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Batrachospermum Roth. (Rhodophyta), a genus of red algae new to Iowa

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ROEDER, DONALD R., AND JAMES H. PECK (Department of Botany and Plant Pathology, Iowa State University, Ames, Iowa, 50011). *Batrachospermum* Roth., (Rhodophyta), a genus of red algae new to Iowa. Proc. Iowa Acad. Sci. 84(4): 133-138, 1977.

Batrachospermum, a floridean red alga, is formally reported from Iowa. Populations have been observed by several workers at nine localities in eight counties: Black Hawk, Bremer, Des Moines, Dickinson, Dubuque, Emmet, Hancock, and Webster. The habitats include permanent and intermittent

streams, a dystrophic lake, and prairie marshes. To date, the species include *B. ectocarpum* Sir. from a stream in Webster County, and an undescribed species from a prairie marsh in Black Hawk County. A discussion of the taxonomy and occurrence of *Batrachospermum* in Iowa is presented. With this report, four genera of freshwater red algae are known from Iowa.

INDEX DESCRIPTORS: *Batrachospermum*, *Batrachospermum ectocarpum*, Red algae, Rhodophyta, Florideae, Iowa algae.

A survey of freshwater red algae in the Midwestern and the Western states has been neglected (G. W. Prescott, Flathead Lake Biological Station, Yellow Bay, Big Fork, Montana, letter dated 2 June, 1977). In Iowa, however, three genera of red algae have already been reported: the bangioidean genera *Porphyridium* (Prescott, 1931) and *Asterocystis* (Gashwiler and Dodd, 1961) and the floridean genus *Audouinella* (Roeder, 1976; 1977). In a previous search of the Iowa phycological literature, Roeder (1976) noted that although a formal report of *Batrachospermum* in Iowa had not been made, the genus has been observed in the state. When one of us (JHP) discovered a well-established population of *Batrachospermum* in Woodman Hollow State Preserve, Webster County, we felt it was appropriate to formally report the occurrence of this fourth genus of red algae. Through discussions with colleagues we have determined that at least four others have also observed *Batrachospermum* in Iowa. We examined the available specimens, compared Iowa material with selected specimens of L. H. Flint's collections, obtained expert opinion on some taxonomic and ecological problems, and visited most of the localities to obtain field observations on its occurrence. In this report, we formally establish the presence of *Batrachospermum* in Iowa, present locality data and specific identification of one Iowa population, and provide a discussion of these taxonomic and ecological observations. With this we hope to stimulate further research on the distribution, taxonomy, and ecology of this algal genus.

LOCALITIES

To date, *Batrachospermum* has been observed at nine locations in eight counties in Iowa (Figure 1). Voucher specimens are available from sites 1, 7, 8, and 9 and are deposited in the Iowa State University herbarium (ISC). We are also reporting observations (sites 2, 3, 4, 5, 6) of the genus which will require confirmation with voucher specimens.

1. Black Hawk Co., Union twp. T-90N R-14W S-19. Soft water marsh in sandy prairie; attached to the snail *Helixoma* sp. in 45 cm water; 24 June 1974; by V. E. Dowel; (ISC, Dowel, 24 June 1974).
2. Black Hawk Co., Washington twp. T-90N R-14W S-34. Snag Creek, attached to rocks in riffle areas; cool, flowing stream; observed in winter by W. E. Picklum 4 or 5 times in last 10 years; apparently persistent; specimen not available.
3. Bremer Co., Jackson twp. T-91N R-14W S-17. Intermittent tributary stream to the Shell Rock River; observed in cool, flowing stream, shaded; attached to limestone cobbles; observed over the last 10 years by V. E. Dowel, apparently persistent; specimen not available.
4. Des Moines Co., Burlington twp. T-69N R-2W S-16. Observed in the cool, flowing headwaters of a spring stream in Crapo Park; attached to sandstone rock; observed by R. L. Hulbary several times in last 10 years; apparently persistent; specimen not available.
5. Dickinson Co., Lakeville twp. T-99N R-37W S-26. Small, unnamed marsh on private land; observed once by J. D. Dodd in early 1960's; population apparently not persistent; specimen not available.
6. Dubuque Co., Liberty twp. T-90N R-2W. White Pine Hollow State Preserve. Observed by V. E. Dowel in clear, cool, flowing headwaters of spring stream. Population observed several times in last 10 years; apparently persistent; specimen not available.
7. Emmet Co., Emmet twp. T-100N R-34W S-21. In cool, clear, flowing water in ditch draining a fen; observed in June 1973 by Dodd; (ISC, Dodd, June 1973).
8. Hancock Co., Ellington twp. T-97N R23W S-4. Pilot Knob State Preserve. Attached to dead branch in Dead Man's Lake; observed once by Dodd in early 1960's; population apparently not persistent; (ISC, Dodd, early 1960's).
9. Webster Co., Otho twp. T-88N R-27W S-22. Woodman Hollow State Preserve; cool (3-5°C), clear, flowing headwaters of spring stream; growing attached to sandstone cobbles in upper one-half of stream; observed from September 1976 through April 1977 by Peck and Roeder; (ISC, Peck and Roeder 23 October 1976).

5. Dickinson Co., Lakeville twp. T-99N R-37W S-26. Small, unnamed marsh on private land; observed once by J. D. Dodd in early 1960's; population apparently not persistent; specimen not available.
6. Dubuque Co., Liberty twp. T-90N R-2W. White Pine Hollow State Preserve. Observed by V. E. Dowel in clear, cool, flowing headwaters of spring stream. Population observed several times in last 10 years; apparently persistent; specimen not available.
7. Emmet Co., Emmet twp. T-100N R-34W S-21. In cool, clear, flowing water in ditch draining a fen; observed in June 1973 by Dodd; (ISC, Dodd, June 1973).
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9. Webster Co., Otho twp. T-88N R-27W S-22. Woodman Hollow State Preserve; cool (3-5°C), clear, flowing headwaters of spring stream; growing attached to sandstone cobbles in upper one-half of stream; observed from September 1976 through April 1977 by Peck and Roeder; (ISC, Peck and Roeder 23 October 1976).

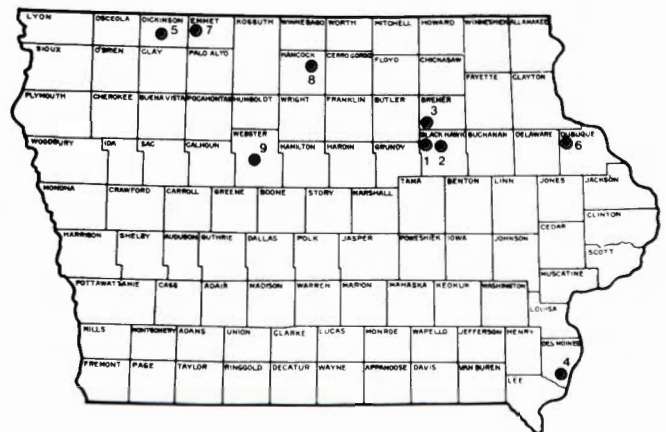


Figure 1.

Localities at which *Batrachospermum* has been collected or observed in Iowa. Arabic numerals refer to locality descriptions in the text.

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DESCRIPTION OF IOWA TAXA

The classification system of Sirodot (1884), as modified by Israelson (1942) and Skuja (1931), was followed. This system is based partially on the number and location of the cystocarps on the mature thallus, and on the shape of the trichogyne. A simplified life cycle of *Batrachospermum* is presented in Figure 2.

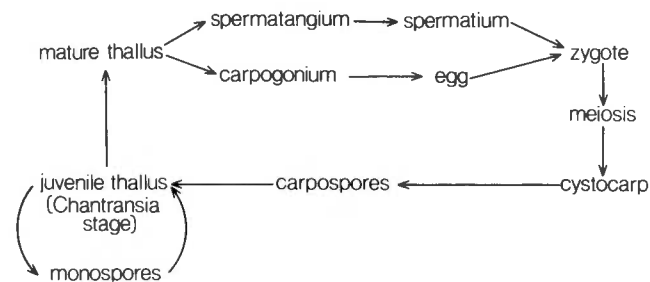


Figure 2. A simplified life cycle of *Batrachospermum*, modified from Prescott (1966).

Specific identifications could not be made of all specimens because some lacked sexual structures or the specimen had dried during storage. The specimen from Emmet County was assignable to section *Moniliforme*, but a specific determination was not possible. The specimen from Black Hawk County (Locality 1) was assignable to section *Contorta*, but could not be assigned to any described species. We designated this species as *Batrachospermum* sp. 2 for this report. Specimens from Webster County consisted primarily of *B. ectocarpum* Sirodot, cohabiting with another unidentified species.

Batrachospermum Section *Moniliforme* Sirodot

1. *B. ectocarpum* Sirod. (Israelson, 1942, pp. 34-35; Kylin, 1912, p. 21, Fig. 7 (as *B. arcuatum* Kylin); Hamel, 1925, p. 300, Fig. 13E; Flint, 1949, p. 551, Figs. 22-27; Prescott, 1962, p. 567, Plate 136, Fig. 4; Mori, 1970, pp. 1-8, Plate II, Figs. 1-5). Habitat: Woodman Hollow Creek, Webster County, Iowa. Attached to rocks, October through April.

Mature thallus up to 18 cm long, mucilaginous, dark olive brown throughout. Ramifications more or less regular, abundant (Figs. 12, 13). Branches of smaller diameter than main axis, gradually tapering. Central axis 62-128 μm diameter. Primary whorls (ramuli) variable from ellipsoidal, barrel, to round, rarely confluent, mostly 800 μm diameter in mature portions, 277 μm in young branches. Internodes 130 μm — 390 μm in young portions, 650 μm in older portions. Basal cells up to 50 μm long, 20 μm wide. Cells of fascicles variable in shape from ellipsoidal to elongate fusiform to pear-shaped. Secondary ramuli abundant on older portion of thallus, lacking on younger. Trichomes sparse. Monosporangia absent. Spermatangia not observed, therefore, segregation of sex organs unknown. Spermatia (attached to trichogyne) globular, 6.5 μm diameter. Carpogonial branches usually arising from cells of primary ramuli in close proximity to basal cells (Fig. 8). Carpogonia 31 μm long, 7-9 μm wide. Trichogyne club shaped (Figs. 7-11). Bractea numerous, surrounding the mature gonimoblast fila-

ments. Cystocarps numerous (up to 12 per primary whorl) along periphery (Fig. 15), some exserted, 74-223 μm diameter. Carpogonial filaments arising from secondary ramuli in older portions of thallus. Carposporangia ovoid, 9-12 μm diameter.

2. *Batrachospermum* sp. 1. Habitat: unnamed drainage ditch, Emmet County, Iowa. June.

The specimen from Emmet County (Locality 7) belongs to section *Moniliforme*, but identification to species is not possible because a) the specimen inadvertently dried after preservation, and b) only carpogonia (Figs. 4-6), not mature cystocarps, were present. It belongs to section *Moniliforme* because there are numerous carpogonia per whorl and the trichogyne is claviforme to club shaped. Because the carpogonia are partially exserted, and the cells of the primary branches lack terminal hairs, this specimen may be an immature form of *B. ectocarpum* Sir.

Section *Contorta* Skuja

3. *Batrachospermum* sp. 2. Habitat: growing on *Helizoma* sp. in marsh on Mark Sand Prairie, Black Hawk County, Iowa.

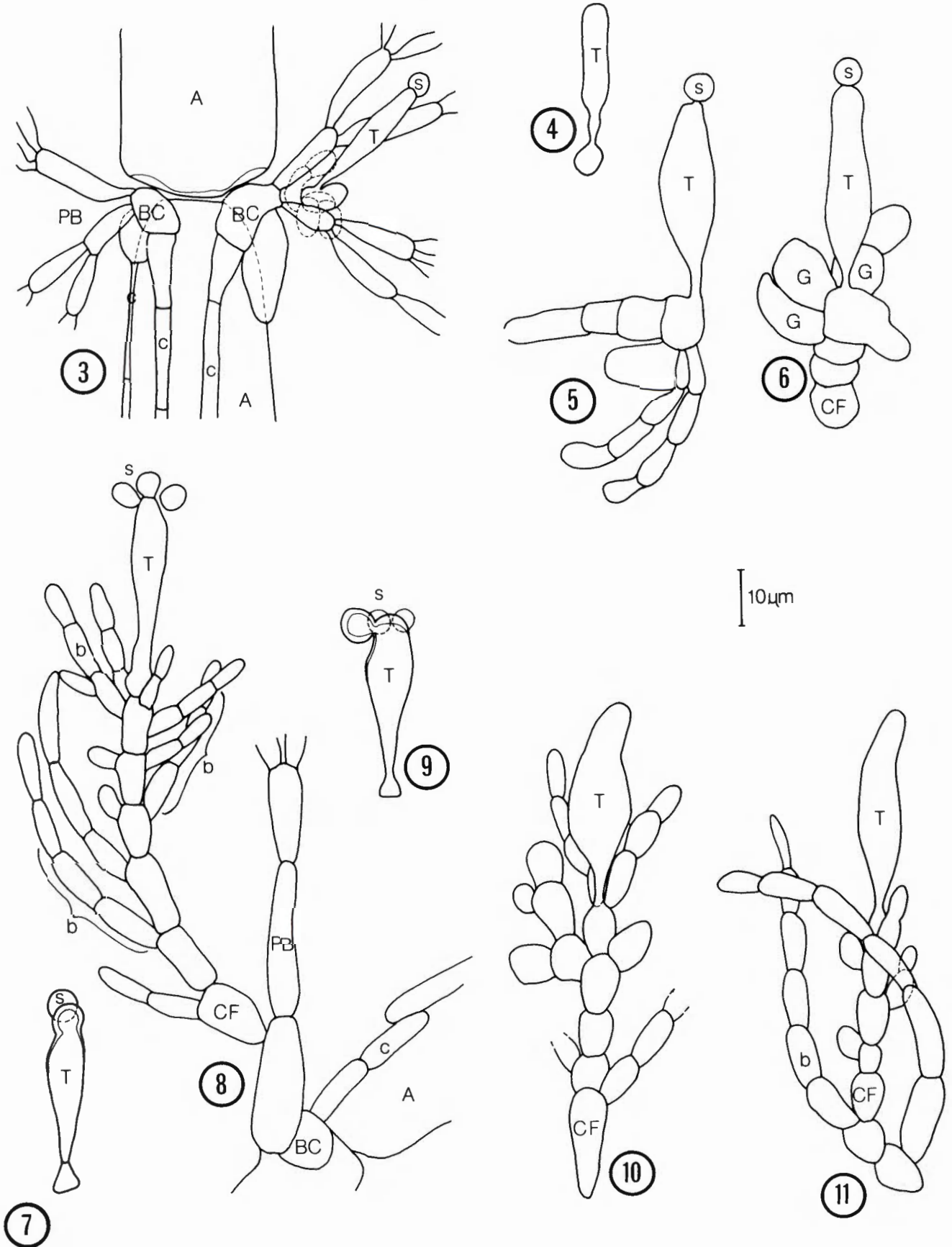
Mature thallus up to 5 cm long (Fig. 17); mucilage covering and original color unknown (preserved specimen). Main branching alternate, of almost equal importance as the main axis. Central axis 90 μm diameter becoming 8 μm or less on youngest portions. Cortications abundant on older portions of thallus, lacking on younger. Primary whorls diffuse, not well defined on older portions. [275 (315) μm diameter.] Two primary branches per basal cell (Fig. 3) consisting of 2-3 dichotomous branchings. Internodes 300-500 μm long. Basal cells 12 μm x 8-10 μm . Cells of fascicles variable in shape; ellipsoid, elongate fusiform to pear shaped. Secondary ramuli on all portions of thallus, abundant. Trichomes lacking. Monosporangia lacking. Spermatangia not observed. Segregation of sex organs unknown. Spermatia (attached to trichogyne) globular, 5 μm diameter. Carpogonial branches short, usually 1-3 (4) cells in length, arising from first cell of primary ramulus or basal cell. Carpogonia 28-35 μm long, 4-6 (10) μm wide. Trichogyne somewhat convoluted. Bractea nearly lacking in cystocarp. One, rarely two, cystocarps per whorl (Fig. 17), developing at the base of the whorl, sessile, 150 μm diameter. Carposporangia 9 μm long, 4-8 μm wide, ovoid to pear shaped. Gonimoblast filaments consistently 3 cells in length.

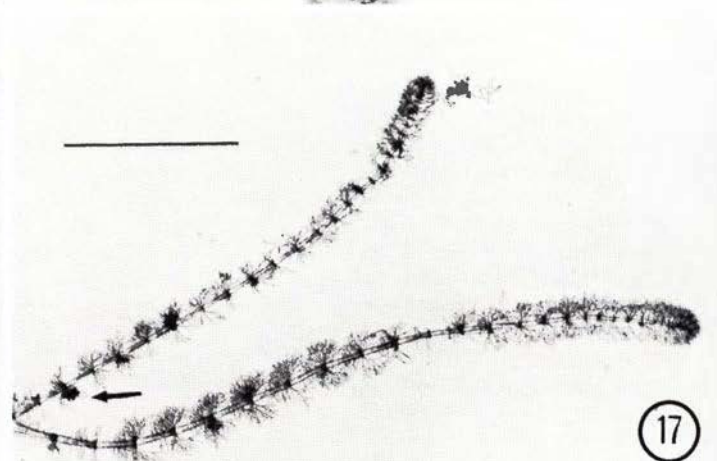
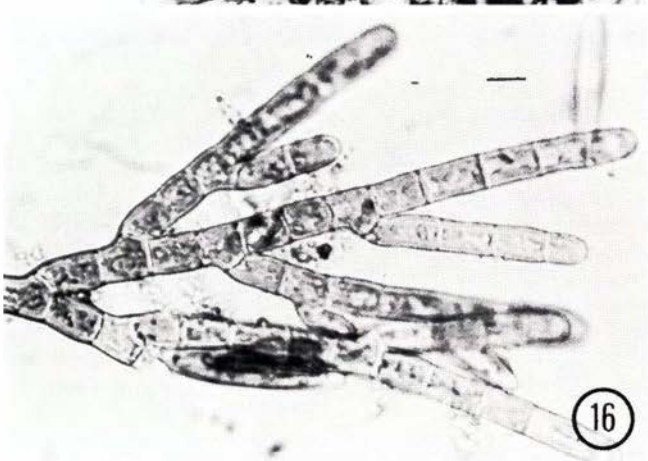
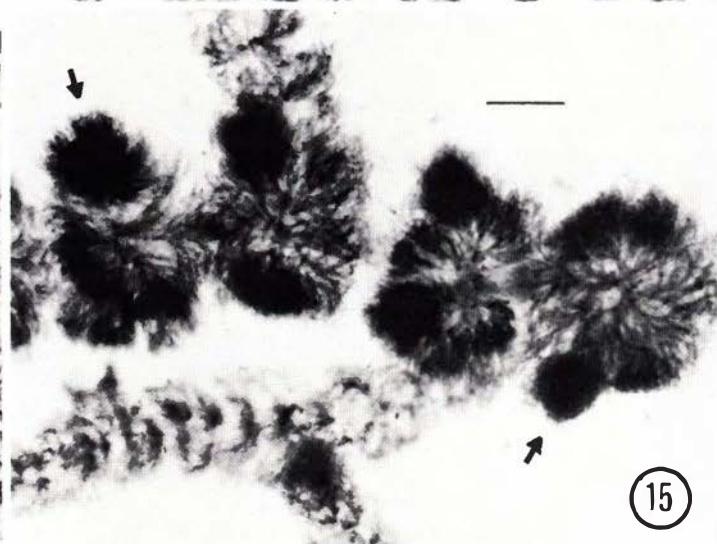
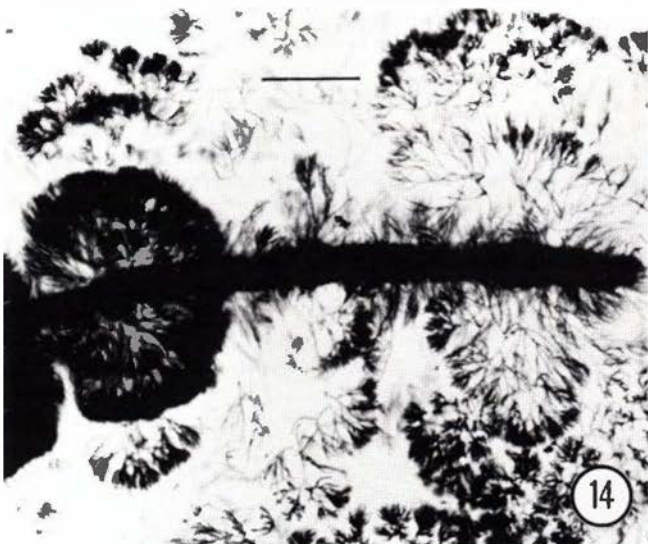
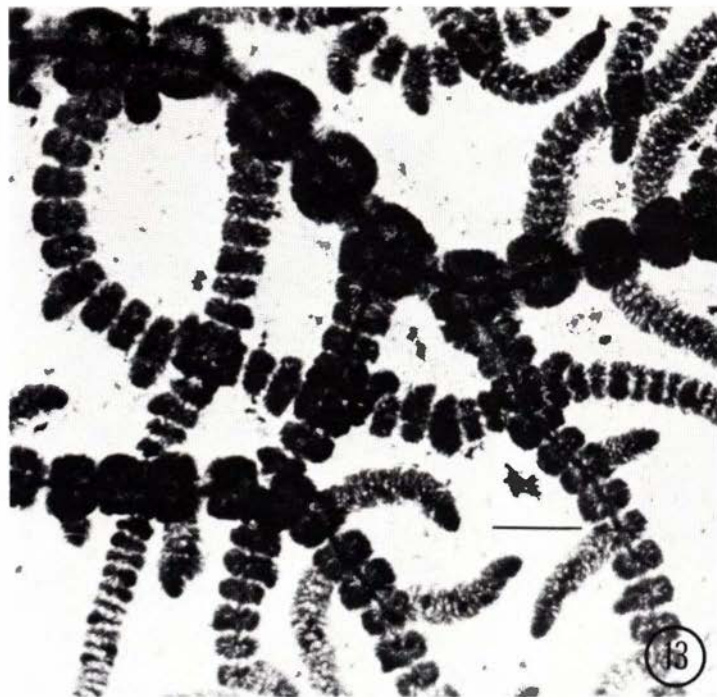
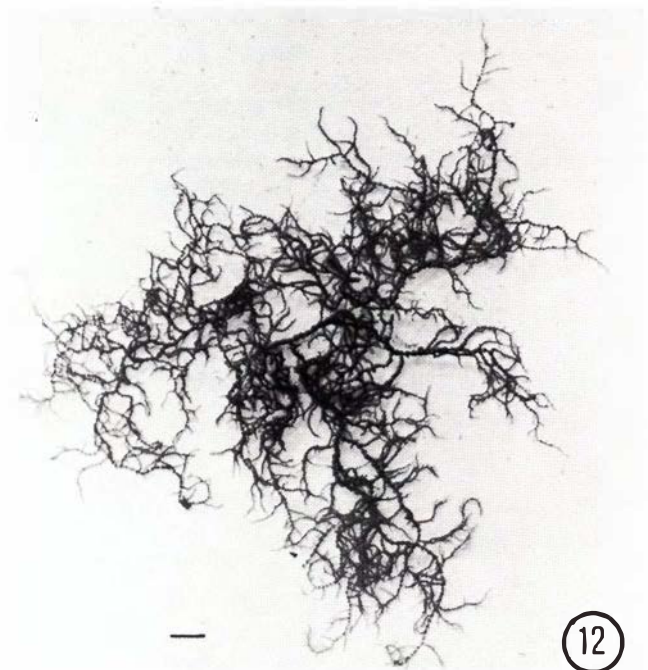
Figure 3. *Batrachospermum* sp. 2. section *Contorta* from Black Hawk County. Portion of sexually mature thallus. Note carpogonium attached directly to the first cell of a primary branch, the developing gonimoblast filaments, and only two primary branches per basal cell.

Figure 4-6. *Batrachospermum* sp. 1 section *Moniliforme* from Emmet County. Various shaped trichogyne: Figures 5 and 6 are fertilized (note attached spermatia). Note developing gonimoblast filaments in Figure 6. Figure 4 is not fertilized.

Figure 7-11. *Batrachospermum ectocarpum* Sir. from Webster County. Carpogonia: Figures 7, 8, and 9 are fertilized with attached spermatia; Figure 8, a long carpogonial filament showing formation of numerous bractea following fertilization; Figures 10 and 11, carpogonial filaments and attached carpogonia.

Legend to Figures 3-11: b, bractea; c, cortical filament; s, spermatium; A, axial cell; BC, basal cell; CF, carpogonial filament; G, gonimoblast initial; PB, primary branch; T, trichogyne.





DISCUSSION

B. ECTOCARPUM. Specimens of *B. ectocarpum* from Woodman Hollow State Preserve, Webster County, fit well the descriptions in the literature. G. W. Prescott, Flathead Lake Biological Station, University of Montana, made this identification. We compared our specimens to L. H. Flint's collections from the Louisiana State University herbarium.

B. ectocarpum persisted through winter in Woodman Hollow Creek, but began to decay in early spring. Only a few mature plants were still present, growing on rocks, by mid-April 1977. The decay process began by the disintegration of the primary whorls (Fig. 14). Most of the branches separating from the whorls appeared viable and often had rhizoid-like appendages at the base, indicating that they may act as a vegetative reproductive mechanism. There appears to be no previous report of this phenomenon in the literature. The immature (*Chantransia*) stage of *Batrachospermum* was abundant on the rocks of the stream bed (Fig. 16) indicating that it was a reproducing population.

An unidentified species of *Batrachospermum* cohabiting with *B. ectocarpum* in Woodman Hollow Creek suggests that more than one species might occur in other Iowa localities. Israelson (1942) found up to seven species cohabiting in Swedish streams. Woelkerling (1975) found *B. boryanum* Sir. always mixed with other *Batrachospermum* species in Wisconsin streams.

The taxonomy of *B. ectocarpum* has been variously interpreted in the literature. According to Flint (1949), Kylin (1912), and Prescott (Flathead Lake Biological Station, Big Fork, Montana, letter dated 6 November 1976), the distinguishing characteristic of this species is the partially exerted nature of the cystocarp, a character reflected in the specific epithet. Mori (1970), however, noted that the degree of exertion is affected by light intensity, so he differentiated *B. ectocarpum* from its close ally *B. moniliforme* Sir., by the absence of terminal hairs and the curvate distal ends of the fascicles in the former. Israelson (1942) noted the frequency and length of hairs is an unreliable characteristic in most species, but "in *B. ectocarpum* . . . the hairs are almost entirely lacking."

There has been considerable disagreement over the segregation of sex cells in this taxon. Kylin (1912) and Hamel (1925) said it was monoecious, while Israelson (1942), Mori (1975) and Reis (1958) indicated that it is polyecious. Mori (1970) showed that male plants become transformed into female plants and vice versa.

Flint (1949, 1970) reported *B. ectocarpum* from Vermont and New Hampshire and Prescott (1962) from Michigan and Wisconsin. Whitford and Schumacher (1969) did not include this taxon in the algal flora of North Carolina.

BATRACHOSPERMUM SP. 2. A search of the literature and personal communication with acknowledged experts in this group has failed to produce a satisfactory identification for this specimen. *Batrachospermum* sp. 2 from Black Hawk County is probably an undescribed species (M. Mori, Uto High School, Uto, Kumamoto-Prefecture, Japan, letter dated 17 February 1977; M. Povoas dos Reis, Universidade Coimbra, Coimbra, Portugal, letter dated 18 February 1977). We incurred considerable difficulty in placing it even in the proper section of the genus, but this is not an infrequent problem (see Reis, 1965; Geitler, 1944). M. Mori (letter dated 17 February 1977) stated that the species lies intermediate between sections *Setacea* and *Batrachospermum* (*Moniliforme*) "but rather belongs to the former because the gonimoblasts are sessile." G. W. Prescott (letter dated 21 February 1977) also felt that the taxon has some similarities to those taxa in section *Setacea*. We feel that the primary whorls are too well developed to warrant incorporation in this section, however.

M. P. dos Reis (letter dated 18 February 1977) feels that the specimen belongs to section *Contorta* Skuja. With the description of *B. procarpum*, Skuja (1931) erected this section and named it in reference to the knarled appearance of the young cystocarp. The other taxa belonging to this section are all delicate in general appearance (i.e. usually less than 7 cm tall) and include, for examples, *B. lusitanicum* Reis, *B. julianum* (Menegh.) Arcang., *B. gracillimum* (W. et G. S. West) emend. Skuja, *B. pseudocarpum* Reis, *B. henriquesianum* Reis, *B. louisianae* Skuja, and *B. basilare* Flint et Skuja. *B. skujae* Geitler, however, approaches 20 cm in length. See Reis (1974) for a description of the section *Contorta*. Our specimen is similar in general appearance to the majority of members of this section and also possesses the characteristic asymmetric and sometimes distorted carpogonium, and the spirally twisted carpogonial branch (*Karpogonast*), although the latter is not as accentuated as it is in the type species. The taxon, in gross appearance, resembles also *B. bruziense* Sir. of section *Viridia* and *B. gulbenkianum* Reis of section *Turficola*. If further research confirms that it is indeed a new species, it will be published elsewhere as *Batrachospermum markii* in honor of the Mark family on whose property it was found.

OCCURRENCE AND DISTRIBUTION. *Batrachospermum* is usually described as a rheobiont. Woelkerling (1975) noticed that all Wisconsin populations of *Batrachospermum* occurred at or near the headwater of spring-fed streams in water flowing at a rate of not less than 10 cm/sec and usually greater than 25 cm/sec. All of his collection sites were relatively free from turbidity and siltation. Israelson (1942), however, noted that diverse *Batrachospermum* populations sometimes existed in highly turbid lowland rivers in Sweden. However, a search for *Batrachospermum* in the turbid Des Moines River near the outlet of

Figures 12-17. *Batrachospermum ectocarpum* Sir. from Woodman Hollow State Preserve, Webster Co., and *Batrachospermum* sp. 2 from Mark's Sand Prairie, Blackhawk Co., Iowa.

- Fig. 12. *B. ectocarpum*. habit, X46.
- Fig. 13. *B. ectocarpum*. mature thallus illustrating the characteristic "beaded" appearance, X14.
- Fig. 14. *B. ectocarpum*. primary whorl (ramulus) breakdown at the start of senescence, X130.
- Fig. 15. *B. ectocarpum*. mature thallus with cystocarps (arrow), X100.
- Fig. 16. *B. ectocarpum*. *Chantransia* stage, X500.
- Fig. 17. *Batrachospermum* sp. 2. two primary branches with cystocarps (arrow), X23.

Legend: Fig. 12 line = 1 cm
 Fig. 13 line = 500 μ m
 Figs. 14, 15 line = 100 μ m
 Fig. 16 line = 10 μ m
 Fig. 17 line = 1 mm

Woodman Hollow Creek was unsuccessful.

Israelson (1942) states that "in smaller bodies of stagnant water the (Florideae) is mostly entirely lacking." The prairie marsh in Black Hawk County, Dead Man's Lake, Hancock County, and an unnamed marsh in Dickinson County should, therefore, be considered unusual habitats for this genus. Skuja (1938), however, noted that *Batrachospermum* taxa "are to be found occasionally on living molluscs in smaller bodies of still water . . ." We have also examined a specimen of *B. densum* Sir. which grew at a depth of 10 meters in Flathead Lake, Montana. Continued field observations may show that *Batrachospermum* is not as restricted to flowing water as was once suspected.

There is a good possibility that additional genera of red algae occur in Iowa. Some of the unconfirmed observations of *Batrachospermum* might be of the genus *Sirodotia* Kylin, which is indistinguishable from *Batrachospermum* except by the structure of the gonimoblast. Furthermore, L. A. Whitford (North Carolina State University, Raleigh, letter dated 17 January 1977) indicated that the genera *Hildenbrandia* and *Boldia* might exist in Iowa. The latter has been observed in shaded streams in Missouri.

It is still not clear how widely distributed *Batrachospermum* is in Iowa. The fact that it has been observed over a period of years at some localities indicates that persistent populations do occur, in at least some habitats. In addition, it has been observed on a wide variety of substrates including submerged branches (Emmet County), sandstone rocks (Webster County), limestone rock (Bremer County) and upon snail shells (Black Hawk County). Clearly more collections must be made before a clear distributional pattern can be defined for the state.

ACKNOWLEDGEMENTS

We are grateful to Virgil E. Dowel and W. E. Picklum, University of Northern Iowa, R. L. Hulbary, University of Iowa, and John D. Dodd, Iowa State University, for making available their observations and specimens of *Batrachospermum* in Iowa; L. A. Whitford, North Carolina State University, and G. W. Prescott, Flathead Lake Biological Station, University of Montana, for providing valuable discussion of taxonomic and ecologic problems of *Batrachospermum*; Michiyasu Mori, Uto, Japan, and M. Pova dos Reis, University of Coimbra, Portugal, for giving their opinion on the undescribed species from locality 1 (Black Hawk Co.); R. L. Chapman, Louisiana State University, for kindly loaning selected specimens of L. H. Flint's extensive collection of North American *Batrachospermum*. Each contributed significantly to this report.

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