BY G. O. ALLEN, I. C. S. The following notes comprise the main results of my pond hunting in quest of charophytes subsequent to the period covered by my

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previous paper ¹. For much of what interest my observations may possess I am, as will be seen, indebted to Mr. Groves.

To my great relief I found myself posted on my return from leave in October, 1923, to the Saharanpur District, my experience of the so-called "cool end" of the United Provinces having been only too limited. This spot is far removed from Gonda and enjoys a climate much more congenial to Europeans though it bears rather a bad reputation for fever. The average rainfall is about 39 inches. Frost of any severity is very uncommon and the maximum shade temperature seldom exceeds 105° in a normal year.

The district forms part of the Meerut civil division and comprises the northernmost portion of the Doab, the tract that lies between the Ganges and Jumna rivers and stretches South and then East as far as their junction at Allahabad. These two rivers form respectively the E. and W. boundaries of the Saharanpur District. Across the Jumna to the West lies the Punjab : to the North of the District that charming vale, Dehra Dun, the dividing line between them being the rugged miniature mountain range of the Siwaliks of geological fame. The actual bearings of the district are about 30° North and 78° East. In its general appearance the district presents a much greater variety than the typical Gangetic plain. Particularly fascinating features are the two canals, the Ganges and the Eastern Jumna, with the refreshing belts of vegetation that fringe their banks. Gazing to the North on a clear day the eye rests first of all on the Siwaliks some thirty miles away and then on the Mussoorie range and beyond that on the peaks of the snow-clad Himalayas. Most of the district is upland in character, the land sloping on either side down to the low-lying valleys, full of swamps and backwaters. As at Gonda I have been obliged from lack of opportunity to confine my attention mainly to a few small patches of water within



portion. This limited tract of country is not nearly so well supplied as Gonda with facilities for the study of aquatic plant life, the majority of the more accessible pools being small and soon drying up as the hot weather approaches. That as much as 7 per cent of the district is covered with water is mainly due to the two big rivers and the canals. Towards the Siwaliks ponds are very scarce, a prominent feature being the typical "raos' (torrent beds) usually dry or almost so except during the rains.

The more favourable localities within easier reach I have often visited throughout four cold weathers: for with the onset of the hot

weather expeditions rapidly become less profitable from the point of view of charophytes, a general decay of cold season vegetation setting in as ponds rapidly dry up. A more concentrated attention devoted to a small area has however advantages of its own. Several promising spots were lost to me the third and fourth seasons from the rains ceasing rather early. To a somewhat lesser degree my pond hunting extended over the rainy seasons also.

The following is a list of the species collected by me here, those previously recorded being arranged in the order given in Mr. Groves' Notes on Indian Charophyta¹ which paper I assume to be in the hands of the reader. The references opposite them are to the more readily accessible published illustrations.

N. mirabilis ... Notes on Indian Charophyta; Notes on Charophytes from Gonda. N. acuminala Notes on Charophytes from Gonda. N. dispersa ... N. axillaris ... N. mucronata British Charophyta.² ... N. leptodactyla Journal of the Linn. Soc. Botany, Vol. xlvi, September 1922. N. batrachosperma Br. Charophyta. N. furcata ... N. patula ... N. flagellifera ... N. hyalina Br. Charophyta. ... T. prolifera do. ... C. Wallichii

C. corallina

C. Braunii

- Notes on Charophytes from Gonda. 6 6 gi
- Br. Charophyta; Notes on Charophytes from Gonda. ¹ Journal of the Linnean Society (Botany), vol. xlvi, April 1924, ² Groves and Bullock-Webster: Ray Society,

C. erythrogyni ... C. hydropitys C. vulgaris Br. Charophyta. ... C. contraria do, ... C. fragilis do. ... C. brachypus . . . C. zeylanica. . .

I have recently compiled a small fasciculus of some Saharanpur charophytes and in connection therewith a paper was jointly contributed by Mr. Groves and myself to the Journal of Botany.¹ Descriptions of two "new species" (*N. flagellifera* and *N. patula*) appear therein together with some notes on the distribution of the plants included in the fasciculus and some remarks on ecology.

Nitella mirabilis (Nordst. MS) J. Groves (Plate I.)

* It will be seen that the genus Nitella is primarily divided into those species with branchlets uniform and in one series (Homcoclemae) and those with branchlets of varying length and nature and arranged in three series (Heteroclemae). As of the Indian species so far recorded there is only one, N. hyalina (which is readily distinguished from all others) falling within this latter division we may pass on to the next sub-division of the former into those with dactyls (ultimate rays of the branchlet) consisting of a single cell (Anarthrodactylae) and those consisting of two or more cells (Arthrodactylae). There are only two Nitellas with single-celled dactyls, N. mirabilis being one of them. This plant is dioecious whilst the other, N. acuminata, is monœcious. Identification should therefore present no difficulties as it differs to a marked degree from all others, the most peculiar feature being the clustered long-stalked reproductive organs (text-fig. 1.) The bunches of red antheridia make it very conspicuous in the water.

In Notes on Indian Charophyta this species is described as "glæocephala?" with the remark that the very young fertile heads of both plants appear to be enveloped in a slight mucus cloud. According to my observations the young male head is normally completely surrounded by a substantial mass of mucus. This can be made out fairly well in the accompanying plate which includes both male and female examples of this species. The female head has only a slight trace of mucus on it. Seen growing it is a delicate looking plant, usually about a foot high and of a decidedly lax habit, feeling

¹ The Journal of Botany, December 1927.

to the touch like a mass of filamentous algae in spite of the lime incrustation. On one occasion I came across a dwarfed form which bore no signs of any mucus.

Lime incrustation is a very common feature amongst charophytes and is generally more or less uniform or else annular in character. The authors of British Charophyta write that "many species appear to flourish most in water charged with a considerable quantity of lime, which they take up readily in the form of incrustation, not only on the exterior but beneath the cortex of the stem and branchlets. This calcareous incrustation adds greatly to the rigidity of their structure." And of the genus Nitella they remark that "the incrustation when present is almost always annular in character, the bands being approximately of the same width as the spaces between them. We have not met with any explanation of the cause of this phenomenon which is apparently peculiar to the genus, Tolypella nidifica and a few Charae." With reference to the last remark I may repeat here that I found in the Gonda district some C. zeylanica with annular incrustation.

On the question of rigidity it is worth noting that in N. mirabilis it almost invariably takes the form in the case of the dactyl of as many as ten narrow rings with usually a coating of lime at the exposed end (a feature often found amongst lime banded charophytes) whereas it takes quite a different form for instance in C. Braunii where in the branchlet the much broader rings always appear singly in the middle of the internode. The C. Braunii pattern would be of little use to strengthen the long slender internode of N. mirabilis where the binding takes the form adopted by the makers of split cane fishing rods. This kind of ring is clearly depicted in the beautiful plate of this plant in Notes on Indian Charophyta. The drawing shows this in the female: it may occur of course in the male as well. General incrustation is confined to the corticate Charas and seems to be particularly developed in those species e.g. C. vulgaris, C. contraria, C. zeylanica and C. brachypus which ordinarily grow in masses. In such surroundings some form of strengthening would appear of special service. In the more solitary C. fragilis I find little if any lime except when it occurs in running water: charophytes in such a habitat tend to be heavily incrusted. It may be mentioned that the lime is not always taken up evenly. For instance I noticed in some C. hydropitys that the corticate segments of the branchlet as well as the stem were thickly incrusted while the ecorticate segments bore none at all. In January 1926 I found a small pond almost completely carpeted by C. Braunii in a young state to the exclusion of every other

charophyte but a few very stunted plants of N. mirabilis in one corner. A peculiarity at once noticeable about the latter was the substitution of the usual type of lime ringing by the C. Braunii form, there being for each internode but one band and that too a broad one. But correlated with this was the much reduced length of the internode. This feature appears to have no connection with protection from being eaten : for charophytes whether incrusted or not appear to be

nobody's fodder, even the voracious water snails that often frequent them not fancying them as food though not despising them as an

occasional site for an egg mass.

N. mirabilis occurs here fairly plentifully wherever the bottom consists of really soft mud. It is always very regular in its time of appearance, never commencing till December. It evidently needs plenty of sunshine not ordinarily obtainable till the decay of the exuberant submerged vegetation of the rainy season has cleared the way, and prefers to have plenty of room to itself.

Nitella acuminata Braun.

Though closely allied from the point of view of classification the present plant bears little resemblance to N. mirabilis, their similarity in both having one-celled dactyls being only revealed with the aid of the microscope. Though the two species agree in the branchlets being but once forked N. acuminata is of a much more substantial build and shows a greater inclination to spread. It is monoecious. A character that readily indicates this species "in the field" is the tufted form of the young branches. (Text-fig. 2). It is not likely to be confused with any other charophyte. The plant's particular feature from which it derives its specific name is the very long sharp point to the dactyl. (Text-fig. 2 a). The species has a wide range in the tropics, more or less encircling the globe, and has been recorded from various parts of India. It grows very freely in masses during the rains.

Nitella dispersa Braun. (Plate II).

Here we pass to that large subdivision of the Nitellas whose dactyls consist of two or more cells. Seen growing the present species is not unlike a tall form of N. mucronata though more forked and with more rays and normally not fruiting at the first furcation. It is however readily distinguished from it by its dioecious character. There are only (apart from N. mirabilis above mentioned) two other dioecious Nitellas recorded as yet from India, the material in both cases being so scanty that neither has yet been assigned a name. They are nos. 4 and 15 in Notes on Indian Charophyte. 1942-2

My first specimens of this plant gathered on November 8th 1923 proved rather a problem even under expert examination. Prior to my finding this species the only records were Braun's from the Concan and Assam. The special features of Braun's plant are the two-celled dactyls, ultimate cells conical, dioecious, branchlets up to four times forked, dactyls three to five of unequal length and the primary rays elongated.

The peculiar feature of my plant is the presence of curious long allantoid (sausage shaped) ultimate cells in many of the dactyls while in others there is the usual conical one. (Text-fig. 3). This ray with the long ultimate cell is often the principal one i.e., the axial one. Nodes may however for instance occur in which a ray proceeds to furcate, while the other lateral rays are very elongated and have the exceptional allantoid apical cell. This long ultimate cell does not occur unless the penultimate cell is also elongated, the former comprising as much as half the ray, though there also occur very loog dactyls with the ultimate cell of the usual short conical form. On the first occasion I gathered this plant the strange elongated cylindrical cells were fairly plentiful which led to the suspicion that this might be something different from Braun's plant where the occurrence of this cell is not mentioned. In a subsequent gathering on 2nd December there was a fair amount of the unusual cell on the male but scarcely any on the female. The irregular occurrence of this cell taken in conjunction with the fact that it otherwise agrees fairly well with N. dispersa-for instance this and the Assam plant are alike in the cospore membrane having imperfect reticulation with a tendency towards a line across the intervals—eventually led Mr. Groves to conclude that my plant belonged to this species and that evidently in the specimens of N. dispersa seen by Braun it did not occur or he would certainly have mentioned the fact. In some further gatherings of this plant in November 1926 there appeared to be two forms, one rather lax and the other of stronger build. The quantities of antheridia all over the extremities somewhat resembled in miniature a lot of little oranges growing on a bush. Some pieces I gathered on one occasion I thought at the time to be covered with ripe cospores but on examination they proved to be quantities of Stentor niger!

On 8th Jan. 1924 I came across a still more puzzling plant (Plate II) in the same place as I had found the *N. dispersa*. In fact my special object in visiting this pond was to obtain some more material of my unusual find. Thanks to several days' recent rain which is always liable to occur in these parts at this season and is known as the Xmas rains I found as I anticipated a much enlarged pond and the water like pea soup. The only thing to do was to resort

to the grapple and with this I managed to haul in a large mass of Nitellas mixed up with a lot of C. Braunii. This method is not one to be recommended if specimens can be secured in any other way as the task of disentangling is tedious and rather disappointing as the material is bound to suffer in the process. Sorting it out proved to be more than usually difficult in the present case: for in addition to much N. dispersa above mentioned I also noticed a species that con_1 sisted of a mass of tufts which acted like so many burs and interlocked in the most exasperating manner. The plate gives a very fair idea of the general appearance of the plant. The main features are as follows: diœcious, dactyls all twocelled, ultimate cell normally conical, generally three furcations, the first and second internodes being very long comparatively and the third very short *i.e.* much shorter than the dactyls so that the plant has the appearance of a lot of little tufts at the end of long branchlet internodes (Text-fig. 4). Incidentally the dense tufts as so often the case with Nitellas were a mass of dirty particles and it was not very easy at first to make out the third furcation. The enveloping cells of the oogonium seem to be rather large compared with the oospore while the eoronula looks small. The reproductive organs are numerous and crowded together at the third furcation.

Mr. Groves found this plant had much in common with my N. dispersa except for the shortening of the upper rays giving it a tufted appearance and the oospores being shorter : the oospore membrane of both is similar. His final verdict is that this plant must be referred to N. dispersa in spite of the difference in vegetative growth. Occasionally an allantoid cell is to be found in the tufted form as well though neither this ultimate cell nor the dactyl is nearly as long as is found in the other form. "The capitate form," he writes, "collected on 8th Jan. looks very different but capitate forms occur in many Nitellas and our common British species vary so much in this respect that these two forms should have flourished together.

Nitella axillaris Braun. (Plate III).

This very peculiar species I did not meet with till the rains of 1926 when I devoted considerably more attention to charophytes than in previous wet seasons. Its chief characteristic lies in its reproductive organs being entirely borne on special little much crowded axillary branchlets. Once examined it cannot be confused with anything else though its close superficial similarity in a young state to N. acuminata in the midst of masses of which the plant occurred very sparingly deseived me somewhat at first.

It is very near N. translucens which occurs in England but in my plant the little heads are always axillary. These fruiting heads are as many as five at a whorl. The branchlets at first sight look single-celled but the lens discloses a terminal furcation into two or three minute sharp-pointed 2 celled dactyls.

This is the only Indian record of this plant. It has not been mentioned from the mainland of Asia before.

In the two ponds where this species occurred it was always closely associated with N. acuminata. I noticed it as early as Aug. 20th: they both disappeared as soon as the rains ceased.

Nitella mucronata Miquel.

"The Nitellas," writes Mr. Goves, "present many difficulties in classification. In such a plastic genus it is difficult to see what characters can be trusted to discriminate species." Now N. mucronata is a sort of miscellaneous department: plants that cannot be got to fit in elsewhere and yet do not possess sufficiently pronounced constant differences of their own to warrant the creation of a new species are apt to find a home here. "In this all too large a category," writes the same authority, "I have had to place a good number of doubtful plants from various parts of the world."

In spite of all this the commonest and typical form is not difficult to distinguish. It grows in a short roundish clump and for a Nitella is quite stiff. If all charophytes behaved as this does making satisfactory dry mounts would present few difficulties : after the excess water has drained off the branchlets soon spring up again and tend to recover their natural position. The furcation of the branchlet is of a comparatively simple and regular character. The primary ray is never more than half the length of the whole branchlet : usually there are only two forks and the rays at the second forking but two or three, reproductive organs occurring at all the nodes.

Under the microscope the dactyls will be seen to consist generally of two cells but occasionally three while the narrow end-cell is perched mucro-like on the rounded lower one, this peculiarity giving the plant its specific name (Text-fig. 5). This form is common in shallow open water in the earlier portion of the cold weather and prefers nice

soft mud.

I have found one or two other forms that provisionally have to be placed under this species but although they differ considerably from the normal form descriptions would not I think serve any useful purpose.

CHAROPHYTE NOTES FROM SAHARANPUR, U. P. 57 Nitella leptodactyla J. Groves.

My hunting in the cold weather of 1924-25 was seriously interfered with by the extensive floods, unprecedented locally in the memory of man, that occurred at the end of September. This gave rise to a dense growth of coarse grass round the ponds and when at last they appeared again as such after being lost for weeks in a watery waste the muddy zone usually made accessible by evaporation in the cold weather instead of being rich in charophytes was often a tangled mass of floating grass ends. I was rewarded however on 10th November by a prize in the shape of an extremely slender Nitella with very bushy whorls due to the numerous branchlets and their many furcations. It proved to be N. leptodactyla hitherto only recorded from Ceylon and first described by Mr. Groves in his paper on Mr Blow's collections from that area. The plate accompanying that paper really makes further description unnecessary. Of this plant Mr. Groves writes that he thinks it quite the daintiest he has yet handled, the ultimate rays being only 25 to 30 μ in diameter. He makes it out to be mucus headed though only apparent in quite the youngest heads. I had noted down in my diary "no signs of mucus" so it is evidently not conspicuous. He is not however disposed to set much store by this mucous character to distinguish species as it is not constant. A striking example of this is N. batrachosperma: the European plant sometimes has the mucus so pronounced as to have given rise to its specific name whereas my Gonda plant as also my Saharanpur one had none. The occurrence of this plant well illustrates the very capricious appearance of charophytes. The particular pond in which I found it is quite small and the open parts can be fairly thoroughly searched in under half an hour. As it received considerable attention from me during this period in 1923 it is improbable that I should have overlooked this species had it been present then. Stress is laid on this characteristic in British Charophyta where an instance is cited of a collector who would not give away the locality of a rare species he had found. The authors remark in that connection that "had he been aware of the true nature of the Nitellas-the practical impossibility on the one hand of ensuring their permanent growth, and on the other of effecting their extermination-he would scarcely have maintained his silence." I have not succeeded in finding this plant again. For two succeeding years the locality was under crops.

¹ On Charophyta collected by Mr. Thomas Bates B'ow, F.L.S., in Ceylon, Journal Linn. Soc., Botany. vol. xlvi, September 1922.

Nitella batrachosperma Braun.

The minute size of this plant, the smallest of all the Indian charophytes, will help to distinguish it : but for this very reason it is probably often everlooked. There are generally eight branchlets to the whorl: the dactyls are very long and narrow (Text-fig. 6); usually twice forked and with gametangia generally at the first furcation only. The oospore ridges have conspicuously broad flanges.

Of Indian plants it most nearly resembles N. tenuissima of which

there is but a single record of var. byssoides by Braun a hundred years ago from the Coromandel coast. So far as my experience goes it occurs very sparingly here. I have found it on but two occasions only. Happening early in December 1924 to examine a little roadside pool, I came across this species though taking it at first to be N. mucronata. It was a distinctly larger plant than the Gonda one reaching 10 cm. in height. My next meeting with it a year later was very unexpected. I was engaged in searching a reach of the river Damola, a fairly rapid shallow stream though frequent bends lead to the formation of many more or less stagnant pools. This species is particularly partial to extremely fine mud such as would not occur in a stream. The plant had however found a very efficient substitute in a mass of decaying filamentous algae, a softer bed than which is hardly possible. The specimens were very minute like the Gonda ones which were also found in very shallow water. It is worth noting that in Ireland it occurs in four to six feet of water. My present record and that from Gonda are the only two so far from India.

Nitella furcata Agardh (= N. Roxburghii Braun). (Plate IV).

This species belongs to a group of four in which some at any rate of the dactyls are conspicuously short and are hence known as the Brachydactylae. These dactyls are divergent and generally arise from a sterile node. (Text-fig. 7 a). The distinguishing feature of the present species is the extraordinarily tall coronula due to the cells of the upper layer being prolonged into sharpish points. This upper layer though normally straight sometimes adopts a very irregular shape (Text-fig. 7 b). The coronula often presents a somewhat striking resemblance on a microscopic scale to the persistent projecting calyx of the pomegranate fruit. To make out this peculiar feature in the coronula requires some care but once seen there is no mistaking it. I had at one time contemplated including another of the four, N. microcarpa, in my Saharanpur list but on a further examination of the very limited material available I hardly felt this was justified. In

both these species the oogonia are clustered. The coronula of N. microcarpa is normal but between the two there are regular gradations.

Happening to devote much more time to charophyte hunting in the rains of 1926 than in previous years I found N. furcata to be quite a plentiful species at that season. Earlier specimens of it collected at the beginning of the cold weather had been in poor condition. Indian records of it are very meagre: it occurs in Ceylon and a few other scattered places such as the Coromandel coast and Pegu.

Nitella patula Groves and Allen.

On 12th October 1926 I chanced during my rounds to revisit a small pond and nearly passed it by as unprofitable as there was such a dense growth of rushes round the edge. Luckily however I was prompted to have a look at the small patch of open water in the centre of the pond and to my great surprise found a mass of a beautiful Nitella in splendid condition in nice deep water. For the time being this had to be relegated to N. mucronata sens. lat. but closer examination has led to its being pronounced worthy of specific rank: it is described in the Journal of Botany as mentioned above. It resembles N. furcata in habit. Its most marked characteristics are the larger number of furcations and rays and the oogonia heing solitary: the oospore is light brown. Nitella flagellifera Groves and Allen. (Plate IV). This has also been recently described in the Journal of Botany. On 24th October 1926 in a pond adjoining that where N. patula occurred I found a plant that I realized at once was different from anything I had gathered before. It was after the style of a stiff N. mucronata but its fruiting was most peculiar. At most stem whorls there was produced at the first two furcations of the branchlets a separate little shoot (flagellum) bearing many reproductive organs: hence its specific name. The illustration shows the rather character. istic shape of the branchlets.

Nitella hyalina Agardh. (Plate V).

This pretty little species is the only Indian representative of the section Heteroclemae. The branchlets in each whorl are in three series, the upper and lower being short and alike, the middle one much longer and more forked. The existence of two distinct kinds of branchlet is very easily made out and renders this plant a simple one to identify. Seen growing it is also readily recognised by its small roundish whorls separated by very long internodes and by its generally having such a lot of mucus on it as to give it quite a jelly-like feel.

I found a couple of little tufts of this species on 18th October 1923: there was rather less mucus than usual. This is the only occasion I have come across this plant at Saharanpur which is rather surprising seeing that it was particularly common at Gonda and has a wide distribution in India and the world generally. A visit to the spot about the same time another year disclosed no signs of it.

Tolypella prolifera Leonh. (Plate V). Judging from my own brief experience the only member of this genus likely to be found in this part of India is the present one.

Tolypella is distinguished from Nitella by the antheridia being lateral instead of terminal but a glance at the accompanying plate will show that the general appearance of the two is very different. The most conspicuous feature of T. prolifera is the presence of long sterile simple, *i.e.*, nonfurcating, branchlets. The only charophyte for which I have on one occasion mistaken it in its natural surroundings was a form of C. contraria in which there occurred at the lower nodes a whorl of entirely ecorticate sterile branchlets that thus produced a distinct superficial similarity between the two, especially as they were growing all mixed together. The ultimate cells of the present species being conical is a character that definitely distinguishes it at once from the other two Tolypellas recorded from India. (Text-fig 8.) T. prolifera like many other charophytes is remarkably constant

in its time of appearance. It commences with December and flourishes for rather over a couple of months: it occurs very sparingly. Gonda was its first Indian record: I hear that it occurs also in South India.

Chara Wallichii Braun.

The genus Chara to which we now pass is primarily divided into those with a single row of stipulodes (Haplostephanae) and those with a double row (Diplostephanae). C. Wallichii belongs to a further sub-division of the former comprising three ecorticate species that are all found here, being easily distinguished from the other two by its dioecious character. It should be added however that in C. Wallichii as well as in C. corallina the stipulodes are usually much obscured by the gametangia which in both these species are produced freely at the base of the whorl.

In life it is a large robust angular-looking plant, rather spiky in appearance and very brittle (Text-fig, 9.). The antheridia are particularly large, much exceeding in length the cospores. It is fairly frequently met with in this area and grown singly in clumps. It is probably a good deal commoner in the Gangetic Plain than the meagre records indicate. I have recently had specimens of it from Benares and found it at Gonda and Lucknow.

Chara corallina Willd. (Plate VI).

Though very different in general appearance this plant has not a great number of characters distinguishing it from C. Braunii. It produces gametangia at the base of the whorlas well as at the branchlet nodes while C. Braunii has none at the former (Text-fig. 10). The oospore is far larger than that of C. Braunii. The branchlet cells of C. corallina tend to be very swollen and the plant is very brittle while the other species is distinctly flexible and slender. C. corallinais usually a very robust plant often growing in largish clumps by itself. When growing amongst fairly thick vegetation the stem internodes are often much elongated and the whole plant as tall as two feet whilst the gametangia are generally borne on rather crowded branches near the water surface. Lime incrustation is usually annular in character. The branchlets though closing together at the tips in the young state project conspicuously when older and may reach the great length of over 8 cm. whereas those of C. Braunii are usually very regular and 2 to 3 cm. in length. These exceptionally long branchlets are sterile.

C. corallina is fairly common and may be found throughout the cold weather being at its best, like C. Braunii, in January and February. It is widely distributed in India.

Chara Braunii Gmel.

This is quite the commonest charophyte here. It may be found freely in almost any pond one visits in the latter half of the cold weather and struggles on right through the hot season as well. Though I did not find this plant common at Gonda, failing in fact to run across it my second season there, it has a wide range in India even reaching 6,000 feet in the Western Himalayas and is found in all the continents of the world. One noteworthy feature is the extremely short terminal segment of the branchlet (Text fig. 11*a*). This segment is only about the same length as the two or three developed bract cells and consequently presents much the same appearance on a larger scale as the tip of a brachydactylous Nitella branchlet. Its synonym of coronata is due to this peculiarity. It not infrequently grows in huge patches.

Chara erythrogyna Griffith. (Plate VI).

In general appearance this plant bears little resemblance to the three Charas already mentioned. It looks more like a small form of C. zcylanica. It will be seen from the illustration that the whorls are far apart and the branchlets comparatively short and stiff. Though belonging also to the haplostephanous sub-division it differs from the first three in the stem having a cortex though the branchlets are entirely ecorticate. 1943-3

There are only two other Indian species in which these two features are combined. *C. crythrogyna* differs however markedly from them in the peculiar fact that as a rule at the branchlet node either oogonia or antheridia are present but not both whereas in the other two both may occur together in the ordinary way. The segregation of the male and female reproductive organs seems to be carried even further than this: for I often found a whole branchlet and not merely a node to be either male or female.

Griffith who first named the plant states that this plant is remarkable for the red colour of the females. The colour of the oogonia ista fine deep reddish brown. The antheridia being bright red as is not uncommon amongst charophytes the combination of the two produces a very pleasing effect. This species has a whorl of from 13 to 16 branchlets: the segments vary from six to eight. In my plant I have not noticed more than 13 branchlets or six segments. The main stem is particularly tough which is fortunate as disentangling it for herbarium purposes is difficult. Braun distinguished another species as C. Thwaitesii that hails from Ceylon. The alleged characteristics of it are the short stipulodes, the branchlets being ten to twelve in a whorl and the segments 4 to 5. Of these three points much the most noticeable is the first but Mr. Groves has little opinion of this character as it is extremely variable in this section : vide for example his remarks under C. flaccida in his paper on Mr. Blow's collections of charophytes in Ceylon that "there is often considerable difference in the length of the stipulodes even on the same plant." He is of opinion therefore that the Ceylon plant is probably a variety of C. erythrogyna. In Braun's "Fragmente" C. erythrogyna appears under the name of C. Griffithii. The recorded distribution of this species is very meagre viz. from the Gangetic plain only except for the Ceylon variety. It is not mentioned however in the Ceylon paper which was confined to two collections in 1895 and 1898 by Mr. Blow who apparently did not come across the plant. Curiously enough one of the few previous records from the Gangetic plain is the Saharanpur Botanic Garden. In these famous gardens however the only spot that was once probably a small pond does not appear to hold water nowadays.

Chara hydropitys Reichb.

This species is closely allied to the last and not at all unlike it in appearance though considerably smaller. In both the stem is corticate: in the present species the branchlets are mainly corticate but the lowest segment is always ecorticate.

I found this species on one occasion only viz. September, 1926 : it was in evidence for a very short time as it was growing in shallow water at the edge of a pond that rapidly dwindled.

There are few Indian records of this species; it has been found in Bengal and Ceylon and I collected it at Gonda. I have also received specimens from Coimbatore.

Chara vulgaris L. (Plate II).

This plant is recorded from all over India and has in fact a worldwide range. It is somewhat surprising that I did not find it at Gonda. It is a species that revels in variations though the authors of British Charophyta remark with reference to Dr. Migula's elaborate enumeration of 70 European varieties that "it is difficult to see that any useful end is served by the attempt to make minute distinctions between plants that are evidently mere states." The causes of these variations moreover are not apparent as plants are found under similar conditions in adjacent spots and yet showing slight differences. Four of the most noteworthy British varieties are figured in plate XX1X Br. Charophyta, vol. II.

Much the commonest form in Saharanpur (Plate II) evidently tends towards var. longibracteata, the particularly lengthy anterior bracteoles and bract cells showing up quite clearly. It is noteworthy that these bract cells should be very long while the stipulodes and spine cells are not correspondingly developed, which is contrary to the usual practice amongst charophytes. With reference to my plate I should mention that the contortions represent the plant's natural state, a feature quite in keeping with its general wayward habits.

It grows in dense masses as a rule. The strong odour it emits makes its old synonym of "foetida" particularly appropriate.

As I mentioned in my Gonda paper the species most nearly resombling C. vulgaris is C. contraria. They both belong to the diplostephanous sub-division of the genus, the most readily distinguishable difference between the two being that in the former the spines seem to lie in furrows *i.c.* the secondary series more prominent than the primary (aulacanthous) whereas in C. contraria the exact reverse is the case, the primary spine bearing series being more prominent than the secondary (tylacanthous). A comparison of plates XXVIII and XXXIII Br. Ch. vol. II will make this point abundantly clear, though in practice the irregularities of the cortex often necessitate the examination of a young shoot before recognition is at all certain. The series that is the larger in girth when viewed in cross section will naturally be the broader in surface view.

There is also a tendency with C. vulgaris for the two rows of stipulodes to be neat and equal in size whereas in C. contrivia the lower is often irregular and smaller than the upper. So far as I have noticed the apex of the branchlet of C. contraria has always a few ecorticate segments this tendency being less pronounced in C. vulgaris. The ripe oospores too of C. contraria are black while those of C. vulgaris are usually dark brown. They may further be distinguished by the marking on the oospore membrane. The decoration in C. contraria is known as granulate, the granules being all contiguous while in C. vulgaris it consists of separate little tubercles.

Chara contraria Kutz.

This plant also tends to vary somewhat. In general appearance it is rather neater than C. vulgaris and often has a slightly bluishgreen tinge about it. I have referred above to a form with ecorticate lower branchlets.

As at Gonda I found this species a distinctly cold weather type: it does not seem to germinate before the middle of November. It is a common plant in Indian waters and is found in all five continents.

Chara fragilis Desv. (Plate I).

Though not unlike in general appearance the other two triplostichous species, *C. brachypus* and *C. zeylanica*, it differs in being of a solitary disposition though often growing in clumps. The branchlets tend to be longer and though not spreading out much near the node generally develop graceful curves towards the free ends. There are usually only three or at most four fertile nodes to the branchlet, these being situated at the base of it and thus leaving a long bare upper portion. The stipulodes and spine-cells are always very inconspicuous, even rudimentary, and blunt in outline. There is little lime incrustation as a rule.

Though not occurring anywhere abundantly it is often come across locally and has a world-wide distribution.

I should add that Prof. N. K. Tiwary of the Benares Hindu University recently sent me a plant he gathered at Benares in 1924 that proves to be *C. delicatula* Agardh. This is the first record of it in India. It closely resembles *C. fragilis* but is mainly distinguished by the primary cortical cells being larger than the secondary, whereas in *C. fragilis* they are both of the same size and by the stipulode cells being more or less elongated instead of rudimentary as in *C. fragilis* and the spine-cells being papilliform instead of hardly visible (vide plates XLIII and XLIV Br. Ch., vol. II).

Chara brachypus Braun.

A typical tropical species that grows in dense masses in the rains and early cold weather. It is usually heavily incrusted, a fact which doubtless accounts for its exceedingly brittle nature. It may be readily distinguished by the lowest branchlet segment being very short and incidentally colourless or nearly so (Text fig. 12 a). This very pale colour may I think be due to this segment apparently not taking up lime, a feature shared by the coronula amongst charophytes, this latter part being consequently never found in the fossil state. The stipulodes being elongated and both they and the spine cells being acute afford a marked contrast with C. fragilis. It seems partial to a firm soil: I have never found it growing in soft mud.

Chara zeylanica Willd.

This is a rather variable species and flourishes at the end of the rains and grows in masses. As soon as ever the cold weather sets in it dies down altogether. Though after the style of *C. brachypus* it is very easily distinguished under the miscroscope by the lowest branchlet segment being ecorticate (Fext fig. 13). This segment is usually much shorter than the others but I found one form where it was as long as the other segments. *C. hydropitys* also has the peculiarity of the lowest branchlet segment being without any cortex but this latter plant is otherwise quite different and belongs to the haplostephanous sub-division of the genus. *C. zeylanica* is common

here and widely distributed in India.

This district may be considered to have a very rich charophyte flora. In the cold weather hardly a pond that is free from disturbance by man and beast will fail to produce a few species. On one occasion a tiny roadside patch of water not thirty yards across that would normally dry up early in the cold weather to my surprise yielded no less than seven different species. My list of 22 local species amounts to just half the total so far recorded from India.

The commonest species are N. mirabilis, N. acuminata, N. furcata, N. mucronata, C. Wallichii, C. Braunii, C. corallina, C. crythrogyna, C. vulgaris, C. contraria and C. fragilis. The list includes two new species and one new record for India.

A comparison with my Gonda list amounting to sixteen shows the addition here of N. dispersa, N. axillaris, N. furcata, N. leptodactyla and the two new Nitellas, C. crythrogyna and C. vulgaris but the absence of Lychnothamnus barbatus and C. gymnopitys, though the former was abundant there. Of two of the species common to both districts C. Braunii was scarce at Gonda but the commonest and most wide-spread here while N. hyalina so common at Gonda was as

already mentioned only met with on one occasion here. The periods during which I found the different species to flourish is shown in the accompanying chart. None commence after January though ten of my list I have not seen appear before November. Few survive far into the hot weather. The periods agree pretty closely with my observations at Gonda with regard to the species common to both areas.

Chart showing the periods during which the different species were found to flourish.

NAME.		June	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
N. mirabilis	•••							_					
N. acuminata	•••												
N. dispersa	• • •												
N. axillaris			,										
N. mucronata			į										
N. leptodactyla													
N. batrachosperma					1				-				
N. furcata		i								J		L 1	
N. patula	• • •												
N. flagellifera	•••												
N. hyalina	•••												
T. prolifera											ĺ	ļ	
C. Wallichii					-			 .			_		
C. corallina	•••					t	-		!		1		



Explanation of Plates

- N. mirabilis.-Showing on the left the male plant Ι. with antheridia in masses of mucus and on the right the female plant (about ? natural size).
 - C. fragilis. Rather less than $\frac{2}{7}$ natural size.
- N. dispersa.—Capitate form. (about ? natural size). II.
 - C. vulgaris. Rather less than $\frac{2}{7}$ natural size.

III. N. axillaris.-(a) Whole plant rather less than half natural size. (b) Enlarged portion about double natural size.



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fragilis.

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N. axillaris.



8



flagellifera z

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prolif H



hyalina ż



٠ erythrogyna



∇I_{\bullet} PLATE

corallina

3

IV. N. furcata.— A well grown plant in a young state. The smaller portion represents an old plant from shallow water. Both about ¹/₄ natural size.
N. flagellifera.—About ¹/₄ natural size.
V. N. hyalina.— About ⁴/₇ natural size.
T. prolifera.— Rather less than ²/₅ natural size.
VI. C. corallina.—(a) The whole plant represents a well grown specimen ; about ¹/₄ natural size.
(b) Enlarged portion (about natural size) showing the swollen branchlet cells; in a young state they close over at the tips.
C. erythrogyna.—About ¹/₄ natural size.

Explanation of text-figures 1-13.

- Fig. 1. N. mirabilis.—Cluster of ripe oogonia.
 Fig. 2. N. acuminata.—(a) Apices of dactyls.
 (b) Terminal whorl.
- Fig. 3. N. dispersa.—Allantoid ultimate cells of dactyls.
- Fig. 4. N. dispersa. (a, b.) Somewhat elongated ultimate cell of dactyl.
 - (c) Normal ultimate cell of dactyl.

(d) Portion of branchlet showing secondary tertiary and quaternary rays. 5. N. mucronata.—(a) Typical apex of dactyl. Fig. (b) Three-celled dactyl. 6. N. batrachosperma.—Apices of dactyls. Fig. 7. N. furcata. (a) Apices of branchlets. Fig. (b) Oogonia showing elongated coro. nula. Fig. 8. T. prolifera.—Fruiting branchlet. Fig. 9. C. Wallichii.—Apex of branchlet. Fig. 10. C. corallina. (a) Apices of dactyls. (b) Stem node with branchlets. Fig. 11. C. Braunii.— (a) Apex of branchlet.

(b) Branchlet whorl. Fig. 12. C. brachypus.— (a) Stem node. (b) Branchlet node. Fig. 13. C. zeylanica.—Stem node.







