14 long. " oospores, 34-36 14 br., 32-40 14 long. " antheridia, 10 14 br., 5 14 long.

Habit.- Found growing epiphytically on blades of Rushes in a pond in N. Shakpur, Tehsil Dasuya, Distt. Hoshiarpur, in the middle of April 1936. 4. <u>Oedogonium cardiacum</u>. Wittrock. op. cit. Heering Susswasser flora Heft. 6.

Dioecious macrandrous, oogonia single ovoid elliptical in shape. Broadened and bulging out laterally Pore wide situated a little above the middle. Oospore rounded, fire-red in colour not completely filling the oogonium(Fym)Oospore membrane smooth. Male filaments a little more slender than the female filaments. Antheridium 2-3 celled, Sperms not seen.

Distribution. So far this species has been only reported from Continental Europe and United State of America.

Diam. of veget. cells of female plants 26-28 & br.3-5 male plant ...22-25 & br.,3-5 times as oogonia 54-60 & br. 60-70 & long.

oospores 50 1 br. .

2

antheridial cells8-9 W long, 23 W br.

Habit:- Epiphytic on blades of grass, and decaying shoots of trees, mixed with <u>Oedogonium urbicum</u>, <u>Anabaenothrix cylindrica</u> and <u>Zygnema chalybeosporum</u> in a pond at X. Jhingran, Distt. Hoshiarpur, in the last week of March 1930.

6. <u>Oedogonium Frankilianum</u>. Wittrock. sec. Hirn., var. Polyspora, var. nov.

-5-

Dioecious macrandrous, oogonia single or in groups of 2-3. Globose or ellipsoid globose, opening by a superior pore. Oospores rounded, chocolate in colour when mature, sometimes completely filling the oogonium, sometimes partly (Fyme) Oospore wall smooth, Suffultory cell wider than the ordinary cells. Male plant slightly narrower than the female plants. Antheridia 3-4 celled separated by a single vegetative cell. Sperms two, division horizontal. Vegetative cells distinctly capitellate.

This differs from the type in (a) Bigger dimensions of vegetative cells and oospores (b) having more than one oogonium in a series (c) oospores often not completely filling the oogonium. Hence the new variety has been established.

Distr:	<u>ibution</u> :	So fa	r this	Alga ha	as only	been reported
			Roumani			
	veget. ce	ells of	female	plant	• • • • •	9-18 4-br. 4-6 times as long.
**	"	п	male	Ħ	• • • • •	7-12 4 br. 4-6 times as long.
n	oogonia .	* * * * * *	• • • • • • •	. 26-3	66 ka br	. 38-40 / long.
H	oospores			24-3	5/ der	oad.
"	antheridi	al cel	ls	10 <i>p</i>	br.	9 14 long.

Habit:- This is rather a rare form, and was found growing epiphytically on the stems of a submerged water plant, along with <u>Eudorina</u> <u>elegans</u> near Beas, during the last week of April 1930.

6. <u>Oedogonium inerme</u> Hirn. var. <u>Polyspor</u>a. var. nov. (Section Nicht genugend bekannte Aretn. Heering Susswasser flora Heft. 6.).

Dioecious macrandrous (probably) oogonia 1-3, usually single or in pairs. More rarely in a row of three, Pore in the middle. Oogonia transversely ellipsoid. Oospore chocolate in colour almost of the same shape as the oogonium which it completely fills. Oospore wall smooth. Vegetative cells not capitellate. Male plants not known.

This differs from the type in having oogonia in a series of two or three and the oospores completely filling the oogonia and in the smaller size of the vegetative cells, oogonia and oospores. Hence this new variety has been established.

Distribution: So far this species has only been reported from France.

Diam. veg. cells 5-9 & br., 4-6 times as long. oogonia 21 u br., 19 & long. oospores 19 M br., 16-17 W long.

Habit:- Found attached to decaying leaves of Dalbergia sissoo, in a brownish mass in a rain-water puddle near Hamira, during the second week of March, 1930.

7. <u>Oedogonium lautumnarium</u>. Wittrock. op. cit. Heering Susswasser flora Heft. 6.

-7-

Dioecious, macrandrous. Oogonia always single globose or slightly expanded in the upper portion. Opening by a superior pore. Oospores yellowish in colour, globose, with a thick opaque whitish smooth wall, Male plants as big as the female plants or slightly smaller. Antheridia 3-celled, Cach with 2 sperms, division [Fi]7.421] horizontal, Suffultory cells of the same diameter as the vegetative cells. It differs from the type in oospores not completely filling the oogonia.

Distribution: This Alga is so far only known from Finland and Sweden.

Diam.	of veg. cells female plant 18-20 12 br. 3-6 times as long.
	" " male " 14-16 12 br. 3-6 times as long.
	oogonia 40-42 / br., 42-48 / long.
	cospores 36 M broad .
	antheridial cells 13-14 / br., 5-8 / long.

Habit:- Epiphytic on water-plants, in a pond near Hamira, along with <u>Spimogyra dubia</u>, <u>Oedogonium</u> <u>lautumnarium</u> and <u>Sirogonium</u> <u>Sticticum</u>, during the middle of April 1930. It is rather, rare alga. 8. <u>Oedogonium</u> <u>Pisanum</u>. Wittrock. op. cit.; Heering Susswasser flora Heft 6.

Dioecious macrandrous. Oogonia single, both terminal and inter-calary opening by a superior (Fig. V22, lid, Oospore oblong ellipsoid, completely filling the oogonium, oospore membrane smooth. Antheridia (Fig. 2224 2-celled, sperms 2, division horizontal, Suffultory cells not broader than the vegetative cells.

<u>Distribution</u>: So far the species has only been reported from Europe and the United States of America.

Diam. veget. cell 5-9 N br., 18-36 14 long.

- " oogonia 16 / br. 36 to long.
- " oospores 14-15 12 br., 24-30 1/ long.
- " antheridia 4-5 W br., 3-5 W long.
- Habit:- Epiphytic on decaying leaves of <u>Dalbergia</u> <u>sissoo</u> along with <u>Oedogonium Pisanum</u> and <u>Oe. Hirnii</u> in a puddle near Ha**mis**ra during the second week of April 1930. The filaments present a greyish appearance.

9. <u>Oedogonium rivulare</u> Hirn. var. nov. Manum. Bandhe op. cit. Heering Susswasser flora Heft 6.

-9-

Dioecious macrandrous. Oogonia usually single, rarely in pairs. Pore superior, oogonia ellipsoid globose, oospore chocolate in colour ovoid, not completely filling the oogonium, oospore wall smooth, The suffultory cells not swollen. Male filaments narrower than female filaments. Antheridia 5-7-celled but sometimes very numerous as many as 17

This species differs from the type in its (1) usually single oogonia (ii) oospores almost completely filling the oogonium (iii) smaller size of oogonium (in <u>Oedogonium rivulare</u> Hirn, they are as much as 160 M br.). So it may be taken as a new variety.

Distribution: So far this species has only been reported from Germany.

Diam. Veget. cells of female plant ... 36-47 4 br. 3-5 times as long. " " " male " ... 32-34 4 br. 3-5 times as long. " oogonia 81 / br..... 90 / long. " oospore 76 / br..... 80 / long. " antheridial cells .. 12 / long 28 / br.

Habit:- This alga was found free-floating in a blackish mass, along with <u>Cylindrocapsa</u> <u>conferta</u>, in the famous tank at Dasuya Distt. Hoshiarpur during the middle of October 1929.

10. <u>Oedogonium sociale</u>. Wittrock. op. cit. Heering Susswasser flora Heft 6.

Dioecious macrandrous, oogonia single, globose in shape, inter-calary, oospore deep-yellow (Figure 28). in colour, completely filling the oogonium, Oospore membrane smooth, basal cells swollen. Antheridia 1-5 celled, $(Fig^{(2)})^{29}$.

This Alga is very social in its growing habit, its individuals occurring in large numbers as epiphytes on water plants.

<u>Distribution</u>: This species is widely distributed in Europe and America.

Diam. veget. cells 9-15 N br., 3-5 times as long.

- " oogonia 34-37 1 br.,
- " oospores 26-30 N br..
- " antheridial cells 12-14 W br., 10 W long.
- Habit:- This is one of the commonest and mostly widely distributed species of <u>Oedogonium</u> and grows as an epiphyte on the submerged leaves and stems of the aquatic plants. Sometimes we can get pure growths of this alga, showing a harvest of bright yellow cospores, under the microscope. In some cases it is also found mixed with <u>Oedogonium urbicum</u>, and <u>Oe. cardiacum</u>. Collected from nearly all over the Eastern Punjab during the middle of March 1930.

-11- fonticole stinde (6 De-mullispour 11. <u>Oedogonium rhodosporum</u> Al. Braun. Pascher 1914. p. 225. Tiffany 1930. p. 163.

Dioecious, macrandrous, oogonia 1-2, obovoid, or globose obovoid, ellipsoid or subglobose nearly filling the oogonium, spore-wall smooth. Male filaments very narrow Fight (Fig. 30131) Distribution: U.S.A., Australia, Europe.

Vegetative cells of female plant ... 16-18 1 broad, 28-48 1 long. Vegetative cells of male plant 12-14 & broad, 2-3 times as long. Oogonia 30-40 N broad, 32-36 N long. Oospore 32 M broad, 32 M long. Antheridial cells 8-10 N broad.

Habit:-Found free-floating in a pond at Lahore by Mr. Prem Lal, during the first week of December 1933.

12. <u>Oedogoniu</u>

-12-

glabre

Dioecious, macrandrous, oogonia always single, globose, pore not seen, though very probably it opens by a pore. Oospore globose, completely filling the oogonium. Oospore wall smooth. Cells of the female filaments very short and rounded, with a thick wall and a conspicuous pyrenoid in the middle, vegetative cells very peculiar. Male filaments have rows of 5-7 antheridia, separated by long cylindrical cells, basal cells elongate (1). This species comes nearest <u>Oedogonium</u> <u>suecicum</u>. Wittrock. sec. Hirn. from which it differs in oospore membrane being smooth and not spinous, and vegetative cells being much broader and smaller in length and its se x organs being slightly bigger.

tant aris

Distribution:

Habit:- Free-floating in a pond. Collected at V. Jhingran, Distt. Hoshiarpur in the middle of March 1930.

13. <u>Oedogonium rufescens</u>. Wittrock. var. Lundellii. Tiffany 1930. p. 66. Pascher, p.192.

Dioecious, macrandrous, oogonia 1-3 obovoid or depressed obovoid, globose. Pore median, oospore globose or depressed globose filling the oogonium.

Distribution: - Southern Tibet.

Vegetative cells of the female filaments - 8-10 M broad 30-40 M long. Cogonia 22-24 M broad, 20-26 M long. Cospore 20-22 M broad, 17-20 M long.

Habit:- This alga was found by Mr. Prem Lal, freefloating in a pond at Lahore during the third week of November 1933, and also by the author at Saharanpore during the first week of December 1935. 14. <u>Oedogonium calcareum</u> - Cleve. Pascher 1914. p.192. Tiffany 1931. p. 67.

Dioecious, macrandrous, oogonia one or rarely two, depressed globose, oospore depressed globose filling oogonium, oospore-wall smooth (Film). 35).

Grows epiphytically on Chara, and is often encrusted with lime, (2.36).

Distribution: England, Denmark, and Sweden.

Vegetative cells of the female plant - 12-16 # broad, 2-3 times as long. Oogonia 32-44 # broad, 32-36 # long. Oospores 30-40 # broad, 32 # long.

Habit:- This alga was first reported by Mr. Prem Lal from an aquarium at Lahore, growing epiphytically on Chara during the first week of December 1933, and also by the author at growing [a] Roorkee, in a pond on Chara

Chara

Section III. Monoica Macrandria

15. <u>Oedogonium gracillimum</u>. Wittrock & Lund. op. cit. Heering. Susswasser flora Heft 6.

Monoecious, macrandrous, oogonia single, both terminal and inter-calary, opening by a superior lid. Cogonia oblong ellipsoid, cospores of the same shape as oogonia and completely filling them. Oospore walls smooth, antheridia 2-3 celled, each with two sperms, division horizontal . Suffultory cells not swollen (Ings. 37 and 38) . Suffultory cells not

Distributions

Diam. veget. cells 9 to br., 36-42 to long. 11 antheridial cells 4-5 th br., 7-8 plong. # bit:-Rather a rare form, found epiphytic on decaying leaves along with <u>Oedogonium Pisanum</u>

and Oe. Hirnii at Hamira during the middle of April 1930.

16. <u>Oedogonium Hirnii</u>. Gutwinski. \$p. cit Heering Susswasser flora Heft 6.

Distribution: So far this species has only been reported from Europe.

Diam.	veget. cell	20-22 / br.,	3-6 times as long.
	oogonia	32-36 N br.,	36-39 Nr long.
	oospores		
	antheridia		

Habit: Grows as an epiphyte on decaying leaves in puddles along with <u>Oedogonium gracillimum</u> and <u>Oe. Pisanum</u>. Found near Hamira during the middle of April 1930.

17. <u>Oedogonium oblongellum</u> Kirchner. op. cit. Heering Susswasser flora Heft 6.

Monoecious, macrandrous, oogonia single, elliptical operculate, division at the upper extremity of the oogonium. Oospores ellipsoid, globose, completely filling the oogonium. Oospore membrane smooth. Antheridia 2-celled (Fig) Each with two sperms. Vegetative cells not capitellate. Suffultory cell not swollen.

Ristrib

Diam.	veget. cells	9-12 to br., 3-4 times as long.
11	oogonia	25-28 Nt br., 40-46 Xt long.
11	oospores	27 / br., 31 / long.
Ħ	antheridium cells	9-10 W long.

Habit:- Found epiphytic on grass-blades in a pond village near ¥. Shahpur, Distt. Hoshiarpur, during the middle of April 1930. This is a fairly common form. 18. <u>Oedogonium urbicum</u>. Wittrock. op. cit. Heering Susswasser flora Heft 6.

Monoecious, macrandrous, oogonia single, ellipsoid globose, pore superior, oospores rounded, not completely filling the oogonium, of dense black colour, oospore walls smooth. (Fig 120, 42.).

Nistribution:

- " oospore 40-42 / br.x
 - antheridia 10 / br., 5 / long.

Habit:- Epiphytic onsubmerged plants and decaying shoots of trees, in a pond near & Jhingran Distt. Hoshiarpur, along with <u>Oedogonium</u> <u>inerme</u> and <u>Vaucheria sessilis</u>. A very common alga during the middle of March.

P. T. O.

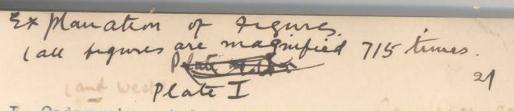
Genus Bulbochaete, Agardh.

19

 Bulbochaete spr This was found associated with <u>Stigeoclonium nemum</u>. Cells are 16-18 M br., 18-24 M long. Each cell bears the characteristic long spines with a bulbous base. (Fig.43) This is a branched form. The material was indeterminable due to the absence of sex organs.
 Habit- Found in a pond near Hamira district Jullunder epiphytic on grass stems along with <u>Stigeoclonium nanum</u> <u>Coleochaete soluta</u> and C.
 Bulbochaete spr. This was found epiphytic on Chaetomorpha. The Alga

is in the form of 10-20 celled unbranched filaments. The terminal (44, cells bearing a long trichome with a bulbous base (fig.). Cells bearingxaxkangxtrickomexwithxaxbalbans are 8-9 AL in diameter, 2-3 time as long. This is probably the juvenile stage of some <u>Bulbochaete</u> species.

Habit. Found epiphytic on a shoot of Hydrilla along with Aphanochaete repens and Chamaes phon filamentoga in the tanks in Shalamar Gardens Lahore in November 1929.



- I. Oedogonium striatum sp. nov. Restance.
 - 1. A filament showing androsporangia.
 - 2. A female filament showing a pair of ripe oogonia with oospores.
 - 3. A female filament with a nannandrium germinating on the basal cell.
 - 4. The attachment cell.
 - 5. A female filament showing two dwarf males germinating on the basal cell.
 - ¥6. A dwarf-male.
 - 7. A germinating cospore with four zoospores inside the membrane.

II. Oedogonium multisporum(Wood)

8. To female filament with oospores, and nannandrig germinating on oogonium.

an

III. <u>Oedogonium capilliforme</u>.

- 9. A female filament
- 10. A male filament.

IV. Oedogonium cardiacum.

11. A female filament showing a ripe cospore 12. A male filament showing antheridia.

Plate No. II.

variety polyspore var. not

22

V. <u>Oedogonium Frankilianum</u>. Wittrock. var. nov. 13. A female filament showing a ripe oospore.

14. A male filament showing antheridia.

15. A male filament showing three oogonia in a series.

var. nor. · VI. <u>Oedogonium inerme</u>. var. Polyspora, Randhama, 16, 17, 18. Filaments showing oogonia with ripe oospores.

VII. Oedogonium lautumnarium.

19,20. Female filaments showing oogonia 21. with ripe oospores. male filament showing and antheredia

VIII. Oedogonium Pisanum.

2,22 Males filaments showing antheridia. 24. A female filament showing oogonia.

IX. Oedogonium rivulare.

- 25. A filament showing an oogonium with an oospore.
- 26. A filament showing two oogonia.
- 27. A male filament showing antheridia.

Plate No. III.

- XI. Oedogonium fonticola. Al. Braun.
 - 30. A female filament showing oogonia and an oospore.
 - 31. A male filament showing antheridia.

XII. Oedogonium glabrum. sp. nov. Randhawa.

- 32. A filament showing the basal cell.
- 33. A female filament with two oogonia containing ripe oospores.
- 34. A male filament.

XIV. <u>Oedogonium calcareum</u> (Cleve)

- 35. A female filament showing an oogonium with a ripe oospore.
- 36. Basal cell.

XV. <u>Oedogonium gracillianum</u>.

37,38. Filaments showing antheridia and oogonia.

XVI. Oedogonium Hirnii. Gutwinski.

39. A filament showing ripe cospores and antheridia.

24

40. A filament showing immature oogonia and antheridia.

XVII. <u>Oedogonium oblongellum</u>(Wittrock)

41. A filament showing oogonia and antheridia.

XVIII. Oedogonium urbicum.

4

42. A filament showing an oogonium with a ripe oospore and antheridia.

XX XIX

*

Bulbochaete sp.K. 43. a branched filament.

XX

Bulbochaete sp.y. 44. Two unbranched filaments.

H. S. 3171936. A.S.-No. 2, (B 6)-1. CONTRIBUTIONS TO OUR KNOWLEDGE OF THE FRESHWATER ALGÆ OF NORTHERN INDIA. 1. Oedogoniales. BY M. S. RANDHAWA, M.Sc., I.C.S. (Saharanpur) Received July 21, 1936. (Communicated by Dr. S. L. Ghose, M.Sc., Ph.D.)

GROUP 5. OEDOGONIALES. Genus Oedogonium Link.

Genus Oedogonium.

THIS alga is found in freshwater ponds, lakes, and streams, nearly all over the world. The filaments have a well-developed basal cell by means of which they get attached to sticks and stones. The filaments are unbranched and the cells are usually cylindrical or barrel-like in appearance. The genus was described by Link in 1820.

A. SECTION Dioca nannandria.-

T

1. Oedogonium striatum sp. nov. Idioandrosporous nannandrous.-Oogonia intercalary or terminal in position occurring singly or in pairs, also in threes (Figs. 2 and 3), pronouncedly oval or oval-ellipsoid in shape. Oospore chocolate in colour, oval, almost completely filling the oogonium. Oospore wall very thick bearing obliquely arranged or straight hyaline striations, 10-15 μ in number which often an astomose (Fig. 2). Basal cells flattened 45–50 μ broad (Fig. 4). Vegetative cells swollen with starch. Androsporangia in rows of 3-6 (Fig. 1 a). Nannandria 2-6 on the basal cells and the walls of the oogonium. Antheridia always internal. Oospores germinating to produce 4 zoospores oval in shape, 10μ broad, 18μ long (Fig. 7).

This alga very much resembles Oe. Wolleanum Wittrock in dimensions of cells and oospores but differs from that form in having an internal antheridium and in having no pore in the wall of the oogonium, the opening taking lid and its peculiar striations. P

place by	veget. cells female pla	nts 2	3-32 µ	broad,	4-5 times as long.	
,,	", " male	13 4	11-40 p		2-3 times long. 85-90 μ long.	
	oogonia		75 μ	33 97	85 μ long.	
13	oospores androsporangia	**	23 µ	11	$20-27 \mu \log$.	
**	nannandria		18 µ	"	72 µ long.	0

Habit .- This alga was found epiphytic on submerged radial waterplants, in Shahniwala Tank at Dasuya, during the second week of March 1930.

2. Oedogonium multisporum. Wood.-Tiffany, 1930, p. 131.

Diæcious nannandrous, oogonia 1-3, sub-ovoid or subglobose, pores superior, oospore globose nearly filling oogonia (Fig. 7 a), spore-walls smooth, dwarf male a little curved near or on the oogonium, antheridium exterior 1-4 (Fig. 8).

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Vegetative cell of the female plant	$ 14-18 \mu$ broad, 2-3 times long. 32-40 μ 28-34 μ long.
Oogonia	32μ 28μ long.
Oospore Nannandria	2-3 times as long.
Habit.—Reported by Mr. Prem I wala in the first week of De	Lal from ponds in Lahore and Gujran- cember 1933.

B. SECTION Dioca macrandria.-3. Oedogonium capilliforme Kutz. var. nov. nanum.-op. cit., Heering,

Susswasser flora, Heft. 6. Diœcious macrandrous, oogonia single or in pairs. Ovoid to sub-ovoid or even slightly ellipsoid in shape with a superior pore. Oospore globose or ovoid globose completely filling the oogonium (Fig. 9). Spore walls smooth. Antheridia 2-4 celled usually alternating with the vegetative cells, two sperms in each division horizontal (Fig. 10). This differs from the type in the smaller dimensions of its vegetative cells, oogonia, oospores and antheridia.

Distribution .- So far this species has only been reported from Europe

be taken as a new variety.



G. Proofs. 1-4 holls

A C_No 9 (B 6)-2 Diam. of female veget, cells ,, male ,, ,,	$\begin{array}{cccc} & 18-20 \ \mu & 2-3 \ \text{times as long.} \\ & 10-12 \ \mu & 2-4 & , \\ & 30-36 \ \mu \ \text{broad}, \ 32-40 \ \mu \ \text{long.} \end{array}$
,, oogonia ,, oospores antheridia	$34-36 \mu$, $32-40 \mu$ long. 10 μ , 5μ ,

Habit .- Found growing epiphytically on blades of rushes in a pond in village Shahpur, Tehsil Dasuya, District Hoshiarpur, in the middle of April 1936.

4. Oedogonium cardiacum.-Wittrock.-op. cit., Heering, Susswasser flora Heft. 6.

Diœcious macrandrous, oogonia single ovoid elliptical in shape. Broadened and bulging out laterally. Pore wide, situated a little above the middle. Oospore rounded, fire-red in colour not completely filling the oogonium (Fig. 11). Oospore membrane smooth. Male filaments a little more slender than the female filaments. Antheridium 2-3 celled (Fig. 12). Sperms not

Distribution .- So far this species has been only reported from Continental Europe and the United States of America. Diam. of veget. cells of female plants 26-28 μ broad, 3-5 times as long.

	and a dama and	male		22-25 H		3-0 11
12	11 11	mune	14	54-60 µ		60-70 µ long.
33	oogoma			 		
**	oospores			 50 µ 8- 9 µ	and the second second	23 µ broad.

Habit .- Epiphytic on blades of grass, and decaying shoots of trees, mixed with Oedogonium urbicum, Anabænothrix cylindrica and Zygnema chalybeosporum in a pond at village Jhingran, District Hoshiarpur, in the last week of March 1930.

Oedogonium Frankilianum. Wittrock. sec. Hirn., var. Polyspora, 5. var. nov.

Diœcious macrandrous, oogonia single or in groups of 2-3. Globose or ellipsoid globose, opening by a superior pore. Oospores rounded, chocolate in colour when mature, sometimes completely filling the oogonium, sometimes partly (Figs. 13, 14, 15). Oospore wall smooth. Suffultory cell wider than the ordinary cells. Male plant slightly narrower than the female plants. Antheridia 3-4 celled separated by a single vegetative cell. Sperms two, division horizontal. Vegetative cells distinctly capitellate.

This differs from the type in : (a) Bigger dimensions of vegetative cells and oospores, (b) having more than one oogonium in a series, (c) oosporesoften not completely filling the oogonium. Hence the new variety has been established.

Distribution .- So far this alga has only been reported from Roumania. Diam. of veget. cells of female plants 9-18 μ broad, 4-6 times as long.

GLIL, OJ	ma	10	7-12 µ		4-6 ,,
33	·· ·· ·· ··			2.20	38-40 µ long.
11	oogonia		$26-36 \mu$	A.2.	00 10 10
	oospores		24-35 <u>µ</u>		0
	antheridial cells		. 10 µ	31	9μ ,

Habit.-This is rather a rare form, and was found growing epiphytically on the stems of a submerged water plant, along with Eudorina elegans near Beas, during the last week of April 1930.

greyish appearance.

9. Oedogonium rivulare Him. var. nov. nanum.-op. cit., Heering, Susswasser flora, Heft 6.

Directious macrandrous. Oogonia usually single, rarely in pairs. Pore superior, oogonia ellipsoid globose, oospore chocolate in colour, ovoid, not completely filling the oogonium, oospore wall smooth (Figs. 25, 26). The suffultory cells not swollen. Male filaments narrower than female filaments. Antheridia 5-7-celled but sometimes very numerous as many as 17 (Fig. 27).

This species differs from the type in its (1) usually single oogonia, (ii) oospores almost completely filling the oogonium, (iii) smaller size of oogonium (in Oedogonium rivulare Hirn. they are as much as 160 μ broad). So it may be taken as a new variety.

6. Oedogonium inerme Hirn. var. Polyspora. var. nov.-(Section Nicht genugend bekannte Aretn. Heering, Susswasserflora, Heft 6.).

Dioecious macrandrous (probably) oogonia 1-3, usually single or in pairs. More rarely in a row of three (Figs. 16, 17, 18). Pore in the middle. Oogonia transversely ellipsoid. Oospore chocolate in colour almost of the same shape as the oogonium which it completely fills. Oospore wall smooth. Vegetative cells not capitellate. Male plants not known.

This differs from the type in having oogonia in a series of two or three and the oospores completely filling the oogonia and in the smaller size of the vegetative cells, oogonia and oospores. Hence this new variety has been established.

Distribution.—So far this species has only been reported from France.Diam. of veget. cells...... $5-9 \mu$ broad, 4-6 times as long.......... 21μ ... 19μ long.......... 19μ

Habit.—Found attached to decaying leaves of Dalbergia sissoo, in a brownish mass in a rain-water puddle near Hamira, during the second week of March 1930.

7. Oedogonium lautumnarium. Wittrock.—op. cit., Heering, Susswasser lora, Heft 6.

Dioecious macrandrous. Oogonia always single, globose or slightly xpanded in the upper portion. Opening by a superior pore. Oospores ellowish in colour, globose, with a thick opaque whitish smooth wall Figs. 19, 20). Male plants as big as the female plants or slightly smaller. Intheridia 3-celled, each with 2 sperms, division horizontal (Fig. 21). Suffulpry cells of the same diameter as the vegetative cells. It differs from the wpe in oospores not completely filling the oogonia.

Distribution.—This alga is so far only known from Finland and Sweden. Diam. of veget. cells female plants.. 18-20 μ broad, 3-6 times as long.

11	,, ,, male	,, 14-16 µ		3-6
.,	oogonia	40-42 µ		42-48 µ long.
3.5	oospores	·· 36 µ	11	
37	antheridial cells	13-14 μ		5-8 µ "

Habit.—Epiphytic on water-plants, in a pond near Hamira, along with Spirogyra dubia, Oedogonium lautumnarium and Sirogonium Sticticum, during the middle of April 1930. It is rather a rare alga.

8. Oedogonium Pisanum. Wittrock.—op. cit., Heering Susswasser flora left 6.

Directious macrandrous. Oogonia single, both terminal and interalary opening by a superior lid (Fig. 22). Oospore oblong ellipsoid, completely ling the oogonium, oospore membrane smooth. Antheridia 2-celled, sperms division horizontal (Figs. 23, 24). Suffultory cells not broader than the egetative cells.

Distribution.—So far the species has only been reported from Europe ad the United States of America.

)iam. o	f veget. cell	5-9	H	broad,	18-36	H	long.	
12	oogonia							
13	oospores	14-15			24-30			
17	antheridia	 4-5	ju.		3-5			
Labit	Thinketis on describe				-	1.		

Habit.—Epiphytic on decaying leaves of Dalbergia sissoo along with Oedogonium Pisanum and Oe. Hirnii in a puddle near Hamira, during the second week of April 1930. The filaments present a greyish appearance.

9. Oedogonium rivulare Hirn. var. nov. nanum.—op. cit., Heering, Sussasser flora, Heft 6.

Directious macrandrous. Oogonia usually single, rarely in pairs. Pore perior, oogonia ellipsoid globose, oospore chocolate in colour, ovoid, not impletely filling the oogonium, oospore wall smooth (Figs. 25, 26). The fiultory cells not swollen. Male filaments narrower than female filaments. atheridia 5-7-celled but sometimes very numerous as many as 17 (Fig. 27).

This species differs from the type in its (1) usually single oogonia, (ii) spores almost completely filling the oogonium, (iii) smaller size of oogonium of *Oedogonium rivulare* Hirn, they are as much as 160 μ broad). So it may a taken as a new variety.

istribu	ution.—So far	this spec	cies has	only	been repo	orted f	rom Germa
diam. c	of veget, cells	of female	plant	36-47	µ broad,	3-5	times as lon
11	12 . 12	male	**	32-34	μ	3-5	
22	oogonia		1474	*81	μ	90	µ long.
11	oospore		÷ 4	76	μ	80	μ ,,
,,,	antheridial	cells		12	u long.		" broad

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,, antheridial cells ... $12 \mu \log$, 28μ broad. Habit.—This alga was found free-floating in a blackish mass, along with Cylindrocapsa conferta, in the famous tank at Dasuya,

District Hoshiarpur, during the middle of October 1929.

10. Oedogonium sociale. Wittrock.—op. cit., Heering, Susswasser flora, Heft 6.

Directious macrandrous, oogonia single, globose in shape, intercalary, oospore deep-yellow in colour, competely filling the oogonium (Fig. 28). Oospore membrane smooth, basal cells swollen. Antheridia 1-5 celled (Fig. 29).

This alga is very social in its growing habit, its individuals occurring in large numbers as epiphytes on water-plants.

Distribution.—This species is widely distributed in Europe and America.

m,	of veget cells			9-15 µ broad,	3-5 times as long.
	oogonia	5.4		34-37 µ "	
**	oospores			26-30 µ	
12	antheridial			12-14 µ	$10 \mu \log$.
hit	-This is one of	Etho	ann man ant	and second state	1.7 4 91 1 1 1

Habit.—This is one of the commonest and mostly the widely distributed species of Oedogonium and grows as an epiphyte on the submerged leaves and stems of the aquatic plants. Sometimes we can get pure growths of this alga, showing a harvest of bright yellow oospores, under the microscope. In some cases it is also found mixed with Oedogonium urbicum, and Oe. cardiacum. Collected from nearly all over the Eastern Punjab during the middle of March 1930.

11. Oedogonium fonticola. Al. Braun.—Pascher, 1914, p. 225; Tiffany, 1930, p. 163.

Directious macrandrous, oogonia 1-2, obovoid, or globose obovoid, ellipsoid or subglobose, oospore nearly filling the oogonium, spore-wall smooth. Male filaments very narrow (Figs. 30 and 31).

Distribution.-U.S.A., Australia, Europe.

Vegetative	cells (of female	plant		16-18	hut	proad,	28-48 µ	long.	
		male		44	12-14	μ	17	2-3 tim	les as lo	ng.
Oogonia					30-40	il		32-36 µ		
Oospore					32			32 µ		
Antheridial	cells				8-10	100			,,	
Habit Fo	and f	no floods	and the la						-	T

Habit.—Found free-floating in a pond at Lahore by Mr. Prem Lal, during the first week of December 1933.

12. Oedogonium glabrum sp. nov.

D

D

Directious macrandrous, oogonia always single, globose, pore not seen, though very probably it opens by a pore. Oospore globose, completely filling the oogonium. Oospore wall smooth. Cells of the female filaments very short and rounded, with a thick wall and a conspicuous pyrenoid in the middle, vegetative cells very peculiar (Fig. 33). Male filaments have rows of 5-7 antheridia, separated by long cylindrical cells (Fig. 34). Basal cells elongate (Fig. 32). This species comes nearest *Oedogonium suecicum*. Wittrock. sec. Hirn. from which it differs in the oospore membrane being smooth and not spinous, and vegetative cells being much broader and smaller in length and its sex organs being slightly bigger.

Diam. of veget. cells of female plants 26-28 µ broad, 28-30 µ long.

11	· · · · ·	male	**	15-20 µ		28-30 µ long.	
22	oogonia			36-45 µ			
2.2	oospores			. 32-40 µ			
32	antheridial			14-16 1		6-8 4	
Habit	-Free-floating	in a por	id.	Collected	at V	Thingtan.	District
I	Ioshiarpur, in	the middl	e of T	March 193	0	· · ··································	

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13. Oedogonium rufescens. Wittrock. var. Lundellii.-Tiffany, 1930, p. 66; Pascher, p. 192.

Diœcious macrandrous, oogonia 1-3, obovoid or depressed obovoid, globose. Pore median, oospore globose or depressed globose, filling the

Distribution .- Southern Tibet.

Vegetative cells of the female filaments. 8-10 μ broad, 30-40 μ long.

Oospore

Habit.-This alga was found by Mr. Prem Lal, free-floating in a pond at Lahore, during the third week of November 1933, and also by

the author at Saharanpur, during, the first week of December 1935. Oedogonium calcareum. Cleve.-Pascher, 1914, p. 192; Tiffany, 14. 1931, p. 67.

Direcious macrandrous, oogonia one or rarely two, depressed globose, oospore depressed, globose filling oogonium, oosporewall smooth (Fig. 35).

Grows epiphytically on Chara, and is often encrusted with lime (Fig. 36). Distribution .- England, Denmark, and Sweden.

Vegetative cells of the female plant. 12-16 μ broad, 2-3 times as long. Oogonia ... 32-44 µ ,, 32-36 µ long. Oospores .. 30-40 µ "

Habit.-This alga was first reported by Mr. Prem Lal from an aquarium at Lahore, growing epiphytically on Chara, during the first week of December 1933, and also by the author at Roorkee, in a pond growing on Chara. SECTION C. Monoica Macrandria.-

15. Oedogonium gracillimum. Wittrock and Lund.-op. cit., Heering, Susswasser flora, Heft 6.

Monœcious macrandrous, oogonia single, both terminal and intercalary, opening by a superior lid. Oogonia oblong ellipsoid, oospores of the same shape as oogonia and completely filling them. Oospore walls smooth, antheridia 2-3 celled, each with two sperms, division horizontal. Suffultory cells not swollen (Figs. 37 and 38). Diam of veget

- accase.	or veget. cens	$\frac{9 \mu}{100}$ broad, $36-42 \mu$ long.	
**	oogonia	$14-17 \mu$, $24-36 \mu$	
12	oospores		
	antheridial cells	$ 14-16 \mu$ 23-30 μ	
Habit -	-Rather a rara form	, found epiphytic on decaying loaves	
	and a fait form	, Iound epiphytic on decaying loaner	

with Oedogonium Pisanum and Oe. Hirnii at Hamira, during the middle of April 1930.

16. Oedogonium Hirnii. Gutwinski.—sp. cit., Heering, Susswasser flora, Heft 6.

Monœcious macrandrous, oogonia usually single, occasionally in pairs, globose. Opening with a big superior pore. Oospore globose, not completely illing the oogonium, yellowish in colour, oospore walls smooth. Antheridia 2-celled, each with two sperms, division horizontal (Figs. 39 and 40).

Distribution .- So far this species has only been reported from Euro

Diam.	or veget. cells		20-22 " h+	Food	a a l'internet autope.
- iii	oogonia	 	32-36 µ	toad,	3-6 times as long.
23	oospores		28-32 µ br		36-39 µ long.
	antheridia			road.	
Habit	0		18μ	10	9 11

Habit.-Grows as an epiphyte on decaying leaves in puddles along with Oedogonium gracillimum and Oe. Pisanum. Found near Hamira, during the middle of April 1930.

17. Oedogonium oblongellum Kirchner.-op. cit., Heering, Susswasser Nora, Heft 6.

Monœcious macrandrous, oogonia single, elliptical, operculate, division at the upper extremity of the oogonium. Oospores ellipsoid, globose, completely filling the oogonium. Oospore membrane smooth. Antheridia 2-celled (Fig. 41), each with two sperms. Vegetative cells not capitellate. Suffultory cell not swollen.

B-6-4

EXPLANATION OF FIGURES.

All figures are magnified 715 times.

PLATE I.

Figs. 1-7.-Oedogonium striatum sp. nov.

FIG. 1.-A filament showing androsporangia,

FIG. 2.-A female filament showing a pair of ripe oogonia with oospores.

FIG. 3.-A female filament with a nannandrium germinating on the basal cell, FIG. 4 .- The attachment cell.

FIG. 5.-A female filament showing two dwarf males germinating on the basal cell. FIG. 6 .- A dwarf-male.

FIG. 7.-A germinating oospore with four zoospores inside the membrane. Fig. 8.—Oedogonium multisporum (Wood).

A female filament with oospores, and nannandrium germinating on an oogonium. FICS. 9-10.—Oedogonium capilliforme. FIG. 9.-A female filament.

FIG. 10 .- A male filament.

Figs. 11-12.-Oedogonium cardiacum.

FIG. 11.-A female filament showing a ripe oospore. FIG. 12 .- A male filament showing antheridia.

PLATE II. Fues. 13-15.-Oedogonium Frankilianum. Wittrock. var. Polyspora var. nov.

FIG. 13.-A female filament showing a ripe oospore.

Fig. 14.-A male filament showing antheridia.

FIG. 15.-A male filament showing three oogonia in a series. Fics. 16-18 .- Oedogonium inerme. var. Polyspora var. nov.

FIGS. 16-18 .- Filaments showing oogonia with ripe cospores. Fics. 19-21.-Oedogonium lautumnarium.

FIGS. 19-20 .- Female filaments showing oogonia,

FIG. 21.-Male filament showing antheridia. Figs. 22-24.-Oedogonium Pisanum.

FIGS. 22-23 .- Male filaments showing antheridia.

FIG. 24.-A female filament showing oogonia, Figs. 25-27.-Oedogonium rivulare.

FIG. 25.-A filament showing an oogonium with an oospore.

FIG. 26.-A filament showing two oogonia.

Fig. 27.-A male filament showing antheridia,

Fics. 28-29.-Oedogonium sociale.

FIG. 28.-A male filament showing empty antheridia. FIG. 29.-A female filament showing oogonia with ripe oospores.

PLATE III.

Fics. 30-31.-Oedogonium fonticola. Al. Braun.

FIG. 30.-A female filament showing oogonia and an oospore. FIG. 31.-A male filament showing antheridia.

Fics, 32-34 .- Oedogonium glabrum. sp. nov. Randhawa.

FIG. 32 .- A filament showing the basal cell.

FIG. 33.-A female filament with two oogonia containing ripe oospores. FIG. 34.-A male filament.

Figs. 35-36 .- Oedogonium calcareum (Cleve).

FIG. 35.-A female filament showing an oogonium with a ripe oospore.

Fics. 37-38.—Oedogonium gracillianum.

FIGS. 37, 38 .- Filaments showing antheridia and oogonia. Figs. 39-40.-Oedogonium Hirnii. Gutwinski.

FIG. 39.-A filament showing ripe osspores and antheridia.

FIG. 40.-A filament showing immature oogonia and antheridia. Fre. 41.-Oedogonium oblongellum (Wittrock).

A filament showing oogonia and antheridia. 42 .- Oedogonium urbicum. FIG.

A filament showing an oogonium with a ripe oospore and antheridia. 43.-Bulbochæte sp. x. FIG. A branched filament.

FIG. 44.-Bulbochæte sp. y.

Two unbranched filaments.

"A Note on Some Attached Forms of Spirogyra from the Punjab."

Vol IV, No 3, Section B

By

4 Menter

n.J. Nas

M.S. Randhawa, M.Sc., I.C.S., Saharanpur. Received February 5, 1936 Communicato (g. Dr. H. Chawhori, M.A., Ph.D.,

Species of <u>Spirogyra</u> are generally free-floating forms but a few species however grow attached to the various substrata in the water.

Delf (2) has described <u>Spirogyra adnata Kutz.</u> and <u>Spirogyra fluviatilis</u> Hilse as forms occasionally producing rhizoids. And according to Kny (2) <u>Spirogyra setiformis</u> Xulz. also sometimes produces rhizoids. <u>S.rivularis</u> (Hass.) Rabenh. (?) and <u>S.fluviatilis</u> Hilse var. <u>africana</u> Fritsch have been recorded by Fritsch and Stephens (3) as attached forms from Africa. Czurda (1) refers to <u>S.fluviatilis</u> Hilse and <u>S.Grossi</u> Schmidle as species growing attached. He has also figured the haptera of <u>S.fluviatilis</u> (1, Fig.15). Vengar (4) has described the haptera of a sterile species of <u>Spirogyra growing in an artificial tank at Madras. Very recently</u> Jao (5) has described a number of new species of <u>Spirogyra from</u> China and among them two species, <u>S.rhizopus</u> and <u>S.rhizobrachislis</u> are described as developing rhizoids.

As far as the author is aware, there has been no record of any <u>fertile</u> species of <u>Spirogyra</u> from India growing in an attached condition. The following three fertile species of <u>Spirogyra</u> have been recorded by him from Northern India.

Spirogyra affinis Kutz.

This alga whose usual mode of reproduction is by lateral conjugation (Fig.1, a) quite often produces rhizoids from its cells. These rhizoids become closely attached to the filaments of an <u>Oedogonium</u> on which this alga is found as a common epiphyte 5.

in ponds. The hapterophores of this alga (Fig.1, b) are bifurcated, and their ends are frayed and are not very different from those described by Delf (2) in Spirogyra adnata. Their size and lateral position indicate that quite possibly they are merely modified conjugation canals, though it is difficult to understand why these structures which are purely reproductive in function should subserve the function of fixation and support.

Spirogyra dubia Kutz.

This alga is found in slowly flowing freshwater streams attached to water plants by means of rhizoids which are very different from those of Spirogyra affinis. The rhizoids are not short and stumpy as in <u>S.affinis</u>, but are long and pillarlike (Fig.11, b) and expand laterally and become frayed when they get attached to any aquatic plant. The chloroplasts in the rhizoids are never in the form of a spiral, but are in the form of palish green, very much elongated and thread-like bodies. The alga was conjugating freely (Fig.II, a).

Spirogyra sp.

This alga, which the author has not been able to refer to any known species and is probably a new species, was found growing attached to the stem of a water plant in the big tank at Dasuya in the Hoshiarpore District. A similar attached form was also found by him in a sheet of water at Dhanauri, Tehsil Roorkee in Saharanpur District. The cells of the filament were 30 u broad and about four times as long as broad. Owing to \mathbf{x} the very closely packed condition of the chloroplasts it was not possible to make out their number or the number of their spirals. Conjugation was observed in the upper parts of the filaments and ripe zygospores also were found in a few cells. (Fig.III, f,g). Some of them were long and dichotomously branched (Fig.111, b,c) while others showed a dichotomously frayed disc at the bottom (Fig. III.e). The former

somewhat the rhizoids of <u>Mougeotia sp.</u> figured by Pascher (<u>6</u>, p.4, fig. D) and those of <u>S. fluviatilis</u> (<u>1</u>, p. 14, fig. 15, a,b), while the latter showed a certain amount of resemblance to the rhizloids of <u>S. fluviatilis</u> Hilse var. <u>africana</u> Fritsch (<u>3</u>, fig. 22, B,D), <u>S. fluviatilis</u> (<u>1</u>, fig. 15,c), <u>Spirogyra</u> <u>rhizopus</u> Jao (5, fig. 11) and also to those of the sterile species from Madras (4, PI.I, 3,4).

In this case and in the case of <u>S.affinis</u> the attached habit was developed in a distinctly still-water environment where the alga was in no danger of being washed away by a current of water. Iyengar's sterile species also was found by him growing in still-water in an artificial tank at Madras. So by no stretch of imagination can an attached habit be regarded as an adaptation to flowing water. Most probably the formation of rhizoids is a tactile response on the part of the filaments, and there is greater possibility of its successful manifestation in the form of rhizoids, in a still-water environment than in moving water.

My experience has shown that the fixed habit is quite common in the above species of Spirogyra, both in ponds and streams in Northern India, especially in the last mentioned form where it is constant feature. A fixed habit with rhizoids is a distinct advance as compared with a free floating habit; and the species of <u>Spirogyra</u> which show this feature should be considered as more advanced structurally than the free floating ones.

Before closing, I must convey my sincere thanks to Dr. S.L. Ghose, Professor of Botany Government College Lahore.

-3-

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A NOTE ON SOME ATTACHED FORMS OF SPIROGYRA FROM THE PUNJAB. EL. D. 20-8-1936 BY M. S. RANDHAWA, M.Sc., I.C.S.

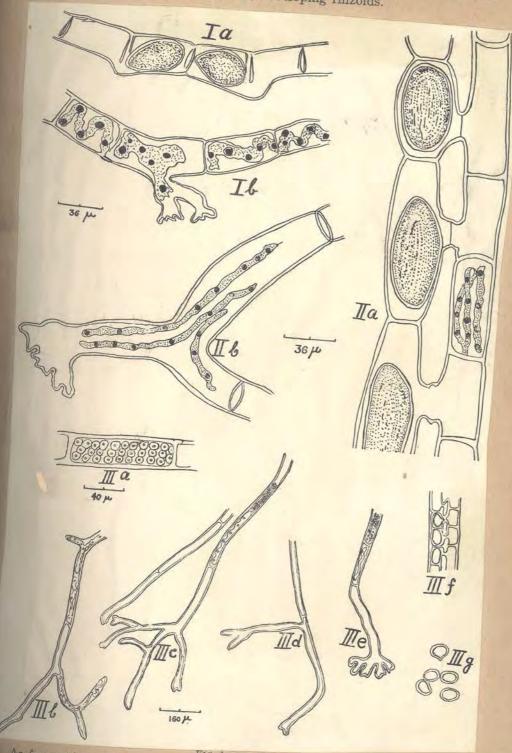
(Saharanpur.)

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(Communicated by Dr. H. Chaudhuri, M.A., Ph.D., D.I.C.)

SPECIES of Spirogyra are generally free-floating forms but a few species however grow attached to the various substrata in the water.

Delf² has described Spirogyra adnata Kutz. and Spirogyra fluviatilis Hilse as forms occasionally producing rhizoids, And according to Kny Spirogyra setiformis Kutz. also sometimes produces rhizoids. S. rivularis (Hass.) Rabenh. (?) and S. fluviatilis Hilse var. africana Fritsch have been recorded by Fritsch and Stephens³ as attached forms from Africa. Czurda¹ refers to S. fluviatilis Hilse and S. Grossi Schmidle as species growing attached. He has also figured the haptera of S. fluviatilis (1, Fig. 15). Iyengar⁴ has described the haptera of a sterile species of Spirogyra growing in an artificial tank at Madras. Very recently Jao⁵ has described a number of new species of Spirogyra from China and among them two species, S. rhizopus Jao and S. rhizobrachialis Jao, are described as developing rhizoids.



As far as the author is aware, there has been no record of any fertile pecies of Spirogyra from India growing in an attached condition. The following three fertile species of Spirogyra have been recorded by him from

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Conjugation between 6-8 filaments is not

This alga whose usual mode of reproduction is by lateral conjugation (Fig. 1, a) quite often produces thizoids from its cells. become closely attached to the filaments of an Ocdogonium on which this alga is found as a common epiphyte in ponds. The hapterophores of this alga (Fig. 1, b) are bifurcated, and their ends are frayed and are not very different from those described by Delf² in Spirogyra adnata. Their size and lateral position indicate that quite possibly they are merely modified conjugation canals, though it is difficult to understand why these structures which are purely reproductive in function should subserve the function of fixation

Spirogyra dubia Kutz.

This alga is found in slowly flowing freshwater streams attached to water, plants by means of rhizoids which are very different from those of Spirogyra affinis. The rhizoids are not short and stumpy as in S. offinis, but are long and pillar-like (Fig. 2, b) and expand laterally and become frayed when they get attached to any aquatic plant. The chloroplasts in the rhizoids are never in the form of a spiral, but are in the form of palish green, very much elongated and thread-like bodies. The alga was conjugating freely The alga was conjugating freely

Spirogyra sp.

This alga, which the author has not been able to refer to any known species and is probably a new species, was found growing attached to the stem of a water-plant in the big tank at Dasuya in the Hoshiarpore District. A similar attached form was also found by him in a sheet of water at Dhanauri, Tehsil Roorkee in Saharanpur District. The cells of the filament were $30 \,\mu$ broad and about four times as long as broad. Owing to the very closely packed condition of the chloroplasts it was not possible to make out their number or the number of their spirals. Conjugation was observed in the upper parts of the filaments and ripe zygospores also were found in a few (Fig. 3, f, g). Some of them were long and dichotomously branched (Fig. 3, b, c) while others showed a dichotomously frayed disc at the bottom (Fig. 3, e). The former resembled somewhat the rhizoids of Mougeotia sp. figured by Pascher (6, p. 4, Fig. D) and those of S. fluviatilis (1, p. 14, Fig. 15, a, b), while the latter showed a certain amount of resemblance to the rhizoids of S. Auviatilis Hilse var. africana Fritsch (3, Fig. 22, B, D), S. Auviatilis (1, Fig. 15, c), Spirogyra rhizopus Jao (5, Fig. 11) and also to those of the sterile species from Madras (4, Pl. I, 3, 4).

In this case and in the case of S. affinis the attached habit was developed in a distinctly still-water environment where the alga was in no danger of being washed away by a current of water. Iyengar's sterile species also was found by him growing in still-water in an artificial tank at Madras. So by no stretch of imagination can an attached habit be regarded as an adaptation to flowing water. Most probably the formation of rhizoids is a tactile response on the part of the filaments, and there is greater possibility of its successful manifestation in the form of rhizoids, in a still-water environment

My experience has shown that the fixed habit is quite common in the above species of Spirogyra, both in ponds and streams in Northern India, especially in the last mentioned form where it is a constant feature. A fixed habit with rhizoids is a distinct advance as compared with a free floating \boldsymbol{x} habit; and the species of Spirogyra which show this feature should be considered as more advanced structurally than the free floating ones.

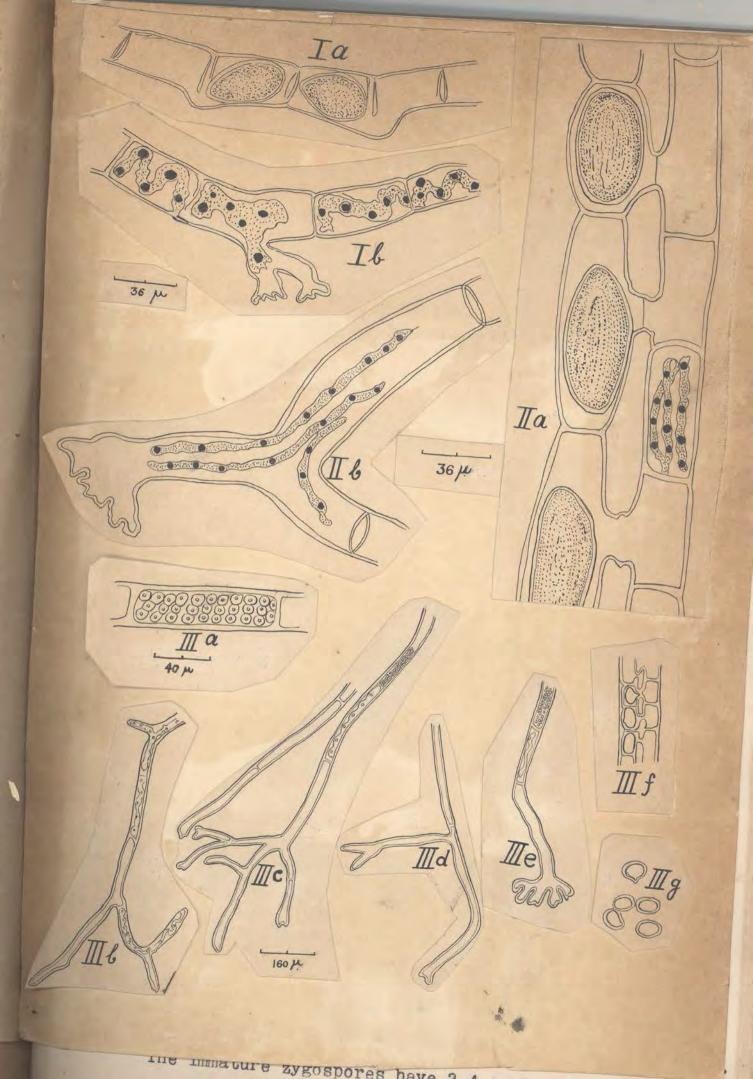
Before closing, I must convey my sincere thanks to Dr. S. L. Ghose, Professor of Botany, Government College, Lahore.

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- 6. Pascher, A., Susswasserflora Deutschlands, Osterreichs und der Schweis, 1913, Heft 9,
 - EXPLANATION OF FIGURES.
- Fig. 1.—Spirogyra affinis. a, lateral conjugation; b, bifurcated hapterophores. Fig. 2.—Spirogyra dubia. a, conjugation; b, rhizoid.

3.—Spirogyra, sp. a, cell with dense chloroplasts; b, c, d, filaments with long and dichotomously divided rhizoids; e, filament with a dichotomously frayed disc at the bottom; f, conjugation; g, zygospores. Cells with degenerated and elongated chloroplasts are seen in b, c, and e.

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Group 6. Conjugatae.

(2) Zygnemaceae.

Genus. Ghosella. gen. nov.

1. <u>Ghosella indica</u>. Randhawa.(Genus novum). This new genus forms the basis of a separate paper ' A new Genus of Conjugatae from India'. and we shall very briefly discuss its salient features.

The vegetative filaments very much resemble those of Genus Zygnema with their two characteristic stellate or rounded chloroplasts surrounding a nucleus (fig.a). The cells are 10-15 u br. and 4-5 times as long. The most interesting feature of the Alga is its reproductive phase. Two filaments which happen to lie side by side give out protubrances, which banks eventually meet forming conjugation canals about 9 u br. The conjugation canals widens enormously (18-40 u in diameter). In the meanwhile remarkable changes take place in the cell wall which becomes lamellated due to deposition of mucilage, which give the Alga a very beautiful appearance. The filaments become genuflexed as in certain species of Mougeotia, probably due to the enormous width of the conjugation canals. Now the walls of the conjugation canals begin to bulge out laterally (figs. d.e.). The zygospores extend into the gametangia and are ultimately cut off from them. In the meantime the joints of the cells begin to be loosened and these H-shaped zygospores swim off independently as in D. desmidioides. The immature zygospores have 2-4 coats of mucilage and are usually rounded in shape (fig. f.) and are 45-50 u broad. Conjugation between 6-8 filaments is not uncommon (fig. i.) Ripe zygospores are of various shapes as in Debarya africana. West, and are firedred

in colour when ripe. Azzygospores are also seen in many cases resembling those of Zygnema fertile Fritsch.

This Alga resembles Zvenema spirale Fritsch in many respects. Transeau has transferred this Alga to Genus <u>Debarva</u> calling it <u>D</u>. <u>spirale</u> but in our opinion this Alga has nothing to do with <u>Debarva</u> due to its definitely stellate chloroplasts and the peculiarities of the zygospores. This Alga shows peculiarities which justify its establishment as a separate Genus, which I have named <u>Ghosiella</u> after my esteemed teacher Dr. S.L. Ghose. A full description on the Genus and its affinities forms the basis of a separate chapter.

Following are the peculiarities of the Genus:-I. Star-shaped two chloroplasts each with one pyrenoid as in Zygnema which certainly are not seen in any species of <u>Debarva</u>.

- II. Complex membrane thickenings in the gametangia as in <u>Debarva</u> <u>Hardvi</u> and <u>Z. fertile</u>.
- III. Extremely wide conjugation canal as in certain species of <u>Debarya</u> and <u>Mougeetia</u>.

IV. Geniculate-type of conjugation as in Mougeotia.

V. Zygospores not only filling the conjugation canal but also encroaching upon the outermost cell-walls of the gametangia.

VI. Zygospores of very various shapes resembling those of <u>D. africana</u> and <u>D. desmidioides</u>.

VII. Dissociation of the Zygospores from one another.

VIII. The peculiar mucilagenous coverings of the zygospores.

IX. The frequent occurrence of zygospores.

-2-

Genus Zygnema. Agardh.

- <u>Zvgnema chalvdospermum</u> Hansg. op. cit. Czurda. Zygnemales. Heft 9 in Susswasser flora. Mitteleuropas.
 Vegetative cells 20-27 u thick, 1-3 times as long. Chloroplasts typically stellate each with one pyrenoid. Zygospores in the gametangia are more or less rounded in shape middle membrane of the zygospore smooth. Steel blue in colour. Zygospores 28-30 u broad, 30-36 u long. The four chloroplasts can easily be distinguished lying in a quartette inside the zygospore(fig. b.)
- Habitat Free-floating in a pond at V. Ghingran, Distt. Hoshiarpur during the middle of March 1930. Also collected from Hamira from a pond, about the middle of April 1930. A common species of zygnema.

II. <u>Zwgenma</u> sp. In this case cells are bigger than those of the former but due to the absence of any fertile material the species could not be determined.

Habitat:- Found free-floating in a pond at Hamira during the middle of April 1930.

-3-

Section II.

Species with septa not swollen. One chromatophore in each cell.

-5-

3. <u>Spirogyra affinis</u> (Hass) Kutz. op. cit. Borge Susswasser flora Heft 9.

Both lateral and scalariform conjugation are seen in this species. Vegetative cells 22-30 u broad. Septa not swollen. Chromatophore single with 2½ to 4 spirals. Fruiting cells swollen on both sides. Zygospores ellipsoid 25-32 u br., 36-46 u long. Placed obliquely in the gametangium, yellowish in colour. Spore-walls smooth. Another interesting feature of the Alga is that many cells give out rhizoids (LXXIII, fig. c.) like those described by Delf by means of which the filaments are attached to coarser filaments of <u>Oedogonium</u>.

Filaments showing lateral conjugation are attacked by rounded endophytic <u>Chvtridiaceous Fungi</u>, 2-4 of which are invariably found in each cell which does not contain a zygospore.

Habit:- Found free-floating in a brownish mass in ponds.Collected in the second week of March 1930 at Hamira, and mixed with <u>Oedogonium</u> <u>urbicum</u> at V. Jhingran Distt. Hoshiarpur about the same time. Fairly common.

4. <u>Spirogyra Jurgensii</u> Kutz. op. cit. Borge Susswasser flora Heft 9.

Vegetative cells, 25-30 u thick, 2½ to 5 times as long. Septa occasionally swollen but not replicate. Cells with one chromatophore of two to four spirals. Fruiting cells not swollen on either side. Zygospores ellipsoid elongated 30-32 u thick, twice as long. Zygospore membrane smooth.

Habit:-Collected from Badami Bagh Tanks Lahore free-

floating, about the middle of March 1930. Fairly common.

-6-

5. <u>Spirogyra condensata</u> Kutz. var. nov. op. cit. Borge Susswasser flora Heft 9.

Vegetative cells 50-65 u broad, 4-6 times as long, each cell with one spiral chromatophore of 3-8 close turns. Fruiting cells not swollen on either side. Zygospores ellipsoid, 42-45 u br., 70-75 u long with a smooth zygospore membrane. Sterile cells with thickened mucilaginous walls frequently alternate with the cells of the male filaments. The Alga differs from the type in having chromatophores with greater number of spirals and much bigger zygospores hence it is necessary to establish a new variety.

Habit:- Free-floating in a greenish mass, in a pond in V. Nowshehra Distt. Hoshiarpu. One of the early fruiting forms, producing 3 zygospores about the middle of October. A very common alga, often found mixed with <u>Spirogyra nitida</u>.

6. <u>Spirogyra bellis</u>-Cleve. var. nov. Borge op. cit. Susswasser flora Heft 9.

Vegetative cells 60-65 u br., 11 times as long as broad, with plain septa. Each cell with 5-7 chromatophores, losely packed. spirals rather indistinct as zygospores characteristically arranged perpendicular to transverse walls. Zygospores oval or rounded in shape, 54-64 u in diameter, 80-85 u long. Zygospore walls smooth. Brownish yellow in colour. Fruiting cells strongly swollen on both the sides. This alga closely resembles S. bellis. Cleve in its dimensions but the middle membrane of the zygospore wall is smooth in this case.

Habit:- Free-floating in a pond near V. Bodal Distt. Hoshiarpur. Collected in the second week of March 1930. 9. <u>Spirogyra jugalis</u> (Dillw) Kutz. op. cit. Borge. Susswasser flora Heft 9.

Vegetative cells 100-120 u in diameter. 1½ to 2½ times as long with plain septa. Each cell with 3-6 chloroplasts making 1-2 spirals. Fruiting cells not swollen. Zygospores oval or ovoid-rounded, 80-95 u in diameter. 1½ times as long with a smooth spore wall.

Habit:- Free-floating in a freswater stream called Siah Baeen, in big masses. Collected in the first week of July 1929. A fairly common form.

10. Spirogyra Grevilliana - Hass. Kutz. Pascher 13, p.17

Vegetative cells 31-35 u broad, 2-4 times as long. Cross-walls not swollen, mostly folded, sometimes replicate. Chromatophore single with 3-5 spirals. Vegetative cells showing a swelling towards the septa, mostly towards the side where zygote is situated.

Fruiting cells 36 - 43 u thick, slightly swollen in the middle. Zygospores broadly ellipsoid 28-32 u thick and twice as long. Spore walls smooth. In certain cell. an ail drop is noticeable. Filaments show lateral conjugation.

Habit - Free-floating in a pond near Shahdra, Lahore. Produces zygospores in the middle of March. Also collected from Saharanpore in March 1935.

11. <u>Spirogvra neglecta</u>(Hass) Kutz. op. cit. Borge Susswasser flora Heft 9.

Vegetative cells 50-58 u thick. 2-5 times as long. Each cell with three chromatophores with 2-2½ spirals. Fruiting cells slightly swollen. Zygote oval or even rounded 54-58 u in diameter. 1½ times as long as broad.

Habit:- Found in a blackish mass, free-floating in a pond near V. Bhattan Distt. Hoshiarpore, in the second week of December 1929.

12. <u>Spirogvra nitida</u>(Dillw.) Link. op. cit. Borge Susswasser flora Heft 9.

Vegetative cells 70-90 u in diameter, 1-3 times as long. Septa plain, 3-5 chromatophores with ½ to 1½ spiral in each cell. Zygospores ellipsoid or even slightly ovoid. Fruiting cells slightly swollen on the outside. Zygospores 50-55 u in diameter, 1½ times as long. Zygospores are slightly smaller than in the type.

Habit: Free-floating in a pond near Tahli Sahib Distt Hoshiarpore, in the second week of October 1929. A very compon form.

13. <u>Spirogyra rivularis</u> (Hass). Rab. op. cit. Borge Susswasser flora Heft 9.

Vegetative cells 40-45 u broad, 3-6 times as long. Only three irregular chloroplasts were seen in certain cells, as purely vegetative cells are very uncommon for almost all the cells had conjugated in the material examined. Fertile cells not swollen. Zygote oval-ellipsoid, 45 u broad, 70-75 u long.

- Habit:- Found free-floating almost filling a pond near V. Battian Distt. Hoshiarpur in the third week of October 1929. A very common form.
- 14. <u>Spirogyra setiformis</u>(Roth) Kutz. op. cit. Borge. Susswasser flora Heft 9.

Vegetative cells 90-110 u in thickness, 1-4 t times as long. 4-6 chloroplasts with ½ to 1 spiral. Fertile cells not swollen. Zygospores ellipsoid brownish, 90-95 u in diameter.

Habit:- Free-floating in Siah Baeen, a freshwater perennial stream near Hamira, during March 1931. -11-

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Genus Sirogonium. Kutz.

1. <u>Sirogonium sticticum</u> Kutz. op. cit. Borge. Susswasser flora Heft 9.

Vegetative cells 40-46 u broad, 2-4 times as long, 3-5 straight chromatophores each with a number of pyrenoids embedded on it. Conjugation knee-like. Zygospores ellipsoid, 60-72 u broad, 1½ times as long. Deep orange yellow in colour. Filaments are very rough to touch and are commonly loaded with epiphytic <u>Algae</u> as <u>Chaetsphaeridium globosum</u>. The zygospores are about 10 u bigger than the type.

- Habit:- Free-floating in a pond. Collected from Hamira and Dhilwan about the middle of March 1930.
 - (3) Mougeotiaceae.

Genus. Mougeotia Agardh.

1. <u>Mougeotia genuflexa</u> (Dillw.)Ag. 182 op. cit. Czurda Susswasser flora Heft 9. Mitteleuropas.

Vegetative cells 21 to 28 u in diameter, 2-5 imes as long. Each cell with a plate-shaped chromatophore bearing 2-to-numerous pyrenoids. Genuflexed filaments are found in great abundance. No zygospores were seen. Another peculiarity of the alga is the readiness with which the individual cells dissociate from one another, as in <u>Debarva desmidioides</u>. West.

Habit:- Found in the form of a greenish mass of filaments many yeards in length in Budha Nala, a preshwater stream near Ludhiana. Genus Zygnema. Agardh.

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1. Zygnema Chalybdospermum Hansg. op. cit. Czurda. Zygnemales. Heft 9 in Sussawasser flora. Mitteleuropas.

Vegetative cells 20-27 U thick, 1-5 times as long. Chloroplasts typically stellate each with one pyrenoid (Fig Conjugation scalariform zygospores in the gametangia are more or less rounded in shape, middle membrane of the zygospore smooth. Steel blue in colour. Zygospores 28-30 U broad, 30-36 long. The four chloroplasts can easily be distinguished lying in a quartette inside the zygospore(Fig)

Habitat:- Free-floating in a pond at v. Jhingran, Distt. Hoshiarpore during the middle of March, 1930. Also collected from Hamira from a pond, about the middle of April, 1930. A common species of Zygnema.

Genus. Ghosella--Randhawa.

1. Ghosella indica- Randhawa.

Vegetative cells 10-15 broad, and 4-5 times as long. Each cell with two stellate or more or less rounded chloroplasts surrounding the centrally situated nucleus. (Fig.)

Conjugation sclariform. Conjugation canals are very wide, being 18-40 in width. Deposition of shining mucilaginous lamellae takes place during the process of conjugation as in <u>Debarya americana</u>. Transeau (Fig.). Marked genuflexion of filaments takes place during conjugation as in certain species of Mougeotia.(Fig) Conjugation between 5-7 filaments at the same time is quite common.

The zygospores are rounded, or oval, and extend into both the gametangia. The zygospores commonly retain the horn-like arms of the gametangia, and joints of the ripened cells get loosened, resulting in detachment of zygospores as in <u>Debarya desmidioides West</u>. The zygospores are 36-46 broad excluding their mucilaginous coats, and inclusive of these may be as broad as 56 . Ripe zygospores are deep yellow in colour, and show a considerable variety in shape. The zygospore wall is composed of three layers, the exospore is thin and light blue in colour, the mesospore is thick checolate brown in colour, and the endospore is yellowish in colour. The zygospore wall shows punctation on its surface i the form of minute circular depressions. (Fig).

Azygospores are also plentifully seen, and these are usually spindle-shaped in appearance (Fig). Some of the zygospores have their arms, and it seems as if these have resulted from the conjugation of a terminal cell of a filament with an intercalary cell of another filament (Fig

) .

Such zygospores are also seen in Debarya americana Transeau (

Delimitation of Genus Ghosellas-

There are four other members of Conjugatas which have been variously described by different authors as belonging to Genus Debarya or Zygnema. These are as follows:-

 Debarya americana. Transeau. from North America.
 Czurda () regards it as a species of Zygnema and has named it <u>Z. americanum</u>.

2. <u>Debarya decussata</u> Transeau from North America, has been named as <u>Z. decussatum</u> by Czurda ().

3. Debarya Spirale (Fritsch) Transeau has been called Z.Spirale Fritsch by Czurda ().

4. Zygnema pseudodecussatum Czurda. from Bohemia.

All these species are characterised by the presence of mucilaginous lamellae, marked geniculation, very wide conjugation canals, and great variety in the shape and structure of their zygospores. In these characters these algae differ from all other known species of Zygnema, and the author suggests that the best course is to include all these in the new genus Ghosella. Thus genus Ghosella comprises the following five species.

- 1. Ghosella indica Randhawa.
- 2. Ghosella spirale (Fritsch) Randhawa.
 - 3. Ghosella decussatum (Transeau) Randhawa.
 - 4. Ghosella americanum (Transeau) Randhawa.
 - 5. Ghosella pseudodeumatum (Czurda) Randhawa.

Zygnema Czurdae- Randhawa.

Vegetative cells are 20-27 U broad, and 11 to 4 times as long. Two more or less rounded chloroplasts with a conspicuous pyrenoid in each, are seen in each cell. Reproduction:-

Both lateral and scalariform conjugation have been noticed in this alga.

1. Lateral conjugation: -

Lateral conjugation is the commonest mode of reproduction in this alga. Both the gametes are mosphologically as well as physiologically isogamous. In one filament it was noticed that the upper part, which contains a kidneyshaped zygospore, is cut off from the remaining part of the conjugating cells by means of distinct walls. However in most of the filaments the zygospore is seen filling the whole of the conjugation canal area, as well as the lower part of the conjugating cells (Fig).

The zygospores are 30-40 U in diameter, and are oval in shape in early stages (Fig), but later on become rounded. Four chloroplasts with a conspicuous pyrenoid in each, and a nucleus in the central part may be observed nearly in all the zygospores (Fig). The zygospore wall is composed of three thin layers, all of which are light blue in colour. The exospore and mesospore are smooth, while the endospore is slightly sinuous. When fully mature the zygospores are perfect--ly round in shape. The middle-basal part of the conjugating cells becomes flattened and the upper part becomes rounded like a dome). In some filaments, which become more mature distinct eniculation may be seen, the flattened basal part ruptures, and the and the zygospore is liberated into water, (Fig

).

11. Scalariform conjugation

Some of the filaments also show the normal type of scalariform conjugation, with zygospores in the conjugation canal. The conjugation canal becomes distended due to the globose shape of the zygospores (Fig). Geniculation is noticeable (Fig). Sometimes three or more filaments may be seen conjugating together (Fig). Habit:-

This alga was found free-floating in a bluish green mass, only with a species of Spirogyra during the third week of February, 1951, in a fresh-water spring at I Tahli Sahib, Tehsil Dasuya, District Hoshiarpore, Punjab.

Zygnema Iyengari-Randhawa.

Vegetative cells are 18-20 U broad and five to eight times as long. Each cell has two rounded chloroplasts (Fig). Reproduction:-

This alga reproduces itself by means of squarish or cushion-shaped azygospores only. The azygospores are of various shapes (Fig), and have a constriction in the middle part when fully mature (Fig). The cells assume a spindle-shaped appearance due to the peculiar structure of the azygospores, and are shining white in appearance, possibly due to mucilage-secretion, though no lamellation is noticeable.

The azygospores are 26-30 U long and just as broad in some cases (Fig). Three layers are clearly notice--able in the well of the azygospores, a bluish exosporium, a dark-brown, crinkled and sinuous mesosporium, and a hyaline endosporium.

Habit:-

This alga was found free-floating in the form of bluish mass of filaments at Shahniwala Tank at Dasuya District Hoshiarpore, Punjab, during the second week of April, 1951.

14.1

Zygnema giganteum-Randhawa.

Vegetative cells are 38-48 U broad and $1\frac{1}{2}$ to $2\frac{1}{2}$ times as long. In thinner filaments, the chloroplasts show a typically stellate structure each with a conspicuous pyrenoid (Fig). In bigger filaments the chloroplasts are loaded with starch granules, and the stellate structure of the chloroplasts is obscured, and they appear to be more or less rounded in appearance. Cell wall is fairly thick as compared with other species of Zygnema.

<u>Reproduction</u>:- Both sexual and asexual modes of reproduction have been noticed in this alga.

1. Asexual Reproduction: -

Asexual reproduction takes place by means of brick-shaped parthenospores which develop orange-coloured thick walls, and sometimes show two pyrenoids in the middle part (Fig). The parthenospores are 36-45 y broad and 54-96 y in length (Fig). The parthenospores may be seen singly, or in rows of twos or threes, and in later stages whole filaments are converted into chains of parthenospores (Fig).

11. Sexual Reproduction:- In some filaments zygospores are found in the conjugation canals, and in others in the conjugating cells, the conjugation being isogamous and anisogamous in the same alga.

(a) Anisogamous conjugation:-

This type of reproduction is quite common in most filements (Fig). The male filements sometimes show an alternation of cells which produce male gametes, and vegetative cells, in which the chloroplasts are surrounded by a shining mucilaginous material and thick walls (Fig). In later stages these sterile cells become loaded with starch granules, and these also produce abortive conjugation canals (Fig). In other cases no cells are left out as purely vegatative in the male filaments, all of them functioning as males (Fig).

The zygospores are 42-46 U broad and 50-58 U long, and are oval in shape. The zygospore wall is composed of two layers only, athick hyaline and smooth exospore, and a thin, light blue, and smooth endospore. Mesospore is obviously missing. The ripe zygospores are orange-coloured in appearance like the parthenospores.

(b) Isogamous conjugation.

This is the commoner mode of reproduction, in this alga. Zygospores are typically egg-shaped in appearance, and project partly into the gametangia, completely filling the conjygation canals at the same time. Zygospores produced by maisogamous conjugation are longer than those produced by anisogamous conjugation, being 70-75 U long. Azygospores also may be seen.

Habit :-

This alga was found free-floating along with Zygnema coeruleum in Siah Baeen, a perennial freshwater stream in Kapurthala ^otate, Punjab, during the second week of March, 1931.

Zygnema cecruleum. Czurda op-cit. Czurda, page 107 Die Susswasserflora Milterleuropas Heft 9 Zygnemales. Vegetative cells 20-24 u broad and 3-4 times as long. Chloroplasts rounded with conspicuous pyrenoids. Conjugation scalariform. Zygospores in the conjugation canal, completely filling the canal. Zygospores rounded, or ellipsoid in shape. Exospore hyaline, mesospore thick, crinkled with depressions. Endospore not clear. Some of the Zygospores have mucilagenous coating (Fig)

Habit- Found free-floating in a freshwater stream near Beas during the second week of March 1931, along with Zygnema giganteum Randhawa and species of Spirogyra. Spirogyra stictica (Engl. Bot.) Wille 1884. Czurda. Sumswasser flora Mitteleuropas Heft. 9.

Sirogonium Sticticum Kutz. op. cit. Borge. Susswasser flora Heft 9.

Vegetative cells 40-46 U broad, 2-4 times as long, 3-5 straight chromatophores each with a number of pyrenoids embedded on it.

Conjugation knee-like. Zygospores ellipsoid, 60-72 U broad, 1½ times as long, deep orange-yellow in colour (Fig) Filaments are very rough to touch and commonly loaded with epiphytic <u>algae</u> as <u>Chaetsphaeridium globosum</u>. The zygospores are about 10 U bigger than the type. Habit:- Free-floating in a pond. Collected from Hamira and Dhilwan about the middle of March, 1950. Spirogyra Seliformis (Roth) Kutz. 1849 op. cit. Gzurda Susswasser flora Mittelearopas Heft 9 = Spirogyra Jugalis (Dillw) Kutz.

Vegetative cells 100-120 u in diameter. 1½ to 2½ times as long with plain septa. Each cell with 3-6 chloroplasts making 1-2 spirals.

Conjugation Scalariform Fruiting cells not swollen. Zygospores oval or ovoid-rounded, 80-95 u in diameter. 11 times as long with a XMEXXEE smooth spore wall ().

Habit :-

Free-floating in fresh water stream called Siah Baeen, in big masses. Collected in the first week of July, 1929. A fairly common form. Spirogyra Grevilliana- Hass. Czurda 1930. op. cit. Susswasser flora Mittelearopas. Heft 9.

Vegetative cells 31-35 u broad, 2-4 times as long. Cross-walls not swollen, mostly folded, sometimes replicate. Chromatophore single with 3-5 spirals. Vegetative cells showing a swelling towards the septa, mostly towards the side where zygote is situated.

Fruiting cells 36-48 u thick, slightly swollen in the middle. Zygospores broadly ellipsoid 28-32 u thick and twice as long. Spore walls smooth. In certain cells an air drop is noticeable. Filaments show lateral conjugation.

Habit:-

Free-floating in a pond near Shahdra, Lahore. Produces zygosporesin the middle of March. Also collected from Saharanpur in March, 1935. Spirogyra fluviatilis Hilse (in Rabenliorst Alg. Nr. 1476) (Spirogyra rivularis (Hass) 1 Rab.) Susswasser flora Mitteleuropas Heft 9. page 199.

Vegetative cells 40-45 U broad, 3-6 times as long. Only three irregular chloroplasts were seen in certain cells, as purely vegatative cells are very uncommon form almost all the cells had conjugated in the material examined. Conjugation scalariform fertile cells not swollen. Zygote oval-ellipsoid, 45 U broad, 70-75 U long. Exospore thim hyaline, mesospore thick dark brown. Endospore not known. Habit:-

Found free-floating almost filling a pond near V. Bhattian Distt. Hoshiarpore in the third week of October, 1929. A very common form. Spirogyra neglecta (Hass) Kutz. op. cit. Borge Susswasser flora Heft 9.

Vegetative cells 50-58 u thick. 2-5 times as long septa plain. Each cell with three chromatophores with 2-21 spirals ().

Fruiting cells slightly swollen. Conjugation sealoriform. Zygote oval or even rounded 54-58 u in diameter. 11 times as long as broad.().

Habit:-

Found in a blackish mass, free-floating in a pond near V. Bhattan Distt. Hoshiarpur, in the second week of December, 1929. Spirogyra nitida (Dillw) Link.op. cit. Borge Susswasser flora Heft 9.

Vegetative cells 70-90 u in diameter, 1-3 times as long. Septa plain, 3-5 chromatophores with ½ to 1½ spiral in each cell (). Conjugation Scalariform Zygospores ellipsoid or even slightly ovoid. Fruiting cells slightly swollen on the outside. Zygospores 50-55 u in diameter, 1½ times as long (). Zygospores are slightly smaller than in the type.

Habit:-

Free-floating in a pond near Tahli Sahib District Hoshiarpore, in the second week of October, 1929. A very common form. Spirogyra Sahnii, Sp. Nov.

This alga was found mixed with filaments of <u>Sphaeroplea</u> <u>annulina</u> free-floating in Siah Baeen, a freshwater stream near Dasuya about the middle of March 1931.

Vegetative cells are 48-72 u broad and 40-74 u long. Usually they are broader than long. They are very much swollen and are barrel-like in appearance. There is a single chloroplast which is more or less coiled in an irregular fashion (Fig). The septa of the cells are plane.

<u>Reproduction</u> Only lateral conjugation has been noticed in this alga, and this is of a very interesting type. The néighbouring cells usually give out tent-like protuberances in the usual way, and the female cells containing the zygospores almost always adjoin empty male cells (Figs). The female cells are usually of the same size, but in one case the emp/ty male cell was considerably swollen and much bigger in size. It gave out a distinct tube which was continuous with similar structure given out by the female cell, and appeared like a retort used by chemists for distillation purposes. Such conjugation tubes have been reported by de Bary in Zygnema insigne (Hassal) Kutz. (Fig).

Azygospores- Azygospores are also seen in large numbers along with the zygospores (Fig). These are usually oval in shape like the zygospores, but are very maximuch smaller in size, being broad, and 22-36 u long. In some cases these are spherical in shape (Xgi Fig).

Some of the cells are infested with a fungal parasite, similar to a species of Myzocitium described on a material of spirogyra affinis by Choudhari (). Some of the zygospores also are full of the cells of this parasite (Fig). It is a curious coincident that both the species of spirogyra from which this form of Myzocitium has been described, reproduce themselves by lateral conjugation.

Zygospores are 22-36 u broad, and 44-68 u long. The zygospore wall is composed of 3 layers, a smooth hyaline exospore, a thick bluish green mesospore, and a smooth endospore.

In one filament, the cells were noticed to produce conical protuberances, which give them a pear-shaped appearance(Fig). Probably these are abortive conjugation canals.

There are four species of Spirogyra which resemble the present form in some features, and especially in the possession of a single chloroplast and lateral conjugation. Of these it differs from S. longata (Vauch.) Czurda. and S. Lagerheimii Wittrock in the size and shape of vegetative cells and zygospores. From S. Condensata (Vauch.) Czurda emend, it mm differs in the shape and size of vegetative cells, the size of zygospores, and in the presence of parthenospores. The fourthspecies is S. asiatica.Czurda from Which the alga differs in the shape of vegetative cells, presence of parthenospores, and the absence of any punctation from the mesospore as well as its bluish green colour.

I have named this species of spirogyra after Dr. Birbal Sahni of Lucknow University, who has done so much to raise the prestige of Indian Botany.

Spirogyra Sahnii sp. nov.

Vegetative cells 48-72 broad, 40-74 u long, barrel-shaped in appearance, with a single irregularly coildd chloroplast, Septa of cells plane. Only lateral conjugation known, zygospores oval 22-36 u broad, 44-68 u long, with a thin smooth, hyaline

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Spirogyra parvula (Trans). Czurda nov. comb. op. cit. Czurda. Susswasserflora Mittèleuropas. Heft 9-

Vegetative cells 20-24 u broad, 2-5 times as long. Each cell with one chromatophone of 2 to 4 times. (Fig.).

Only lateral conjugation was observed in the material collected, though both lateral and scalariform conjucation is known to occur in the species. The zygospores occur in pairs at regular intervals, and when they are found singly, they are separated by many vegetative cells. Lateral conjugation in this species is very interesting. The female cell becomes very much swollen, and its contents become rounded (Fig Thus there is not only a physiological difference between the gametes, but also a mosphological one. The contents of both the male and female cells become very much granular and vacuolated. In some cases the female cells are swollen on both sides and present a flask-shaped appearance. The male gamete passes into the female cell through a pore in the middle of the cell-wall separating the two cells (Fig). empty male cells may be seen adjoining the female cells containing zygospores.

Zygospore ellipsoid to oval in shape 26 u broad, and 36-54 u long. The zygospore-wall is made up of three layers, a smooth and brown exospore, a smooth and bluish-green mesospore, and light brown endospore.

Habit:- Found free-floating in a small freshwater spring near V. Fatehpur District Saharanpur in the middle of February 1936. Spirogyra paludosa Czurda. op. cit. Die Susswasserflora Mitteleuropas. Heft 9. page 167-

Vegetative cells 18-22 u broad and 5-8 times as long. There is a single chloroplast in each cell (Fig). Septa of the cells plane.

Conjugation scalariform. Female cells containing zygospores slightly swollen. Zygospore ellipsoid, much longer than broad, being 24-26 u broad and 44-46 u long. Exfospore clear and smooth, mesospore light brown in colour. Habit:- Found free-floating in a pond at V. Dodal Distt. Hoshiar-

pore in the first week of April 1931.

I Spirogyra foveolata (Trameau) Czurda nov. nom (Spirogyra inflata (Vauch) Rab.) op.cit. Czurda Susswasser flora Milteleuropas Heft 9.

Vegetative cells 14-18 u thick, 7-10 times as long, septa swollen and replicate, chloroplast single with 3-6½ spirals, sometimes almost straight (Fig) Fruiting cells clearly swollen, 28-36 u broad. In fertile stages replication of septa becomes very clear. Zygospore ellipsoid 26-30 u in diameter. 1% to 2 times as long as broad (Fig In this specimen only scalriform conjugation was seen, though

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lateral conjugation is also known in this species. Habit:-Free-floating in a blackish mass in a pond at V. Shahpur, dist. Hoshiarpur, in the second week of April 1930. Also collected from Saharanpur in April 1935. A very common form. Spirogyra quadrate (Hass) Petit. op. cit. Borge Susswasser flora Heft 9.

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Vegetative cells 28-32 u in diameter, 3-4 times as long. A single chloroplast in each cell with two to six spirals (Fig Septa replicate, fertile cells clearly swollen, 44-48 u br., and flattened near the middle. Zygospores ellipsoid-elongated, 32-42 u in diameter, 2-22 times as long. (Fig). Habit:-Free-floating in a greenish mass of filaments in a freshwater stream near V. Kiri, Dist. Gurdaspur. Produces zygospores in the middle of December. Rather rate.

Species with septa not swollen. One chromatophore in each cell.

Spirogyra affinis (Hass) Kutz. op. cit. Borge Susswasser flora Heft 9.

Both lateral and scalariform conjugation are seen in this species. Vegetative cells 22-30 u broad. Septa not swollen. Chromatophore single with 2½ to 4 spirals. Fruiting cells swollen on both sides. Zygospores ellipsoid 25-32 u br., 36-46 u long. Flaced obliquely in the gametangium, yellowish in colour. Spore-walls smooth. Another interesting feature of the Alga is that many cells give out rhizoids (LXXIII, fig. c.) like those described by Delf by means of which the filaments are attached to coarser filaments of <u>Oedogonium</u>.

Filaments showing lateral conjugation are attacked by rounded endophytic <u>Chytridiaceous Fungi</u>, 2-4 of which are invariably found in each cell which does not contain a zygospore. Habit:-Found free-floating in a brownish mass in ponds. Collected

> in the second week of March 1930 at Hamira, and mixed with <u>Oedogonium urbicum</u> at V. Jhingran Distt. Hoshiarpur about the same time. Fairly common.

Spirogyra Jurgensii Kutz. op. cit. Borge Susswasser flora Heft 9.

Vegetative cells, 25-30 u thick, 22 to 5 times as long. Septa occasionally swollen but not replicate. Cells with one chromatophore of two to four spirals. Fruiting cells not swollen on either side. Zygospores ellipsoid elongated 30-32 u thick, twice as long. Zygospore membrane smooth. Habit :- Collected from Badami Bagh Tanks Lahore free-floating, about the middle of March 1930. Fairly common.

Spirogyra bellis-Cleve. var. nov. Borge op. cit. Susswasse flora Heft 9.

Vegetative cells 60-65 u br., 12 times as long as broad, with plain septa. Each cell with 5-7 chromatophores, closely packed. Spirals rather indistinct as zygospores characteristically arranged perpendicular to transverse walls. Zygospores oval or rounded in shape, 54-64 u in diameter, 80-85 u long. Zygospore walls smooth. Brownish yellow in colour. Fruiting cells strongly swollen on both the sides. This alga closely resembles S. bellis. Cleve in its dimensions but the middle membrane of the zygospore wall is smooth in this case. Habit :- Free-floating in a pond near V. Bodal Distt. Hoshiarpur. Collected in the second week of March 1930.

Mougeotiaceae.

Genus. Mougeotia Agardh.

1. Mougeotia sp.

Vegetative cells21 to 28 U in diameter, 2-5 times as long. Each cell with a plate-shaped chromatophore bearing 2 to numerous pyrenoids. (Fig). Genuflexed filaments are found in great abundance. No zygospores were seen. Another peculiarity of the <u>alga</u> is the readiness with which the individual cells dissociate from one another, as in <u>Debaryz desmidioides</u>. West. Possibly it is <u>M. genuflexa</u> (Pillw) Ag.

Habit:- Found in the form of a greenish mass of filemants many yards in length in Budha Nala, a freshwater stream near Ludhiana. Spirogyra condensata (Vanch). Czurda emend. Susswasser flora Mitteleuropas Heft 9. page 178.

vegatative cells 40-65 U broad, 2-5 times as long. Septa of the cells plain. There is a single chloroplast of 1 to 25 spirals in kength each cell.

Conjugation lateral as well as scalariform. In lateral conjugation the zygospores usually occur in pairs. Zygospores eval 52-36 y broad and 60-70 y long. Female cells containing zygospores are not swollen. Exospore hyaline, thick, mesospore brown, and endospore not known (Fig.). The zygospores produced by lateral conjugation are slightly smaller than those of the type.

Zygospores in forms reproducing by means of scalariform conjugation are bigger being 42-45 U broad, and 70-75 U long. Sterile cells with thickened mucilaginous walls frequently alternate with the male cells (Fig).

Azygospore may also be seen plentifully, are rounded in appearance and 24-26 U in diameter. Habit:-

Specimen showing scalariform conjugation were f found free-floating in a greenish mass, in a pond in V. Nowshera Distt. Hoshiarpore. It is one of the early fruiting forms, producing zygospores about the middle of October. A very common alga, often found mixed with <u>Spirogyra nitida</u>. Also found free-floating in a freshwater spring at Tahli Sahib Distt. Hoshiarpore in the first week of March, 1931, reproducing by lateral conjugation.

Spirogyra condensata Kutz. var. nov. op. cit. Borge Susswasser flora Heft 9.

Vegetative cells 50-65 u broad, 4-6 times as long, each cell with one spiral chromatophore of 3-8 close turns. Fruiting cells not swollen on either side. Zygospores ellipsoid, 42-45 u br., 70-75 u long with a smooth zygospore membrane. Sterile cells with thickened mucilaginous walls frequently alternate with the cells of the male filaments. The Alga differs from the type in having chromatophores with greater number of spirals and much bigger zygospores hence it is necessary to establish a new variety.

Habit:- Free-floating in a greenish mass, in a pond in V. Nowshera Distt. Hoshiarpur. One of the early fruiting forms, producing 3 zygospores about the middle of October. A very common alga, often found mixed with <u>Spirogyra nitida</u>. Spirogyra condensata (Vanch). Czurda emend. Susswasser flora Mitteleuropas Heft 9. page 178.

Vegetative cells 28-45 U broad, 2-3 times as long. Septa of the cells plain. There is a single chloroplast of 1 to $2\frac{1}{2}$ spirals in each cell.

Conjugation lateral only. Zygospores usually in pairs. Zygospores oval 32-36 U broad and 60-70 U long. Female cells containing zygospores are not swollen. Exospore hyaline, thick, mesospore brown, and endospore not known (Fig). The zygospores are slightly smaller than those of the type.

Azygospore may also be seen plentifully, are rounded in appearance ind 24-26 U in diameter. Habit:-

Free-floating in a fresh-water spring at Tahli Sahib Distt. Hoshiarpore in the first week of March, 1931.

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Mougeotia Viridis (Kutzing) Wittrock 1872- op. cit. Czurda. Susswasser flora Mitteleuropas Heft. 9.

Vegetative cells 6-8 U broad, chloroplast plateshaped, with 3-4 pyrenoids in each. (Fig)..

Conjugation scalariform. Zygospores more or less squarish cushion-shaped in appearance, and may bee seen free-floating with the four horn-like remains of the gametangia attached to them at the corners. Mesospore clear and smooth. Zygospores darkish in colour, 22-26 U X 22-26-U. (Fig.).

Distribution:- This alga has been reported from Germany, Austria, Czechoslovakia, France, Russia, Romania, and North America. Almost a cosmopolitan alga.

Habit:- Found free-floating mixed with <u>Zygnema Czurdae</u>. Randhawa. and a species of <u>Oedogonium</u> during the second week of March, 1951, in Siah Baeen, a freshwater stream in Jullundar district, Punjab. Rather a rare alga.

Conclusion.

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The study and investigation of the members of Zygnemals with their infinite variety in the shape and size of their chloroplasts and zygospores, apart from its scientific value, gives a great aesthetic pleasure to the worker. The beauty of shape, symmetry and pattern which these algae possess has a fascination of its own.

In recent years considerable interest has been shown in the study of algae in this country, but the group is such a vast one, that it is impossible for any individual worker to devote intensive attention to all the various forms. The author has specially interested himself in the study of the members of Zygnemales, and shall be much obliged to receive collections of these algae from various parts of India C/o the Secretary, Indian Academy of Sciences, Bangalore.

Before concluding the author expresses his thanks to his sister-in-law Mrs. Ilse Randhawa she gave to him in his investigations by translating into English the various German books on algae.

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A Short note on an Indian Variety of Sphaeroplea annulina (Roth) Agardh. Var. Multiseriata, Var. Nov. "

> M.S. Randhawa, M.Sc., I.C.S.

" A Short note on an Indian Variety of Sphaeroplea annulina (Roth) Agardh. Var. Multiseriata, Var. Nov."

A variety of Sphaeroplea annulina (Roth) Agardh was collected by the author from many ponds during the months of March and April in 1950from Hoshiarpore, Jullundar and Amritsar. During March the filaments become yellowish green in colour, and on examination under the microscope numerous green ova may be seen in most of them. By the end of April nearly all the filaments show red oospores, and they occur in such large numbers that drying banks of most ponds present a crimson-red appearance.

Under the microscope a number of annular chloroplasts may be seen in each coenocyte. Under the high power mf the annular bands of chloroplasts show bridge-like inter-connections (Fig.1), the whole presenting the appearance of a veticulum as in S.africana Fritsch. A number of pyrenoids may be seen arranged in a row on each chloroplast One to two nuclei may also be seen in the cytoplasm.

The septa are homogeneous ingrowths of the longitudinal walls (Fig. 2) as in typical fillaments of S.annulina (Roth) Agardh, and the coenocytes do not inter-communicate by means of any pores. The coenocytes are 60-80 in diameter being somewhat broader than those reported from Europe.

Sexual Reproduction.

The remarkable feature of the alga are its oogonia which are formed from the ordinary coenceytes without any change of form. The protoplasm of the coenceytes becomes cleft into numerous **BWM** green ova, which in the present variety may be seen arranged in three longitudinal rows (Fig. 3). It is due to this that the author has named this variety of S. annulina (Roth) Agardh as Var. Nov. multiseriata. Such a multiserial arrangement of ova and cospores is seen only in S. africana Fritsch, and Klebahn's figure of a segment of an cogorium of S. annulina (Roth) Agardh as reproduced by Fritsch in his "The structure and Reproduction of the Algae, " shows only a single row of ova. The ova in the present variety are deep green in colour and have 1-3 pyrenoids in each (Fig.3). Apertures for the entry of the sperms may be seen in the walls of the oogonia (Fig. 40). The ova are 17-27 in diameter.

The young oospores are green in colour and are often found enclosed in a thin hyaline membrane (Figs. 5 and 6), which is later shed, and may be found in large numbers alongside of the oospores (Fig. 4.M.). The oospores are spherical in shape, and the outer hyaline wall is produced into 10-15 blunt spines. The number of spines in the present variety, is fewer as compared with S. annulina (Roth) Agardh as figured by Fritsch and Rich (). Under an oil immersion lens, the surface of the oospores shows distinct aereolotion (Figs. 7, 8, 9, 10, 11 ans 12).

This form differs from the type in the disposition of its ova and oospores in 2-5 rows, fewer number of teeth on the oospore wall, and the slightly broader size of its coenocytes. Hence I have named it as Var. Multiseriata Var. Nov. This is also, so far as I know, the first report of this alga from India.

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Explanation of Figures.

Fig. 1.-Shows a part of KMM a coenocyte with chloroplasts, pyrenoids

(p) and nuclei (n) 420

Fig. 2.-Shows a Septum. 420.

Fig. 3 .- Shows a part of an oogonium with three rows of ova.

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New Species of Cylinarocar

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M.S. Ranchawa, M.Sc., I.C.S.

Cylindrocapsa oedogonioides.

Sp. Nov.

This very rare alga was found entangled in the filaments of a species of oedogonium, which was growing epiphytically on the blades of Typha plants in Shahniwala Tank at Dasuya, Punjab, during the months of March and April, 1930, and 1931. During March only sterile filaments were seen, but by the last week of April, some filaments developed oogonia, antheridia, and oospores. So far as the author knows there has been no record of any species of the rather uncommon genus Cylindrocapsa from Indéa. Possibly this is due to the habit of the alga, for even where it occurs it is found in such a scattered condition that after a long search under the microscope one may be lucy enough to spot a filament or so.

The filaments are unbranched and consist of a single row of more or less sub-rectangular cells, which are enclosed within a lamellose sheath, as in Cylindrocapsa conferta. West. But the cells of this alga differ from those of C.conferta West in having two small pyrenoids at the opposite ends of the cells (Figs 1 and 2), instead of a single massive pyrenoids as in the former. There is a single massive chloroplast, which is parictal in position, and presents a more or less granular appearance. In most of the cells a dumb-bell shaped nucleus may be seen in the middle surrounded by two pyrenoids at the sides (Figs.2 and 4). Vegetative cells are broad, and 12-28 U long, being considerably narrower than those of C. conferta West.

Reproduction.

This alga is characterised by the presence of a well developed oogamy. Of the species so far known, sexual reproduction has been worked out only in C. involuta Reinsch. In the present form the method of reproduction and the sex organs differ from that of Cylindrocapsa involuta Reinsch in many details. The filaments may be monoccious; the antheridia and oogonia developing in the same growing epiphytically on Typha blades in Shahniwala Tank Dasuya,

district Hoshiarpore, Punjab, during March and April, 1930 and 1931

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Osterreichs under Schweiz. Chlorophyceae 111

Heft 6.

Explanation of Figures.

Cylindrocapsa Oedogonioides.

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Fig.1. A vegetative filament showing cells with two pyrenoids in -

Fig. 2. A filament showing active division of some cells developing

later into antheridia (a) and enlargement of other cells . developing into oogonia (0).

Fig. 3. A filament showing a chain of female cells which later ig. 4. A filament showing some empty cells.

rig. 5. A portion of a filament showing antheridial cells (a), ig. 6. A mature filament showing an oogonium with an oospore.

ig. 7. A filament showing three cogonia with oospores.

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