TAXONOMY AND ECOLOGY OF KANSAS HEPATICAE

by

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INTRODUCTION

During the 90 years of botanical activity in Kansas, prior to the present work, the Hepaticae received little attention. A few publications mentioned liverworts and a few lists were prepared. It is significant that Frye and Clark (1937-47) list one species only from the state indicating that the general literature contained little on this group of plants in Kansas.

The first paper to report a hepatic from Kansas was that of Carruth (1873) in which he listed *Marchantia polymorpha* from Douglas County. Cragin (1884) noted Carruth's paper and reported *Reboulia hemisphaerica* from Clay and Ottawa Counties. Smyth and Smyth (1911) included 25 species of hepatics in their catalogue of the Flora of Kansas. Lorenz (1915) reported *Riccia frostii* from the state and Thompson (1948) reported *Sphaerocarpus michelii* and *Sphaerocarpus texanus*. Gier (1949) published a list of Kansas Hepaticae in which he listed 25 species based on the publication of Smyth and Smyth (1911). McGregor (1952) reported *Riccia rhenana* and Wittlake (1953) reported *Oxymitra androgyna* from the state. In most of these papers the hepatics are mentioned only incidental to other objectives or are merely lists of species occurring in the state, or new to the state.

For the past 7 years the author has made an extensive and intensive study of the Hepaticae of Kansas. Each of the 105 counties has been visited and all habitat types occurring

in the state have been observed. Most of these habitat types have been studied many different times and throughout all seasons of the year. A collection of each species was made from each location as it was found. In addition the same species was again collected from the same site at various times during the growing seasons. For each collection detailed notes were made to cover collection data, abundance and ecological conditions.

It is not the purpose of this work to prepare a taxonomic manual of the Hepaticae of Kansas but rather an attempt to record all species found to occur in the state, their abundance, morphological variations and to give a detailed study of their ecology in relation to other Hepaticae and to other vegetation. Such a study has never been made in this region of the United States. The only works to cover the ecology of a hepatic flora anywhere in the United States are the important publications on Central New York State by Schuster (1949) and the equally important work on Minnesota by Schuster (1953). Sharp (1939) included some ecological data on hepatics in his publication on Eastern Tennessee Bryophytes but for the most part his work is concerned with mosses. Many other papers have included a limited amount of hepatic ecologic data but not a complete account for a hepatic flora in a definite area of any size.

It was therefore considered worthwhile to study the hepatic flora of a state located in the center of the United

States; one in which the vascular flora shows a transition from the eastern forest areas to the short-grass prairies; and, at the same time, one that includes northern, southeastern and strong southern floristic affinities.

This work is divided into two parts. The first section is concerned with the taxonomic studies, referred to above, and the second section describes the ecology of the different taxa.

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TAXONOMIC STUDIES

In the following list are included all the described taxa of hepatics now known to occur in the state of Kansas. For each are given brief notes on the habitats, comparative frequency, distribution by counties and other pertinent taxonomic or morphological features.

At present the annotated list includes 70 taxa. This is believed to include nearly all the hepatics to be found in the state since few additional species have been found during the last two seasons.

The arrangement of taxa follows, in general, that of Schuster (1953) in so far as order of families and genera are concerned. The species are arranged alphabetically under each genus. Since most collections have been made by the writer they will be simply designated by placing an M before the collection number. All other records are designated following usual standard procedures. Unless otherwise mentioned all collections are deposited in the Herbarium of the University of Kansas.

Anthocerotaceae

1. Anthoceros crispulus (Mont.) Douin. Uncommon in our area but found in prairie swales where the characteristic plant association is dominated by Andropogon gerardi and Tripsacum dactyloides. It has also been found once in

an overgrazed pasture near a pond. In all habitats the soil was loam or clay, moist and shaded.

As noted by various authors A. crispulus is very closely related to A. punctatus. Proskauer (1948) who merged A. crispulus with A. punctatus considered A. crispulus to be a phase or modification of A. punctatus with surface outgrowths "especially in plants from relatively dry situations." This concept may be correct but the writer has not been able to verify it so far as Kansas material is concerned. A. punctatus has been found in several habitats much drier than those in which material referred to A. crispulus has been found and no sign of surface outgrowths has been noted. In one habitat hundreds of specimens of typical A. crispulus were found and nothing referrable to A. punctatus could be discovered. Yet, less than a mile away and on a drier prairie slope only A. punctatus could be found. In addition to the dorsal surface bearing crowded lamellae characteristic of A. crispulus and absent in A. punctatus, Kansas material of A. crispulus has pseudoelaters often 3 - 5 cells long and measuring up to 210μ long while A. punctatus has pseudoelaters only 1 - 2 cells long and 60 - 100μ long. The number of cells and length of pseudoelaters in both overlap, however, and do not always allow for easy separation on these points alone. Until more information is obtained it seems best to consider the two as separate taxa.

Distribution: DOUGLAS CO: 1 mile west of Pleasant

Grove, in bluestem prairie, July 18, 1951, M4987; July 24, 1951, M5001. JACKSON CO: 1 mile west of Hoyt, bluestem prairie, Aug. 22, 1951, M5076. JOHNSON CO: near Desoto, prairie pasture, October 2, 1951, R. H. Thompson. LEAVENWORTH CO: 3 miles northeast of Tonganoxie, bluestem prairie, Aug. 4, 1951, M5007.

2. Anthoceros punctatus L. Rather widely distributed in the eastern half of the state where it is found commonly on moist, sandy soil in prairie dominated by Andropogon gerardi, Sorghastrum nutans and Tripsacum dactyloides. It also occurs occasionally on alluvial deposits of creek banks, sandy oak-hickory woodlands, overgrazed prairie pastures, and along paths or trails in the sand dune areas of central Kansas.

The occurrence of the species in the state is directly related to rainfall. A dry winter and spring such as occurred in 1952-53 prohibits the appearance of the species for the season. During the 1953 season not a single mature plant was found while in contrast the very wet season of 1951 revealed an abundance of plants.

It should be noted that in Kansas the species occurs most frequently in relatively moist, sandy prairie and less commonly on limestone prairie. Its occurrence in woodlands is usually in close association with such prairie areas and the occurrence on alluvial deposits is attributed to water dispersal.

The frequency of occurrence of this species was determined by use of meter quadrats dispersed at random in a prairie area. It was found that an average of 33 plants per meter quadrat existed in a prairie of some 160 acres. Most of these occurred around the base of Andropogon gerardi clumps. A casual study of such an area might lead one to believe that the usual habitat was along the more moist drainage areas. However the large number of plants found along moist ditches and banks seems to be due to a concentration of spores by drainage from the "mother lode" which actually is dispersed over a large area and thus might escape notice. The same condition is to be found in forested areas.

Kansas specimens of A. punctatus seem to agree with descriptions given for the species except that they are usually at the lower range given for size of the thallus and length of the sporangium.

Distribution: ALLEN CO: 5 miles north of Moran, alluvial deposit on creek bank, Oct. 8, 1948, M2503; 1 mile south of Humbolt, oak wooded hillside, July 7, 1949, M3334. ANDERSON CO: 5 miles south of Garnett, creek bank, Oct. 8, 1948, M2488; 2 miles south of Garnett, clay soil in oak woods, June 4, 1951, M4877. BOURBON CO: 2 miles south of Uniontown, rocky, moist hillside, Oct. 8, 1948, M2514; 1 mile south of Uniontown, creek bank, July 7, 1949, M3344. CHEROKEE CO: 5 miles east of Baxter Springs, clearing in oak woods, April 30, 1948, M1363; 5 miles east of Baxter

Springs, creek bank, July 31, 1948, M1939. CLAY CO: 5 miles north of Morganville, sandy bluestem prairie, Aug. 16, 1951, M5069. CLOUD CO: on soil, Sept. 13, 1948, Rev. S. V. Fraser. CRAWFORD CO: lespedeza pasture, Nov. 24, 1949, L. J. Gier 2952. DOUGLAS CO: 2 miles southeast of Baldwin City, creek bank, Nov. 2, 1947, M1133; 1 mile west of Pleasant Grove, swale in bluestem prairie, July 24, 1951, M4999. ELLSWORTH CO: 3 miles northeast of Carneiro, low moist prairie, May 22, 1948, M1499. FRANKLIN CO: 1 mile southeast of Ottawa, wooded hillside, June 28, 1949, M3308. HARVEY CO: 5 miles north of Burrton, cattle trail through sand dunes, June 11, 1951, M4915. JACKSON CO: 1 mile west of Hoyt, bluestem prairie, Aug. 22, 1951, M5075. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandy bluestem prairie, May 7, 1948, M1408; 2 miles west and 1 mile south of Linwood, sandy oak-hickory woods, June 16, 1949, M3086. MONTGOMERY CO: 3 miles south of Elk City, sandy oak woods, April 4, 1942, R. H. Thompson. NEMAHA CO: sandy bluestem prairie, Aug. 9, 1948, M2018. OSAGE CO: 6 miles south of Quenemo, moist bank in oak woods, July 1, 1949, M3324. OTTAWA CO: Ottawa Co. State Park, seepy area below sandstone outcrop, May 21, 1948, M1466. RENO CO: 6 miles northeast of Hutchinson, cattle path through sand dunes, June 11, 1951, M4955. SALINE CO: 2 miles northwest of Brookville, moist sandy prairie ravine, May 22, 1948, M1478. WASHINGTON CO: 2 miles southwest of Palmer, sandy bluestem prairie, May 27, 1951,

M4827. WILSON CO: 1 mile northeast of Neodesha, open sandy oak woods, April 10, 1948, M1271. WOODSON CO: 2 miles northwest of Yates Center, on shallow soil over surfacing sandstone in prairie, April 9, 1948, M1244; Lake Fegan, sandy path in oak woods, June 19, 1949, M3191.

3. Phaeoceros laevis (L.) Proskauer. Found commonly on shaded moist sandstone ledges, less frequently on creek banks, seepy areas below ledges and springs. It rarely occurs elsewhere and seldom with Anthoceros punctatus and A. crispulus. It is an almost constant associate with Conocephalum conicum, Plectocolea hyalina, and often with Reboulia hemisphaerica.

P. laevis occurs characteristically as extensive mats on the sides of shaded, moist sandstone ledges along creek banks, ravines and often on boulders in stream beds.

Kansas material of P. laevis seems to match closely the descriptions given for the species. However, in some of the collections from very moist habitats mature specimens often exhibit the characters of Phaeoceros carolinianus (Michx.) Proskauer in that the involucres do not flare and marginal glandular thickenings are to be found. These characters are by no means constant and seem to intergrade with P. laevis in which the involucre does flare at the summit and glandular thickenings are rare. One colony, represented by collections M1058, M3105, M4147, M4673 and M5003, has been studied each year from 1947 through 1953.

Usually a few involucres do not flare at the mouth and some glandular thickenings do occur but in 1951, a year of record rainfall, most of the involucres did not flare and glandular thickenings were rather frequent. It thus seems best not to consider P. carolinianus as a distinct taxon. Schuster (1953) noted these conditions and reduced carolinianus to a forma of P. laevis. It might be best considered thus, but Kansas material intergrades so completely that separation here seems unwarranted.

Distribution: ANDERSON CO: 5 miles south of Garnett, creek bank, October 8, 1948, M2489. CHAUTAUQUA CO: 3 miles northeast of Sedan, moist sandstone ledge, July 1, 1947, M1073; 1½ miles northeast of Sedan, on moist sandstone rocks, July 8, 1949, M3381. DOUGLAS CO: 5 miles west of Baldwin City on moist sandstone ledge, June 24, 1947, M1058; June 18, 1949, M3105; Oct. 15, 1949, M4147; Sept. 16, 1950, M4673; Aug. 2, 1951, M5003. ELK CO: 10 miles north of Busby, sandy soil below a spring, July 27, 1948, M1917. FRANKLIN CO: 4 miles southwest of Ottawa, moist sandstone ledge, June 18, 1949, M3097. GREENWOOD CO: near Severy, Sept. 2, 1945, R. H. Thompson; 5 miles northeast of Fall River, moist sandstone ledge, July 17, 1947, M1075; 1 mile east of Fall River, on moist sandstone rocks, July 9, 1949, M3413. LABETTE CO: 4 miles north of Chetopa, creek bank, July 2, 1948, M1620. LEAVENWORTH CO: 5 miles southwest of Leavenworth, moist sand-stone ledge, July 27, 1947, M1078. LINCOLN CO: 10 miles

southeast of Lincoln, moist sandstone ledge, Sept. 4, 1950, M4651. MONTGOMERY CO: 3 miles southwest of Elk City, moist sandstone rocks, and cattle trail through oak woods, July 1, 1947, M1068; Sept. 1, 1948, M2385; Sept. 22, 1951, M5221. WASHINGTON CO: 1 mile west of Linn, on moist sandstone ledge in prairie ravine, Aug. 23, 1947, M1086; Aug. 10, 1948, M2055; 2 miles west of Linn, sandstone ledge on creek bank, Aug. 22, 1952, M5712, M5715. WILSON CO: 3 miles west of Neodesha, edge of pond in sandy prairie, June 30, 1947, M1065. WOODSON CO: 2 miles northwest of Yates Center, moist sandstone ledge, Oct. 26, 1947, M1128; 8 miles south and 4 miles west of Yates Center, moist sandstone ledge, Sept. 27, 1952, M6064. WYANDOTTE CO: 5 miles northwest of Bonner Springs, on moist sandstone ledge, July 27, 1947, M1080.

4. Notothylas orbicularis (Schwein.) Sulliv. Widely distributed over the eastern half of the state. It has been found abundantly in a few prairies dominated by Andropogon gerardi and Tripsacum dactyloides. These areas include sandy soils and heavy loam soils. N. orbicularis is found in such areas in moist prairie swales. The species has been found twice on alluvial deposits along stream banks, once in an overgrazed tame grass pasture and once in a thicket of Rubus argutus in a clearing on an oak-hickory wooded hillside.

In one moist prairie swale N. orbicularis was found to average over 150 plants per meter quadrat in an area three

acres in extent. It was not to be found on alluvial deposits in the drainage area below this prairie or in adjacent prairies with the equivalent habitat sites.

All collections of N. orbicularis seem to agree morphologically with published descriptions.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, alluvial deposit along Shoal Creek, Aug. 30, 1948, M2356. CLAY CO: sandy bluestem prairie, Aug. 16, 1948, M5070. DOUGLAS CO: 1 mile west of Pleasant Grove, bluestem prairie, July 17, 1941, M4985; July 24, 1951, M5001. JACKSON CO: near Desoto, overgrazed pasture, Oct. 2, 1951, R. H. Thompson. LEAVENWORTH CO: 3 miles northeast of Tonganoxie, bluestem prairie, Aug. 4, 1951, M5008. WASHINGTON CO: 1 mile northeast of Linn, sandy bluestem prairie, Aug. 21, 1951, M5074. MIAMI CO: Miami Co. State Park, river bank, Oct. 3, 1948, M2467. WILSON CO: 1 mile northeast of Sedan, sandy soil, Rubus thicket, clearing in oak woods, May 1, 1948, M1380.

Sphaerocarpaceae

5. Sphaerocarpus michelii Bellardi. Found on sandy soil near surfacing sandstone and in bare areas between clumps of Andropogon gerardi in sandy bluestem prairies. Plants are to be found in the spring, usually maturing in April in this region.

S. michelii is found most abundantly in a spring following

a summer and fall of above average rainfall. In other years it is rare or absent. In this respect the species is like S. texanus and therefore is not a plant characteristic of the same habitat year after year.

One site, 5 miles west of Baldwin City, Douglas County, has been studied several years in succession. S. michelii and S. texanus are both found in this sandy, overgrazed prairie pasture. The abundance of plants to be found is directly correlated with rainfall and degree of removal of cover. A moist summer and fall with a simultaneous major reduction in grass cover has twice resulted in an abundance of Sphaerocarpus in this area. Meter quadrat studies revealed an average of 223 plants of S. michelii and S. texanus per meter quadrat over an area of two acres. S. texanus dominated at the rate of 12 to 1. In normal seasons and with more cover the abundance of Sphaerocarpus was reduced to an average of 18 plants per meter quadrat over the same area and S. texanus was dominant over S. michelii by a rate of over 30 to 1.

Sphaerocarpus michelii is not always easily separated from S. texanus in our area. It has never been found in pure colonies for S. texanus is invariably present and dominant in number of plants. S. texanus, however, has been found many times in pure colonies. Haynes (1910) described the chief differences separating S. texanus from S. Sphaerocarpus (S. michelii) to lie "in the more pointed fusiform-

clavate rather than obovoid involucres, in the meshes of the surface of sporetetrads being nearly twice as wide, and in the high ridges forming these meshes being sinuous or crenulate-margined or irregularly dissected, or occasionally rising into obtuse spines at the points of intersection, but never forming sharp needle-like spines as in S. Sphaerocarpus." Frye and Clark (1937-1947) report that the most reliable character separating S. michelii from S. texanus is the sharply spinose spore of the former. Frye and Clark also give the size of the spore tetrad as 80 - 110μ in diameter for S. michelii and 72 - 170μ in diameter for S. texanus while Haynes (1910) gives the size as 90 - 120μ for S. michelii and 72 - 171μ for S. texanus.

Studies on Kansas collections of these two species indicates clearly that the shape of the involucre is of no value in separating these taxa. The size of the spore tetrad is likewise of little use as the average size for both species is 108 - 110μ. S. texanus has the largest and also the smallest tetrads of the two and thus size alone is of little significance. The only constant character which can be used to separate the species is the size of the meshes on the spore tetrad. In S. michelii these range from 9 - 16.5μ while on S. texanus they range from 16 - 30μ with the average being 21μ.

S. michelii in its best expression has the ridges separating the spines low, their intersections with very

acute or acicular spines. S. texanus characteristically has intersections spineless or with blunt spines. Kansas material, however, reveals a number of specimens in which these spine characters are intermediate and in which the ridges separating the meshes also intergrade. Haynes (1910) illustrates considerable variation of S. texanus spores. These variations are present in the species from our area. It seems possible, then, that some degree of hybridization has occurred but as yet this is only surmised.

S. michelii was first reported authentically from the United States by Frye and Clark (1937-1947) as occurring in Austin, Texas. Thompson (1948) reported the species from Shawnee County, Kansas. In addition to the Kansas records listed below the writer has collected the taxon from Arkansas and Oklahoma.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, sandy clay soil, April 30, 1948, M1357. DOUGLAS CO: 5 miles west of Baldwin City, sandy bluestem prairie, April 18, 1948, M1343. ELK CO: 10 miles north of Busby, sandy prairie, April 10, 1948, M1346. GREENWOOD CO: 1 mile northeast Fall River, sandy prairie, April 10, 1948, M1347. LEAVENWORTH CO: sandy clearing in oak-hickory woods. MONTGOMERY CO: 3 miles south of Elk City, sandy soil over surfacing sandstone, April 4, 1942, R. H. Thompson. SHAWNEE CO: Calhoun bluffs, north of Topeka, sandy soil, March, 1942, April, 1942, David Clark. WILSON CO: 2 miles

northeast of Neodesha, sandy soil in oak-hickory woods, April 10, 1948, M1345. WOODSON CO: 2 miles northwest of Yates Center, sandy soil in prairie pasture, April 9, 1948, M1344.

6. Sphaerocarpus texanus Aust. Widely distributed over the eastern half of the state. It occurs most abundantly on sandy bluestem prairie dominated by the big bluestem Andropogon gerardi. In these prairies it occurs in bare areas between the grass or around the base of the grass. Other habitats consist of trails or paths through sandy, or sandy clay-loam woods, alluvial deposits of streams, overgrazed pastures, and shallow soil over surfacing sandstone. It is rarely found on calcareous soils.

S. texanus is essentially a spring or early summer species and in this region produces mature spores in April and May. Druing the summer it is not to be found but in the fall it occurs from September to November on alluvial soils of stream banks, seepy areas and other very moist sites. It has never been found fruiting in the fall, a fact which may be due to a lack of development of male plants. A careful search, in the fall, has failed to reveal the presence of male plants at that time.

Morphological variations and other taxonomic points of S. texanus are discussed under S. michelii above.

The distribution of S. texanus in Kansas is undoubtedly greater than indicated below since many sterile plants have

been seen but not collected. It almost certainly occurs in all counties of the eastern third of Kansas.

Distribution: CHAUTAUQUA CO: 3 miles north of Elgin, sandy prairie pasture hilltop, April 5, 1952, M5348. CHEROKEE CO: 5 miles east of Baxter Springs, rocky clay soil in clearing of oak-hickory woods, April 30, 1948, M1356. COFFEY CO: 2 miles southwest of LeRoy, sandy prairie pasture, April 9, 1948, M1238. COWLEY CO: 3 miles southeast of Arkansas City, sandy clay soil in open woods, April 11, 1948, M1301. DOUGLAS CO: 12 miles south of Lawrence, sandy prairie pasture, April 18, 1948, M1342; 5 miles northwest of Lawrence, moist soil in cattail-sedge marsh, May 14, 1948, M1420; 5 miles west of Baldwin City, sandy overgrazed prairie meadow, March 25, 1948, M1165; 2 miles northeast of Lawrence, alluvial deposit on bank of Kansas River, June 12, 1952, M5605. ELK CO: 10 miles north of Busby, sandy clay soil in prairie, April 10, 1948, M1288. ELLSWORTH CO: 5 miles east of Carneiro, sandy soil in prairie, April 30, 1949, M2699. FRANKLIN CO: 1 mile northeast of Norwood, sandy prairie pasture, April 2, 1948, M1226. GREENWOOD CO: 1 mile northeast of Fall River, sandy soil, clearing in oak woods, April 10, 1948, M1292. JEFFERSON CO: 1 mile west of Medina, sandy clay pasture, April 2, 1948, M1232. LABETTE CO: sandy soil, oak woods, April 10, 1948, M1268. MONTGOMERY CO: 3 miles south of Elk City, oak woods, April 4, 1942, R. H. Thompson. NEOSHO CO: east of Chanute, sandy

soil, February 14, 1945, R. H. Thompson; 2 miles northeast of Chanute, sandy soil, clearing in oak woods, April 9, 1948, M1259; 3 miles east of Chanute, sandy soil, May 12, 1951, R. H. Thompson. RICE CO: 1 mile east of Genesco, sandy prairie pasture, April 30, 1949, M2710. RILEY CO: near Manhattan, alluvial deposit, bank of Kansas River, April 30, 1949, Lucille Paslay. SALINE CO: 2 miles northwest of Brookville, sandy prairie pasture, April 30, 1949, M2691. SHAWNEE CO: 7 miles southeast of Topeka, clay soil in severely overgrazed pasture, April 23, 1949, M2686. WILSON CO: 1 mile northeast of Neodesha, sandy soil over surfacing sandstone, April 10, 1948, M1274. WOODSON CO: 2 miles northwest of Yates Center, sandy prairie, April 9, 1948, M1247; March 26, 1948, M2650. WYANDOTTE CO: 1 mile northeast of Bonner Springs, sandy clearing in oak woods, May 15, 1948, M1442.

Lophoziaceae

7. Lophozia bicrenata (Schmid.) Dumort. This species is rare in Kansas having been found in two rather distant sites. In both places it occurred on the bare, dry crest of small sandy cliffs and is one of the most xerophytic of our Kansas leafy hepaticae.

A careful search of many suitable habitats for the species has been made without success. It agrees morphologically with published descriptions of the species.

Distribution: WASHINGTON CO: 1 mile west of Linn, on dry sandy soil at crest of small cliff over sandstone outcrop, Aug. 22, 1952, M5723. WOODSON CO: Woodson County State Park, exposed sandy soil at top of small cliff, March 26, 1949, M2643.

Jungermanniaceae

8. Jamesoniella autumnalis (D. C.) Steph. A species restricted to rather undisturbed oak-hickory wooded hillsides where it occurs on shaded sandstone outcrops or among mosses below decaying logs. It also is to be found on sandy clay soils and on small cliffs in the forest.

Due to its habitat requirements J. autumnalis occurs most frequently in northeastern Kansas where it is abundant in two sites. It has not been found in fruit and occurs as a rather large shade form which is light green in color except in dry seasons when it has a decided reddish tinge. It agrees well with published descriptions of the species otherwise.

Distribution: DOUGLAS CO: 2 miles north of Baldwin City, sandy clay soil, hillslope in mixed woods, March 30, 1952, M5325; 5 miles west of Baldwin City, shaded sandstone outcrop, April 26, 1952, M5441; 2 miles north of Baldwin, rotten log, July 19, 1952, M5660. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, shaded sandstone cliff, June 1, 1952, M5663. WOODSON CO: 2 miles northwest of Yates Center,

side of moist sandstone rocks, March 29, 1949, M2651; Oct. 28, 1951, M5295; Sept. 27, 1952, M6072.

9. Jungermannia lanceolata L. This species has been found but once in Kansas and then in the northeastern quarter in an area characterized by a flora with decided east and northeastern affinities.

A small colony of typical appearing J. lanceolata was found on sandy soil under an overhanging sandstone cliff. The surrounding areas, though carefully studied, failed to reveal additional specimens. The small colony, six inches long, has maintained itself and seems to be enlarging.

Specimens studied agree very well with published descriptions except that it seems regularly to produce gemmae.

Distribution: LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandy soil under an overhanging sandstone cliff, June 1, 1952, M5579.

10. Plectocolea crenuliformis (Aust.) Mitt. Rare in Kansas having been found but once. This site consisted of a shaded, moist, overhanging sandstone ledge on which the plants occurred as pure green mats but which were reddish-brown when the growth extended beyond the edge of the overhanging rock and were thus exposed.

The one collection of this species has the leaf margins swollen, oil-bodies 7.5μ in diameter and numbering 5 - 10 per cell of the leaf. In these and other characters the specimens agree with descriptions of the species.

Distribution: WOODSON CO: 8 miles south and 4 miles west of Yates Center, underside of moist, shaded, overhanging sandstone ledge, Sept. 27, 1952, M6062.

11. Plectocolea fossombronioides (Aust.) Mitt. Rare in Kansas but has been collected in five counties in the eastern third of the state. It has been found only on the sides of moist sandstone ledges along shaded creek banks where it forms extensive green mats often covering several square feet of rock. It seems to tolerate severe flooding and may prefer such conditions as it is most abundant on rock ledges inundated by high water.

Kansas specimens are clearly bisexual, have small barely evident trigones, purplish rhizoids and typically crenulate perianths. These features, characteristic of the species, serve to separate P. fossombronioides from other species of the genus in this area.

Distribution: CHAUTAUQUA CO: 3 miles northeast of Sedan, moist sandstone ledge, March 26, 1948, M1218; April 12, 1950, M4200a. DOUGLAS CO: 5 miles west of Baldwin City, on moist sandstone rocks, Aug. 26, 1948, M2312; April 22, 1950, M4233. ELK CO: 10 miles north of Busby, sandstone rocks, July 27, 1948, M1915. LEAVENWORTH CO: 1 mile south of Kent, moist sandstone ledge, May 15, 1948, M1424; M1425. WOODSON CO: 2 miles northwest of Yates Center, moist sandstone ledge, April 9, 1948, M1241; Sept. 24, 1949, M1949.

12. Plectocolea hyalina (Lyell) Mitt. This species

has the general range and distribution of P. fossombronioides. It seems, however, to tolerate a wider range of habitat particularly in the ability to grow on drier sandstone rocks. It is also much more abundant than the above species with which it occurs in most sites studied.

Extensive mats of P. hyalina are reddish purple in early spring but later in the season, after unfolding of tree leaves, they become light green or nearly transparent. A characteristic of the species is the sheathing, orbicular bracts which seem to fuse with the perianth for a distance and from between which the perianth projects. This seems to vary in our collections from a rather loose to a tight ensheathing condition. The length of projection of the perianth seems also to vary. Rhizoids are reddish in color on drier sites and light yellowish-pink on more moist places. Spore size varies from 13 - 17μ in diameter and elaters are usually 9 - 10μ in diameter.

The amount of morphological variation in the species indicates that a careful detailed study of the plant is desirable. This has also been indicated by Frye and Clark (1937-1947) and Schuster (1953).

Distribution: CHAUTAUQUA CO: 1½ miles northeast of Sedan, on moist sandstone ledge, April 5, 1952, M5338. DOUGLAS CO: 5 miles west of Baldwin City, on moist sandstone rocks, Aug. 26, 1948, M2313; Nov. 7, 1948, M2575; Oct. 15, 1949, M4149; Oct. 15, 1951, M5252. LEAVENWORTH CO:

6 miles northeast of Tonganoxie, on moist sandstone ledge, Aug. 24, 1948, M2264. MONTGOMERY CO: 3 miles southwest of Elk City, moist sandstone ledge and sandy soil below ledge, Sept. 22, 1951, M5227. WOODSON CO: 2 miles northwest of Yates Center, moist sandy soil at base of cliff, Oct. 28, 1951, M5277; 6 miles south and 4 miles west of Yates Center, moist sandstone rock, Sept. 27, 1952, M6072.

Plagiochilaceae

13. Plagiochila asplenioides (L.) Dumort. Rare. Found once in the extreme southeast corner of the state in the small segment of Ozark flora which extends just into the state. It occurred on a steep, north facing, heavily wooded cliff. A colony some three inches long was found at the base of a large oak. The same colony has existed for the past several years but seems to barely survive. A thorough search of the surrounding areas failed to reveal more plants.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, base of large oak, north facing cliff, July 4, 1948, M1746.

Harpanthaceae

14. Geocalyx graveolens (Schrad.) Nees. Rare. Has been found in only three places in eastern Kansas. In each place the plants were on subcalcareous conditions usually

calcareous sandy areas rich in humus.

The characteristic yellow-green opaque color seems to be very outstanding in Kansas material but the perigynia produced are few in number and are usually small and spherical. Even mature plants do not exhibit the prominent cylindrical perigynia found in the species in the eastern regions of this country. Otherwise the specimens agree favorably with descriptions of the species.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, sandy soil on wooded hillside, Oct. 22, 1951, M5262. DOUGLAS CO: 2 miles north of Baldwin, sandy clay soil in rich woods, May 10, 1952, M5470. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, calcareous sandstone, wooded bluff, June 1, 1952, M5573.

Lophocoleaceae

15. Lophocolea minor Nees. Rare. Found once in the Ozark area of extreme southeastern Kansas. It was growing among mosses on sandy soil below sandstone and limestone outcrops. A careful search of the area indicated that the species was not common but scattered among clumps of mosses such as Leucobryum glaucum. The plants produced numerous globular masses of gemmae and were typical of the species.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, growing in clumps of Leucobryum glaucum, May 9, 1953, M7202.

16. Lophocolea bidentata (L.) Dumort. Infrequent. Found on moist sandstone ledges and sandy-loam soil of hillsides in woodlands. It never is found in abundance but occurs among mosses on sandstone ledges or among mosses and debris on hillsides.

Kansas plants of this species are consistantly sterile, light green in color and resemble the following listed species to such an extent that it may have been overlooked in the past.

Distribution: DOUGLAS CO: 2 miles north of Baldwin City, on decaying leaves, wooded hillside, March 30, 1952, M5323; on sandy soil among mosses, July 19, 1952, M5661; M5663. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, moist sandstone ledge, June 1, 1952, M5574. MONTGOMERY CO: 3 miles southwest of Elk City, sandy soil among mosses, Sept. 22, 1951, M5228. WOODSON CO: 2 miles northwest of Yates Center, on moist sandstone ledge, Oct. 28, 1951, M5294.

17. Lophocolea heterophylla (Schrad.) Dumort. Widely scattered in eastern Kansas. Where found it is usually abundant but many suitable appearing habitats are without the species. It seems able to tolerate a large variety of habitats from moist rotting logs to dry sandy-clay soils of oak-wooded cliffs where it may cover the ground over large areas. It is strange that it is not more evenly distributed in eastern Kansas as it fruits freely and succeeds

very well in some of our most common habitats.

The species shows all the usual morphological variations described and seems typical of the taxon as generally known.

Distribution: ATCHISON CO: 1 mile south of Oak Mills, sandy-clay soil among mosses, July 14, 1948, M1803. CHAUTAUQUA CO: 2 miles northeast of Sedan, sandy soil among mosses and lichens, Aug. 10, 1950, M4395. CHEROKEE CO: 5 miles east of Baxter Springs, among mosses on limestone ledge, April 26, 1947, M1020; on sandy-clay soil, July 31, 1948, M1924; Aug. 30, 1948, M2354. DOUGLAS CO: 2 miles north of Baldwin, base of tree on bark, June 20, 1948, M1588; clay soil, among mosses, June 4, 1951, M4855; sandy-loam bank, Oct. 15, 1951, M5251; on rotten log, March 30, 1952, M5322; 5 miles west of Baldwin City, sandy soil and among Leucobryum glaucum and Cladonia spp., April 26, 1952, M5439, M5469. JOHNSON CO: 2½ miles south of Stanley, moist calcareous soil, wooded cliff, Aug. 30, 1948, M2337. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, on thin soil over sandstone ledge, June 1, 1952, M5568, M5576. LINN CO: 3 miles north of Pleasanton, on sandy-clay soil, Aug. 1, 1948, M1949. MONTGOMERY CO: 3 miles southwest of Elk City, sandy soil, ledge in oak woods, Sept. 1, 1948, M2386; Sept. 22, 1951, M5229. NEOSHO CO: 2 miles east of Chanute, sandy soil, April 17, 1949, R. H. Thompson. SHAWNEE CO: 5 miles east of Topeka, rotten log, April 23, 1949, M2677.

WILSON CO: 1 mile northeast of Neodesha, on sandy soil among mosses and lichens, Aug. 31, 1948, M2377. WOODSON CO: 1 mile northwest of Yates Center, sandy bank, Oct. 20, 1951, M5294.

18. Chiloscyphus pallescens (Ehrh.) Dumort. Rare. One site known for the species in the state. At this site the plant is rather common along a sandstone cliff which is about a mile long. Here the plant is found on the sides of moist sandstone ledges and on sandy soil below the ledges.

Distribution: LEAVENWORTH CO: 4 miles northeast of Tonganoxie, on side of sandstone ledge, Oct. 29, 1948, M2564; on sandy soil below sandstone ledge, June 1, 1952, M5567.

19. Chiloscyphus pallescens (Ehrh.) Dumort. var. fragilis (Roth) K. Müller. Rare. Found only with the species mentioned above but in more moist situations. The variety differs from the species in the larger cells of the leaves, darker color and requirement for a more moist habitat. It seems doubtful whether var. fragilis merits taxonomic status but needs more study.

Distribution: LEAVENWORTH CO: 4 miles northeast of Tonganoxie, on side of very moist sandstone ledge, June 11, 1948, M1579; June 1, 1952, M5569.

Scapaniaceae

20. Diplophyllum apiculatum (Evs.) Steph. Rare. Found once in the Ozark area of the extreme southeast corner of

the state. It was growing on a rocky, clay-loam wooded hillslope. Plants were not common and occurred only in mats of Scapania nemorosa.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, rocky, clay-loam hillside, among Scapania nemorosa, April 30, 1948, M1361a.

21. Scapania irrigua (Nees) Dumort. Rare. Characteristic specimens of the species were found once on a very moist depression on the side of a sandstone cliff. The plants were not numerous and occurred only in the depression which was kept moist by a small spring above it.

Distribution: LEAVENWORTH CO: 4 miles northeast of Tonganoxie, depression in sandstone cliff, May 7, 1948, M1390.

22. Scapania nemorosa (L.) Dumort. Abundant in sandstone areas of eastern Kansas much less common on clay-loam hillsides and absent from all but very moist calcareous sites. Where found, S. nemorosa may form large mats on moist sandstone ledges or be generally distributed on soil, among mosses, or on sandy banks. Elsewhere the species forms isolated colonies among mosses.

In our area S. nemorosa usually forms abundant one-celled, reddish or reddish-brown gemmae. However, it may often produce few gemmae and these may be light green in color or scarcely pigmented. The expression of the denticulate leaf margin is highly variable. In some collections

the leaves are sharply spinous-dentate and in others it is barely evident. This may be correllated with amount of moisture and exposure though study fails to verify this conclusively. The latter plants are difficult to separate from S. undulata due to these variable conditions. Also S. undulata occurs with nemorosa though it is never as common or abundant. S. undulata, of our area, characteristically has 2-celled, light green gemmae, a leaf margin with a distinct border of several rows of thick walled cells, and ventral lobes of leaf rather indistinctly decurrent. S. nemorosa has leaves with all cells collenchymatous, gemmae are one celled and reddish-brown, and the leaf lobe is distinctly decurrent.

Distribution: CHAUTAUQUA CO: 3 miles northeast of Sedan, sandy soil, March 26, 1948, M1217; May 1, 1948, M1369; July 8, 1949, M3382; April 5, 1952, M5337. CHEROKEE CO: 5 miles east of Baxter Springs, rocky wooded hillside, April 30, 1948, M1361. DOUGLAS CO: 5 mile west of Baldwin City, on moist sandy bank, Oct. 18, 1947, M1144; Nov. 7, 1948, M2574; June 18, 1949, M3106; Sept. 16, 1950, M4672; April 26, 1952, M5441. FRANKLIN CO: 4 miles southwest of Ottawa, moist sandy bank, June 18, 1949, M3098. GREENWOOD CO: 6 miles north of Fall River, on sandstone ledge, July 27, 1948, M1907, M1908; 1 mile east of Fall River, sandy bank, April 13, 1949, M2671; July 8, 1949, M3412. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, moist sandstone

ledge, May 7, 1948, M1400. MONTGOMERY CO: 6 miles south of Elk City, moist sandy bank, March 26, 1948, M1186; 3 miles southwest of Elk City, sandy bank, Sept. 1, 1948, M2389; Sept. 22, 1951, M5226. WOODSON CO: 2 miles northwest of Yates Center, moist sandstone ledge, June 19, 1949, M3197; Oct. 28, 1951, M5285.

23. Scapania undulata (L.) Dumort. Rare. Collections of this species have been made several times in two similar habitats. These consist of wooded sandstone cliffs with northern exposure and usually very moist. All plants were found among mosses such as Atrichum angustatum, Dicranum scoparium, Entodon seductrix, Pohlia nutans and Leucobryum glaucum. These mosses, with S. undulata and often S. nemorosa, form a dense mat over moist sandy banks.

Distribution: DOUGLAS CO: 2 miles north of Baldwin City, sandy bank, July 19, 1952, M5659. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandy moss covered cliff, Aug. 24, 1948, M2261; 2265, June 1, 1952, M5565.

Cephaloziellaceae

24. Cephaloziella byssacea (Roth) Warnstf. Rare. Found on the crests of moist sandy ledges which are only partially shaded. It is usually intermingled with various mosses and species of Cladonia. This species undoubtedly has a greater distribution than is indicated below.

Distribution: GREENWOOD CO: 6 miles north of Fall

River, crest of moist, partially shaded, sandy cliff, July 27, 1948, M1913. MONTGOMERY CO: 6 miles south of Elk City, crest of moist sandy cliff, March 26, 1948, M1187.

25. Cephaloziella hampeana (Nees) Schiffn. Rare. Found admixed with other hepatics and mosses on moist sandstone ledges and seepy sandy banks particularly where limestone occurs associated with the above habitats.

Distribution: CHAUTAUQUA CO: 2 miles northeast of Sedan, sandy soil on seepy bank, April 5, 1952, M5343. DOUGLAS CO: 2 miles north of Baldwin City, sandy subcalcareous moist bank, July 19, 1952, M5666. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandy subcalcareous bank, June 1, 1952, M5575.

26. Cephaloziella rubella (Nees) Douin. Widely distributed in the eastern half of the state and abundant in many of the sites. It is a distinct xerophyte and occurs on denuded crests of sandstone cliffs which are dry through most of the year or which dry quickly after rainfall. It also occurs in sandy or sandy-clay oak-hickory forest where it is found on denuded or eroded banks, base of trees or along the edge of road cuts and trails. It occasionally is to be found on the sides of moist sandstone ledges.

On some of the dry crests of sandstone ledges this is the only hepatic to be found and often forms reddish-brown or blackish mats which may cover several square feet.

C. rubella seems to be quite variable even in the same

colony. Little sods of the species have been collected which were mostly autoecious. Such plants would be referred to Cephaloziella rubella (Nees) Douin var. bifida Lindb.; however, the character is not constant and a colony usually shows some autoecious plants though mostly paroecious plants are to be found. This condition is apparently not related to moisture or exposure factors.

In some of the more moist sites and particularly those in which more humus is found one encounters plants which might be referred to C. rubella var. sullivantii (Aust.) K. Müller. They have leaf cells 9 - 12μ wide and walls which are a little thinner than in C. rubella. Also the involucral bracts form a ring of 7 - 9 lobes and are dentate on the margin while in C. rubella the ring has 5 - 6 lobes which are only slightly dentate to entire. However, none of the specimens show the minute underleaves of var. sullivanti and since the other characters seem to be quite variable it seems best not to segregate specimens from Kansas into varieties. If such segregation were attempted it would mean that var. rubella var. bifida and var. sullivantii would all occur in the same colony.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, moist sandy-clay soil, crest of cliff, Oct. 22, 1951, M5270. DOUGLAS CO: 12 miles south of Lawrence, dry sandy crest of ledge, Oct. 13, 1951, M5243, M5250; 5 miles west of Baldwin City, ledge above sandstone outcrop, March 12, 1952,

M5321, M5324; April 26, 1952, M5432; 4 miles north and 5 miles east of Baldwin City, edge of road cut in sandy oak woods, May 3, 1952, M5460. ELLSWORTH CO: 2 miles north and 4½ miles west of Langley, bare sandy soil, crest of cliff, May 3, 1952, M5444, M5451. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandy bank in oak-hickory woods, June 1, 1952, M5564, M5565. MONTGOMERY CO: 3 miles southwest of Elk City, on side of dry sandstone ledge, Sept. 22, 1951, M5224, M5225, M5226. WASHINGTON CO: 2 miles west of Linn, dry sandy soil over surfacing sandstone, Aug. 22, 1952, M5717, M5721. WOODSON CO: 2 miles northwest of Yates Center, side of dry sandstone ledge, Oct. 28, 1951, M5276, M5286; 8 miles south and 4 miles west of Yates Center, side of sandstone rock, Sept. 27, 1952, M6066.

Cephaloziaceae

27. Cephalozia bicuspidata (L.) Dumort. Rare. Found on moist sandstone ledges usually on the under side of overhanging rocks which are kept moist by seepage. It was discovered once among mosses on a sandy-clay hillslope in oak-hickory forest.

Distribution: DOUGLAS CO: 2 miles north of Baldwin City, sandy-clay soil, among mosses, July 19, 1952, M5662. WOODSON CO: Lake Fegan, Woodson County State Park, on under side of moist, overhanging sandstone ledge, March 26, 1949,

M2644, M2645; Sept. 24, 1949, M4131.

38. Cephalozia catenulata (Huben.) Spr. Rare. This species was found once on the side of a moist, sandy-clay bank in an oak-hickory woods. The plants formed an extensive mat on the shaded portions of these banks.

Distribution: WOODSON CO: Lake Fegan, Woodson County State Park, sandy-clay bank in oak-hickory woods, March 26, 1949, M2657.

29. Cephalozia connivens (Dicks) Lindb. Rare. Found once on a north facing sandstone cliff where the plants occurred on sandy soil among mosses and lichens. A careful search showed the plant to be rare in the area.

Distribution: LEAVENWORTH CO: 4 miles northeast of Tonganoxie, north facing sandstone bluff, on sandy soil, June 1, 1952, M5577.

30. Cephalozia media Lindb. Rare. Collected from a moist sandy bank and again from the side of a nearby sandstone ledge. The plants occurred in considerable quantity on these two sites.

Distribution: WOODSON CO: Lake Fegan, Woodson County State Park, on moist sandy-clay bank, March 26, 1949, M2642; on side of moist sandstone rocks, Sept. 24, 1949, M4132.

Calypogeiaceae

31. Calypogeia meylanii Buch. Rare. Found once on the side of a sandstone ledge on a north facing oak-hickory

wooded bluff. The plants were very rare in the area.

Distribution: LEAVENWORTH CO: 4 miles northeast of Tonganoxie, on moist sandstone ledge, Oct. 3, 1953, M7521.

32. Calypogeia muelleriana (Schiffn) K. Müller. Rare. Found once on the side of a moist sandstone ledge in a deep ravine running through an oak wooded area. The plants were rather generally distributed along the ledges in the ravine.

Our collections of this species have colorless oil bodies and seem close to C. meylanii in many respects but after a detailed study it was finally decided to recognize our collections as indicated. However, a detailed study of the species in this country seems to be necessary.

Distribution: WOODSON CO: 8 miles south and 4 miles west of Yates Center, on moist sandstone ledges, Sept. 27, 1952, M6063, M6065, M6073, M6074, M6077, M6078.

33. Calypogeia trichomanis (L.) Corda. Rare. This species occurs in the same general habitat as do the previous listed species of the genus. However, it seems to be more prevalent and perhaps a little more dispersed. The blue colored oil bodies in leaf cells separate this species readily from all closely related forms.

Distribution: LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandy ledge, June 1, 1952, M5571, M5572, M5580. WOODSON CO: Lake Fegan, Woodson County State Park, moist sandstone ledge, Sept. 24, 1949, M4133.

Porellaceae

34. Porella pinnata L. Scattered in the southeastern quarter of the state. The species is found in two very different types of habitat. One is on the bark of trees or on rocks at water level of creeks in the extreme southeast corner of the state. In such places the plants may be partially submerged. Usually they are found between water level and flood level. The second habitat is on dry limestone outcrops on cliffs. This is not a common habitat but plants have been found in two different places on these very dry outcrops. In the latter sites P. pinnata is associated with P. platyphylla and P. platyphylloidea.

Morphologically P. pinnata on bark at water level and on dry limestone outcrops exhibit slight differences which one expects in plants occupying such diverse habitats. A careful study of the species over its entire range is, perhaps, desirable.

Distribution: ANDERSON CO: 5 miles south of Garnett, on dry limestone outcrop, Oct. 8, 1948, M2485. BOURBON CO: 2 miles south of Uniontown, on dry limestone outcrops, Oct. 9, 1948, M2515. CHEROKEE CO: 5 miles east of Baxter Springs, on rocks, bank of Shoal Creek, July 5, 1948, M1747; bark of birch, July 31, 1948, M1946; bark of sycamore, Oct. 22, 1951, M5255.

35. Porella platyphylla (L.) Lindb. Scattered in the

eastern third of the state particularly in the southern half. In some places the species forms large mats on limestone outcrops. Abundance depends upon moisture and shade. Dry exposed sites are without the species and it becomes more common and abundant as moisture increases.

In Kansas P. platyphylla occurs on exactly the same type of habitat as does P. platyphylloidea though they are seldom found together. Schuster (1953) says that P. platyphylla is by far the less frequent species in North America. However, in Kansas, we find P. platyphylloidea only a little more common than P. platyphylla.

Morphologically the two species are quite similar and Frye and Clark (1937-1947) reduced P. platyphylloidea to a variety of P. platyphylla. Difficulties are met with in Kansas material in that neither of the taxa have been found fruiting. This is apparently true elsewhere resulting in incomplete studies being made on one of the common species. Our determinations have been made on mature vegetative plants. In our experience it is only the juvenile plants or young shoots that seem to intergrade. Our findings agree very closely with those given by Schuster (1953) on the complex.

Distribution: ALLEN CO: 1 mile south of Humbolt, on dry limestone ledge, July 7, 1949, M3338. BOURBON CO: 1 mile south of Uniontown, on limestone outcrop, July 7, 1949, M3347. COWLEY CO: 2 miles southeast of Arkansas City, on limestone ledge, Sept. 2, 1950, M4646. DONIPHAN CO: 2 miles

northwest of Iowa Point, limestone outcrop, Aug. 2, 1948, M1972. GREENWOOD CO: 4 miles west of Fall River, limestone ledge, April 13, 1949, M2673. JOHNSON CO: 5 miles south of Stanley, on limestone outcrop, Aug. 30, 1948, M2330; Aug. 3, 1950, M4388. MIAMI CO: Murray Lake, limestone rocks, Oct. 9, 1948, M2530. MONTGOMERY CO: 4 miles east of Elk City, on limestone outcrop, April 12, 1949, M2667. WILSON CO: 3 miles southwest of Neodesha, on limestone ledge, April 13, 1949, M2668.

36. Porella platyphylloidea (Schwein.) Lindb. Distributed over the eastern third of Kansas. Its habitat requirements are so similar to those of P. platyphylla that no further mention of the subject need be given. Morphological information of this species is likewise considered with P. platyphylla.

Distribution: ANDERSON CO: 2 miles south of Garnett, on limestone outcrop, April 13, 1949, M2674. BOURBON CO: 2 miles south of Uniontown, moist limestone ledge, July 5, 1949, M1775. CHAUTAUQUA CO: 2 miles southwest of Sedan, on limestone outcrop, April 12, 1949, M2666. CHEROKEE CO: 5 miles west of Baxter Springs, on limestone rocks, April 25, 1942, R. H. Thompson; on limestone outcrop, April 12, 1949, M2662. DOUGLAS CO: 2 miles north of Clinton, on limestone ledge, Sept. 10, 1948, M2443. FRANKLIN CO: 1 mile southeast of Ottawa, on limestone outcrop, June 28, 1949, M3312. LEAVENWORTH CO: 5 miles northwest of

Leavenworth, on limestone outcrop, Sept. 7, 1948, M2420; 2 miles north of Leavenworth, on limestone outcrop, Oct. 29, 1948, M2565. LINN CO: 2 miles north of Trading Post, on limestone outcrop, April 11, 1949, M2659. MONTGOMERY CO: 8 miles west of Sycamore, on limestone outcrop, Sept. 1, 1948, M2406; March 30,1952, M5327.

Lejeuneaceae

37. Cololejeunea biddlecomiae (Aust.) Evs. Rare. Found in three mesic woodlands in eastern Kansas. In each case the plants were growing on the bark of trees at the base of the trunk and in shaded rather moist conditions. Two of these sites were on calcareous cliffs and the third was in a sandstone canyon.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, limestone cliff, on bark at base of hackberry tree, Oct. 22, 1951, M5259. LEAVENWORTH CO: north edge of Military Reservation, limestone bluff, bark of burr oak, Nov. 28, 1948, M2619. WOODSON CO: 8 miles south and 4 miles west of Yates Center, sandstone canyon, bark of Asimina triloba, Sept. 27, 1952, M6067.

Frullaniaceae

38. Frullania asagrayana Mont. Rare. Found but once in the state and that in a mesic forest on the bluffs of the Missouri River. In this local forest, plants of F.

asagrayana were found on limestone ledges which are dry most of the year but have a period of heavy seepage over them in early spring.

Distribution: LEAVENWORTH CO: 2 miles north of Leavenworth, on limestone ledge, Oct. 29, 1948, M2566.

39. Frullania brittoniae Evs. Common in the Ozark area of southeastern Kansas but known from only one station outside of that restricted habitat. This species has been found only on the bark of trees.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, bark of Quercus alba, July 31, 1948, M1930, M1932; Oct. 22, 1951, M5257; bark of Betula nigra, M5269. WOODSON CO: 2 miles northwest of Yates Center, bark of Quercus macrocarpa, Oct. 28, 1951, M5288.

40. Frullania eboracensis Gottsche. To be found in nearly all mixed forests in the eastern quarter of the state. It is limited exclusively to occurrence on the bark of trees especially oak. In general a lowland or flood plain forest supports an abundance of this species and it becomes less common as drier forest conditions are reached. The species seems also to be more common and abundant on forests of calcareous soils than in those on sandy soils.

In most of our material there is a decided tendency for the plants to have caducous leaves and thus to appear leafless in late summer or early spring. Otherwise the species exhibits the morphological structures described for the taxon.

In extreme southeastern Kansas F. eboracensis is often difficult to separate from F. brittoniae especially when sterile or juvenile; however, they can usually be separated on the underleaf, the upper halves of which, in F. brittoniae, are usually dentate or dentate-crenate and are entire or bear one tooth in F. eboracensis. The characters of the inflated lobules as given by Schuster (1953) to separate the two species seem to intergrade too much to be of value in our area.

Distribution: ATCHISON CO: 1 mile east of Potter, bark of Quercus macrocarpa, June 2, 1949, M2816. BROWN CO: 5 miles west of Hiawatha, bark of Quercus macrocarpa, June 3, 1949, M2826. CHAUTAUQUA CO: 2 miles northeast of Sedan, bark of Quercus stellata, April 12, 1950, M4196. CHEROKEE CO: 5 miles east of Baxter Springs, bark of Quercus alba, July 3, 1948, M1627, M1628; bark of fallen oak, July 4, 1948, M1745; bark of Quercus rubra, Oct. 9, 1948, M2522; bark of Betula nigra, Oct. 22, 1951, M5254. COFFEY CO: 4 miles west of Waverly, bark of Quercus velutina, June 27, 1948, M1601. COWLEY CO: 2 miles southeast of Arkansas City, bark of Quercus macrocarpa, Sept. 2, 1950, M4645. DOUGLAS CO: 2 miles north of Baldwin City, bark of Quercus alba, May 29, 1948, M1516; 4 miles northwest of Baldwin City, bark of Quercus macrocarpa, Aug. 26, 1948, M2303; 5 miles west of Baldwin City, bark of Quercus velutina, Dec. 28, 1948, M2620; bark of Ulmus rubra, Sept. 18,

1949, M4077; bark of Platanus occidentalis, July 19, 1952, M5658. LABETTE CO: 4 miles northwest of Chetopa, bark of Ulmus americana, July 2, 1948, M1612. LEAVENWORTH CO: 1 mile south of Kent, bark of Quercus macrocarpa, June 11, 1948, M1581; bark of Quercus muehlenbergii, June 11, 1948, M1582. MIAMI CO: 3 miles east of Fontana, bark of Quercus macrocarpa, Oct. 10, 1948, M2531; bark of Quercus muehlenbergii, Oct. 8, 1950, M4683; bark of Carya illinoensis, Oct. 8, 1950, M4686; bark of Ulmus rubra, Oct. 27, 1950, M4690; bark of Fraxinus lanceolata, Oct. 27, 1950, M4691. NEOSHO CO: 2 miles east of Chanute, bark of oaks, April 17, 1949, R. H. Thompson. SHAWNEE CO: 5 miles east of Topeka, bark of Quercus macrocarpa and Ulmus americana, April 23, 1949, M2675. SEDGWICK CO: 2 miles northwest of Wichita, bark of Ulmus americana, Sept. 3, 1950, M4648. WOODSON CO: 2 miles northwest of Yates Center, bark of Quercus velutina, Q. stellata, Q. marilandica and Celtis occidentalis, Oct. 28, 1951, M5287; bark of Quercus macrocarpa, Sept. 27, 1952, M6081.

41. Frullania inflata Gottsche. This species is without doubt the most abundant hepatic in the state. It is found in all of the eastern half where it occurs on the bark of many trees, moist limestone cliffs and often on the sides of sandstone ledges. It is most abundant in the elm floodplain forests along creeks and rivers and only slightly less frequent in the mixed forests on river bluffs and hillsides.

It extends westward into the mid-grass prairies as far as Quercus macrocarpa can be found along the streams of that area.

Frullania inflata is highly variable in our area. It fruits abundantly and mature capsules are to be found from January to July in seasons following average or above average rainfall but never fruits after a very dry year. The most variable structure seems to be the lobules. These are characteristically inflated but explanate or lingulate lobes are nearly always present on young parts. The drier the habitat the more frequent the inflated lobule while the more moist the habitat, such as seepy rock ledges, the more abundant are the ligulate lobules. The size of lobule varies from 1/5 - 1/2 the size of the dorsal lobe and sometimes almost equals the dorsal lobe in size. Such plants from Kansas have been named by some, as Frullania oakesiana Aust. a northern species not yet found in Kansas. Since such identifications have not been reported in the literature they have been corrected and will not be further cited.

Distribution: ALLEN CO: 1 mile south of Humbolt, on dry limestone ledge, July 7, 1949, M3337. ANDERSON CO: 3 miles north of Garnett, on bark of Ulmus rubra, Aug. 1, 1948, M1960; 2 miles south of Garnett, on Ulmus rubra, June 4, 1951, M4878. BOURBON CO: 2 miles south of Uniontown, bark of Quercus rubra, Oct. 8, 1948, M2519; 1 mile south of Uniontown, on limestone outcrop, July 7, 1949, M3346; Oct. 22,

1951, M5271. CHASE CO: 1 mile south of Strong City, bark of Quercus macrocarpa, Nov. 27, 1948, M2602. BUTLER CO: 5 miles north of ElDorado, bark of Juglans nigra, Aug. 18, 1953, M2251. CHAUTAUQUA CO: 2 miles northeast of Sedan, on bark of Quercus stellata, April 5, 1953, M5334. CHEROKEE CO: 5 miles east of Baxter Springs, limestone outcrop, July 3, 1948, M1649; July 7, 1949, M3363; bark of Quercus macrocarpa, Oct. 22, 1951, M5266, M5267; bark of Celtis occidentalis, July 8, 1952, M5650; bark of Quercus alba, May 9, 1953, M7200. COWLEY CO: 2 miles southeast of Arkansas City, bark of Quercus macrocarpa, Sept. 2, 1950, M4644. CRAWFORD CO: Crawford County State Park, bark of Ulmus rubra, July 5, 1948, M1753; Oct. 9, 1948, M2529. DICKINSON CO: 6 miles northwest of Herrington, bark of Quercus macrocarpa, June 24, 1950, M4357. DONIPHAN CO: 1 mile northwest of Iowa Point, bark of Ulmus rubra, Aug. 2, 1948, M1965. DOUGLAS CO: 6 miles northwest of Lawrence, bark of Ulmus americana, Aug. 26, 1948, M2275; Lone Star Lake, bark of Quercus macrocarpa, Aug. 28, 1948, M2320; 2 miles northwest of Clinton, bark of Quercus muehlenbergii, Sept. 10, 1948, M2447; 4 miles northwest of Lawrence, bark of Quercus muehlenbergii, Aug. 19, 1950, M4483; 2 miles east of Lecompton, bark of elm, July 13, 1949, R. H. Thompson; 2 miles north of Baldwin City, bark of Quercus velutina, April 25, 1953, M7197. FRANKLIN CO: 4 miles east of Princeton, bark of Quercus macrocarpa, May 29, 1949, M2763; 2 miles south of Lane, on

dry limestone rocks, June 5, 1952, M5589. HARVEY CO: 1 mile east of Annelly, bark of Quercus macrocarpa, Aug. 19, 1948, M2254. JEFFERSON CO: 1 mile north of Valley Falls, bark of Quercus macrocarpa, Jan. 22, 1953, M7000. JEWELL CO: 4 miles north of Burr Oak, on bark of Quercus macrocarpa, Sept. 5, 1950, M4653. JOHNSON CO: 5 miles south of Stanley, bark of Quercus velutina, Aug. 30, 1948, M2335; on moist limestone rocks, Aug. 3, 1950, M4387. LABETTE CO: 4 miles northwest of Chetopa, bark of Betula nigra, July 2, 1948, M1616. LEAVENWORTH CO: 1 mile south of Kent, bark of Quercus macrocarpa, June 11, 1948, M1580. LINN CO: 3 miles north of Pleasanton, on limestone outcrop, Aug. 1, 1948, M1950. LYON CO: 4 miles southwest of Emporia, bark of Quercus macrocarpa, June 26, 1948, M1592. MARION CO: 1 mile south of Florence, bark of Ulmus americana, Nov. 27, 1948, M2613. MARSHALL CO: 8 miles north of Frankfort, bark of Quercus macrocarpa, Aug. 9, 1948, M2032. MCPHERSON CO: 6 miles north of Conway, bark of Ulmus rubra, July 24, 1948, M1819. MIAMI CO: 2 miles southeast of Fontana, bark of Quercus macrocarpa, Nov. 12, 1948, M2580. MONTGOMERY CO: 8 miles west of Sycamore, on limestone outcrop, Sept. 1, 1948, M2407; bark of Quercus macrocarpa, Sept. 1, 1948, M2408. MORRIS CO: 2 miles north of Council Grove, bark of Ulmus americana, Nov. 27, 1948, M2618. NEMAHA CO: Nemaha County State Park, bark of Quercus macrocarpa, Aug. 9, 1948, M2013. RILEY CO: 4 miles south of Manhattan, on bark of

Quercus macrocarpa, June 24, 1953, M7480. SEDGWICK CO: 2 miles north of Wichita, bark of Ulmus americana, Sept. 3, 1950, M4647. SHAWNEE CO: 5 miles east of Topeka, bark of trees, April 23, 1949, M2681. WASHINGTON CO: 2 miles west of Linn, bark of Quercus macrocarpa, Aug. 22, 1953, M5714. WAUBAUNSEE CO: 5 miles west of Eskridge, bark of Ulmus americana, July 25, 1948, M1857. WILSON CO: 1 mile northeast of Neodesha, bark of Quercus macrocarpa, Aug. 31, 1948, M2379; 1 mile east of Altoona, bark of Quercus velutina, Aug. 29, 1952, M5726. WOODSON CO: 2 miles northwest of Yates Center, bark of Quercus velutina, July 5, 1948, M1792; March 26, 1949, M2640; 8 miles south and 4 miles west of Yates Center, bark of Quercus stellata, Sept. 27, 1952, M6082, M6070.

42. Frullania kunzei Lehm. and Lindenb. Rare. Known from one collection from the Ozark area of the extreme southeastern corner of the state. Here it was found on the bark of Quercus alba. Our collection probably represents the most northwestern record of the species.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, on bark of Quercus alba, Oct. 22, 1951, M5256.

43. Frullania riparia Hampe. Rather frequent in the eastern half of Kansas where it is found on limestone ledges and on tree bark in forests occurring on limestone hillsides. It seems to be entirely absent from sandstone areas except for an occasional occurrence on bark of Quercus macrocarpa.

Kansas specimens of this species are often very difficult to separate from Frullania squarrosa. In seasons of average or above average rainfall most material seems easily referable to F. riparia. However, on very dry sites and during dry years such as in 1952-53 most plants seem to fall within the range of F. squarrosa. The possibility that F. squarrosa is a xeric extreme and F. riparia a mesic extreme has been mentioned by Schuster (1953). Our findings seem to fall in line with those of Schuster. With us R. riparia, in mesic conditions, shows rather small trigones and has no intermediate thickenings, the lobules are mostly explanate or ligulate, leaves are rather lax and distant to underleaves. The color is usually green or reddish-green. In xeric conditions our F. riparia is reddish-brown or copperish in color, leaves are somewhat squarrose, having large trigones and the underleaves are large. Often the leaves are also imbricated. The only character in these xeric plants which is absent, but present in F. squarrosa, is the intermediate thickening between trigones. None of our plants of the two extremes have been found with mature capsules.

The above indicates then, as did the findings of Schuster (1953), that a careful detailed study of F. riparia over its range is needed. Furthermore, careful ecological data should be taken along with specimens. It seems possible that the finding of mature capsules of F. riparia might help clear the problem.

Distribution: ALLEN CO: 2 miles south of Iola, bark of Quercus macrocarpa, July 5, 1948, M1789. BOURBON CO: 5 miles north of Hepler, May 30, 1949, L. J. Gier, 1864; 2 miles south of Uniontown, on limestone rocks, July 5, 1948, M1774. CHAUTAUQUA CO: 2 miles southwest of Sedan, on limestone rocks, April 12, 1949, M2664; bark of Quercus macrocarpa, April 12, 1949, M2665; 1 mile north of Sedan, on bark of Quercus stellata, April 5, 1952, M5335. CHEROKEE CO: 5 miles east of Baxter Springs, on bark of Quercus alba, July 3, 1948, M1655; on limestone rocks, April 12, 1949, M2663; Oct. 22, 1951, M5260; bark of Quercus macrocarpa, Oct. 22, 1953, M5261. DOUGLAS CO: Lone Star Lake, bark of Ulmus rubra, May 15, 1948, M1445; 2 miles north of Baldwin City, on bark of Quercus alba, May 29, 1948, M1517; 2 miles northwest of Clinton, limestone ledge, Sept. 10, 1948, M2444; 1 mile west of Pleasant Grove, tree bark, May 8, 1949, R. H. Thompson; 2 miles north of Baldwin City, on bark of Ostrya virginiana, Dec. 8, 1951, M5295. JEFFERSON CO: 2 miles west and 5 miles south of McLouth, bark of Quercus macrocarpa, Oct. 15, 1949, M4155. JOHNSON CO: 2½ miles south of Stanley, on limestone outcrop, Aug. 3, 1950, M4387; April 11, 1949, M2656. LINN CO: 2 miles north of Trading Post, on limestone outcrop, April 11, 1949, M2660. MIAMI CO: Miami County State Park, on bark of Quercus macrocarpa, Oct. 3, 1948, M2480; 2 miles southeast of Fontana, bark of Quercus muehlenbergii, Nov. 12, 1948, M2581; bark of Quercus

velutina, Oct. 17, 1949, M4159, M4160. MONTGOMERY CO: 8 miles west of Sycamore, on side of limestone outcrop, Sept. 1, 1948, M2409; April 5, 1952, M5328. OSAGE CO: 7 miles south of Overbrook, bark of Celtis laevigata, Feb. 22, 1953, R. H. Thompson. SHAWNEE CO: 5 miles east of Topeka, bark of Quercus macrocarpa, April 23, 1949, M2682. WABAUNSEE CO: 6 miles northwest of Pasco, bark of Quercus macrocarpa, June 25, 1950, M4364. WILSON CO: 3 miles west of Neodesha, bark of Quercus macrocarpa, April 13, 1949, M2660; 1 mile east of Altoona, bark of Carya ovata, Aug. 29, 1952, M5727.

44. Frullania squarrosa (R., Bl. N.) Dumort. Two collections of Frullania have been definitely assigned to this taxon. In both cases the specimens match perfectly the descriptions given for the species and in addition were fruiting. In our area the species is difficult to separate from Frullania riparia and the subject is discussed under F. riparia.

Distribution: DOUGLAS CO: 1 mile northwest of Clinton, on limestone ledge, Sept. 26, 1948, M2464. LEAVENWORTH CO: 2 miles north of Leavenworth, bark of Quercus macrocarpa, Oct. 29, 1948, M2567.

Fossombroniaceae

45. Fossombronia brasiliensis Steph. Uncommon. A species found on moist sandy soil in bluestem prairie, over surfacing sandstone, sides of moist sandstone ledges and

along sandy paths or roadside cuts. It prefers exposed or recently eroded sites. Where found it is usually abundant though it may be found in an area one season and absent in the next. It, like Sphaerocarpus texanus, is most abundant in a spring following a very moist summer, fall and winter.

F. brasiliensis, in Kansas, seems to be a variable species particularly as regards the mature spores. Frye and Clark (1937-1947) give the size of the mature spores as 41 - 48μ while we find them to range from 29 - 59μ. In one collection (M1358) the size range was 33 - 42μ with the average being 39μ or some 2μ below the minimum given for the species. Another large collection (M1269) has spores ranging from 29 - 40μ with the average being 35μ or some 6μ below the minimum. This is in contrast with a third collection (M5339) which has a spore size range of 46 - 59μ, an average size of 52μ which is 4μ above the maximum described for the species. All of our spores have some perfectly formed meshes on the convex face. These meshes are, however, very irregular even on spores from the same sporangium. The number of meshes varies from 4 - 14 and the size of mesh varies from 3.3 - 16μ. Frye and Clark (l.c.) state that some spores are regularly reticulate with 11 - 12 meshes on the convex face while usually spores have irregularly forked lamellae without distinct meshes. None of our spores, then, agree with the descriptions given for the species.

Another character of the spore which seems at variance

is the height of lamellae. Frye and Clark (l.c.) say the lamellae are low and illustrate a spore in which lamellae are low. Our spores have prominent lamellae which are up to 4.9μ high. Sharp (1939) mentions in his key to Fossombronia species that the lamellae are high.

The inner faces of the spores are not mentioned in descriptions of the species. In ours the inner faces are smooth, minutely granulate or occasionally very faintly ridged.

The pseudoperianth of F. brasiliensis is described as turbinate, about 1.5 mm. high, deeply cleft on one side, crispate at mouth, deeply and irregularly sinuate lobed; the lobes rounded and entire. This in general matches our material except that the lobes are often more acute than rounded; have a few dentate teeth, and the sinuate lobing appears to be quite regular. Another feature of our turbinate pseudoperianths is the presence of a few lateral scales, usually reddish in color, on the sides of the structure near the base.

In many respects our F. brasiliensis seems very close to Fossombronia foveolata. Frye and Clark (1937-1947) separate F. brasiliensis from F. foveolata by the former having either no meshes on the convex surface or only 0 - 13 while foveolata has 15 - 20. Our material seems to be intermediate between the two in these respects. Sharp (1939) separates the two by keying F. brasiliensis as having ridges

on spores high, enclosing depressed areas 10 - 13μ in diameter and F. foveolata as having ridges on spores low, enclosing depressed areas 7 - 9μ in diameter. Again our material will not separate out following such characters.

A comparison of our material with that from other areas reveals even more difficulties. Collections of F. foveolata by the writer, from Arkansas, Louisiana and Texas and by Schuster from Minnesota and Mississippi have been studied. These show the meshes of F. foveolata to be far less regular than described for the species. Spores range in size from 32 - 61μ in diameter and ridges are from 0 - 4.2μ high. The pseudoperianth also varies and grades into that of F. brasiliensis. The only constant differences now observed between the species is a tendency for the spores of F. foveolata to have ridges lower, and less dark in color than in F. brasiliensis and for meshes to be a little more regular in F. foveolata. Vegetative characters of the two species seem to be similar and equally variable.

From evidence at hand it would seem that F. brasiliensis should be treated as a variety or forma of F. foveolata. Until more material is available for study, however, it seems best not to change taxonomic rank of the plants involved at this time.

The study of Fossombronia species in Kansas is handicapped by the short fruiting period, which lasts barely two weeks in any given season. Consequently sterile plants

have been found frequently which could not be identified. Most of these would probably come within the present concept of F. brasiliensis.

Distribution: CHAUTAUQUA CO: 2 miles northeast of Sedan, on side of moist sandstone rock ledge, April 5, 1952, M5339. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandy soil in prairie, May 15, 1948, M1438. MONTGOMERY CO: 3 miles southwest of Elk City, sandy path in oak woods, April 10, 1948, M1269. WILSON CO: 1 mile northeast of Neodesha, sandy soil over surfacing sandstone, April 10, 1948, M1271. WOODSON CO: 2 miles northwest of Yates Center, sandy soil of roadside cut, May 12, 1951, M4812.

In addition to the above records sterile material of Fossombronia has been found in Allen, Cherokee, Douglas, Franklin, Greenwood, Jefferson, Linn and Neosho counties. As mentioned above most of these plants are probably F. brasiliensis.

46. Fossombronia foveolata Lindb. Rare. Habitat of the above species. Three collections of Fossombronia are referred to this concept because they seem to match descriptions and specimens of the species within certain limits. For a discussion of this species see under F. brasiliensis.

Distribution: CHAUTAUQUA CO: 2 miles north of Sedan, sandy soil in forest clearing, April 5, 1952, M5344. CHEROKEE CO: 5 miles east of Baxter Springs, sandy-clay soil, path in oak woods, April 30, 1948, M1358. WOODSON CO: Lake

Fegan, on moist sandstone ledge, April 24, 1949, M4134a.

Pelliaceae

47. Pellia epiphylla (L.) Corda. Rare. This species was found once in the Ozark area of extreme southeastern Kansas where it occurred on a seepy limestone ledge in a shaded ravine. Plants were abundant on the ledge for a distance of several feet. A search of nearby similar sites failed to reveal more plants and repeated visits to the first collection point, in subsequent years, have indicated that the colony has disappeared. The site from which the collection was made regularly dries up each summer, is covered by leaves and other debris, and was burned in early spring following the season in which the colony was discovered. This may have been responsible for its disappearing.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, moist limestone ledge, July 31, 1948, M1933.

Riccardiaceae

48. Riccardia pinguis (L.) Gray. Rare. The known range of this species in Kansas is truly remarkable. It was found once in mouse runways in a cattail-sedge marsh in the southwestern quarter of Kansas. At this site the marsh is due to artesian water and the marsh is bounded by buffalo-grass or short-grass prairie. The other site is in the southeastern quarter of Kansas where the plants are

found on the sides of a small, moist, sandy ditch below a spring in an oak forest. In the latter habitat the plants have been observed year after year but a search of other similar locations in the same area and elsewhere has failed to turn up additional stations for the species.

Distribution: MEADE CO: Meade County State Park, mouse runways in cattail-sedge marsh, May 8, 1942, W. H. Horr. MONTGOMERY CO: 3 miles southwest of Elk City, sandy, moist ditch below a spring, July 1, 1947, M1071; April 10, 1948, M1270; Sept. 22, 1951, M5222; Oct. 9, 1953, M7311.

Rebouliaceae

49. Asterella tenella (L.) Beauv. Scattered in the eastern half of Kansas where it seems to be limited to sandy soils and sandstone ledges. Where found it is usually very abundant though it is absent from many stations where the habitat seems suitable in every way.

Asterella tenella is often found on sandy soils on prairie hillsides dominated by Andropogon gerardi, Bouteloua curtipendula and in which clumps of the cactus Opuntia humifusa are conspicuous. In such places it is extremely xerophytic. In the same area it is found on the underside of overhanging, dripping sandstone ledges which occur along prairie ravines or creeks. The species seems to exist better in the more xeric stations and certainly fruits more abundantly on such sites.

Distribution: CHAUTAUQUA CO: 3 miles northeast of Sedan, sandstone ledge, May 1, 1948, M1366; 3 miles north of Elgin, sandy prairie hillslope, April 5, 1952, M5347. CHEROKEE CO: 5 miles east of Baxter Springs, sandy clay soil, clearing in oak woods, April 30, 1948, M1359. CLAY CO: 5 miles north of Morganville, sandy prairie hillside, Aug. 16, 1951, M5064. DOUGLAS CO: 12 miles south of Lawrence, sandy bank, April 18, 1948, M1337. ELLSWORTH CO: 5 miles east of Carneiro, sandy soil under sandstone ledge, April 30, 1949, M2702. LABETTE CO: 8 miles northeast of Cherryvale, sandy prairie bank, June 30, 1947, M1067. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandstone ledge, May 7, 1948, M1402. MONTGOMERY CO: 3 miles southwest of Elk City, sandstone ledge, and sandy prairie hillside, July 1, 1947, M1069. NEOSHO CO: 4 miles northeast of Morehead, sandy roadside bank, June 30, 1947, M1066. RICE CO: 1 mile east of Genesco, sandy prairie bank, April 30, 1949, M2714. SALINE CO: 2 miles northwest of Brookville, sandy prairie ravine, April 30, 1949, M2694. WILSON CO: 1 mile northeast of Neodesha, thin sandy soil over surfacing sandstone, May 1, 1948, M1381. WOODSON CO: Lake Fegan, under overhanging sandstone ledge, Sept. 24, 1949, M4130. WYANDOTTE CO: 1 mile northeast of Bonner Springs, sandy bank in road cut, May 15, 1948, M1439.

50. Mannia fragrans (Balb.) Frye and Clark. Abundant on a number of sites in the eastern half of Kansas where it

is found on dry exposed sandy prairie hillslopes and on moist sandstone ledges which are moist only in the spring. The species is very xerophytic and occurs only on sandy soil or sandstone.

A characteristic habitat for M. fragrans consists of prairie hillslopes characterized by a mixture of Andropogon gerardi, Andropogon scoparius, Bouteloua curtipendula, Anemone caroliniana, Opuntia humifusa and thickets of Rhus glabra. It is also commonly found in mixed prairie of the above plants with Quercus stellata, Q. marilandica and Q. velutina.

Our plants fruit abundantly from April to June after which they become inconspicuous: drying, shriveling, thallus margins roll up and overlap or become strongly incurved exposing the very black-purplish underside. At such times the plants are easily overlooked as they are covered by grass, dust or otherwise partially hidden. The application of a bucket of water causes them to unroll quickly and after early fall rains they unroll and continue growth.

Kansas material of this species varies considerably in the position and arrangement of antheridia. The description of the antheridia as given by Frye and Clark (1937-1947) states that the antheridial receptacle is sessile, distinct, oval to broadly lunate, limiting the growth of the somewhat elongate male branch. This is true of some of our plants in that they have an antheridial disk at the tip of the thallus

which does prohibit further growth of the thallus segment. However, many of the male thallus branches have antheridia in a scattered group near the tip but they also extend back from this in the dorsal groove for $\frac{1}{2}$ - 3/4 the length of the thallus branch. Such an arrangement does not prohibit increase in length of that segment and it does continue to grow. This disagrees with the European and American descriptions given for the species but agrees with the findings of Schuster (1952) on material of the species from Minnesota.

In addition our specimens show that the carpocephala are nearly always developed at the tip of a thallus branch and on the dorsal surface. Occasionally they develop on short, lateral ventral branches. The former is characteristic of the species as previously conceived while the latter is not. Schuster (1953) found in Minnesota that a well developed tendency for development of carpocephala on ventral branches occurred. This tendency is weakly expressed in Kansas material.

The above variations do not seem constant enough to call for taxonomic segregation of subspecies or species. Much more work over the range of the concept will have to be done. It is felt that we are dealing with a fairly common hepatic which has not received critical attention and thus the variable characters perhaps escaped notice.

Distribution: ANDERSON CO: 2 miles south of Garnett, sandy-clay soil, June 4, 1951, M4874. CHAUTAUQUA CO: 3

miles northeast of Sedan, sandy bank in oak woods, March 26, 1948, M1216; sandy soil, prairie hillside, April 5, 1952, M5340. COFFEY CO: 2 miles southwest of LeRoy, sandy cliff, April 9, 1948, M1239. CRAWFORD CO: Farlington Tree Farm, Sept. 17, 1949, L. J. Gier 2365. DOUGLAS CO: 3 miles southeast of Baldwin City, sandy prairie ridge, April 2, 1948, M1225; 12 miles south of Lawrence, sandstone ledge, Oct. 13, 1951, M5246. ELK CO: 10 miles north of Busby, sandy trail in oak woods, April 10, 1948, M1283. ELLSWORTH CO: 3 miles northeast of Genesco, moist sandstone ledge, April 13, 1948, M1309; 5 miles northwest of Langley, shaded sandy bank in prairie ravine, May 3, 1952, M5447; 6 miles southeast of Kanopolis, sandstone cliff, May 3, 1952, M5454. JEFFERSON CO: 1 mile west of Medina, sandy prairie slope, April 2, 1948, M1235. GREENWOOD CO: 1 mile northeast of Fall River, sandstone ledge in prairie ravine, April 10, 1948, M1293. LABETTE CO: 5 miles southwest of Dennis, sandy roadside bank, April 10, 1948, M1265. MCPHERSON CO: 2 miles northwest of Lindsborg, sandstone ledge, May 3, 1952, M5457. MONTGOMERY CO: 3 miles southwest of Elk City, April 4, 1942, R. H. Thompson; 6 miles south of Elk City, sandy soil, March 26, 1948, M1181. NEOSHO CO: 2 miles northeast of Chanute, sandy slope in oak forest, April 9, 1948, M1257. WASHINGTON CO: 2 miles west of Linn, sandstone ledge, Aug. 22, 1952, M5713. WILSON CO: 1 mile northeast of Neodesha, sandy soil over surfacing sandstone,

April 10, 1948, M1271; April 5, 1952, M5331. WOODSON CO: 2 miles northwest of Yates Center, sandy prairie, April 9, 1948, M1242.

51. Plagiochasma rupestre (Forst.) Steph. Rare. This southwestern species has been found once in Kansas extending its known range considerably north of previous records from in Oklahoma. However, a collection is in the herbarium of the University of Kansas from Clay County, Missouri, collected by L. J. Gier 1179 on July 26, 1948, which extends the known range to west central Missouri. Our plants were growing on the side of a sandstone outcrop in a wooded ravine.

Distribution: WOODSON CO: 8 miles south and 4 miles west of Yates Center, sandstone outcrop, Sept. 27, 1952, M6084.

52. Reboulia hemisphaerica (L.) G. L. and N. Common in the eastern half of the state. It tolerates a wide range of habitat variations and is met with frequently in our area. It seems to exhibit a preference for sandstone or sandy situations and is rather uncommon on limestone and calcareous soils. This may be due to the shortage of moisture so usual on limestone sites in Kansas.

R. hemisphaerica is usually to be found on the sides of sandstone outcrops, in crevices and sometimes on moist sandy soil below outcrops.. It seldom grows upon soil unless in moist shaded conditions. Even though the plant requires a moist habitat it can survive severe drying and is therefore

one of our more xeric hepatics. During hot dry summers the thallus will curl up exposing the black-purple ventral surface. Normally most of the thallus will winter kill leaving only the tips alive. These may continue growth or if they contain antheridia and archegonia they will result in formation of fruiting bodies.

This species is found characteristically to form rosette patterns on rock faces and becomes gregarious only during unusually moist seasons or when on moist soil.

Distribution: ANDERSON CO: 5 miles south of Garnett, on moist limestone rock ledge, Oct. 8, 1948, M2484. CHAUTAUQUA CO: 3 miles northeast of Sedan, on side of sandstone ledge, May 1, 1948, M1365; April 12, 1950, M4193; April 5, 1952, M5336. CHEROKEE CO: 5 miles east of Baxter Springs, moist limestone ledge, April 30, 1948, M1360. CLAY CO: 1 mile southwest of Longford, sandstone ledge, May 23, 1948, M1513. CLOUD CO: Sept. 13, 1948, S. V. Fraser. COWLEY CO: 2 miles southeast of Arkansas City, sandy bank, Sept. 2, 1950, M4643. CRAWFORD CO: 1 mile east of Pittsburg, sandy bank, April 11, 1952, M5354. DICKINSON CO: 8 miles northeast of Solomon, sandstone ledge, May 23, 1948, M1512. DOUGLAS CO: 12 miles south of Lawrence, sandstone ledge, April 18, 1948, M1336; 5 miles west of Baldwin City, sandstone ledge, Oct. 15, 1949, M4146; April 22, 1950, M4232; April 26, 1952, M5440. ELK CO: 10 miles north of Busby, sandstone ledge, April 10, 1948, M1284. ELLSWORTH CO: 3 miles northeast of

Genesco, April 13, 1948, M1308; 6 miles south of Kanapolis, sandstone ledge, May 3, 1952, M5455. FRANKLIN CO: 4 miles southwest of Ottawa, sandstone ledge, June 18, 1949, M3094; Aug. 2, 1949, M3611; May 12, 1950, M4248. GEARY CO: 2 miles southeast of Junction City, moist limestone ledge, April 30, 1949, M2716. GREENWOOD CO: 1 mile northeast of Fall River, margin of sandstone outcrop, April 10, 1948, M1294. HARPER CO: 1 mile west of Danville, sandy moist roadside bank, Aug. 18, 1948, M2233. JEFFERSON CO: 1 mile west of Medina, sandy bank, Nov. 16, 1947, M1136. LABETTE CO: 5 miles southwest of Dennis, sandstone ledge, April 10, 1948, M1266. LINCOLN CO: 10 miles southeast of Lincoln, sandstone ledge, Sept. 4, 1950, M4650. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, side of sandstone outcrop, May 7, 1948, M1401. MCPHERSON CO: 2 miles northwest of Lindsborg, on sandstone outcrop, July 24, 1948, M1822; May 3, 1952, M5458. MIAMI CO: Miami County State Park, on limestone rocks, Oct. 19, 1947, M1112. MITCHELL CO: 1 mile northwest of Simpson, sandstone outcrop, Sept. 4, 1950, M4652. MONTGOMERY CO: 3 miles southwest of Elk City, on sandstone rocks, April 4, 1942, R. H. Thompson. NEMAHA CO: Nemaha County State Park, on sandy bank, Aug. 9, 1948, M2019. NEOSHO CO: 2 miles northeast of Chanute, on sandstone ledge, April 9, 1948, M1258. OSAGE CO: 6 miles south of Quenemo, on sandstone cliff, July 1, 1949, M3323. OTTAWA CO: 2 miles southwest of Minneapolis, sandy soil below ledge, April 14, 1948,

M1316. RICE CO: 2 miles southwest of Crawford, sandy roadside bank, July 24, 1948, M1828. RILEY CO: 3 miles southwest of Manhattan, limestone ledge, April 30, 1949, M2720. RUSSELL CO: 7 miles north of Dorrance, base of sandstone ledge, June 25, 1949, M3292. SALINE CO: 2 miles northwest of Brookville, on sandstone outcrop, May 22, 1948, M1480. SHAWNEE CO: 3 miles northeast of Topeka, sandstone ledge, April 2, 1948, M1231. WASHINGTON CO: 1 mile west of Linn, sandstone outcrop, April 15, 1948, M1328; Aug. 10, 1948, M2056; Aug. 22, 1952, M5722. WILSON CO: 3 miles west of Neodesha, limestone ledge, June 30, 1947, M1064; 1 mile northeast of Neodesha, sandstone ledge, May 1, 1948, M1382. WOODSON CO: 2 miles northwest of Yates Center, sandstone ledge, April 9, 1948, M1243; Sept. 27, 1952, M6083.

Conocephalaceae

53. Conocephalum conicum (L.) Dumort. Found in the eastern quarter of Kansas where it is largely confined to the vertical sides of sandstone ledges along creeks or moist hillsides. It regularly forms large, extensive mats over the surface of the rocks and will extend on soil at the base of the rocks if the soil is moist. Less frequently it occurs on boulders on the stream margins and hard packed sandy alluvium. Occasionally, small patches of this species have been found at the base of seepy limestone outcrops but such colonies never persist for more than a season.

In Kansas Conocephalum conicum fruits very rarely. In fact it seldom seems to produce reproductive structures and when produced they are usually winter killed. This liverwort does not tolerate xeric conditions and is limited in Kansas to sites which are moist even during the driest of seasons. Drought seasons invariably reduce the size of colonies and completely eliminates them in limestone stations. The lack of spore production and inability to tolerate drouth, in Kansas, restricts the occurrence of this species in the state. This explains the fact that in normal moisture seasons many apparent favorable sites do not have Conocephalum conicum as part of their hepatic flora.

Distribution: CHAUTAUQUA CO: 3 miles northeast of Sedan, side of sandstone ledge, July 1, 1947, M1072; July 8, 1949, 3380; April 12, 1950, M4192. COWLEY CO: 4 miles southeast of Arkansas City, seepy limestone ledge, July 23, 1947, M1076. DOUGLAS CO: 5 miles west of Baldwin City, side of sandstone outcrop, June 24, 1947, M1057; April 2, 1948, M1221; April 18, 1948, M1338; April 22, 1950, M4230. FRANKLIN CO: 5 miles northeast of Ottawa, side of sandstone ledge, Oct. 15, 1949, M4151. GREENWOOD CO: 1 mile east of Fall River, on sandstone ledge, July 9, 1949, M3411. LEAVENWORTH CO: on side of sandstone outcrop, July 27, 1947, M1077. MONTGOMERY CO: 5 miles southeast of Elk City, sandstone boulders, July 17, 1947, M1074. WILSON CO: 3 miles west of Neodesha, on side of seepy limestone ledge, June 30,

1947, M1063. WOODSON CO: 3 miles northwest of Yates Center, sandstone cliff, June 29, 1947, M1061; June 19, 1949, M3198. WYANDOTTE CO: 5 miles northwest of Bonner Springs, sandstone cliff, July 27, 1947, M1079; May 21, 1949, M2744.

Marchantiaceae

54. Marchantia polymorpha L. Widely dispersed over the eastern half of the state. It occurs on both sandstone and limestone ledges, showing no preference for either. In our area this species may be expected on any rocky ledge or outcrop which is seepy or preferably from which a spring flows. The distribution, however, is localized and the species is seldom found. The absence of the species from most of the favorable sites is unexplainable.

Throughout late summer one can find M. polymorpha on alluvial deposits of our creeks and rivers. It occurs rather evenly distributed in all such places in the eastern two thirds of the state. Yet "mother colonies" are rarely found and never in abundance.

At one site plants were found in a woods which had been thinned and debris raked into small piles and burned. Each such area contained an abundance of both male and female fruiting thalli. These occurred only on the circular burned areas. Yet it is known definitely that a colony of M. polymorpha does not exist anywhere near this forested hill top.

Our collections of this species show all the usual

variations met with in this polymorphic taxon. In a few springs at the base of sandstone cliffs one finds the forma aquatica Nees but it intergrades completely with strand plants. Other plants have been found on the sides of sandstone cliffs which could be called forma alpestris Nees but again intergradation seems complete and subspecific names apparently useless in our area.

In the list of distribution which follows all stations, regardless of habitat or abundance, are noted. In some of these only a few gemma cup bearing dichotomies were found along alluvial deposits of streams. The plants would not be anywhere near as common or abundant as the distribution would seem to indicate. A bryologist, unfamiliar with Kansas, might search for days in the state and never see a single specimen of M. polymorpha.

Distribution: ANDERSON CO: 2 miles south of Garnett, alluvial deposit, June 19, 1949, M3207. BROWN CO: 5 miles northeast of Hiawatha, alluvial deposit, Sept. 7, 1948, M2434. CHASE CO: 1 mile south of Strong City, bank of river, Nov. 27, 1948, M2604. COFFEY CO: 2 miles north of Burlington, river bank, Nov. 26, 1948, M2594. DOUGLAS CO: 5 miles northwest of Lawrence, bank of Kansas River, May 14, 1948, M1419; southeast corner of Lone Star Lake, May 14, 1948, M1444; University of Kansas Campus, under library steps, June 13, 1949, M3063; 3 miles north of Baldwin City, side of sandstone rock, Oct. 14, 1951, M5253; May 10, 1952,

M5467. ELLSWORTH CO: 3 miles northeast of Genesco, side of sandstone cliff, April 13, 1948, M1313; May 22, 1948, M1501. FRANKLIN CO: 3 miles east of Pomona, river bank, June 8, 1948, M1576; 1 mile southeast of Ottawa, on alluvial deposit, June 28, 1949, M3307. GEARY CO: 2 miles southeast of Junction City, river bank, April 30, 1949, M2715. LEAVENWORTH CO: 2 miles northwest of Leavenworth, moist limestone ledge, Sept. 7, 1948, M2430; 2 miles west of Linwood, sandy creek bank, June 16, 1949, M3083, M3085. LYON CO: 1 mile north of Emporia, on alluvial deposit, Nov. 26, 1948, M2597. MARION CO: 1 mile south of Florence, river bank, Nov. 27, 1948, M2608. MARSHALL CO: ½ mile east of Blue Rapids, river bank, Aug. 9, 1948, M2037. MCPHERSON CO: 2 miles northwest of Lindsborg, on sandstone ledge, July 24, 1948, M1823. MIAMI CO: Miami County State Park, alluvial deposit along river, Oct. 3, 1948, M2469; Oct. 17, 1949, M4157. OSAGE CO: 2 miles north of Vassar, river bank, June 8, 1948, M1572. OTTAWA CO: 2 miles south of Wells, on moist sandstone outcrop, April 14, 1948, M1320; May 21, 1948, M1468. RICE CO: 2 miles southwest of Crawford, on sandstone ledge, July 24, 1948, M1830. RILEY CO: bank of Kansas River, Oct. 22, 1948, T. E. Brooks. SALINE CO: 2 miles northwest of Brookville, on sandstone outcrop, May 22, 1948, M1477. WASHINGTON CO: 1 mile west of Linn, moist sandstone outcrop, April 15, 1948, M1328; Aug. 10, 1948, M2057; Aug. 22, 1952, M5718. WILSON CO: 1 mile northeast of Neodesha, on

burned over brush pile site, May 1, 1948, M1380. WOODSON CO: 2 miles northwest of Yates Center, alluvial soil, June 19, 1949, M3199. WYANDOTTE CO: 2 miles southeast of Wolcott, below a spring on limestone outcrop, Sept. 6, 1948, M2420.

Oxymitraceae

55. Oxymitra paleacea Bischoff. Found in six counties in the southeastern quarter of Kansas where it grows only on sandy soil over surfacing sandstone or on sandy soil in rocky bluestem prairie. It may be found on dry sandy ledges, open places in oak woods and along trails.

This species is an extreme xerophyte and regularly has its sides roll up and recurve onto the dorsal surface. In such a position the large ventral scales overlap and cover the thallus. In such a condition the plants are capable of passing through long severe dry periods.

O. paleacea fruits in September - November during normal seasons. A dry summer, however, delays early fall growth resulting in the maturation of spores the following spring. Plants are always found in gregarious colonies which may cover an area of several square yards.

In North America Oxymitra paleacea is known from Mexico, central Texas, through Oklahoma and into Kansas. The Texas plants were discovered first and named as Oxymitra androgyna by Howe (1914). Previous to that time only one species,

Oxymitra paleacea Bischoff, was known and it had been found in Europe, Africa and South America. Howe (l.c.) described the Texas material as a new species and separated the North American material on the basis of spore size which he gave as 125 - 175μ while the European, African and South American material was believed to have spores 100 - 120μ in diameter. The European plants were unisexual and the North American were bisexual with an occasional tendency toward the unisexual condition. In addition the walls radiating from the pores were thought to be thicker in North American material than in the other known species.

Recently Müller (1952) reduced Oxymitra androgyna Howe to a synonym of Oxymitra paleacea Bischoff. In this we concur. The writer has collected or studied specimens of Oxymitra from all of its known range in North America. We find that the use of spore size completely fails as a specific criterion. Wittlake (1953) has shown that spore size of Kansas Oxymitra ranges from 90 to 180μ thus in its lower range going below that given for the European material and much surpassing the maximum size of the European spores. The writer finds North American spores to have the range as given by Wittlake (1953) but most consistantly fall in a range of 118 - 140. Spores of material which we have studied from France and Italy range from 82 - 142μ with most being in a range of 115 - 132μ. Thus spore size in plants of the two continents are very similar and show only that those

from North America tend to be a little larger.

The walls radiating from the pores in North American and European plants vary over the same range and therefore are of no taxonomic importance.

In North American material we have found that thalli are bisexual and unisexual with most being of the former type. However, unisexual plants are not uncommon and are found in all collections made. The only European material we have been able to study (France and Italy) revealed that both conditions existed but material was too scarce to gain any idea of relative frequency of each type. In American material 9 bisexual thalli were found for every 2 that were unisexual. In some one segment was bisexual while the sister segment was unisexual.

Wittlake (1953) describes the spore of Oxymitra paleacea (= O. androgyna) as having areolae too variable to consider as worth mentioning. This we do not find to be the case and further mention that the spore illustrated by Wittlake is characteristic and shows areolae to be quite regular in size or at least as regular as one expects areolae to be on spores in the Oxymitraceae and related Ricciaceae. We find the largest areolae to be 42μ in greatest diameter and the smallest to be 24. However, out of a great number measured we find them to fall consistently in the range of 30 - 40μ. Wittlake (1953) also gives the length of the projections of the spore (verrucae) as .5 - 2μ while we find

them to be rather consistently 3.3μ long and range from .2 - 6.7μ.

Oxymitra paleacea, as now conceived, exhibits a striking geographic distribution. It is found in Europe, North Africa, Brazil, Argentina, Paraguay, Mexico and in Texas, Oklahoma and Kansas in the United States. The Mexico record is not reported in the literature but collections in the herbarium at the University of Kansas by E. B. Wittlake 50241 taken on July 2, 1953, 2 miles southeast of Tecamachalco, State of Puebla and McGregor 8029 from Tamuzunchale, State of San Luis Potosi, constitute valid records for Mexico.

Distribution: CHAUTAUQUA CO: 3 miles east of Sedan, sandy prairie, edge of oak woods, March 26, 1948, M1209; May 8, 1949, W. H. Horr; 4 miles south of Sedan, sandy soil, July 8, 1949, M3370; 1½ miles northeast of Sedan, sandy open wooded prairie, April 5, 1952, M5341; 3 miles north of Elgin, sandy hilltop prairie, April 5, 1952, M5346. ELK CO: 10 miles north of Busby, sandy soil over surfacing sandstone, April 10, 1948, M1287. GREENWOOD CO: 1 mile northeast of Fall River, edge of surfacing sandstone, April 10, 1948, M1291; 1 mile east of Fall River, sandy soil, April 13, 1949, M2670; July 9, 1949, M3409; Aug. 21, 1949, R. H. Thompson. MONTGOMERY CO: 3 miles southeast of Elk City, sandy soil, April 4, 1942, R. H. Thompson; 3 miles southwest of Elk City, sandy open wooded hillside, Oct. 25, 1947, M1119; 6 miles south of Elk City, sandy soil, March 26, 1948, M1185; 3 miles

southwest of Elk City, sandy soil, Sept. 22, 1951, M5230. WILSON CO: 1 mile northeast of Neodesha, sandy soil, Oct. 25, 1947, M1115; April 10, 1948, M1272. WOODSON CO: 2 miles northwest of Yates Center, sandy soil, Oct. 26, 1947, M1124; April 9, 1948, M1244; Lake Fegan, sandy soil, March 26, 1949, M2648; 2 miles northwest of Yates Center, sandy soil, June 19, 1949, M3200; Lake Fegan, sandy soil, edge of sandstone outcrop, Sept. 24, 1949, M4129; 2 miles northwest of Yates Center, shallow sandy soil over surfacing sandstone, Oct. 28, 1941, M5274.

Ricciaceae

56. Ricciocarpus natans (L.) Corda. Rare. Found in a few swamps, lakes and ponds in eastern Kansas where it floats on the surface of the water. Land-forms also occur at the above habitats in late summer and fall as the water level recedes. These land-forms are also to be found occasionally on alluvial deposits along streams in the eastern part of the state.

In Kansas R. natans (water form) fruits abundantly in early spring and then passes into a vegetative phase during which it reproduces actively by division and fragmentation of thalli. These water forms persist into winter and eventually are frozen in ice. One station was observed through several seasons. At this site the floating forms regularly are frozen in ice in early winter. This results in death

of the posterior portion of the plants. This early freeze invariably is followed by complete thawing during which plants undergo some growth. Through the rest of the winter season successive freezing and thawing takes place. Never is R. natans killed by being frozen in ice even when frozen for a period of several weeks. The result is that by spring many small thalli tips are present on the body of water. These grow rapidly and produce typical fruiting plants.

In the summer and early fall many of the floating plants are left stranded on muddy banks by receding water. These plants develop into rosettes or irregularly gregarious colonies of the land form and become submerged with the advent of fall rains. Such submerged colonies exist through the winter and in the spring the tips of the apices produce small plantlets which become detached, float to the surface, and develop into fruiting individuals.

The finding of some strand plants along creek and river banks indicates that the distribution of this species, at least in northeast Kansas, is greater than the distribution listed below would seem to indicate. However, we have found some strand plants on creek banks whose drainage area is completely known and in which no floating plants have been found. The occurrence of such plants is not explainable unless they developed from spores carried in or blown into the water shed area.

Distribution: ATCHISON CO: ½ mile south of Muscotah,

mud bank of Little Grasshopper Creek, Oct. 18, 1947, M1105. DOUGLAS CO: 1 mile north of Lawrence, alluvial deposit of Kansas River, Nov. 13, 1948, M2593; 3 miles northeast of Lawrence, floating in cattail-sedge marsh, Nov. 6, 1949, R. H. Thompson; 1 mile northeast of Lawrence, floating in old ox-bow marsh, Aug. 27, 1949, M3893; Nov. 13, 1949, M4163; Sept. 23, 1950, 4676; 2 miles northeast of Lawrence, alluvial deposit on bank of Kansas River, Aug. 9, 1952, M5686. JEFFERSON CO: 3 miles west of Williamstown, floating in cattail marsh, Nov. 13, 1949, M4165. JOHNSON CO: ½ mile north of DeSoto, alluvial deposit on bank of Kansas River, July 27, 1952, M5668. LEAVENWORTH CO: 2 miles north of Leavenworth, alluvial deposit bank of Missouri River, Oct. 29, 1948, M2582. LINN CO: 2 miles west of LaCygne, floating in cattail marsh, June 4, 1949, M2855. MIAMI CO: Murray Lake, Miami County State Park, alluvial deposit, Oct. 19, 1947, M1114; Pigeon Lake on Hugh Whitford Ranch, on alluvial deposit, April 24, 1948, M1348; 3 miles east of Fontana, bank of Marias de Cygne River, Oct. 3, 1948, M2470; Pigeon Lake, mud bank, Nov. 12, 1949, M2579; Pigeon Lake, floating, May 29, 1949, M2772; Oct. 17, 1949, M4158; Oct. 8, 1950, M4681.

57. Riccia beyrichiana Hampe. Found over most of Kansas except the northwest quarter and rare in the southwest quarter. This species ranks with Frullania inflata and Riccia frostii as the most widely distributed species of

hepatic in the state. It tolerates a wide range of habitats but is most common on sandy soils associated with surfacing sandstone in prairie and in oak forest. In moist seasons it is scattered in limestone areas particularly in mixed forest and prairie sites. It is also to be found on alluvial deposits along river banks, flood plains, roadside ditches and deposits from eroded fields.

R. beyrichiana is one of the more easily recognized species in the genus but nevertheless is quite variable in many respects. In our specimens we find the margin characteristically has one or two rows of stout, usually curved cilia from 30 to 300μ long. These are always prominent at the apex but become less frequent posteriorly but never are they absent. Macvicar (1926) says that specimens from England most frequently have naked margins and Müller (1952) concurs in this for European material. Frye and Clark (1937-1947) report cilia rarely wanting, usually few, in 1 or 2 series stout and often curved. Kansas specimens are more as described by Frye and Clark in this character but seem to show even a more pronounced tendency for frequent stout, curved cilia. Occasionally specimens found in the shade or on very moist soil show a tendency for cilia suppression but never is the margin without them.

The coloration of the thallus sides is usually greenish in our specimens except for those on drier or exposed sites where the color may range from reddish to black-purple.

Ventral scales likewise are usually hyaline to whitish but may become purplish on dry exposed habitats.

Thallus size varies also with the habitat. On exceptionally dry areas the length may be from 7 - 12 mm. and the width from 1 - 2 mm. On more favorable sites the length is usually 5 - 10 mm. and the width 2 - 4 mm. Thickness of thallus, width of dorsal groove and angle of margin also vary with respect to moisture and light conditions.

With regard to the spore we find a difference in characters given by different workers. Frye and Clark (1937-1947) and Howe (1923) give the size range of greatest spore diameter as 65 - 140μ for American material. Macvicar (1926) gives the range as 95 - 120μ for English specimens while Müller (1952) gives the spore size as 100 - 120μ. Schuster (1953) gives the spore size of the species as 90 - 130μ. In Kansas material we find, on the basis of an examination of spores from all the collections listed below, that the range in size of mature spores is 74 - 138μ. However, the overall average of spore size is 106μ. The use of spore size as a taxonomic character must be used with caution as a given colony often has a range different from that of another. My collections M4143 and M5446, for example, show that the range of spore size in M5446 is 75 - 112μ and average size is 90μ while M4143 has a range of 115 - 138μ and an average spore size of 124μ. Thus the spores of M4143 average larger than the maximum limit of spore size

allowed for the species by Macvicar (1926) and Müller (1952). At the other extreme the spores of M5446 average 90μ or the exact size of the minimum size allowed for the species by Schuster (1953). As a further comparison my collection M1353 shows a range of spore size of 99 - 122μ and an average size of 113 thus the collection falls in line with sizes as given by all the above cited workers.

Another spore character which seems to vary is the size of areoles on the outer spore face. Macvicar (1926) reports the size of areoles as up to 15μ, Frye and Clark (1937-1947) give a range of 10 - 18μ, and Müller (1952) states a range of 10 - 15μ. Müller (1952) also gives the number of areolae across the face of the spore as 6 - 8 and Macvicar (1926) gives the number as 7 - 9. We find, in our Kansas plants, that the size of areolae varies from 7.2 - 19.8μ in diameter and from 5 - 7 across the face of the spore. The average of areolae diameters is 15 - 17μ and the average number across spore face is 5 - 6. Thus Kansas material shows a tendency to fewer but larger areolae as compared to European plants.

Another spore character, that of papillae revealed when the spore is viewed in profile, seems also to vary. Macvicar (1926) states that spores are highly papillose in profile while Frye and Clark (1937-1947) refer to the papillae as being absent or obscurely present. Most of our Kansas collections show only faint signs of papillae though occasionally they are evident and up to 2.4μ in length. When such

are observed they are found to be truncate to obtuse.

Occasionally collections of R. beyrichiana are obtained in Kansas (such as M1059) which are extremely atypical as far as spore characters are concerned. The collection mentioned has spores in which no complete areolae are to be found on the outer face. Instead rather heavy irregular ridges occur and these rarely anastomose. The area from which this collection was made has been studied extensively through several seasons and only one gregarious colony was found with such spore characters. A tendency toward this condition has been noticed in other stations. At all such places R. campbelliana is common and intermingled with R. beyrichiana. It thus seems possible that hybridization between the two might have occurred.

It seems possible that a critical study of R. beyrichiana in North America and Europe might show that a part of the material (European) should be split off as a subspecies if some of the differences noted above prove to be constant.

Distribution: ALLEN CO: 5 miles north of Moran, creek bank, Oct. 8, 1948, M2499. ANDERSON CO: 1½ miles northeast of Welda, bluestem prairie, Oct. 31, 1948, R. H. Thompson; 5 miles south of Garnett, moist bank in woods, Oct. 8, 1948, M2482; 2 miles south of Garnett, sandy-clay soil, June 4, 1951, M4876. ATCHISON CO: ½ mile south of Muscotah, creek bank, Oct. 18, 1947, M1106. BARTON CO: ¼ mile north of Pawnee Rock, sandy prairie, Aug. 30, 1950, M4629. BOURBON

CO: 2 miles south of Uniontown, creek bank, Oct. 8, 1948, M2511; 6 miles south of Fort Scott, sandy-clay prairie bank, May 9, 1953, M7201. BROWN CO: 5 miles northeast of Hiawatha, sandy-clay prairie bank, Sept. 7, 1948, M2432. CHASE CO: 1 mile south of Strong City, river bank, Nov. 27, 1948, M2605. CHAUTAUQUA CO: 3 miles northeast of Sedan, sandy soil, March 26, 1948, M1214; 1½ miles northeast of Sedan, sandy prairie, April 12, 1950, M4188; April 5, 1952, M5342. CHEROKEE CO: 5 miles east of Baxter Springs, rocky-clay soil, open places in oak woods, April 30, 1948, M1353, M1362; 3 miles southeast of Baxter Springs, sandy bluestem prairie, Oct. 22, 1951, M5263, M5265; 3 miles northeast of Riverton, sandy abandoned field, May 9, 1953, M7199. COFFEY CO: 2 miles southwest of LeRoy, sandy prairie, April 9, 1948, M1236; 2 miles north of Burlington, river bank, Nov. 26, 1948, M2596. COWLEY CO: 2 miles southeast of Arkansas City, sandy prairie bank, Sept. 2, 1950, M4642. CRAWFORD CO: Crawford County State Park, moist clay bank, Oct. 9, 1948, M2528. DOUGLAS CO: 1 mile southeast of Lawrence, sandy soil, April 24, 1942, R. H. Thompson; 5 miles west of Baldwin City, very moist sandy soil, June 24, 1947, M1059; 2 miles southeast of Baldwin City, moist sandy soil, Oct. 11, 1947, M1100; 5 miles west of Baldwin City, sandy bluestem prairie, June 18, 1948, M3104; Oct. 15, 1949, M4143; Sept. 16, 1950, M4675; Oct. 13, 1951, M5249; April 26, 1952, M5434; 2 miles northeast of Lawrence, alluvial deposit, bank of

Kansas River, June 12, 1952, M5604. EDWARDS CO: 2 miles east of Kinsley, sandy prairie, Aug. 28, 1950, M4508. ELK CO: 10 miles north of Busby, sandy open oak woods, April 10, 1948, M1286. ELLSWORTH CO: 3 miles northeast of Carneiro, sandy prairie, May 22, 1948, M1500; 4 miles northwest of Langley, sandy prairie, May 3, 1952, M5446. FORD CO: 4 miles southwest of Dodge City, sandy soil, Aug. 28, 1950, M4509. FRANKLIN CO: 1 mile northeast of Norwood, sandy soil, March 25, 1948, M1169. GEARY CO: 2 miles southeast of Junction City, river bank, April 30, 1949, M2716. GREENWOOD CO: 1 mile northeast of Fall River, sandy soil, April 10, 1948, M1295. HAMILTON CO: 2 miles south of Syracuse, sandy soil, Aug. 29, 1950, M4581. HARVEY CO: 3 miles north of Burrton, sandy soil, July 24, 1949, M3505; Aug. 28, 1950, M4505; June 11, 1951, M4911; Aug. 25, 1951, M5083. JEFFERSON CO: 1 mile west of Medina, sandy soil, Nov. 16, 1947, M1135. JOHNSON CO: 5 miles west of Olathe, sandy prairie, Nov. 2, 1947, M1130. KEARNEY CO: Lake McKinney, edge of lake, Aug. 29, 1950, M4590. LABETTE CO: 5 miles southwest of Dennis, sandy soil edge of oak woods, April 10, 1948, M1264. LEAVENWORTH CO: 1 mile west of Turkey Creek Station, sandy soil, Dec. 2, 1947, M1142; 4 miles northeast of Tonganoxie, sandy prairie, May 7, 1948, M1405; 2 miles west of Linwood, sandy soil, June 16, 1949, M3090. LYON CO: 1 mile north of Emporia, river bank, Nov. 26, 1948, M2599. MIAMI CO: 3 miles east of Fontana, river bank, Oct. 19, 1947,

M1107. MONTGOMERY CO: 3 miles north of Independence, sandy soil, April 24, 1942, R. H. Thompson; 3 miles southwest of Elk City, sandy soil, July 1, 1947, M1070; March 26, 1948, M1182. MARION CO: 1 mile south of Florence, river bank, Nov. 27, 1948, M2610. MORRIS CO: 2 miles north of Council Grove, river bank, Nov. 27, 1948, M2615. NEMAHA CO: Nemaha County State Park, sandy-clay soil, Aug. 9, 1948, M2016. NEOSHO CO: 3 miles southeast of Chanute, sandy soil, Nov. 27, 1947, M1141; April 9, 1948, M1261. OTTAWA CO: Ottawa County State Park, sandy soil, May 21, 1948, M1467. RENO CO: 6 miles northeast of Hutchinson, sandy soil, June 11, 1951, M4956; Aug. 28, 1950, M4506; Aug. 25, 1951, M5084. RICE CO: 1 mile east of Genesco, sandy prairie, April 30, 1949, M2708. RILEY CO: 3 miles southwest of Manhattan, moist wooded hillside, April 30, 1949, M2721. SALINE CO: 2 miles northwest of Brookville, sandy prairie, May 22, 1948, M1479. SEDGWICK CO: 2 miles northwest of Wichita, sandy pasture, Sept. 2, 1950, M4649. SHAWNEE CO: 5 miles east of Topeka, rocky clay bank, April 23, 1949, M2679. STAFFORD CO: 1 mile west of Stafford, sandy roadside ditch, Aug. 28, 1950, M4507. STANTON CO: 1 mile north of Saunders, sandy soil, Aug. 28, 1950, M4547. WASHINGTON CO: 2 miles southwest of Palmer, sandy prairie, May 27, 1951, M4830. WILSON CO: 1 mile northeast of Neodesha, sandy soil, June 11, 1952, M5602. WOODSON CO: 2 miles northwest of Yates Center, sandy prairie, June 29, 1947, M1062; May 12, 1951, M4807; 14

miles southwest of Yates Center, sandy oak woods, Sept. 1, 1951, R. H. Thompson. WYANDOTTE CO: 1 mile northeast of Bonner Springs, sandy soil, May 15, 1948, M1440.

58. Riccia bifurca Hoffm. Rare. Found but three times in Kansas and known only from alluvial deposits along streams. It therefore is not a characteristic species in our hepatic flora. In each of the three stations where the species was taken we have since failed to locate more specimens. The occurrence of the species on alluvial deposits indicates that plants must occur elsewhere in our area but as yet they have not been found.

Our plants agree in all respects with descriptions of the species and with specimens seen from other areas. Two rosettes of number M2521, however, would be referred to R. bifurca var. subinermis Heeg on the basis of the presence of a few acutely pointed cilia on the margin of terminal segments. This character does not seem worthy of taxonomic recognition in this instance and the specimens are therefore not segregated.

Some difference of opinion is apparent in the literature as to the correct name for this species. Frye and Clark (1937-1947) recognize Riccia bifurca Hoffm. and reduce R. arvensis Aust. to a synonym of it. Müller (1952) also considers R. arvensis as a synonym but Schuster (1949, 1953) recognizes R. bifurca as a synonym of R. arvensis. A study of North American specimens named as R. arvensis by Austin

(1870) shows that they are identical with the plants in Europe known as R. bifurca. It thus is necessary to recognize R. bifurca as the valid name.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, bank of Shoal Creek, Oct. 9, 1948, M2521. DOUGLAS CO: north edge of Lawrence, bank of Kansas River, May 1, 1951, R. H. Thompson. RILEY CO: bank of Kansas River, Oct. 22, 1948, Travis Brooks.

59. Riccia campbelliana Howe. Common on sandy soil in prairie and open oak wooded areas. It is most frequent on shallow soil over surfacing sandstone and in bluestem prairies near such environments. Occasional plants are found on alluvial soil along stream banks. As yet this species has not been found on calcareous sites.

The distribution of Riccia campbelliana in the United States, based on the literature, is somewhat confusing. The species was described by Howe (1899) based on material from California. Later Howe (1923) gave the range of the species as California and Texas. Frye and Clark (1937-1947) list the species as known definitely only from California. Jacobs (1951) reported the species from Arkansas and Georgia and referred to Howe's and Frye and Clark's statement of the range. This distribution, to Jacobs, seemed to provide a remarkable parallel to the disjunct ranges of several vascular plants. However, both Jacobs and Frye and Clark overlooked a paper by McAllister, Hoglund and Whitehouse (1932)

in which R. campbelliana was listed from four stations in Texas. The distribution of the species, based on specimens seen by the author or collected by him is now known to be California and from central Texas, north through Oklahoma, to northeastern Kansas then southeastward to central Arkansas, to northwestern Louisiana and southwest to central Texas. In addition to this is the record of Jacobs (1951) for Georgia. In areas of Granite and sandstone outcrops in Texas and Oklahoma and sandstone outcrops of Kansas and Arkansas the species is quite generally distributed and often is locally abundant. The use of the species by Jacobs (l.c.) in his discussion of disjunct ranges, therefore, seems unwarranted.

Howe (1923) gives the size range of spores of this species as 75 - 108μ but mostly 90 - 100μ. We find the maximum limit to be 118μ and the lower limit of the range as 70μ. The average spore size, of Kansas material, is 96μ. A few Kansas collections show the outer face of the spore to be somewhat regularly areolate with areoles up to 13.2μ in diameter as compared to a size of 4 - 7μ given by Howe. Otherwise Kansas material agrees with the description of the species.

Distribution: ANDERSON CO: 1½ miles northeast of Welda, open sandy prairie, Oct. 31, 1948, R. H. Thompson. CHAUTAUQUA CO: 3 miles northeast of Sedan, sandy soil, oak woods, March 26, 1948, M1212; 3 miles north of Elgin, sandy

prairie pasture, April 5, 1952, M5350; 3 miles north of Sedan, sandy soil over surfacing sandstone, April 5, 1952, M5353. CHEROKEE CO: 5 miles east of Baxter Springs, rocky clay prairie bank, April 30, 1948, M1354. COFFEY CO: 2 miles southwest of LeRoy, sandy prairie, April 9, 1948, M1240. DOUGLAS CO: 12 miles south of Lawrence, sandy prairie, April 18, 1948, M1335; Oct. 13, 1951, M5248; 5 miles west of Baldwin City, sandy soil, April 26, 1952, M5435. ELK CO: 10 miles north of Busby, sandy prairie, April 10, 1948, M1280. FRANKLIN CO: 1 mile northeast of Norwood, sandy oak woods, March 25, 1948, M1168. GREENWOOD CO: 1 mile northeast of Fall River, sandy soil, April 10, 1948, M1289. HARVEY CO: 5 miles north of Burrton, sandy path in sand dunes, June 11, 1951, M4917. JEFFERSON CO: 1 mile west of Medina, sandy prairie pasture, April 2, 1948, M1233. LABETTE CO: 5 miles southwest of Dennis, sandy soil at edge of oak woods, April 10, 1948, M1267. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandy soil in prairie, May 7, 1948, M1404; 2 miles west of Linwood, sandy soil in oak woods, June 16, 1949, M3087. MONTGOMERY CO: 3 miles south of Elk City, sandy soil, April 4, 1942, R. H. Thompson; 6 miles south of Elk City, sandy soil in oak woods, March 26, 1948, M1183. NEOSHO CO: 2 miles east of Chanute, sandy prairie, April 9, 1948, M1260. RENO CO: 6 miles northeast of Hutchinson, sandy path in sand dunes, June 11, 1951, M4958. WILSON CO: 1 mile northeast of Neodesha, sandy soil

edge of oak woods, April 10, 1948, M1278. WOODSON CO: 2 miles northwest of Yates Center, sandy prairie, April 9, 1948, M1246; Lake Fegan, sandy soil in oak woods, March 26, 1949, M2649; Sept. 24, 1949, M4125; 2 miles northwest of Yates Center, sandy prairie at edge of oak woods, May 12, 1951, M4810; Oct. 28, 1951, M5278.

60. Riccia canaliculata Hoffm. This species is listed here as of questionable taxonomic standing and is based on one collection made in extreme east central Kansas. The plants occurred on soil at the edge of a lake.

As yet no North American specimens of the Ricciella section of Riccia have been studied which match the European R. canaliculata with the possible exception of a collection by the author from Texas which Müller (personal correspondence) refers to R. canaliculata. However, Crundwell (personal correspondence) says he has seen no American material which is the same as the European R. canaliculata. With this latter statement I am inclined to agree.

The Kansas collection under consideration differs from the descriptions of R. canaliculata and with European specimens of the species in several ways. The spores have 4 - 6 areolae across the outer face while R. canaliculata has 3 - 4 and the areolae average 2 - 4μ smaller in diameter in the Kansas material. The ventral scale cells are similar in the two though those of our material average 4μ wider and some 10μ longer. The thallus in our plants is more similar to

that of R. duplex than of R. canaliculata though it differs from both in that the compact cells of the ventral half of the thallus has small air-chambers. R. canaliculata is not known in a water form while Kansas material readily grows and fruits in water culture as well as on soil.

The present lack of critical study of the species in the fluitans complex of the genus Riccia makes it difficult to assign the Kansas collection to a suitable taxon. It is, therefore, provisionally assigned to R. canaliculata to which it seems to be closely related on the basis of spore characters.

Distribution: MIAMI CO: 3 miles east of Fontana, Hugh Whitford Ranch, margin of Pigeon Lake, on soil, April 24, 1948, M1349b.

61. Riccia dictyospora Howe. Found in all but the northwestern quarter of the state. It is very common on sandy soil near sandstone outcrops, in sandy prairie in local areas in sand dune areas of central and southwest Kansas. It is also to be found on alluvial deposits and on rocky-clay banks. The species is found but rarely on calcareous sites and seems to be restricted almost entirely to sandstone or sandy areas.

This species is extremely xerophytic and survives the most severe drought conditions. In fact it seems to grow best on open exposed sites which regularly dry up early in the growing season and remain dry until fall rains. During these periods the older parts of the thallus die leaving the

tips to begin growth with the advent of moisture.

The determination of Kansas material as R. dictyospora was accomplished only after detailed study of the species over its range and after careful study of R. mcallisteri Howe. There has been much confusion in the literature as to the proper relationships of these two concepts. We have reached the conclusion that R. mcallisteri is not a valid concept and must be reduced to synonomy under R. dictyospora.

The characters which have been used to separate the concepts are as follows:

R. mcallisteri	R. dictyospora
1. Scales violet.	1. Scales blackish purple.
2. Margins decolorate.	2. Margin narrowly blackish purple.
3. Hypodermal cells in distinct rows.	3. Upper surface reticulate.
4. Spores first violet but finally opaque.	4. Spores brown, rather translucent.
5. Antheridial ostioles elev. 50-160μ.	5. Anth. ostioles elev. 0-50μ.

Comparative studies show that the above characters break down completely when used to attempt species separation. We have studied the type specimens of the two, specimens from the entire range of the concepts and have studied them in the field over much of their range but most importantly in the type locality of R. mcallisteri.

It has been observed that the color of ventral scales is a highly variable character in Riccia's and such is true

with the concepts here considered. We have observed the same colony of these plants over several seasons and have noted that in dry seasons they exhibit scale color of R. dictyospora and in more moist seasons the color as given for R. mcallisteri. The same statement applies to color of the thallus margin. In the type locality of R. mcallisteri (Granite Mountain Texas) we have observed plants growing on the sandy margins of water holes, left by quarrying granite, which had violet scales. As one moved away from the moist environment a progressive change in scale color from violet to blackish purple was found. The margin of the thallus exhibited the same transition. Even the type collection of R. mcallisteri exhibits variation in these colorings.

The arrangement of the cells on the upper surface has been used as a key character by Frye and Clark (1937-1947). How such a character came to be recognized is indeed puzzling as type specimens and thousands of specimens seen in the field fail to show any such distinction. We have yet to see any difference between the two and find them both to be reticulate and yet to have cells somewhat aligned in rows.

The question of spore color is also one of confusion. We find the spores of the same colony to vary in color from spring to fall and from year to year. If a given colony is observed through a season it will be noted that spores are at first yellowish after which they become brown or violet brown and finally may become opaque. Most material which has

been identified as R. dictyospora show spores to be immature. Howe who described both species apparently did not rely on spore characters too much as collections identified by him as R. dictyospora have opaque spores and others with light brown spores were identified as R. mcallisteri. The difficulty with spores in this complex seems to be due to the fact that spores mature very slowly and thus plants which look good for specimen purposes seldom have immature spores. As indicated above the matter of spore color intergrades completely and is so variable as to be useless as a taxonomic character.

Jacobs (1951) discusses the two species and admits that they are closely akin but states that they are quite separable. He further states that the differences between the two are correllated with habitat but are associated with habitat preference rather than habitat induction. Apparently Jacobs relies on the presence or absence of the black margin or degree of expression of color to separate the two so-called species. We have studied the species in the field over the entire range of R. mcallisteri and over most of the range of R. dictyospora. As a result we have failed to verify the statements of Jacobs which actually seem to be based on a rather meager cultural study.

Another factor which has probably led to some confusion is the fact that Howe received specimens from McAllister (from Texas) and grew them in a greenhouse at the New York

Botanical Garden after which he described the material as a new species (R. mcallisteri). This undoubtedly was somewhat responsible for the views on coloration of the thallus.

Finally it may be true that some of the variations noted may be, in part, found to be grouped into geographic areas and thus perhaps some subspecific segregation will be necessary. This can only be decided after much more work has been done in the field, in culturing and in cytological studies.

Distribution: ALLEN CO: 5 miles north of Moran, creek bank, Oct. 8, 1948, M2501. ANDERSON CO: 4 miles south of Garnett, sandy prairie, Oct. 8, 1948, M2486. BARTON CO: ¼ mile north of Pawnee Rock, sandy prairie, Aug. 30, 1950, M4630. BOURBON CO: 2 miles south of Uniontown, creek bank, Oct. 8, 1948, M2513. BROWN CO: 5 miles northeast of Hiawatha, sandy roadside bank, Sept. 7, 1948, M2431. CHASE CO: 1 mile south of Strong City, river bank, Nov. 27, 1948, M2607. CHAUTAUQUA CO: 3 miles east of Sedan, sandy soil, May 1, 1948, M1367; 4 miles south of Sedan, sandy prairie, July 8, 1949, M3372; 1½ miles northeast of Sedan, sandy soil over surfacing sandstone, April 12, 1950, M4202. CHEROKEE CO: 5 miles east of Baxter Springs, rocky clay bank, April 30, 1948, M1355. CLAY CO: 5 miles north of Morganville, sandy prairie, Aug. 16, 1951, M5066. DOUGLAS CO: 2 miles southeast of Baldwin City, creek bank, Oct. 11, 1947, M1099; 12 miles south of Lawrence, sandy prairie, April 18,

1948, M1339; 5 miles west of Baldwin City, sandy soil over surfacing sandstone, June 18, 1949, M3103; Sept. 16, 1950, M4674; Aug. 2, 1951, M5004; Oct. 13, 1951, M5247; 2 miles north of Lawrence, river bank, June 12, 1952, M5606. ELK CO: 10 miles north of Busby, sandy prairie, April 10, 1948, M1279; July 27, 1948, M1916. ELLSWORTH CO: sandy prairie, 6 miles southeast of Kanopolis, sandy prairie bank, May 3, 1952, M5453. FRANKLIN CO: 4 miles southwest of Ottawa, sandy prairie pasture, June 18, 1949, M3096; May 12, 1950, M4247. GREENWOOD CO: 6 miles north of Fall River, sandy soil in oak woods, July 27, 1948, M1912; 1 mile east of Fall River, sandy prairie, July 9, 1949, M3406. HARPER CO: 1 mile west of Danville, moist sandy roadside ditch, Aug. 18, 1948, M2234, M2236. HARVEY CO: 5 miles north of Burrton, on sandy soil at edge of pond in sand dunes, June 11, 1951, M4916; July 24, 1949, M3506; Aug. 25, 1951, M5083. JEFFERSON CO: 1 mile east of Williamstown, sandy prairie bank, Nov. 6, 1948, M2569. KIOWA CO: 5 miles east of Greensburg, roadside ditch, Aug. 17, 1950, Olin Fearing 543, 544. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandy soil edge of oak woods, May 15, 1948, M1438; 2 miles west of Linwood, sandy oak woods, June 16, 1949, M3089. LYON CO: 1 mile north of Emporia, river bank, Nov. 16, 1948, M2601. MARION CO: 1 mile south of Florence, river bank, Nov. 27, 1948, M2612. MIAMI CO: 3 miles east of Fontana, river bank, Oct. 19, 1947, M1110. MONTGOMERY CO: 1 mile south of

Independence, sandy soil, April 24, 1942, R. H. Thompson; 4 miles southwest of Elk City sandy soil in oak woods, Sept. 1, 1948, M2395; Sept. 22, 1951, M5223. MORRIS CO: 2 miles north of Council Grove, bank of Neosho River, Nov. 27, 1948, M2617. NEMAHA CO: Nemaha County State Park, sandy-clay prairie bank, Aug. 9, 1948, M2017. NEOSHO CO: 2 miles east of Chanute, Feb. 14, 1945, R. H. Thompson; April 9, 1948, M1262. RENO CO: 6 miles west of Pretty Prairie, sandy roadside bank, Aug. 17, 1948, M2221; 6 miles north of Hutchinson, sandy soil, June 11, 1951, M4957; 2 miles north of Hutchinson, edge of pond in sand dunes, Aug. 25, 1951, M5084. RICE CO: 1 mile east of Genesco, sandy prairie, April 30, 1949, M2709. SALINE CO: 2 miles northwest of Brookville, sandy soil in prairie, April 30, 1949, M2690. SHAWNEE CO: 7 miles southeast of Topeka, sandy overgrazed prairie pasture, April 23, 1949, M2683. STANTON CO: 1 mile north of Saunders, sandy prairie, Aug. 28, 1950, M4548. SUMNER CO: 2 miles east of Milan, sandy-clay roadside bank, Aug. 18, 1948, M2240. WASHINGTON CO: 1 mile west of Linn, sandy prairie pasture, Aug. 23, 1947, M1085; 2 miles southwest of Palmer, sandy prairie, May 27, 1948, M4828; Aug. 22, 1952, M5724. WILSON CO: 1 mile northeast of Neodesha, sandy soil, Oct. 25, 1947, M1118; 4 miles north of New Albany, sandy prairie, July 9, 1949, M3402. WOODSON CO: 2 miles northwest of Yates Center, sandy prairie, April 9, 1948, M1248; Sept. 1, 1951, R. H. Thompson; Oct. 28, 1951,

M5281. WYANDOTTE CO: 1 mile northeast of Bonner Springs, sandy prairie bank, May 15, 1948, M1441.

62. Riccia evexa sp. nov. Thalli medium sized, 4 - 10 mm. long, .5 - 2 mm. wide, 1 - 3 times dichotomous, usually with 30 - 60° forkings, forming rosettes or rarely gregarious, light-green and reticulate above, concolorous below or with sides and margins red-purple; main segments linear obcuneate to obcordate; terminal segments oblong, subacute; margins and dorsal surface bearing obtuse or sharp-pointed, often curved, smooth or granulate cilia 120-310μ long, or cilia sometimes deficient; margins obtuse; median sulcus narrow at apex, broadening rapidly toward base, becoming obsolete just back of apex; scales few, hyaline, whitish, cells 26μ wide 45μ long; transverse sections mostly 2 - 3 times as broad as high; dorsal epidermis 1 or 2 stratose, cells of primary stratum rounded obtuse, soon collapsing and leaving irregular vestiges. Dioecious; antheridial ostioles inconspicuous, sometimes elevated 20μ; capsules not numerous, long included; spores light brown to brown, 56 - 94μ in maximum diameter, averaging 80μ, angular, with a crenulate or lobulate margin 2 - 7μ wide, outer face areolate or irregularly areolate, areolae 6 - 13μ wide, the outer face showing in profile very low broad-truncate papillae 1 - 2μ high, inner faces similar but much less strongly marked. Named for the rounded surface of older parts of thallus.

Type collection: 5 miles east of Baxter Springs, Cherokee County, Kansas, on moist sandy-clay soil, clearing in oak-hickory forest, July 31, 1948, R. L. McGregor 1940. Type specimen filed in the herbarium at the University of Kansas.

Riccia evexa differs from all other North American ciliated species, except R. donnellii, in that it is dioecous. It can be easily distinguished from the latter by the much smaller spore size, spores not opaque, much smaller size of thallus and round rather than flat cilia.

R. beyrichiana differs in having inner faces of spore smooth, no cilia on dorsal surface and its general larger size. R. evexa differs from R. hirta in smaller spore size, longer cilia and obsolete median sulcus. R. trichocarpa is at once separated by its black opaque spores, larger spore size, longer and more dense cilia and with dorsal cilia above each capsule. R. eldeeniae (as noted later, R. eldeeniae is here considered to be an ecological variant of R. hirta) seems close to R. evexa but the latter differs in having irregular to regular areolae, spores less papilliate, smaller wing margin, dorsal groove shorter, cilia not located chiefly at apex and, as with other ciliate forms mentioned, in being dioecious rather than monoecious. The only other species close to R. evexa is R. californica which differs in having longer and more slender cilia, these not regularly on dorsal surface, spores with wider wing margin

and in being monoecious.

Riccia evexa has been found only on sandy-clay soil, in shade, and on the flood plains of streams. It is therefore somewhat remarkable in that plants of other ciliate species of Riccia, on such sites, have cilia formation restricted. The species has been found in only two localities but in one of these it was very abundant.

Distribution: CHEROKEE CO: 5 miles east of Baxter Springs, sandy-clay soil, in shade, July 31, 1948, M1940 (Type); Aug. 30, 1948, M2357; Aug. 31, 1948, M2368; Oct. 9, 1948, M2561. MIAMI CO: Miami County State Park, alluvial deposit, bank of Marais des Cygnes River, Oct. 3, 1948, M2472.

63. Riccia fluitans L. Rare. Found in two places in extreme east central Kansas. In both places the plants were found in small lakes in the Marais des Cygnes River valley. Specimens have been taken from water and from mud banks of these stations. Our specimens agree in every respect with the description of the species given by Müller (1952).

Distribution: LINN CO: 2 miles west of LaCygne, in water, June 4, 1949, M2856. MIAMI CO: 3 miles east of Fontana, in Pigeon Lake, May 29, 1949, M2773; mud bank of Pigeon Lake, Oct. 8, 1950, M4679; Oct. 27, 1950, M4696; Nov. 30, 1951, M5293.

64. Riccia frostii Aust. A common and often abundant species on stream banks, flood plains, and lake shores. It

is to be found in all of Kansas except the southwest quarter where it seems to be entirely absent.

One of the remarkable features of this species is the abundance of the plants to be found on alluvial deposits left by major floods of the Kansas River. McGregor (1952) reported the occurrence of this species on silt deposits after the record breaking flood of 1951. It was found that silt covered fields, in the river valley, contained an average of 1,699,202 rosettes per acre. Hundreds of square miles of the river valley had plants in such numbers following the flood. Houses and other buildings which had been filled with a few feet of silt soon had the surfaces of such deposits dotted with young rosettes of R. frostii.

Our collections of this species seem to agree very well with descriptions published and with specimens studied from other areas.

Distribution: ATCHISON CO: ½ mile south of Muscotah, bank of Little Grasshopper Creek, Oct. 18, 1947, M1103. BARTON CO: 4 miles southeast of Great Bend, bank of Arkansas River, Sept. 4, 1949, M3950. CHASE CO: 1 mile south of Strong City, bank of Cottonwood River, Nov. 27, 1948, M2603. CHEYENNE CO: 1 mile southwest of St. Francis, bank of Republican River, Aug. 28, 1947, M1088; Aug. 13, 1948, M2144. CLAY CO: south edge of Clay Center, bank of Republican River, Aug. 22, 1947, M1084. COFFEY CO: 2 miles north of Burlington, bank of Neosho River, Nov. 26, 1948,

M2595. DECATUR CO: Decatur County State Park No. 2, bank of Sappa Creek, Aug. 12, 1948, M2107. DOUGLAS CO: 1 mile northwest of Lawrence, bank of Kansas River, Sept. 27, 1947, M1092; Nov. 6, 1948, M2568; Sept. 5, 1951, M5216; 2 miles northeast of Lawrence, flooded corn field, Aug. 9, 1952, M5685. FORD CO: 7 miles northeast of Dodge City, creek bank, Sept. 5, 1949, M3976. FRANKLIN CO: 1 mile north of Norwood, creek bank, June 19, 1948, M1583. GEARY CO: Milford, alluvial deposit, sandbar in Republican River, Aug. 22, 1947, M1083. HODGEMAN CO: 5 miles east of Grayling, creek bank, Sept. 5, 1949, M3963. JACKSON CO: ½ mile east of Holton, creek bank, Aug. 9, 1948, M2001. JEFFERSON CO: 1 mile south of Williamstown, bank of Kansas River, Sept. 28, 1947, M1096. JOHNSON CO: ½ mile north of DeSoto, bank of Kansas River, Sept. 27, 1947, M1095. LABETTE CO: 4 miles northwest of Chetopa, creek bank, July 2, 1948, M1614. LEAVENWORTH CO: 5 miles northwest of Tonganoxie, bed of dry lake, Aug. 2, 1947, M1081; ½ mile south of Linwood, bank of Kansas River, Sept. 27, 1947, M1093. LINCOLN CO: 1 mile south of Lincoln, bank of Saline River, July 29, 1952, M5671. LOGAN CO: 1 mile west of Elkadeer, bank of Smoky Hill River, Aug. 29, 1947, M1090. LYON CO: 1 mile north of Emporia, bank of Neosho River, Nov. 26, 1948, M2600. MARION CO: 1 mile south of Florence, bank of Cottonwood River, Nov. 27, 1948, M2609. MARSHALL CO: ½ mile east of Blue Rapids, bank of Blue River, Aug. 9, 1948, M2036. MIAMI

CO: Miami County State Park, edge of Lake, Oct. 19, 1947, M1108; Oct. 3, 1948, M2473. MORRIS CO: 2 miles north of Council Grove, bank of Neosho River, Nov. 27, 1948, M2614. NORTON CO: 1 mile west of Calvert, bank of Prairie Dog Creek, Aug. 12, 1948, M2102. OTTAWA CO: 1 mile south of Bennington, bank of Solomon River, July 29, 1952, M5670. PAWNEE CO: 1 mile west of Larned, creek bank, Sept. 5, 1949, M3960. POTTAWATOMIE CO: St. George, bank of Kansas River, Aug. 22, 1947, M1082. RAWLINS CO: 6 miles south of Atwood, bank of Beaver Creek, Aug. 13, 1948, M2141. REPUBLIC CO: Scandia, Bank of Republican River, Aug. 24, 1947, M1087; Aug. 1953, W. H. Horr. RILEY CO: Manhattan, bank of Kansas River, Oct. 22, 1948, Travis Brooks. ROOKS CO: Stockton, bank of Solomon River, Aug. 27, 1947, M1089. RUSSELL CO: 1 mile south of Lucas, bank of Wolf Cceek, July 29, 1952, M5684. SALINE CO: Salina, bank of Smoky Hill River, Aug. 30, 1947, M1091. SEDGWICK CO: west edge of Derby, bank of Arkansas River, Nov. 26, 1953, M7522. SHAWNEE CO: 6 miles east of Topeka, bank of Kansas River, Sept. 28, 1947, M1097; 1 mile north of Topeka, bank of Soldier Creek, Oct. 12, 1947, M1102. SHERMAN CO: 12 miles southwest of Goodland, bank of Smoky Hill River, Sept. 5, 1951, M5216. SMITH CO: ½ mile south of Coudell, bank of Solomon River, Aug. 11, 1948, M2094. WASHINGTON CO: 1 mile west of Linn, creek bank, Aug. 23, 1947, M1351. WILSON CO: 2 miles northwest of Neodesha, bank of Fall River, Oct. 26, 1947, M1123. WOODSON CO: 2

miles northwest of Yates Center, creek bank, Sept. 25, 1948, M2460. WYANDOTTE CO: Bonner Springs, bank of Kansas River, Sept. 27, 1947, M1094; Sept., 1951, O. F. Fearing.

65. Riccia hirta (Aust.) Underw. Common on sandy soils in prairie, over surfacing sandstone, and alluvial deposits below such areas. It is rarely found on calcareous sites and never in close association with limestone outcrops.

This species occurs most frequently as gregarious colonies or scattered rosettes on dry, exposed sandy locations. It is an extreme xerophyte and regularly rolls up in early summer and remains dormant until fall rains when it begins growth again. Mature sporangia are found in late fall, through the winter and in early spring.

R. hirta is one of the more variable species of hepatics in this area. The variations in ciliation, length-width-thickness ratios and color are exceptional. Spore characters also show variations which apparently have not been recorded. Several colonies of R. hirta have been studied during eight successive seasons and the degree of variation noted.

One striking variation concerns the occurrence of marginal cilia. Usually marginal cilia are present and most abundant near the apex and become fewer in number towards the basal end. In some specimens cilia are very dense, 30 - 120μ long, slender and pointed. In others cilia are nearly absent, 30 - 60μ long, stout and obtuse. A few collections show numerous cilia on the dorsal surface.

The usual color of this species is glaucous-green to blue-green fading to whitish upon drying on the dorsal surface while the sides are concolorous to purplish. Ventral scales are usually purplish but may be hyaline or whitish. In some specimens, from more xeric sties, the dorsal surface of the thallus has a blue-green or slate colored surface and blackish purple lateral sides.

Spores of Kansas R. hirta vary from 82 - 171μ and have areoles varying from 6.6 - 20μ. The measurements usually expressed in the literature are 90 - 135μ and 10 - 13μ for spore and areole size respectively. The inner faces of spores vary from an appearance exactly like that of the outer face to definitely less strongly areolate to irregularly areolate.

The above mentioned variations have been found in the same colonies. The strongly ciliate, darker pigmented, larger spore size is correllated with dry seasons and drier periods within a season though in a given station all variations may be encountered in an area one meter square. The statements just made would indicate that material in central Kansas would tend to show variations in line with those stated for drier situations. Such is true and, unless caution was used, might lead to unnecessary taxonomic segregations.

This latter difficulty seems to be apparent in a paper by Jacobs (1949) in which Jacobs described two new species

of Riccia which to the writer seem to be no more than ecological variations of R. hirta as found in sandstone areas of Kansas and the granite outcrop areas in the Edwards Plateau of Texas.

The first of these two species described by Jacobs (l.c.) is Riccia tenella which seems to be a gregarious form of R. hirta and occurs on shallow sandy soil over surfacing sandstone or granite outcrops, in full sunlight and thus a habitat which readily dries out. Such sites also become moist quickly after slight rains causing the plants to grow for a time, become dormant awhile, and then repeat the process. Such growth has been observed in several stations in Kansas and invariably resultant plants match perfectly the description given of R. tenella. These plants typically lack cilia, have a non gibbose dorsal surface, longer terminal segments which are linear. These are characters used by Jacobs to distinguish R. tenella from R. hirta. Other characters, mentioned by Jacobs fall within normal range of variation to be found in R. hirta. Through the courtesy of Dr. D. L. Jacobs specimens of R. tenella were obtained from the type locality (Jacobs 1251). A study of these specimens reveals that they are near exact duplicates of the variations of R. hirta mentioned above. Jacobs further compares R. tenella with R. nigrella, a comparison which is pointless to one who has seen specimens of the latter species. A number of Kansas specimens fit the description of R.

tenella but since it is only an ecological variant of R. hirta it seems best to consider R. tenella as a synonym of hirta.

The second species described by Jacobs (1949) is R. eldeeniae and likewise is an ecological form of R. hirta. Supposedly R. eldeeniae differs from hirta in having smaller areolae, smaller spores and outer face and inner face similarly sculptured. Those differences are to be found within a single colony of R. hirta. R. eldeeniae was described as having dorsal and marginal cilia. Such is also known in several collections of R. hirta and all other characters used to separate R. eldeeniae from R. hirta likewise fail. A collection of R. eldeeniae (Jacobs 920) has been made available for study by Dr. Jacobs. We find the specimens to be a variation of R. hirta as mentioned above. It thus seems that R. eldeeniae must be reduced to a synonym of R. hirta.

From the above it is noted that R. hirta is indeed a variable species. A detailed study of the concept in Kansas and from stations in Arkansas, Oklahoma, Louisiana, and Texas indicates that the same variations occur in those areas. Only a careful cytological study coupled with detailed field and cultural studies will show whether taxonomic segregations are necessary. Our studies indicate that this must be done over the complete range of the species as now known.

Distribution: ALLEN CO: 5 miles north of Moran, creek

bank, Oct. 8, 1948, M2502. ANDERSON CO: 5 miles south of Garnett, creek bank, Oct. 8, 1948, M2487; 1½ miles northeast of Welda, open places in prairie, Oct. 31, 1948, R. H. Thompson. BROWN CO: 5 miles northeast of Hiawatha, sandy roadside bank, Sept. 7, 1948, M2433. CHAUTAUQUA CO: 3 miles northeast of Sedan, sandy soil over sandstone outcrop, March 26, 1948, M1211; 4 miles south of Sedan, sandy prairie, July 8, 1949, M3371; 3 miles north of Elgin, sandy prairie pasture, April 5, 1952, M5349. CHEROKEE CO: 5 miles east of Baxter Springs, sandy-clay soil, edge of oak woods, April 30, 1948, M1364. CLAY CO: 5 miles north of Morganville, sandy prairie, Aug. 16, 1951, M5067. COFFEY CO: 2 miles southwest of LeRoy, sandy prairie, April 9, 1948, M1237. DOUGLAS CO: 1 mile southeast of Lawrence, sandy soil, May 24, 1942, R. H. Thompson; 2 miles southeast of Baldwin City, sandy soil, edge of pond, Oct. 11, 1947, M1098; 5 miles west of Baldwin City, sandy prairie, Nov. 16, 1947, M1138; Oct. 15, 1949, M4144; Aug. 2, 1951, M5005; Oct. 13, 1951, M5244. ELK CO: 10 miles north of Busby, sandy prairie, April 10, 1948, M1282. ELLSWORTH CO: 5 miles east of Carneiro, sandy soil, outcrop in prairie, April 30, 1949, M2698; 2 miles northwest of Langley, sandy soil over outcrop, May 3, 1952, M5450. FRANKLIN CO: 1 mile northeast of Norwood, sandy prairie, March 25, 1948, M1166. GREENWOOD CO: Severy, sandy soil, Sept. 2, 1945, R. H. Thompson; 1 mile north of Fall River, margin of sandstone outcrop,

April 10, 1948, M1296; April 13, 1949, M2672; July 9, 1949, M3407. HARVEY CO: 5 miles north of Burrton, cattle trail in sand dunes, June 1, 1951, M4916. JEFFERSON CO: 1 mile east of Williamstown, sandy soil in pasture, Nov. 6, 1948, M2570. JOHNSON CO: 5 miles west of Olathe, sandy bank, Nov. 2, 1947, M1129. KINGMAN CO: 6 miles northwest of Kingman, sandy roadside bank, Aug. 7, 1948, M2226. KIOWA CO: Rezeau Ranch, sandy prairie, June 12, 1951, M4922. LABETTE CO: 5 miles southwest of Dennis, sandy bank, April 10, 1948, M1263. LEAVENWORTH CO: Military Reservation, Oct. 22, 1942, R. H. Thompson; 1 mile west of Turkey Creek Station, sandy bank, Dec. 2, 1947, M1143. MIAMI CO: 3 miles east of Fontana, river bank, Oct. 19, 1947, M1109. MONTGOMERY CO: 3 miles south of Elk City, sandy soil, April 4, 1942, R. H. Thompson; Oct. 25, 1947, M1122; Sept. 22, 1951, M5233. NEOSHO CO: east of Chanute, sandy soil, Feb. 14, 1945, R. H. Thompson. SHAWNEE CO: 7 miles southeast of Topeka, sandy clay prairie, April 23, 1949, M2684. WABAUNSEE CO: 5 miles northwest of Paxico, at base of granite glacial drift boulders, June 25, 1950, M4370. WASHINGTON CO: 1 mile west of Linn, sandy prairie, Aug. 23, 1947, M1352; 1 mile northeast of Linn, sandy prairie bank, Aug. 21, 1951, M5071, M5072; Aug. 22, 1952, M5720; 1 mile west of Linn, sandy alluvial deposit, Aug. 22, 1952, M5724. WILSON CO: 1 mile northeast of Neodesha, sandy soil, edge of outcrop, Oct. 25, 1947, M1117; 4 miles north of New Albany, sandy pockets in

surfacing sandstone, July 9, 1949, M3403; 1 mile east of Neodesha, sandy ledge, April 5, 1952, M5332. WOODSON CO: 2 miles northwest of Yates Center, sandy oak woods, Oct. 26, 1947, M1126; Lake Fegan, shallow soil over surfacing sandstone, Sept. 24, 1949, M4127; 2 miles northwest of Yates Center, sandy soil, edge of sandstone outcrop, May 12, 1951, M4809; 14 miles southwest of Yates Center, sandy soil, Sept. 1, 1951, R. H. Thompson; Oct. 28, 1951, M5282.

66. Riccia lamellosa Raddi. A species found in the eastern third of Kansas where it occurs most commonly on sandy soil in prairies, near sandstone outcrops and moist sandy-clay banks. It will tolerate calcareous sites and has been found as rare rosettes on black soil over surfacing limestone in oak-hickory woods.

In late fall and early spring this species appears as rosettes or in gregarious colonies. During summer or dry seasons it is found as rare dichotomies of small size but otherwise is absent. It does not seem to withstand prolonged drought as it apparently does in Oklahoma and Texas.

Our studies on this species in Kansas verifies the decision of Müller (1952) in which he reduces R. austini Steph. to a synonym of R. lamellosa Raddi. We fail to find a single character which consistently could be used to separate American material from the European R. lamellosa. The size of the ventral scale in particular is a quite variable feature and is determined by ecological conditions.

Distribution: ANDERSON CO: 1½ miles northeast of Welda, open places in prairie, Oct. 31, 1948, R. H. Thompson. CHASE CO: 1 mile south of Strong City, bank of Cottonwood River, Nov. 27, 1948, M2606. CHAUTAUQUA CO: 3 miles northeast of Sedan, sandy soil, oak woods, March 26, 1948, M1210; 3 miles north of Elgin, sandy prairie pasture, April 5, 1952, M5351. CHEROKEE CO: 3 miles southeast of Baxter Springs, rocky pasture, Oct. 22, 1951, M5263a. CLAY CO: 5 miles north of Morganville, sandy prairie, Aug. 16, 1951, M5065. DOUGLAS CO: 1 mile southeast of Haskell, sandy soil, May 7, 1942, R. H. Thompson; 3 miles southeast of Baldwin City, sandy soil over sandstone ledge, Nov. 2, 1947, M1132; 5 miles west of Baldwin City, sandy soil over surfacing sandstone, Nov. 16, 1947, M1139; Oct. 13, 1951, M5245. ELK CO: 10 miles north of Busby, sandy prairie, April 10, 1948, M1281. ELLSWORTH CO: 4 miles northwest of Langley, sandy soil over surfacing sandstone, May 3, 1952, M5449. GREENWOOD CO: 1 mile northeast of Fall River, sandy soil, April 10, 1948, M1297. JEFFERSON CO: 1 mile west of Medina, sandy prairie bank, Nov. 16, 1947, M1134. JOHNSON CO: 5 miles west of Olathe, black soil over surfacing limestone, Nov. 2, 1947, M1131. LEAVENWORTH CO: 2 miles west of Linwood, sandy soil, oak woods, June 16, 1949, M3088. LYON CO: 1 mile north of Emporia, bank of Neosho River, Nov. 26, 1948, M2598. MARION CO: 1 mile south of Florence, bank of Cottonwood River, Nov. 27, 1948, M2611. MCPHERSON

CO: 2 miles northwest of Lindsborg, sandy prairie, May 3, 1952, M5439. MIAMI CO: 3 miles east of Fontana, river bank, Oct. 19, 1947, M1113. MONTGOMERY CO: 3 miles southwest of Elk City, sandy bank, Oct. 25, 1947, M1121; sandy soil over surfacing sandstone, Sept. 22, 1951, M5231. MORRIS CO: 2 miles north of Council Grove, bank of Neosho River, Nov. 27, 1948, M2616. NEOSHO CO: 2 miles east of Chanute, sandy bank, Nov. 27, 1947, M1140; sandy soil around Sante Fe Pond, Oct. 30, 1948, R. H. Thompson; 3 miles east of Chanute, sandy soil, May 12, 1951, R. H. Thompson. SHAWNEE CO: 5 miles east of Topeka, soil over surfacing limestone, April 23, 1949, M2678. WASHINGTON CO: 1 mile west of Linn, sandy prairie bank, Aug. 10, 1948, M2046; 2 miles southwest of Palmer, sandy prairie, May 27, 1951, M4827; 2 miles northeast of Linn, sandy prairie, Aug. 22, 1952, M5719. WILSON CO: 1 mile northeast of Neodesha, sandy soil over surfacing sandstone, Oct. 25, 1947, M1116. WOODSON CO: 2 miles northwest of Yates Center, sandy soil, Oct. 26, 1947, M1127; Lake Fegan, sandy prairie bank, Sept. 24, 1949, M4128; 2 miles northwest of Yates Center, sandy soil over surfacing sandstone, May 12, 1951, M4808.

67. Riccia rhenana Lorbeer. This species was first reported from North America and Kansas by McGregor (1952). In Kansas the species has a scattered distribution but seems to grow in most abundance in water below springs or in cattail sedge marshes.

Kansas specimens exhibit all the characteristics described for the species and match European material of the concept. It has been found in water and as strand plants but never produces reproductive structures. This makes its survival in our cattail-sedge marshes a matter of interest as they often dry up completely and for long periods of time. However, R. rhenana makes its appearance soon after such marshes are refilled. It has been observed that the apices of the plants resist rather severe desiccation and this may account for survival and spread by waterfowl.

Distribution: DOUGLAS CO: 2 miles northeast of Lawrence, on mud, edge of cattail-sedge marsh, May 9, 1948, R. H. Thompson; 1 mile northeast of Lawrence, in water, marsh, Aug. 27, 1949, M3894; 3 miles northeast of Lawrence, in cattail-sedge marsh, Nov. 6, 1949, R. H. Thompson; Nov. 13, 1949, M4162; Sept. 23, 1950, M4677; Nov. 30, 1951, M5294; May 8, 1952, M5461. JEFFERSON CO: 3 miles west of Williamstown, marsh in Kansas River Valley, Nov. 13, 1949, M4164. KIOWA CO: 5 miles north of Belvidere, in water below a spring, June 12, 1951, M4921. LINN CO: 2 miles west of LaCygne, in cattail-marsh, June 4, 1949, M2857. MEADE CO: Meade County State Park, in pond fed by artesian water, May 8, 1942, W. H. Horr; May 16, 1948, W. H. Horr 3111; Aug. 16, 1948, M2199. MIAMI CO: Pigeon Lake, shallow water, March 16, 1947, M1056; April 24, 1948, M1349; May 29, 1949, M2774.

68. Riccia sorocarpa Bisch. A rather uncommon species

in Kansas and never found in any abundance. It occurs on sandy soil in prairie, borders of sandstone outcrops and alluvial deposits. This species is essentially an early spring plant, disappearing during the summer, but found again in the late fall. It is the first species of Riccia to disappear as the various stations dry out and thus is mesic in its requirements.

Kansas material never seems to branch more than once and thus appears as scattered dichotomies which fruit abundantly but do not develop into gregarious colonies. Otherwise our material seems typical of the species.

Distribution: ANDERSON CO: 2 miles south of Garnett, sandy-clay soil, open places in oak-hickory woods, June 4, 1951, M4875. CHAUTAUQUA CO: 3 miles northeast of Sedan, sandy prairie, March 26, 1948. CHEROKEE CO: 5 miles east of Baxter Springs, creek bank, Oct. 22, 1951, M5258. CLAY CO: 5 miles north of Morganville, sandy prairie, Aug. 16, 1951. CRAWFORD CO: 2 miles west of Hepler, field, May 1, 1948, J. J. Gier 1073. DOUGLAS CO: Univ. of Kansas Campus, May 26, 1942, R. H. Thompson. LEAVENWORTH CO: 4 miles northeast of Tonganoxie, sandy bank, May 7, 1948. MONTGOMERY CO: 3 miles south of Elk City, sandy soil, April 4, 1942, R. H. Thompson; 6 miles south of Elk City, sandy soil, oak woods, March 26, 1948, M1220. NEOSHO CO: 3 miles east of Chanute, sandy soil, May 12, 1951, R. H. Thompson. SHAWNEE CO: 7 miles southeast of Topeka, sandy soil, overgrazed

prairie pasture, April 23, 1949, M2685.

69. Riccia sullivantii Aust. Infrequent on alluvial deposits along streams in the eastern fourth of Kansas. It is not abundant nor is it to be found in successive years in the same stations. The species occurs in late fall, usually after fall rains, thus its length of growing season is curtailed and mature sporangia rarely develop. Kansas appears to be the western limit of the range of this species.

Distribution: ALLEN CO: 5 miles south of Moran, bank of stream, Oct. 8, 1948, M2500. ANDERSON CO: 4 miles south of Garnett, alluvial deposit, creek bank, Oct. 8, 1948, M2483. ATCHISON CO: ½ mile south of Muscotah, alluvial deposit along Little Grasshopper Creek, Oct. 18, 1947, M1104. BOURBON CO: 1 mile south of Uniontown, bank of Marmaton River, Oct. 8, 1948, M2516. CHEROKEE CO: 5 miles east of Baxter Springs, alluvial deposit, bank of Shoal Creek, Aug. 30, 1948, M2355, M2367; Oct. 22, 1951, M5264. DOUGLAS CO: 2 miles northeast of Lawrence, bank of Mud Creek, Sept. 26, 1948, M2462. LEAVENWORTH CO: 2 miles north of Leavenworth, bank of Missouri River, Oct. 29, 1948, M2563. MIAMI CO: 3 miles east of Fontana, bank of Marais des Cygne River, Oct. 19, 1947, M1111; Oct. 3, 1948, M2468; Oct. 8, 1950, M4680.

70. Riccia trichocarpa Howe. Limited to occurrence on sandy soil near surfacing sandstone in prairie or oak-hickory woods. The species is an extreme xerophyte and is

to be found on the driest, exposed sandy stations.

Distribution: CHAUTAUQUA CO: 3 miles northeast of Sedan, on sandy soil in oak-hickory woods, March 26, 1948, M1213. DOUGLAS CO: 5 miles west of Baldwin City, sandy soil near sandstone outcrop, Nov. 16, 1947, M1137; Nov. 7, 1948, M2575; Oct. 15, 1949, M4145; March 30, 1952, M5326; April 26, 1952, M5433. ELK CO: 10 miles north of Busby, sandy soil in oak woods, April 10, 1948, M1285. FRANKLIN CO: 1 mile northeast of Norwood, sandy soil, March 25, 1948, M1167. GREENWOOD CO: 1 mile northeast of Fall River, sandy soil in oak woods, April 10, 1948, M1290. MONTGOMERY CO: 3 miles southwest of Elk City, sandy soil near sandstone outcrop, Oct. 25, 1948, M1120; 6 miles south of Elk City, sandy soil in oak woods, March 26, 1948, M1184; 3 miles southwest of Elk City, sandy prairie, Sept. 22, 1951, M5235. WILSON CO: 1 mile northeast of Neodesha, sandy soil near sandstone outcrop, April 10, 1948, M1273. WOODSON CO: 2 miles northwest of Yates Center, sandy soil in Prairie, Oct. 26, 1947, M1125; April 9, 1948, M1245; May 12, 1951, M4811; Oct. 28, 1951, M5279.

Excluded Species

A few species have been reported in the literature as present in Kansas but for which specimen evidence is not known. Such reports were probably based on incorrect determinations as it seems unlikely that some of them could

occur in the state. All were listed by Smyth and Smyth (1911) and are as follows:

1. Chiloscyphus polyanthus (L.) Corda.
2. Fossombronia angulosa Raddi.
3. Jungermannia schraderi Martius.
4. Leucolejeunea clypeata (Schweinitz) Evans.
5. Pallavicinia lyellii Gray.
6. Pellia endiviaefolia (Dicks) Dum.
7. Preissia quadrata (Scop.) Nees.
8. Ptilidium ciliare (L.) Hampe.
9. Riccardia latifrons Lindb.

ECOLOGICAL STUDIES

Location and Area

Kansas is located in the center of the United States and has a general rectangular shape. The north and south boundaries are the parallels of 40°N. and 37°N., respectively, the eastern boundary is the Missouri River and 94°38'W., and the western boundary is 102° 1'34"W. This area, about 210 miles north-south and 410 miles east-west, contains an area of about 82,000 square miles.

Physiographic Regions

A number of schemes for physiographic subdivision of the state have been published and several maps prepared.

Among the more important of these are those of Adams (1903), Fenneman (1931), Frye (1946), Frye and Swineford (1949), Schoewe (1949) and Frye and Leonard (1952). All of these seem similar, basically, but the map and discussion given by Schoewe (1949) is the most useful for one interested in the study of the state's flora.

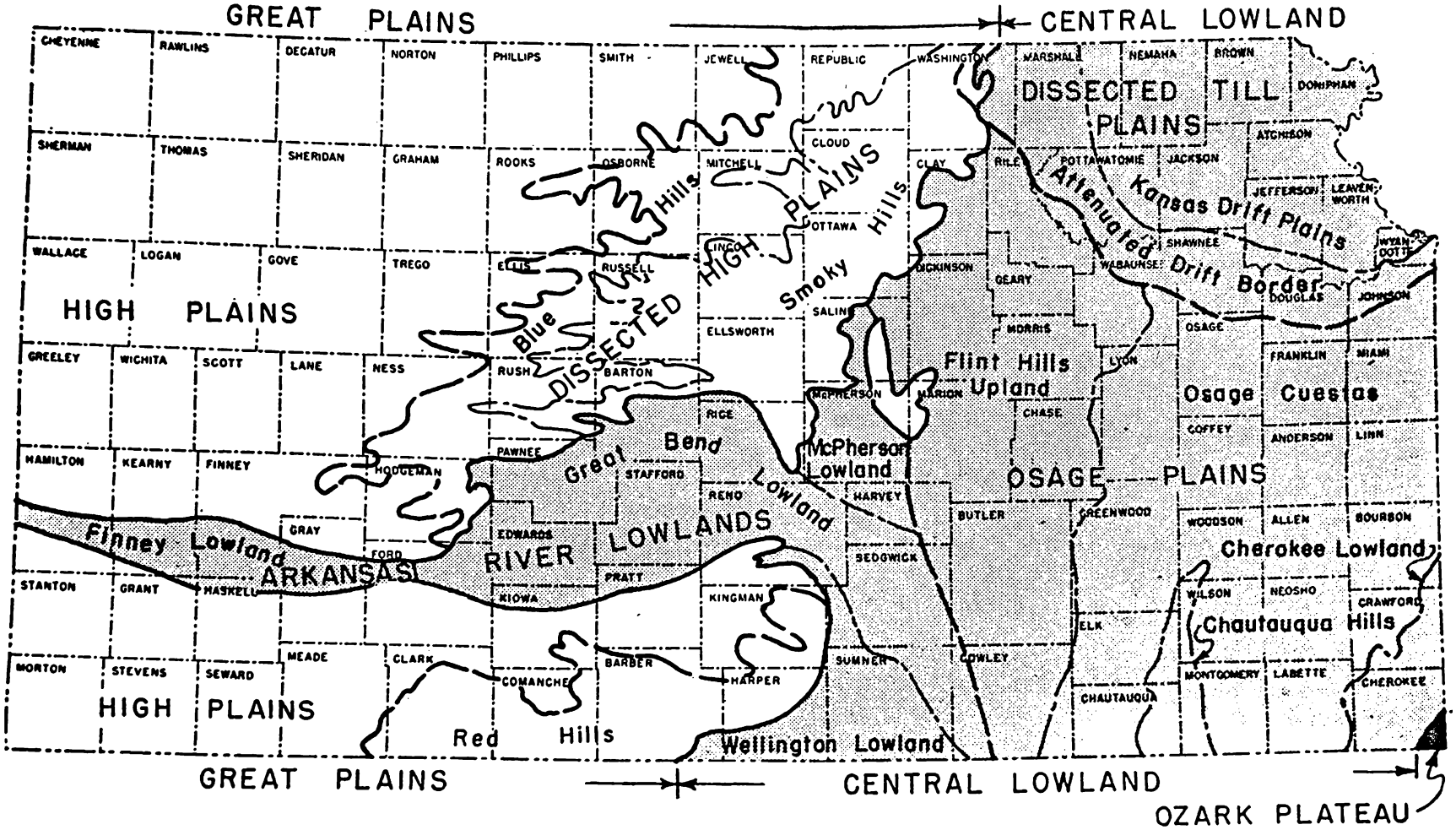
Map 1 is adopted from Schoewe (1949) and outlines the major and minor physiographic divisions of Kansas. It is apparent that the area is divided into three provinces. The Ozark Plateau province is a small area which extends into Kansas from the Springfield Plateau in Missouri and constitutes the edge of a westward dipping plain underlain by limestones of Mississippian age. This area is essentially flat but with sufficient slope for good drainage. It has a reflief which averages less than 60 feet.

The Central Lowland province is divided into three sections and ten minor divisions. These minor divisions are important in the study of vegetation and will be briefly considered. The Cherokee Lowland is an erosional plain whose surface slopes to the west at an average rate of 10 feet per mile and is developed from weak shales and sandstones. The surface is gently undulating except for a few broad, flat-topped mesa-like wooded hills which are capped by resistant sandstone. Some of these hills rise 80 or more feet above the surrounding country. Several wide, shallow, flat bottomed valleys occur.

The Chautauqua Hills include a belt developed on thick sandstones in which erosion has dissected the surface into a series of low hills characterized by growths of Quercus stellata and Quercus marilandica. These hills are intersected by many small streams which have cut deep valleys. The sandstones of this area extend northeastward to Leavenworth and Jewett (1941) believes that this extension should be included in the Chautauqua Hills division. The flora of the area corroborates Jewett's opinion.

The Osage Cuestas consist of a series of northeast-southwest escarpments which face east and between which are flat to gently rolling plains. Each cuesta consists of a steep, bold, east-facing front or escarpment and a gentler inclined surface sloping westerly in the direction of the dip. The crest of each escarpment is capped by resistant limestone. These escarpment fronts range from a few feet to more than 200 feet in height.

The Flint Hills Upland, commonly called Flint Hills, is a range of hills about 20 miles wide extending from Marshall County in the north to Cowley County in the south. The Flint Hills are separated from the Osage Cuestas by a very prominent rocky escarpment several hundred feet high. This highly dissected east-facing escarpment has terraced rocky slopes. The rocks of the area are limestone which bear flint. The surface of the Flint Hills is gently rolling and merges on the west with a smooth gentle slope



Map 1. Physiographic map of Kansas. (After Schoewe, 1949)

towards the Arkansas River. The streams of the Flint Hills flow in steep precipitous channels lined with rock ledges. The area is dominated by a growth of Andropogon gerardi and Andropogon scoparius.

In northeast Kansas occurs the Dissected Till Plains Section which is divided into two minor divisions; the Kansas Drift Plains and the Attenuated Drift Border. These areas differ from the Osage Plains in that the former have been glaciated whereas the latter have not. For the most part the area is an erosional drift-controlled surface which is gently undulating. Near large streams the country is dissected into rough and hilly areas with river bluffs too rough for cultivation and revealing ledges of limestone and some sandstone. Interstream areas are smooth, broad, and well rounded and become more dissected as one approaches larger stream courses. Most valleys are wide and open.

The Arkansas River Lowlands section is divided into four minor divisions which, though different from each other physiographically, are similar enough that they need not be treated separately here. The Arkansas River Lowland section for the most part follows the valley of the Arkansas River. The river flows in a shallow channel developed on easily eroded shales and sandstone. Much of the large flat river valley is covered with sandy soil and at many places low sand dunes are found. In many places in this Lowland section one finds depressions which have ponds or marshes.

In other places extensive sand dunes are found which may be up to 100 feet in height. Many ponds and marshes are found between some of the dunes. A detailed discussion of this Arkansas River Lowlands section is given by Schoewe (1949).

The Great Plains province has two sections. The first, the High Plains section, is a near featureless plain which is the most level area of Kansas. It is a virtually treeless area and one many people think of as representative of Kansas; a view far from accurate and reflects the lack of observation of individuals who travel across the state. This section is almost devoid of hepatics and need not be treated further here.

The second section of the Great Plains Province known as the Dissected High Plains has three minor divisions. One of these, the Smoky Hills, is very important in hepatic distribution. This area consists of a maturely dissected, broad, hilly, belt carved in Dakota sandstone and having a relief at places of from 200 - 300 feet. Numerous outlying hills and mounds are found. Stream valleys are wide but small tributaries often have abrupt banks with outcroppings of sandstone. These often have springs or are seepy and usually shaded. The other minor divisions of this section are virtually without hepatics and hence are not further treated further. A somewhat detailed account of these divisions is, however, given by Schoewe (1949).

CLIMATE OF KANSAS

It is necessary to preface a discussion of ecology in Kansas by considering the recorded data on temperature, moisture, winds, etc. The present discussion of climate in Kansas is based directly on the publication of Flora (1948) and supplemented observations of the writer.

As a whole the state has an annual mean temperature of 55°, almost equal to that of Virginia, more sunshine than any state to the east, and summer rains which average, in eastern counties, higher than those of other states except the states along the Gulf Coast. This combination of weather elements makes the state a leading agricultural region for grains and livestock but tends to restrict the development of a hepatic flora which a consideration of weather elements will show. The 400 mile spread of the state from east to west results in three rather distinct climates known as eastern, middle, and western thirds.

Rainfall: Rainfall varies from an average of near 36 inches in the eastern third, to about 26.5 in. in middle, and to 19 inches in the western third. This rainfall is often not equally distributed during the season with a result that prolonged dry periods, such as occurred in 1952-53, may affect the flora more than the long term averages would lead one to suspect.

Humidity: The average relative humidity over Kansas

is less than in any state east of the continental divide of the rockies. Average mid-day and evening humidities over the state in July range from 30 - 40 per cent in the western part to 45 - 50 per cent in the eastern part. This low relative humidity allows for rapid evaporation and drying out of most of the habitats in the state. This has a profound effect on Hepaticae.

Temperatures: As noted previously Kansas has a mean annual temperature of 55°. The warmest month of the year is July with an average mean temperature of 79° and the coldest is January with an average mean of 30°. The lowest temperature ever recorded officially in the state was 40° below zero and occurred in north central Kansas. The highest official temperature was recorded in the southeast quarter of the state at 121°.

Winds: The prevailing direction of wind in all parts of the state is from the south and southwest, April to November, inclusive. In other months northerly winds prevail. In eastern Kansas winds have an average hourly movement of 9 miles while they average 12 miles in southwest Kansas.

An outstanding effect of wind occurs occasionally during the course of hot summer weather. At such times winds of rather high velocity, low relative humidity, and with shade temperatures of 100-110° or higher have been known to kill foliage and destroy growing crops. These are the "hot winds" which the writer has observed to kill a corn crop in

one days time.

Frosts: The average last date for killing spring frosts ranges from April 9 in extreme southeast Kansas to May 2 in the extreme northwest part of the state. However, killing frosts have been known to occur as late as the second week of May in southeast Kansas and in the last week of May in extreme northern counties.

The average date of first killing frost is the first week of October in northwest Kansas to the last week of October in the southeast. Killing frosts have been known in the first week of September in the northwest to the third week of September along the southern border.

The climate of Kansas is, then, one of great extremes and sudden changes in temperature, precipitation, and wind. Conditions at any one point may vary widely from year to year and very often are extremely unsatisfactory for vegetation. It must be emphasized that it is the extremes of climate which affect the occurrence and distribution of hepatics in the state most rather than the average which at first glance might seem to be favorable for a more diverse vegetation including liverworts.

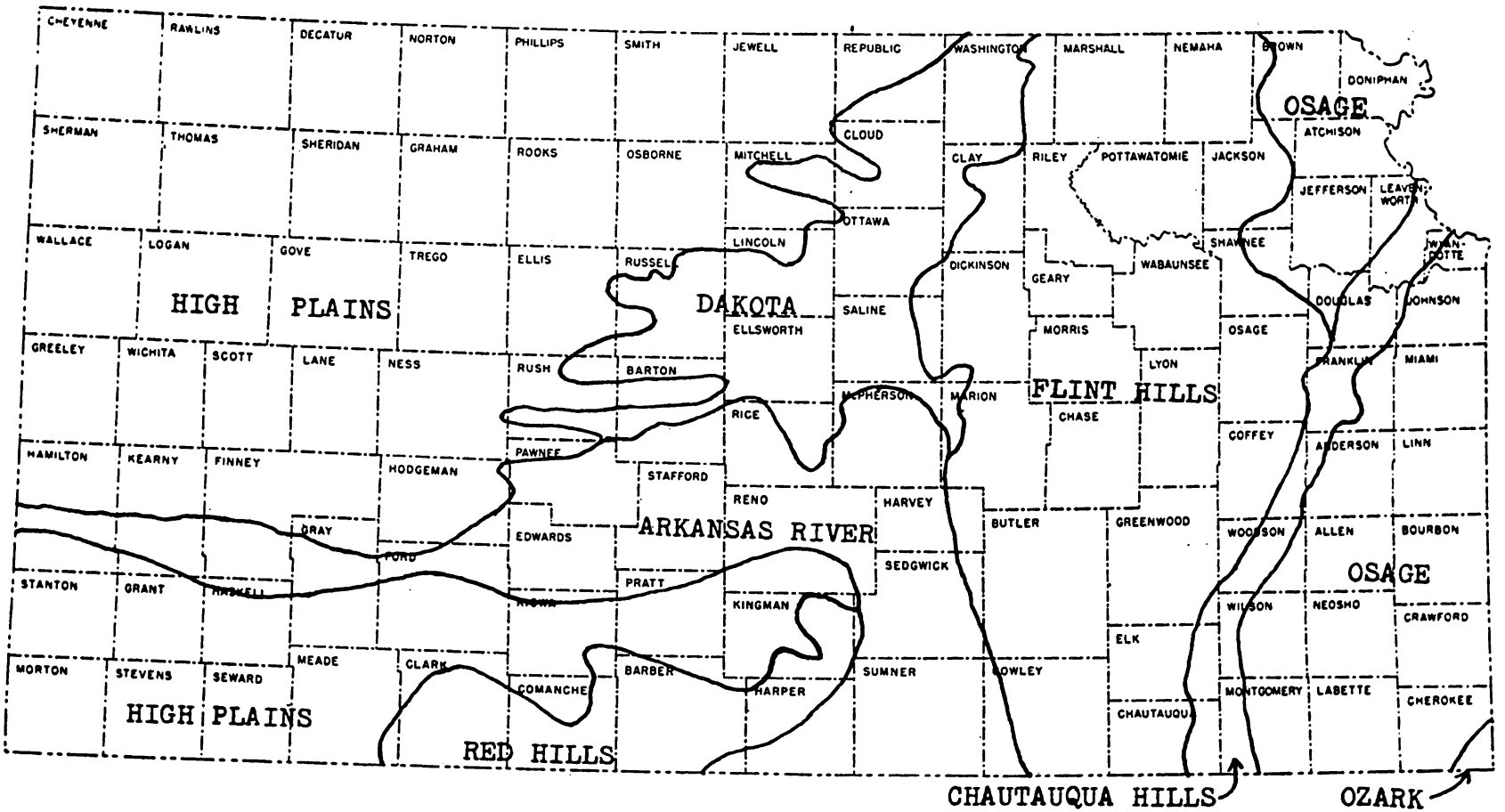
VEGETATION AREAS IN KANSAS

Studies on the vegetation of Kansas during the past 100 years have been concerned mainly with attempts to obtain a complete record of all species found to occur in the area.

Numerous publications have been produced which give lists of species and counties where such species have been found. As yet no one has made a serious attempt to delimit and define vegetative areas in Kansas. It is true that, as yet, insufficient field studies have been made and thus it is not possible to prepare a map of vegetative areas which would show more than broad generalizations.

A few publications have included discussions and maps which involve vegetation areas to some extent. Some of these are Brumwell (1941), Cockrum (1952), Fearing (1952), and Gates (1937, 1940). All of these have contributed to our knowledge of vegetative areas either directly or indirectly but none have been close to adequately portraying the true nature of vegetation assemblanges in Kansas.

Since none of the previously published maps of vegetation areas in Kansas seem to be of much value, the writer here presents, as map 2, a break-down of the major vegetation areas in Kansas. In preparing this map it was not intended that it show all minor zones or deal with the complexities of the numerous transition areas. The map is based on the writer's studies made in each county of the state and is based on a study of the distribution of bryophytes and all higher plant groups. Future studies will without doubt alter the boundries of some areas and in a few places subdivide the areas delimited here into additional vegetation areas.



Map 2. Vegetation areas in Kansas

The small Ozark area in extreme southeastern Kansas is botanically one of the more interesting parts of the state. More species of higher plants are known for this area than for any other of equal or larger size in the state. In this area of Kansas a number of eastern and Ozarkian species find the western limit of their range. In addition a number of plants common in this Ozark area are found only rarely elsewhere in adjacent vegetation assemblages. Some of the taxa known in Kansas from the Ozark area only are: Isoetes butleri, Dryopteris hexagonoptera, Saururus cernuus, Arabis laevigata, Asclepias quadrifolia, Ludwigia glandulosa, Polymnia uvedalia, Cornus florida, Ulmus alata, Vaccinium stamineum var. interius, Vaccinium vacillans var. missouriensis, Hieracium gronovii and Aster turbinellus.

The Ozark area is characterized by oak-hickory wooded hillsides on which the common trees are Quercus alba, Q. macrocarpa, Q. muehlenbergii, Q. marilandica, Q. shumardii, Q. velutina, Carya cordiformis, C. laciniosa, C. ovata, C. texana, Celtis occidentalis, Ulmus americana, U. rubra, and Acer saccharum. The understory is dominated by Symphoricarpos orbiculatus, Aesculus glabra var. sargentii, Ostrya virginiana, Staphylea trifolia, Cercis canadensis and numerous other plants. Among the forested hillslopes, hilltops and bluffs are islands of tall grass prairie which are dominated by Andropogon gerardi, Sorghastrum nutans, Tripsacum dactyloides, and Panicum spp. These prairies often have

thickets or marginal bands of Sassafras albidum, Diospyros virginiana and Prunus spp. A few marshes, streams and extensive rock outcrops offer a variety of additional habitats for hepatics.

The Osage vegetation area consists basically of oak-hickory wooded hillslopes, creek valleys and ravines. Uplands were originally covered with tall-grass prairie dominated by Andropogon gerardi. It is an area much disturbed by man and original vegetation is to be found primarily in out of the way places. Woods, in general, are dominated by Quercus macrocarpa, Q. muehlenbergii, Q. velutina, Carya cordiformis, C. ovata, Ulmus americana, U. rubra and Celtis occidentalis. In some locations significant stands of Acer saccharum, Tilia americana, Quercus alba, Juglans nigra and Fraxinus lanceolata are found. The understory consists principally of Symphoricarpos orbiculatus, Ostrya virginiana, Aesculus glabra var. sargentii, Asimina triloba, and Staphylea trifolia. Characteristic herbs are Podophyllum peltatum, Carex spp., Agrimonia spp., Sanicula marilandica, Phlox divaricata, Isopyrum biternatum, and others.

Prairies of the Osage area are dominated by Andropogon gerardi. In dry sites Andropogon scoparius and Bouteloua curtipendula become evident while in moist places Tripsacum dactyloides, Sorghastrum nutans, Triodia flava and Panicum virgatum may be locally dominant. In all cases species of

Panicum and Poa are usual components. A number of forbs give the prairie seasonal aspects. Some of these are Baptisia leucophaea, Sisyrinchium campestre, Phlox pilosa, Hypoxis hirsuta, Tradescantia bracteata, Senecio plattensis, Silphium laciniatum, Helianthus spp., Ratibida pinnata, Rudbeckia serotina, Liatris pynostachya, Solidago spp., Aster spp., Amorpha canescens, Petalostemum purpureum, Psoralea esculenta, P. tenuiflora and many others.

A number of streams dissect the Osage area and in the valleys formed the usual Salix, Populus, Ulmus, Acer and Fraxinus stream bank floristic assemblages are found. In the lower third of this area significant stands of Quercus palustris are found in lowland woods.

As noted on the map of vegetation areas (Map 2) the Osage area is separated into two parts by the Chautauqua Hills area. The northern part differs from the southern to only a slight degree and is not worthy of detailed consideration in the present paper.

One of the most interesting of the vegetation areas is the Chautauqua Hills. This is an area distinguished primarily by a range of sandy and sandstone hills whose tops and slopes are forested with scrub oak. The southern fourth of this area is very distinct but the rest is somewhat dispersed and allows for transition sites with the Osage and Flint Hill areas. The dominant trees of characteristic Chautauqua Hills consist of Quercus marilandica, Q. stellata,

Q. prinoides, and Q. velutina. Along streams and in the northern parts of the area many of the trees of the Osage area become admixed with the above.

The prairies of the Chautauqua Hills are similar to those of the Osage area except that they occur on sandy soils and those of the latter are predominantly calcareous. The Chautauqua Hills contain more hepatics both in number of species and plants of each species than all other of our vegetation areas.

The Flint Hills area is best characterized as a bluestem grass region. On the uplands and dry places Andropogon scoparius is the dominant species while hillslopes and moist places are dominated by Andropogon gerardi. Bouteloua curtipendula is usually present with both of the bluestems. Forbs are similar to those of the Osage prairies except a larger number of legumes are present. Along the streams are found a limited amount of forests which are tongues or finger-like projections of the Osage forest through the Chautauqua Hills into the Flint Hills. Trees found are usually Ulmus americana, Quercus macrocarpa, Fraxinus lanceolata, Acer negundo, Populus deltoides and Salix spp. The Flint Hills are of little importance in hepatic distribution since species present in the area are few in number, found only on bark or stream banks, and consist of ubiquitous taxa.

An important vegetation area in regard to hepatic distribution is the Dakota area which is often referred to as

the Smoky Hills. This area is conspicuous due to the frequent outcropping of the dark Dakota sandstone. The original vegetation was dominated by the bluestem grasses Andropogon scoparius and Andropogon gerardi but overgrazing and drought have allowed the more resistant short-grasses Buchloe dactyloides and Bouteloua spp. to become dominant and, in severe cases, annual grasses, such as Hordeum pusillum, have invaded. Therefore, the area is not stabilized and is mainly one of transition between bluestem on the east and short-grasses on the west. Forbs also represent a mingling of eastern and western species. No species known in Kansas are confined to this area but since the area is quite well defined, has a better soil moisture relationship than areas to the east or west, it does form a discrete vegetation area as noted by Gates (1937). The streams of the area are forested similar to those of the Flint Hill area.

The numerous sandstone outcrops and exposures along with sandy soil prairies and the trees, particularly Quercus macrocarpa, allows for a hepatic flora which ranks third behind the Chautauqua Hills and Ozark area in number of plants present.

The Arkansas River area is a loosely defined area consisting of the Arkansas River valley and associated low, undulating plains along the river and its tributaries. The soil is sandy and vegetation is dominated by sand grasses both along the streams and in the extensive sand dune

formations located in the area. Doell (1938) reports that the sand hills of Harvey, Reno and Rice counties are similar to the sand hills westward along the Arkansas River. Doell believes that the sand hills present a true transition between tall and short grass prairies and that stability is never reached. In the Arkansas River area both tall and short grass associations are found. The latter are located on drier more stable soil but the very sandy and sand dune parts, so characteristic of the area, though including plants of both short and tall bluestem grass associations in addition have some distinctive species such as Calamovilfa gigantea, Andropogon hallii and Panicum virgatum which are found to be locally dominant. The forbs present are also a mixture from other areas but several are found only in the Arkansas River vegetation assemblage. In general the vegetation is xerophytic and grasses are the dominant plant cover with Salix spp., Populus spp., and thickets of Prunus spp. forming the only significant woody components. Hepatics are few in number and are found along cattle trails through moist sandy pastures or around bodies of water in dune areas, all are ubiquitous species.

One of the most picturesque areas of Kansas is the Red Hills. It has red soil and outcrops of red shales, siltstones, sandstones, including gypsum and anhydrite, of Permian age. Barber County is especially scenic with many steep-sided buttes, pinnacles, and stream valleys lined by

steep bluffs. Vegetation of this area is xerophytic and the most conspicuous plant, now largely removed, is the red cedar Juniperus virginiana. Plant cover is predominantly the short grasses Buchloe dactyloides and Bouteloua gracilis. A large number of forbs are found, a few of which, are known only in Kansas from the Red Hills. Few mosses and virtually no hepatics are to be found in this area except near springs where conditions are similar to areas in the eastern part of the state.

The High Plains area is also known as the short grass region in which the dominant plants are the short grasses Buchloe dactyloides and Bouteloua gracilis. Many other distinctive grasses and forbs occur, some of which are found, in Kansas, only in the High Plains area. This well defined area is nearly devoid of bryophytes and need not be further considered.

HABITATS AND FACTORS

Very little experimental data concerning environmental factors in relation to bryophytes, especially Hepaticae, is available. With regard to this Garjeanne (1932) says, "Though it is sometimes possible to grow them for shorter or longer periods, in the end they always die: this is certainly a great handicap to gaining a more intimate knowledge of the Bryophytes." This statement while not certainly applicable to all bryophytes is in general true and has

handicapped the study of this phase of Bryology.

In the absence of specific experimental data careful field observations have been made on a variety of habitats and involve transplanting, pH, moisture, temperature and soil studies. From these a number of generalizations may be made. The discussions of Richards (1932) and Garjeanne (1932) encourage the use of physiological and ecological characteristics which bryophytes have in common with vascular plants and note that factors which affect one group will also affect the others. In our area it is the degree to which such factors affect various plant groups that becomes important.

Moisture conditions of both the substratum and the atmosphere are of prime importance in the growth and survival of hepatics. The occurrence of an abundance of hepatics in a few Kansas sites can be directly correllated with moisture conditions of the substratum and perhaps more importantly with that of the relative humidity of such places.

In most of our areas the majority of species of hepatics are to be found on moist sandstone outcrops, sandy prairie, around and below springs or in shaded protected places which dry out slowly. It is often possible to collect over sections of forested areas and find only a few widely tolerant ubiquitous species except for a few little seepy nooks, in outcrops or seepy ledges where a number of species may be found. If the localized sites are characterized by very

seldom drying out a good hepatic flora will be found. Any prolonged drouth will, however, reduce the colonies and may lead to extermination of certain species.

A study of Kansas hepatics leads one to the conclusion that, except for a few, most species are fighting for survival and that with the disturbance by man some have probably disappeared from the scene while others are barely surviving. In contrast disturbance has probably been responsible for an increase in numbers of some species such as members of Riccia, Sphaerocarpus, Frullania and Asterella.

The only species, in Kansas, which actually live in water are the water forms of Ricciocarpus natans, Riccia fluitans, R. rhenana, and possibly the plant provisionally referred to as Riccia canaliculata. A few exist on very wet mud banks or alluvium of streams and lakes. Among these are land forms of the four species just mentioned and Phaeoceros laevis, Notothylas orbicularis, Conocephalum conicum, Marchantia polymorpha, Plectocolea hyalina and several species of Riccia. These latter, however, are present on such sites due to water dispersal and are only temporary elements except for Riccia frostii and R. sullivantii.

A few species seem capable of withstanding severe flooding for prolonged periods. These are usually species found on the faces of sandstone outcrops on creek banks. Plants in this class are Conocephalum conicum, Marchantia polymorpha, Plectocolea hyalina, Phaeoceros laevis, Reboulia

hemisphaerica and Porella pinnata which is found on bark of trees at edge of streams. In addition Frullania inflata has been observed to withstand flooding while growing on the bark of trees found on flood plains.

The only perennial species which seem to be able to survive on substrata which regularly dry out are: Cephaloziella rubella, C. byssacea, Lophozia bicrenata, Mannia fragrans, Asterella tenella, Oxymitra paleacea and several species of Riccia. Scapania nemorosa is able to survive in a few places where the above occur but actually seems to be losing out on such sites. A few annual species appear on these locations during moist springs or falls. Among these are: Sphaerocarpus texanus, S. michelii, Fossombronia braziliensis and Anthoceros punctatus.

Most species of hepatics in Kansas occur on sites which are so located that moisture is present the year round and in which the relative humidity is higher than the surrounding area. Such areas consist of moist outcrops in shaded ravines or along creek banks, shaded, protected north hillslopes and at the base of grass clumps in tall grass prairie.

Moisture is, then, a critical controlling factor in the occurrence and distribution of hepatics in Kansas.

Light seems to be another factor to be considered in determining distribution of hepatics but is most difficult to evaluate because of its effect on temperature and humidity. In general light requirements of hepatics are not

generally high. This is well shown, in Kansas, in that most hepatics grow in shaded habitats or at least where light is much reduced. In general the Marchantiales are light-loving while the rest of the hepaticae have low light requirements. In general the more moist the location the more tolerant our species are of light. It is, therefore, difficult to evaluate the effect of light on liverworts.

The nature of the substratum is another factor important in hepatic occurrence and distribution. Species growing on tree bark are limited to host plants from which the bark does not readily flake or slough off. Frullania spp., for instance, regularly are found on bark of Quercus velutina and Q. macrocarpa but the more abundant Q. muehlenbergii has few colonies due to the more loose, flaky bark. If Q. muehlenbergii is found in a moist ravine the number of colonies of Frullania on this tree increases. Thus, a moisture factor is involved. In this case, however, the flaking of the bark seems to be an important factor as occurrence of species on bark in a given area is directly correllated with permanency of bark. Soft sandstones likewise have a small hepatic flora while resistant sandstones in the same area support a good population.

The nature of the soil is important in distribution. This is often correllated with moisture relationships of the soil. In Kansas better than 90 per cent of soil hepatics are to be found on distinctly sandy sites. These soils have

a more permanent moisture supply and better aeration. Cultures have been tried on sandy soil, loam, clay and on mixtures of these. Successful growth has been found only on sandy soils.

A few of our hepatics seem to prefer a nitrogen-free medium. Cephaloziella rubella and Lophozia bicrenata seem regularly to occur in nitrogen-free sites and seldom are to be found on any other type of habitat. Griggs (1933, 1935) gives a discussion of the colonization of a nitrogen-free medium by Cephalozia bicrenta and Cephaloziella byssacea.

The most completely investigated substrate factor is that of hydrogen-ion concentration. A number of observations have been made on a large number of bryophytes and the findings reported in the literature. In Kansas most of our hepatics occur on neutral or just under neutral pH conditions. Distribution does not seem to be related so much to pH as to availability of calcium. Calcium may be easily available under slightly acid conditions and a species may react much more to calcium occurrence than to hydrogen-ion concentration. Some workers such as Meylan (1924) consider species occurring in conditions with pH less than 7.0 as lacking tolerance for lime containing rock or soil. In our area by far the majority of our species occur on calcareous sandstones or sandy soils in which pH is neutral, slightly acid or slightly alkaline. If the work of Meylan (l.c.) was followed most of our species would alternately be classed as

lime avoiding or lime-loving as the site might be. The lack of very acid stations undoubtedly, however, limits the hepatic flora of the state as it has been shown by Schuster (1949) that uncommon species often appear very much restricted in occurrence by pH conditions. Thus pH probably has little bearing on the distribution of hepatics now known in Kansas.

Temperature effects on our hepatic distribution is difficult to evaluate because of its effects on humidity and moisture in general. It has been observed that sudden drops of temperature results in death of some members of the Marchantiales. Colonies of Conocephalum conicum, Reboulia hemisphaerica, Riccia campbelliana and Mannia fragrans are quickly killed back to growing tips by sudden drops in temperature and if the drop goes from temperatures which have averaged above freezing to a reading of 20°F or lower even the growing tips succumb. In general, though, temperature is unimportant in our area except in its effect on moisture conditions an effect which is often most severe.

Invasion and Succession

Though many species of hepatics seem to be attempting to survive in Kansas habitats several are capable of not only existing but of invading and some successional stages can be demonstrated. The literature on invasion and succession by hepaticae is meager and most of it in this country

is of more or less recent publication.

Durand (1908), Skutch (1929), Emig (1930), Torrey (1932a, 1932b), Graff (1935, 1936), Sharp (1939) and Schuster (1949) all have noted the invasion of Marchantia polymorpha upon areas following fires. This was observed once in Kansas at a station in a forest dominated by Quercus stellata, Q. marilandica, Q. velutina and with an understory of Q. prinoides, Cornus drummondii and Rubus spp. During one fall much of the understory and a few oak trees were cut. The brush and tree branches were piled in a number of heaps over an area several acres in extent and burned. This left several large circular burned places which the next spring were populated by solid growths of Marchantia polymorpha and the moss Funaria hygrometrica. The plants of Marchantia polymorpha were small, exceptionally fertile and were to be found only on the burned spots. This occurrence was remarkable in that M. polymorpha was not previously known near the station and has not since been located near the burned areas. The nearest permanent station was some 25 miles away. The second year following burning only a few plants of Marchantia were present on these burned sites and in following years none were discovered. In the meantime herbs and grasses invaded the circular spots and eventually Quercus prinoides dominated the sites.

On a few sandy-clay banks which have been recently eroded, and in which the soil is nearly nitrogen free an

invasion by Cephaloziella rubella occurs. In a few sites this species is soon followed by Lophozia bicrenata. Various species of Cladonia seem to follow these two hepatics closely and eventually leads to occupancy by several species of mosses, later by shrubs, grasses and often by either Mannia fragrans, or Asterella tenella. Later the hepatics lose out in about the same order as the original succession.

Invasion of moist sandstone ledges is initiated by Phaeoceros laevis or Plectocolea hyalina. These may exist separately or together and very often appear to maintain their dominance of the site. This latter situation appears most often in places where the site is partially exposed to full sunlight. In more shaded conditions Reboulia hemisphaerica may soon appear and in still more moist shaded places Conocephalum conicum may take over and eventually exclude most of the earlier arrivals.

Moist limestone ledges are so rare in Kansas that little in the way of possible invasion, much less succession, can be noted. Dry limestone ledges are plentiful and are colonized by Frullania inflata or Frullania riparia. Often these two are found as mixed colonies. On the crests of such ledges Porella platyphylla, P. platyphylloidea and very rarely Porella pinnata may be found in isolated stations. No other hepatics are regularly found on this habitat and thus succession of hepatics does not occur. A moss succession is observed but is outside of the scope of this paper,

Hepatics found on floodplains are often considered as invaders. The most common hepatic on floodplains or alluvial deposits along streams is Riccia frostii. However, this is the regular habitat of this species and should perhaps be best eliminated from a list of invaders on such sites. Species which do more or less regularly appear on alluvial deposits other than the above species are: Riccia beyrichiana, R. sorocarpa, R. hirta, R. bifurca, R. dictyospora, R. lamellosa, R. sullivantii, Notothylas orbicularis, Phaeoceros laevis, Plectocolea hyalina, Marchantia polymorpha and land forms of Ricciocarpus natans, Riccia rhenana, R. fluitans and possibly R. canaliculata. These species do appear after the deposits are left but never last for more than a season if that long. Such habitats are useful in checking species to be found in a water shed but other than Riccia frostii they are of no importance, ecologically, in this area. The statement of Schuster (1953) that Riccias are confined largely to alluvial soils, or areas bordering alluvial soil does not apply in our area for most species of the genus in this country. The same statement has been made for Notothylas orbicularis by Schuster (l.c.), Sharp (1949), and others but again is not applicable to Kansas as it has been noted above the "mother lode" of this species is found in the prairie. Except for Riccia frostii, the land forms of Ricciocarpus natans, Riccia fluitans and R. rhenana all the above species invade but only temporarily so. The

latter four can hardly be considered as invaders since their usual habitat is on alluvial sites.

The invasion of hepatics on tree bark is of regular occurrence and involves, essentially, only the species of the genus Frullania. These seem to persist as expanding colonies on tree bark and last as such until crowded out by mosses. No hepatic succession occurs in this area on bark. Other hepatics found on bark are too rare to cite as examples of invasion.

Bryophytes are active in the revegetation of abandoned fields in Kansas particularly those fields with sandy soils. Mosses are of primary importance but a few hepatics are to be noted. The latter, however, are relatively unimportant and seem to play a more important part in disturbed prairies and woodlands than they do in true revegetation. Species which have been observed on sites undergoing revegetation are: Riccia beyrichiana, R. dictyospora, R. sorocarpa, Anthoceros punctatus, Asterella tenella, Fossombronia brasiliensis and Sphaerocarpus texanus.

Undisturbed prairie is inhabited by a comparative large number of species. These are well scattered and inconspicuous. The first stages of disturbance, however, results in many small isolated bare areas which are immediately invaded by several species of Riccia of which the more important are R. beyrichiana, R. hirta, R. dictyospora, R. campbelliana and R. sorocarpa. These may form single scattered rosettes

or more commonly form irregular gregarious colonies which hold soil and help prevent erosion and water loss. Often Sphaerocarpus texanus, Fossombronia brasiliensis and Anthoceros punctatus form conspicuous secondary invaders. Later small amounts of Asterella tenella and Mannia fragrans may appear at about the time mosses become evident. The mosses soon gain control resulting in decline of hepatics and eventual return to the original conditions of near complete grass cover. If the conditions causing disturbance such as mowing, burning, or grazing, remain the area will continue to exhibit a hepatic flora of many plants. In low moist prairie sites the early invaders may often be Notothylas orbicularis and Anthoceros punctatus. Such areas are soon dominated by mosses, hepatics are excluded, and bare areas return to normal grass cover.

CORRELLATION WITH OTHER VEGETATION

As might be expected the distribution of Hepaticae, in Kansas, is often directly correllated with the occurrence of higher plants. It has been found possible to drive through an area and select stations, based on higher plant associations, which are the most important in hepatic collecting. This fact is shown by a number of tests in which areas were selected on the basis of higher plant assemblages and a prospective list of hepatics for the area was made before collecting was started. Even though such specific areas had

never been studied previously it was found that the list of species suspected for the station was invariably 90 per cent or more correct. After much field work had been accomplished it was found that the use of higher plant associations as indicators of spots worth studying proved an efficient method of completing distribution data in little studied counties.

As a result it has been possible to prepare lists of species which are found in the various associations of higher plants in the state.

The oak-hickory association mentioned as occurring in the Chautauqua area contains by far the largest number of hepatic species in Kansas. This association is characteristically dominated by Quercus stellata, Q. marilandica, Q. velutina, Q. prinoides and Carya ovata. The soil is always sandy and sandstone outcrops are frequent either as ledges or barely surfacing on slopes and hilltops. In such forested areas the hepatic flora is dominated by members of the Marchantiales and the genus Riccia in particular. The following lists indicate the degree of occurrence:

Species invariably found are:

Asterella tenella

Frullania inflata

Riccia beyrichiana

Riccia dictyospora

Riccia hirta

Riccia lamellosa

Sphaerocarpus texanus

Species found, in addition to those above, if site includes dry sandstone ledges or exposed banks are:

Cephaloziella rubella

Lophozia bicrenata

Reboulia hemisphaerica

Species found, in addition to all above, if site includes moist sandstone ledges and banks are:

Conocephalum conicum

Mannia fragrans

Phaeoceros laevis

Plectocolea hyalina

Scapania nemorosa

In the southern third of the Chautauqua Hills the association would nearly always include, in addition to all above, the following:

Fossombronia brasiliensis

Oxymitra paleacea

Riccia campbelliana

Riccia trichocarpa

Species found only in this association but of rare occurrence are:

Jungermannia lanceolata

Plectocolea crenuliformis

Plectocolea fossombronioides

Chiloscyphus pallescens

Chiloscyphus pallescens var. fragilis

Scapania irrigua

Cephaloziella byssacea

Cephalozia catenulata

Cephalozia connivens

Cephalozia media

Calypogeia meylani

Calypogeia muelleriana

Calypogeia trichomanis

Plagiochasma rupestre

Bluestem prairie of the Chautauqua Hills is usually sandy and dominated by Andropogon gerardi. Swales may have Tripsacum dactyloides or Sorghastrum nutans as dominant vegetation to be equal to occurrence of Andropogon gerardi. Most of these prairies are either mowed once a year for hay or are grazed. If grazing is well controlled the two uses result in prairie of about the same characteristics. In such prairies hepatic species usually expected occur as follows:

Species invariably present on flats or hilltops are:

Anthoceros punctatus

Asterella tenella

Riccia beyrichiana

Riccia dictyospora

Riccia hirta

Riccia sorocarpa

Sphaerocarpus texanus

Species found in swales in addition to all above are:

Notothylas orbicularis

Riccia lamellosa

In southern third of area the following are expected:

Oxymitra paleacea

Riccia trichocarpa

A number of other species have been found on these prairies but are rare and not of usual occurrence.

In the extreme southeast corner of Kansas is found a bit of the Ozark Plateau and here referred to as the Ozark area. As mentioned before this area consists of rocky oak-hickory forests with islands of rocky bluestem prairie. It is an area which ranks only second to the Chautauqua Hills in abundance of hepatics but it breaks down into fewer groups when correllation of hepatics with other vegetation is made. The groups are:

Species found in upland oak-hickory forests on bark, soil or dry rock ledges.

Porella platyphylloidea

Frullania brittoniae

Frullania eboracensis

Frullania inflata

Frullania riparia

Riccia beyrichiana

Riccia hirta

Species found on moist north facing rocky wooded

hillsides and which occur on bark, soil and moist rock ledges.

Plagiochila asplenioides

Geocalyx graveolens

Lophocolea minor

Lophocolea heterophylla

Diplophyllum apiculatum

Scapania nemorosa

Porella platyphylloidea

Cololejeunea biddlecomiae

Frullania brittoniae

Frullania eboracensis

Frullania inflata

Frullania kunzei

Frullania riparia

Pellia epiphylla

Asterella tenella

Species found in the prairie islands are:

Anthoceros punctatus

Sphaerocarpus michelii

Sphaerocarpus texanus

Riccia beyrichiana

Riccia dictyospora

Riccia hirta

Riccia lamellosa

Riccia sorocarpa

The Osage area in general has comparatively few hepatics both in number of species and quantity of any species. The only exception is the genus Frullania which is to be found in any oak-hickory area. The dominant trees of this association are consistently Quercus macrocarpa, Quercus muehlenbergii, Quercus velutina, Carya cordiformis and Carya ovata. The oaks are by far the most abundant. On the bark of these trees Frullania inflata can always be found and occasionally F. eboracensis and F. riparia will be observed. Moist, mossy, north facing cliffs or banks in this association often have several species of hepatics among which Lophocolea heterophylla and Scapania nemorosa are the most common and often are the only species present. If the moss Leucobryum glaucum is present on these banks a careful search of the area may reveal one or all of the following species in addition to the two named above.

Jamesoniella autumnalis
Geocalyx graveolens
Lophocolea bidentata
Scapania undulata
Cephalozia bicuspidata

In a few places in the northern part of the Osage area there are places where the habitat is intermediate with that of the Chautauqua Hills. Such places have a larger hepatic flora but in general the characteristics of such sites are much more similar to types of the Chautauqua Hills and are

thus considered with the latter area.

The prairie of the Osage area, if sandy, characteristically has a few species of which Riccia beyrichiana, R. dictyospora, R. hirta, R. lamellosa and R. sorocarpa are the only ones usually found. The rate of occurrence varies greatly.

The Flint Hills has such a small hepatic flora that no associations can be made. The only consistent correlation is the occurrence of Frullania inflata in all places where Quercus macrocarpa is found. This oak occurs along a few streams and bluffs.

The Dakota is primarily a prairie association on sandy soil and with numerous sandstone ledges, boulders or flat surfacing sandstone exposures. Most of the hepatics in the area are found near the edge of the exposed sandstones. However, the Andropogon gerardi-Andropogon scoparius dominated prairies have an abundance of liverworts in some places. Species usually found are Riccia beyrichiana, R. hirta, R. dictyospora, Asterella tenella, Mannia fragrans, Sphaerocarpus texanus and more rarely Anthoceros punctatus and Notothylas orbicularis. On the bark of trees along streams or ravines will be found the ever present Frullania inflata if Quercus macrocarpa is present.

All other areas of Kansas have so few hepatics that no correllation is possible. Those found in such areas usually are associated with springs or alluvial deposits on streams.

The latter type stations are very unstable and thus allow for little in the way of comparisons.

PHYTOGEOGRAPHY

The hepatic flora of Kansas is a flora composed mainly of ubiquitous, widely distributed species which occur to the east, north, west and south of the state. This is as might be expected due to the location of the region in the near exact center of the United States. The environment is such that only those species with a wide degree of habitat toleration find it possible to survive.

The hepatic flora of the state is decidedly dominated by members of the Marchantiales whose species, though not more numerous, are much more abundant. They form the characteristic component of the state's hepatic vegetation and in many sites an observer finds only this group represented.

A few species seem to indicate that a relationship to southern, southeastern and southwestern hepatic floras is evident. These species are:

Frullania kunzei

Oxymitra paleacea

Plagiochasma rupestre

Plectocolea fossombronioides

Riccia campbelliana

Riccia dictyospora

Riccia trichocarpa

Sphaerocarpus michelii

Frullania kunzei is listed by Frye and Clark (1937-1947) as found in North Carolina, Arkansas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, West Indies and South America. In Kansas it is found in the Ozark Plateau area in extreme southeast Kansas. It thus is not far removed from Arkansas.

Oxymitra paleacea has been reported in Texas and Oklahoma and the writer has collected it in those two states plus six counties in Kansas. This species, then, is clearly southern in its affinities ranging into Mexico and occurring in South America, North Africa and Europe.

Plagiochasma rupestre is reported by Frye and Clark (1937-1947) as occurring in North America in New Mexico, Arizona and Mexico. However, there are specimens in the herbarium at the University of Kansas from Texas, Oklahoma and extreme west central Missouri. Our Kansas collection, therefore, completes the gap from Missouri to Mexico.

Plectocolea fossombronioides has a range according to Frye and Clark (1937-1947) of Connecticut, Ohio, Illinois, North Carolina, West Virginia and New Jersey. Thus Kansas seems far out of range for this species; however, Wittlake (personal communication) reports that he has specimens (verified by Evans) from Arkansas. Kansas material (also verified by Evans) is, then, not far out of the known range of the species but nevertheless is an important extension

of range.

Riccia campbelliana was reported by Frye and Clark (1937-1947) as in California; by Jacobs (1951) as in Georgia and Arkansas; by McAllister, Hoglund and Whitehouse (1932) in Texas and has been collected by the writer in Oklahoma and Kansas.

Riccia trichocarpa has been reported by Frye and Clark (1937-1947) from California, Oregon, Texas and Oklahoma in the United States. It occurs in several counties in Kansas and Schuster (1953) reports a single station in Minnesota. The species ranges into lower California and is definitely southern and southwestern in its affinities.

Sphaerocarpus michelii is a species which has probably been overlooked or misinterpreted. Frye and Clark (1937-1947) report the species from Texas and Thompson (1948) reported it from Kansas. The writer has collected it in Arkansas, Oklahoma and several places in Kansas. Indications to date, therefore, are that the species is southern in its range.

Other species show some relationship to southern and southwestern floras. Riccia evexa now known only from Kansas seems to be most closely related to R. californica known from California and Texas. It might eventually be found to be a variant of the latter species or perhaps a subspecies of it.

The two stations of Porella pinnata on dry limestone ledges, mentioned previously, is an example of the habitat

of this species in the south. Sphaerocarpus texanus seems to be mainly southern in its range at least in abundance.

About the only indication of a relationship to northern hepatic floras is the occurrence of Scapania irrigua from a glaciated region in northeastern Kansas.

A few species might reveal relationship with other areas, particularly the south, if taxonomic and distribution details were known. In general much more field work needs to be done before many phytogeographic interpretations in the Hepaticae can be made.

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