

Notes on distribution and bio-ecology of Characeae

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The Butler University Botanical Studies journal was published by the Botany Department of Butler University, Indianapolis, Indiana, from 1929 to 1964. The scientific journal featured original papers primarily on plant ecology, taxonomy, and microbiology.

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Ray C. Friesner

The *Butler University Botanical Studies* journal was published by the Botany Department of Butler University, Indianapolis, Indiana, from 1929 to 1964. The scientific journal featured original papers primarily on plant ecology, taxonomy, and microbiology. The papers contain valuable historical studies, especially floristic surveys that document Indiana's vegetation in past decades. Authors were Butler faculty, current and former master's degree students and undergraduates, and other Indiana botanists. The journal was started by Stanley Cain, noted conservation biologist, and edited through most of its years of production by Ray C. Friesner, Butler's first botanist and founder of the department in 1919. The journal was distributed to learned societies and libraries through exchange.

During the years of the journal's publication, the Butler University Botany Department had an active program of research and student training. 201 bachelor's degrees and 75 master's degrees in Botany were conferred during this period. Thirty-five of these graduates went on to earn doctorates at other institutions.

The Botany Department attracted many notable faculty members and students. Distinguished faculty, in addition to Cain and Friesner, included John E. Potzger, a forest ecologist and palynologist, Willard Nelson Clute, co-founder of the American Fern Society, Marion T. Hall, former director of the Morton Arboretum, C. Mervin Palmer, Rex Webster, and John Pelton. Some of the former undergraduate and master's students who made active contributions to the fields of botany and ecology include Dwight W. Billings, Fay Kenoyer Daily, William A. Daily, Rexford Daudenmire, Francis Hueber, Frank McCormick, Scott McCoy, Robert Petty, Potzger, Helene Starcs, and Theodore Sperry. Cain, Daudenmire, Potzger, and Billings served as Presidents of the Ecological Society of America.

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NOTES ON DISTRIBUTION AND BIO-ECOLOGY OF CHARACEAE IN NEBRASKA*

By WALTER KIENER

INTRODUCTION AND ACKNOWLEDGMENT

The species of the family Characeae have for many years been generally neglected by botanists leaving identification a difficult matter due to the absence of usable and practical keys and descriptions. Because of this difficulty to correctly identify species, field workers, particularly those in wildlife research, further neglected the study of the ecology of the species. Most workers lumped the species together as though they were all alike. This resulted in much ambiguity when species of Characeae were under consideration.

It was a good fortune when in 1943 Fay Kenoyer Daily began to study this family and was backed by the facilities of the Botany Department of Butler University. All collections of Characeae made in Nebraska were sent to her and she made all the identifications. These are the accepted ones for this work. Without her help and the facilities of Butler University this work could not have been carried on and whatever progress is registered in the following pages is due to her cooperation and that of Butler University. The result of her own work is published simultaneously in this issue and the reader is referred to this for more details of the geographic distribution of the Characeae and their taxonomic status (4). For courtesy and opportunity to study the collections, credit is due Dr. L. B. Walker, curator of the herbarium of the University of Nebraska.

HISTORICAL RECORDS AND THEIR DISTRIBUTION

In a catalogue of the flora of Nebraska, in 1890, Webber (9) lists *Chara coronata* as being "very common in the ponds of central

* This is a joint contribution from the Pittman-Robertson Division of the Nebraska Game, Forestation and Parks Commission, L. L. Mohler, supervisor, Paul T. Gilbert, executive secretary; University of Nebraska, Conservation and Survey Division, G. E. Condra, dean and director; and Butler University, Botany Department, Ray C. Friesner, chairman.

and western Nebraska," and gives as localities Thedford in Thomas Co., and Belmont and Ft. Robinson in Dawes Co. *Chara* sp. occurred "in ponds usually with the preceding." *Nitella opaca* is listed as occurring "in small, stagnant ponds, Lincoln, May 5, 1890. A medium sized dioecious species found in considerable quantity by Mr. Shimek of the state university."

In an appendix to the catalogue of 1892, Webber (10) lists *Chara contraria* as occurring in "flowing or standing water and cold springy lakes," and gives one locality namely Fremont in Dodge Co., and collected by Williams. *Chara fragilis* is listed as occurring "in ponds." The localities given for this species are Greeley Center in Greeley Co., Greenwood in Cass Co., and Fremont in Dodge Co., this latter being collected by Williams. *Nitella acuminata* var. *glomerata* is listed from "ponds near Lincoln (Bessey)," Lancaster Co. *Nitella flexilis* is listed as from "ponds near Minden," Kearney Co. *Nitella mucronata* is also listed from "ponds near Minden." Both these plants were "in material collected by Dr. Hapeman (Bessey)."

In a supplementary list, also in 1892, Bessey (1) reports *Chara foetida* "collected by J. M. Bates at Valentine," Cherry Co.

The report on collections made in 1892 by the Bot. Surv. of Nebr. (7) lists *Chara fragilis* "in a small lake, Cherry Co., July 19." *Chara contraria* is listed from "ponds in wet valleys, Cherry Co., July 17, 18." *Chara foetida* var. *longibracteata* is listed from "ponds in wet valleys, Sheridan Co., July 12, 13." *Chara coronata* is listed as occurring "in small lake, Cherry Co., July 18."

The report for 1893 of the Bot. Surv. of Nebr. (2) gives no information other than localities and lists *Nitella translucens* as from York, York Co. *Nitella translucens* form *confervoides* is also from York. *Chara crassicaulis* is reported from Haigler in Dundy Co., and Pine Ridge, presumably Dawes Co. *Chara evoluta* is listed from Sheridan Co. as part of material reported as *C. foetida longibracteata* in 1892, *Chara sejuncta* is listed from Minden, Kearney Co.

The year 1894 brought the illustrated paper on Characeae by Woods (11). He gave detailed descriptions and illustrations of the following species, *Nitella subglomerata*, *N. flexilis*, *N. opaca*, *N. mucronata*, and *N. translucens*, *Chara coronata*, *C. contraria*, *C. foetida*, *C. crassicaulis*, *C. evoluta*, *C. fragilis*, and *C. sejuncta*. This makes twelve species for the state of which several had subspecies named. For about half of these species, Woods does not mention any habitat, and for the others only with insufficient curtness. The

localities from which the collections were made are stated but cursorily. No collections were named and herbarium specimens were cited only in few cases and these very meagerly. Woods neither stated whether the illustrations were all original drawings from Nebraska specimens or were adapted from other works. All species reported on by Woods, had previously been recorded in the works cited above. As nearly as can be made out, Woods had apparently twenty-five herbarium records available for his study of the twelve species he listed at that early date of botanical exploration in Nebraska. His determinations were remarkably accurate for that time. A culminating point was reached in the study of Characeae in Nebraska. For half a century interest in this group of plants nearly ceased. Seldom was a species named in the literature, and equally seldom did a specimen find its way into the herbarium. The number of collections rose from twenty-five to fifty-eight. It remains a great pity, however, that the locations from which these collections came were so poorly stated that they can not be re-located to ascertain any possible changes in the vegetation during this long interval.

In 1897 and 1900 Pound and Clements (6) had their work on the phytogeography of Nebraska published. Their short statements regarding distribution and occurrence of Characeae were apparently based on the paper by Woods, which due to insufficient material and observation were bound to be erroneous in many respects.

COLLECTION RECORDS AND THEIR DISTRIBUTION

For the study of Characeae there are now available at the University of Nebraska two groups of collections. For convenience the collection of the writer will be referred to as the Kiener collection and that of the herbarium of the University of Nebraska as the herbarium collection.

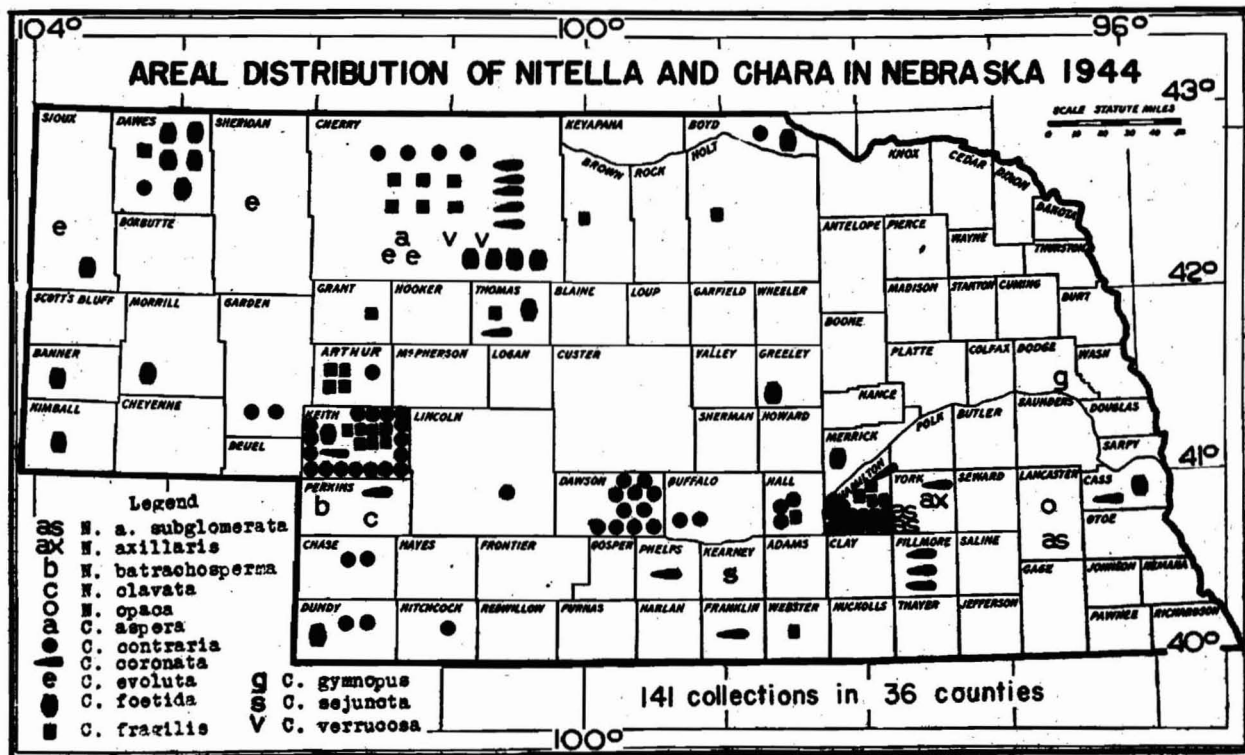
THE HERBARIUM COLLECTION. The number of collections in the university herbarium increased from the twenty-five Woods had at his disposal in 1894 to fifty-eight by 1941. This small accretment in nearly fifty years remained however practically unidentified until 1944 when Fay Kenoyer Daily (4) revised and identified the whole collection. At this date the herbarium collection of fifty-eight single collections was made by sixteen collectors from twenty-one counties and contained eleven species as now recognized. From certain indications it may be assumed that few of these collectors were particularly

interested in Characeae and all the collections were thus more or less incidental.

THE KIENER COLLECTION. The writer collected the first specimens of *Chara* in Nebraska incidentally during fieldwork in the summer of 1941 in the southwestern counties which make up the Republican River watershed. This work was done under the auspices of the Conservation and Survey Division of the University of Nebraska. In the summer of 1943 and through the winter to the spring of 1944, Characeae was studied advisedly. Specimens were collected for biological and taxonomical reasons during a preliminary investigation of aquatic communities in the counties along the Platte River in central Nebraska. This work was done under the auspices of the Pittman-Robertson Division of the Nebraska Game, Forestation and Parks Commission. Eighty-three collections from sixteen counties and representing seven species were obtained through the different seasons of this field work.

COMPARISON OF THE TWO COLLECTIONS. Certain features of interest become apparent when the two groups of collections are compared. For analysis the herbarium group may be subdivided into an early and late subgroup. The early subgroup includes the twenty-five species Woods had available and identified by 1894. In *Chara* he listed seven species, one of which (*C. crassicaulis*) is not now recognized as being represented. These early collections were fairly scattered over the state and already represented the main species of this genus. In *Nitella* Woods listed five species, two of which have not been substantiated, and of which two others appear with a change in nomenclature. The second subgroup, comprising the collections from 1894 to 1941, added two more species to those listed by Woods. No species of *Nitella* were collected during this period. The sixteen collectors, sampling twenty-one counties out of ninety-three in Nebraska, obtained in fifty-eight collections an apparently fair random sample of the species of Characeae present in the state and their approximate geographical distribution. As now recognized there were eight species of *Chara* and three of *Nitella*.

In contrast, the Kiener collection was not made to obtain a geographic random sample, but (a) to establish sociological relations of aquatic communities, and (b) to gain biological information on the species of Characeae. The interest was wholly ecological and many collections were made from the whole extent of a single habitat such as a lake or pond, and at different times of the year. Geographically



these eighty-three collections were made from sixteen counties. They represent five species of *Chara*, one of which was new to the state record and two species of *Nitella*, both of which were also new records. By coincidence, fifteen of the sixteen counties of the Kiener collection were not represented by the herbarium collection, thus forming a considerable extension in area. Altogether the record of Characeae for Nebraska, available at this time, consists of 141 collections from thirty-seven well-scattered counties. *Chara* is now represented by nine species and *Nitella* by five. The addition of these eighty-three collections to the fifty-eight of the herbarium added only three rare species to the record as each of these was found only once. It is of considerable interest to note that by more than doubling the number of collections, and nearly doubling the number of counties from which collections were made, the knowledge of the geographic distribution of the members of this family was not materially altered. A good, geographic random sample had been obtained by the many collectors, gathering a modest number of collections from widely spaced counties. From this it may be assumed that the number of further additions will be interstitial and probably small. Plate I and tables 1 and 2 analyze and summarize the geographic distribution of the species in the state. It shows three trends in geographical distribution. *Chara coronata* has a more pronounced presence in the southern counties, due probably to the intermittent pools of the table lands; *Chara contraria* has the greatest presence in the Platte River Valley, due no doubt, to the gravel-pit ponds; and *Chara fragilis* and *Chara foetida* have their greatest presence in the sand-hill lakes. Knowledge of geographical distribution of the species is of importance. It does, however, in itself give little ecological information which is most needed in the management of aquatic wildlife.

ECOLOGICAL DISTRIBUTION OF THE SPECIES AND THEIR HABITATS

If a species is studied over the whole of its range, its ecological amplitude of adaptation to certain conditions of environment become known. Already in the early stages of collecting it became evident that the different species of *Chara* differed among themselves with regard to their habitat preferences and consequent distribution. There are not as yet enough ecological studies and collections available to draw final conclusions as to which species will grow best in a certain habitat, and what effect a certain species of *Chara* may exert

on the aquatic community, or be influenced by it. Much more needs to be known about these plants to be of full aid to intelligent game management. To this end some observations are herewith presented.

CHARA CORONATA. Woods (11) states that this species is "common all over the state," but fails to support this statement by evidence. Nor do the eight herbarium records give much ecological information. In the experience of this writer, however, *Chara coronata* seems to have a definite habitat preference. Seven times out of eight, it occurred in intermittent pools of peculiar characteristics, formed in depressions on the table lands. The rhythmically submerged and emerged soils also are peculiar to these depressions and are known as Scott soils (8). These topographic depressions with their intermittent pools and peculiar aquatic plant communities, and whose soils are mapped as Scott soils, will henceforth be referred to as Scott bodies, to include in this term the whole of physiography, biology, soil and climate, to signify their unit character. The Scott bodies are the result of geologic and climatic processes, but are under control of climate. Late winter snows and spring rains supply water to these depressions, on the average from two to five feet deep. Summer showers tend to maintain the body of water, but increasing transpiration by plants and evaporating power of the air, with progressing season, lower the water level and dry up the pool, some as early as July and others as late as September. Many plants typical of the Scott bodies are annuals. They germinate, fulfill their seasonal life cycle, and produce seed before the soil becomes dry, and then pass the unfavorable period of the year in the seed stage. *Chara coronata* is an annual and was found to produce large quantities of spores before the time the pools dry up. These spores lying on the ground are subject to high temperatures and dryness, but apparently carry the plants successfully over to the next season. This species appears to be an important component of the aquatic communities of the Scott bodies, but more needs to be known about its biology and ecological distribution. *Chara coronata* seems however well adapted and in harmony with the peculiar environmental conditions of the intermittent pools of the Scott bodies of the table lands of Nebraska.

CHARA CONTRARIA. The earlier collectors contributed only six records from three counties for this species, and from this it might have been considered a rare inhabitant in Nebraska. The writer's collections, however, number fifty-five from eleven counties, although the majority came from only three counties and three habitats.

all of which were gravel pits. There are along the streams, and particularly along the Platte River, large numbers of pits, made by man to obtain sand and gravel. These pits fill up with ground water and as a rule have neither inlet nor outlet, but have usually a slow movement down grade as a part of the general ground water. Although there is an annual fluctuation in the water level, it does as a rule not exceed two to three feet. Most of the pits are deep, the greatest depth measured being sixteen feet. These bodies of water are referred to in this work as gravel-pit ponds, or ponds in short. There is always water in them. *Chara contraria* was found at depths that usually do not exceed five feet. Curiously, when this species is present in a pond, this is always clean, that is, the water is noticeably transparent, little plankton is in evidence, and blue-greens and blanket algae are nearly absent. Whether or not, *Chara* is a cause that cleans the water or keeps it clean, is not known to this writer at this time, but there are indications that it might be. Of many pits visited, the most recently created were devoid of *Chara*, suggesting that *Chara* is not a pioneer in the progressive development of the aquatic communities of these ponds. Of fifty-five collections of this species, fifty came from gravel-pit ponds, and the others from meander ponds of creeks, or intermittent marsh ponds. *Chara contraria* in Nebraska is therefore a characteristic species of the gravel-pit ponds. When the early collections of *Chara* were made in Nebraska, relatively few of the gravel pits had been in existence at that time, and the scant record of *Chara contraria* in the herbarium may be a good indication that this species developed in abundance only subsequent to the creation of these man-made ponds; it followed thus in the wake of the settlements by white man, finding greater opportunities to spread.

THE HAMILTON COUNTY CHARA POND. Located in the NW $\frac{1}{4}$ sect. 6, T. 10 N., R. 8 W., 300 yards northeast and east from the bridge and highway crossing the Platte River from near Phillips to Grand Island, it is the largest pond of several, one being in the process of excavation at this time. Collections in this pond were made in July and August 1941, in July 1943, in February 1944, and observations in between and subsequent.

The plants of *Chara* cover perhaps sixty per cent of the bottom surface, and some grow three feet tall. There is a margin of shallow water where *Chara* does not grow. This suggests then that *Chara contraria* for optimum conditions of growth needs a certain depth of water to have these conditions fulfilled. One important factor may

be temperature, as a deep body of water will not heat up as much as a shallow one, and temperature in turn may significantly affect carbon dioxide and oxygen pressures. Admixed with *Chara contraria* was *Chara fragilis* whose presence may indicate a more advanced stage of development of the aquatic community. The most luxurious growth with abundance of spore production was observed to occur during July. In the winter time the mats formed by the plants appeared more compact. Perhaps the stems were less buoyant, but more likely they were "grazed" by waterfowl and fish. Fish, frog, and smaller animal life were found hiding in the shelter of these mats. The immediate shore of this pond was devoid of willows, and there was very little amphibious shore vegetation, the soil being of coarse sand supporting only a xeric weed population.

THE DAWSON COUNTY GRAVEL-PIT POND. This pond is located at the northwest edge of the city of Lexington and apparently within the corporate city limits. It is administered by the park department of the city and has had some improvements around the pond, which, however, at the present time appear neglected. When first visited on Sept. 2, 1943, the shallower eastern part of the pond was uniformly covered with a dense mat of *Chara contraria*. A large quantity of these plants was taken out the same day and transported to Johnson Reservoir for the purpose of propagation in that reservoir lake. Among the stems of this transplant was a conspicuously large number of small crayfishes and other aquatic biota which in this way were also transplanted into the large reservoir. But a month and a half later, on Oct. 14, the *Chara* vegetation appeared considerably different. The mats appeared more compact, as though the tips of the stems had been "grazed" off, or had become lax and decumbent, or broken off. But outside the general mat there was a new growth of plants which had the appearance of being a different species. These were, however, young plants of the same species which had germinated from spores late in summer. Many plantlets were collected with the spore cases still attached to the young stems. These young plants did not survive during the winter. They were apparently too far out, in too shallow water where environmental conditions were not suitable for survival. In June 1944 the mats of *Chara contraria* showed luxurious growth where the water was three to four feet deep. The top of the mat had a distinct brownish appearance due to a preponderance of orange-colored antheridia. It is obvious that this species, as far as observed, has perennial stems, produces

spores early in summer, with the maximum antheridial stage in the middle of June, shortly followed by the oogonial stage, which is followed by a physiological relapse in late summer when the spores already begin to germinate. Survival of young and old stems is assured in suitable environment during winter if not "grazed" by animals, or broken off by wave and ice action. The plants apparently are dormant during winter but again increase physiological activity and reproduction in spring and early summer. With a complete life cycle and local abundance in numbers the species seems to be in harmony with its climatic and physical environment.

THE KEITH COUNTY GRAVEL-PIT PONDS. There is a typical gravel-pit pond at the east edge of the town of Ogallala which is inhabited by *Chara contraria*. There are many small ponds just below Kingsley dam on the North Platte River, about eight miles northeast of Ogallala. Many of these ponds are also inhabited by *Chara contraria* which grows here in a similar way and under similar conditions as in the ponds reported above. With eight collections of *Chara contraria* in these ponds was found once each *C. fragilis* and *C. foetida*.

CHARA FRAGILIS. Sixteen collections of this species from four counties were made by this writer. Four collections came out of the pond in Hamilton county where it grew as a subdominant with *Chara contraria*. One sparse collection came out of another pit across the Platte River from Hall county. Seven collections came from Keith county. Only two came from gravel-pit ponds at Kingsley dam. All these collections so far enumerated for this species came from typical gravel-pit ponds where *Chara contraria* was the dominant member of this family. The next collection from Keith county came from a floodplain pond west of Keystone at the southern edge of the sandhill area. This pond was a shallow depression in a marsh mostly supplied by ground water, and surrounded by wet meadow, therefore, a marsh pond. Here *Chara fragilis* was the dominant, although *Chara contraria* was well represented. Four collections came from the sand hills about nine miles north of Kingsley dam from the east side of highway 61 in sect. 18, T. 16 N., R. 38 W. This is a low area with the water table close to the surface supplying the several small ponds with most of the water. The ponds might have been made by the road builders to obtain gravel, but their characteristics are more those of marsh ponds. The dominant was again *Chara fragilis* with an admixture of *Chara contraria*. Four collections were made in Arthur county, a typical sand-hill county. One collection

was made on the east side of highway 61, three miles south of the town of Arthur, from a dried-up pond in a similar marshy situation as the last mentioned from Keith county. There too, *Chara fragilis* was the dominant with *Chara contraria* admixed. The other three collections came from Beeken Lake, a typical shallow sand-hill lake, surrounded by marshes and wet meadows. The only species of this family present was *Chara fragilis*. The records in the herbarium number twelve and from their scanty information it may be surmised that most of them also came from sand-hill lakes and marsh ponds. It is then in the sand-hill lakes and marsh ponds that *Chara fragilis* is best at home in Nebraska, and wins in competition over the other species of *Chara*.

CHARA FOETIDA. Only one collection of this species was made by this writer. It came out of the gravel-pit ponds at Kingsley dam where it grew with *Chara contraria*. This is too scant to reach any conclusions regarding the ecological distribution of the species.

RARE SPECIES. Seven species, *Chara aspera*, *C. evoluta*, *C. sejuncta* and *C. verrucosa*, *Nitella acuminata* var. *subglomerata*, *N. axillaris* and *N. opaca*, were nearly all collected by the earliest collectors in single collections. Three single collections of *Chara gymnopus*, *Nitella batrachosperma*, and *N. clavata* were made by the writer and are additions to the flora of this family for this state. There are thus ten species of this family found so sparingly that very little can be inferred from their presence.

AGENTS OF DISTRIBUTION

The question arises how do the species of Characeae become scattered over such wide areas. As the plants are non-motile, anchored to the bottoms of pools and ponds, and sink to the bottom when broken off because of their incrustation with lime, they must have effective and unceasing agents which carry on the dispersal of their propagules. These agents are obviously the aquatic birds, mainly ducks. Although there is no direct information available, it is not difficult to imagine that parts of the brittle stems, with or without adherent spores, might cling to the feathers or feet of the birds. A little mud with it might help in carrying such plant parts over relatively long distances. Some spores may pass the intestinal tracts of the birds and remain viable.

It is generally estimated that ducks by the millions cross Nebraska twice annually during their migrations. As they fly from pond to

pond there are therefore twice a million chances to carry propagules from one place to another over wide areas. Some of these surely must find a suitable place to propagate and become established. If the lakes of the sand hills are the most suitable places for *Chara fragilis*, it would be expected that this species also would be carried to the ponds of the gravel pits in the adjacent Platte Valley, where they would be able to grow and compete with other plants on a reduced scale only, due to the dissimilarity of the two environments. Similar dispersal takes place among the other species and their respective habitats. The rarer species of *Chara*, and particularly those of *Nitella*, seem to indicate this condition of dispersal. Since out of 141 collections only six were of *Nitella*, it must be presumed that the environmental conditions in Nebraska are not suitable for the requirement of these species, hence, they do not survive. Dispersal, however, takes place continually and some plants may succeed for a season or two. *Nitella batrachosperma* and *N. clavata* were collected in 1941 on the Scott body on the highway one mile east of Grant in Perkins county. By the summer of 1943 this whole aquatic community was destroyed, partly by drought and partly by hogs. *Nitella opaca* was collected in 1890 in considerable quantity at Lincoln in a creek known as Deadman's Run. None are to be found there to-day, none would be expected because the creek has been channeled and is now mostly dry. Man's work has here eradicated the habitat of one species, but in the case of the gravel-pit ponds he has created many more new habitats into which the ducks carry unwittingly the propagules for the perpetuation of their own food.

GEOLOGICAL OCCURRENCE OF CHARA

One might also wonder how long the species of Characeae have been inhabitants of the area known as Nebraska. That the plants are so widely distributed over the state seems to indicate that they must have been age-long components of the aquatic communities in this state. So far as this writer is aware *Chara* has never been reported for certain in the fossil state from the rock beds of Nebraska. It was the good fortune of this writer in 1943 to run on to a small deposit of fossilized *Chara* in a rock on the shore of Kingsley lake. The fossils were embedded in a buff-colored, hard marl, of the Ash Hollow formation, Ogallala Group of Pliocene age (3). The locality of this find is in the north-facing bluffs, on the shore of Kingsley lake, about six miles north of Ogallala and half a mile east, in the N $\frac{1}{2}$

sect. 5, T. 14 N., R. 38 W. A detailed study of the plant fossils has not yet been made, but it is believed that they are rather widespread in this rock formation, but have thus far escaped recognition. Members of the family Characeae have therefore a long history in Nebraska and may originally have been brought here by the ducks or other waterfowl.

CHARA IN RELATION TO AQUATIC WILDLIFE MANAGEMENT

Martin and Uhler (5) in an important treatise of foods for game ducks, list from stomach analysis Chara as fifth in importance for the United States and Canada. They list it as fourth in rank for the western region of the United States. They list its food value as good to excellent and give some detailed information. Though Chara is of great importance as direct food to waterfowl, it may have a yet greater importance in its community relations and as nurse bed for large quantities of small animal life, which is very important food to fish. As pointed out above, Chara is usually found only in clean ponds, but it is not known whether this is a cause or a result. Two ponds were puzzling, one in Hall County southeast of Grand Island, in the apex of a triangle formed by highway 2 and the Platte River in the SE $\frac{1}{4}$ sect. 35, T. 11 N., R. 9 W., and the other in Buffalo County, south of Kearney in the very corner formed by highway 10 and the Platte River in the SW $\frac{1}{4}$ sect. 13, T. 8 N., R. 16 W. Both of these ponds were visited in July 1941 and had at this time overwhelming masses of algae, chiefly *Rhizoclonium hieroglyphicum*, much of which was in a state of decay and gave off bad odors, giving the ponds generally an ugly appearance. No Chara was in evidence. But in 1943 when the same ponds were again visited they had a much cleaner appearance and the blanket algae were present only in much reduced quantities. *Chara contraria* was now present in both ponds and in addition *Chara fragilis* in the Hall County pond. By June 1944 both ponds looked even fresher and cleaner with fewer algae than before. Perhaps there is a normal sequence in which Chara can only develop after some organic matter has been deposited in the pond, or else there is a possibility that Chara might give off some substance toxic to other algae and prevent them from growing in their proximity. Whatever the real reason or true sequence in the population cycles of these ponds, game management will need to know the exact facts.

On the other hand the whole economy of raising fish in the state hatchery on Rock Creek in Dundy County seems to be based chiefly on *Chara contraria*. When the ponds had been dug out to hold the fish, *Chara* appeared naturally and became a dominant plant. Now every year at the end of the season the plants of *Chara* have to be removed from the ponds to make seining of the fish possible. Tons of *Chara* are removed from the water and thrown upon the banks and later hauled away. The cleaning-out of these plants is undertaken only to make the seining possible, hence much of the plant material, such as spores, remain to provide a new crop for the following year. Inseparably connected with the plants are the quantities of animal life which represent the food needed to raise the fish. While many plants enter into this economy, it seems certain that *Chara contraria* is the most important, perhaps the basic one in the whole food chain of raising fish successfully.

Over the ridge where the tons of *Chara* have been dumped over the years a small white hill has been formed by the lime incrustated plants. The idea suggested itself that these tons of *Chara* taken out of the ponds annually, might represent not only propagating material to put in other newer ponds, but might be valuable as lime fertilizer on land gone sour. It certainly would contain quantities of finely divided lime with much nitrogenous matter of value to poor soils. Uses for this material may be found and *Chara* may become even more valuable as a natural resource.

SUMMARY

In 1894 was published the first paper on Characeae in Nebraska, based on twenty-five collections which already established the names of twelve species. The next thirty-eight years added thirty-three, mostly unidentified collections to the herbarium. From 1941 to 1944 the writer added eighty-three records making the total on which this paper is based 141 records. Ecological information has now been added which shows tendencies for *Chara coronata* to occur mainly in the intermittent pools of the table lands, for *C. contraria* to be at home in the gravel-pit ponds made by man, and for *C. fragilis* and *C. foetida* to occupy the lakes in the sand hills. Fossilized plants found in the Ash Hollow formation of Pliocene age indicate that this family was represented in this area in geological time. Waterfowl are the agents of geographical dispersal of the Characeae. Some species of *Chara* are important food to waterfowl, chiefly some ducks. The mats of

Chara are nurse beds for small aquatic animals and are generally important in the aquatic foodchain. It is suggested that Chara might be useful as a lime fertilizer on poor land. New names to the state flora are, *Nitella batrachosperma*, *N. clavata*, and *Chara gymnopus*.

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TABLE I.
Geographical Distribution of Characeae by Counties

Counties	Species	Collections	
		Kiener	Herbarium
ARTHUR	C. contraria	1	
	C. fragilis	4	
BANNER	C. foetida		1
BOYD	C. contraria		1
	C. foetida		1
BROWN	C. fragilis		1
BUFFALO	C. contraria	2	
CASS	C. coronata		1
	C. foetida		1
CHASE	C. contraria	2	
CHERRY	C. aspera		1
	C. contraria		4
	C. coronata		5
	C. evoluta		2
	C. foetida		4
	C. fragilis		6
	C. verrucosa		2
	C. contraria		1
DAWES	C. foetida		5
	C. fragilis		1
DAWSON	C. contraria	11	
DODGE	C. gymnopous	1	
DUNDY	C. contraria	2	
	C. foetida		1
FILLMORE	C. coronata	3	
FRANKLIN	C. coronata	1	
GARDEN	C. contraria	2	
GRANT	C. fragilis		1
GREELEY	C. foetida		1
HALL	C. contraria	3	
	C. fragilis	1	
HAMILTON	C. contraria	13	
	C. coronata	1	
	C. fragilis	4	
HITCHCOCK	C. contraria	1	
HOLT	C. fragilis		1
KEARNEY	C. sejuncta		1
KEITH	C. contraria	17	
	C. coronata	1	
	C. foetida	1	
	C. fragilis	7	
KIMBALL	C. foetida		1

TABLE I—(Continued)
Geographical Distribution of Characeae by Counties

Counties	Species	Collections	
		Kiener	Herbarium
LANCASTER	N. a. subglomerata		1
	N. opaca		1
LINCOLN	C. contraria	1	
MERRICK	C. foetida		1
MORRILL	C. foetida		1
PERKINS	N. batrachosperma	1	
	C. coronata	1	
	N. clavata	1	
PHELPS	C. coronata	1	
SHERIDAN	C. evoluta		1
SIOUX	C. evoluta		1
	C. foetida		1
	C. coronata		1
THOMAS	C. foetida		1
	C. fragilis		1
	C. fragilis		1
WEBSTER	C. fragilis		1
YORK	N. a. subglomerata		2
	N. axillaris		1
	C. coronata		1

TABLE II
Geographical Distribution of Characeae by Species

Species	Counties	Collections	
		Kiener	Herbarium
N. a. subglomerata	LANCASTER		1
	YORK		2
N. axillaris	YORK		1
N. batrachosperma	PERKINS	1	
N. clavata	PERKINS	1	
N. opaca	LANCASTER		1
C. aspera	CHERRY		1
C. contraria	ARTHUR	1	
	BOYD		1
	BUFFALO	2	
	CHASE	3	
	CHERRY		4
	DAWES		1
	DAWSON	11	
	DUNDY	2	
	GARDEN	2	
	HALL	3	
	HAMILTON	13	
(14 counties represented)			

TABLE II—(Continued)
Geographical Distribution of Characeae by Species

Species	Counties	Collections	
		Kiener	Herbarium
	HITCHCOCK	1	
	KEITH	17	
	LINCOLN	1 (55)	(6)
C. coronata	CASS		1
	CHERRY		5
	FILLMORE	3	
	FRANKLIN	1	
	HAMILTON	1	
(10 counties represented)	KEITH	1	
	PERKINS	1	
	PHELPS	1	
	THOMAS		1
	YORK	(8)	1 (8)
C. evoluta	CHERRY		2
	SHERIDAN		1
	SIOUX		1
C. foetida	BANNER		1
	BOYD		1
	CASS		1
	CHERRY		4
	DAWES		5
	DUNDY		1
(13 counties represented)	GREELEY		1
	KEITH	1	
	KIMBALL		1
	MERRICK		1
	MORRILL		1
	SIOUX		1
	THOMAS	(1)	1 (19)
C. fragilis	ARTHUR	4	
	BROWN		1
	CHERRY		6
	DAWES		1
	GRANT		1
(11 counties represented)	HALL	1	
	HAMILTON	4	
	HOLT		1
	KEITH	7	
	THOMAS		1
	WEBSTER	(16)	1 (12)
C. gymnopus	DODGE	1	
C. sejuncta	KEARNEY		1
C. verrucosa	CHERRY		2