

SOME CHAROPHYTES (CHLOROPHYTA, CHARALES) FROM ALASKA, USA

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Abstract. Based on herbarium studies, seven charophytes are reported from Alaska: *Nitella flexilis*, *N. opaca*, *Tolypella canadensis*, *Chara contraria*, *C. globularis*, *C. virgata* and *C. aspera*. In addition *Nitella acuminata* and three North American species have been reported: *Nitella opacoides*, *N. atkahensis* and *Chara macounii*. The author questions the validity of these taxa, and is of the opinion that they are forms of *Nitella flexilis* and *Chara aspera* respectively. Ecological information and distributions are given for each species; maps illustrate their distribution in Alaska.

■ Charophytes, Characeae, *Chara*, *Nitella*, *Tolypella*, Alaska.

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Introduction

Alaska is the northernmost state of the USA. It covers an area of c. 1.5 million km², and extends from 51°N to 71°N. The climate varies greatly, from arctic in the north, to continental in the interior to coastal in the south. Much of the state has permafrost (Text-fig. 1).

Charophytes have been little studied in Alaska, and there are few references to these algae from this area (Allen 1901; Robinson 1906; Wood 1965; Wood 1967). In a recent article on North American charophytes (Mann et al. 1999) there is no information from Alaska.

This article is based on material from the herbarium of The University of Alaska Museum, Fairbanks (ALA), Canadian Museum of Nature, Ottawa (CAN), Komarov Botanical Institute, St. Petersburg (LE) and on published records. Herbaria are abbreviated according to Index herbariorum (Holmgren et al. 1990).

Observations

The species of charophytes found in Alaska are listed below.

Nitella flexilis (L.) C. AGARDH

Syn.

Nitella opacoides R. D. WOOD

Nitella flexilis f. *opacoides* R. D. WOOD

Nitella atkahensis R. D. WOOD

The two species described from North America are here considered as forms of *Nitella flexilis*. *Nitella atkahensis* is a tiny, compact form, which grows on sand. *Nitella opacoides* is an elongated form, referred to as *N. flexilis* f. *elongata* A. BRAUN (Migula 1897). Krause (1997) reports *N. flexilis* f. *elongata* a form of *N. opaca*. This cannot be correct, as *N. opacoides* is monoecious.

Another species reported from Alaska is *Nitella acuminata subglomerata*, which has no visible differences from *N. flexilis* f. *subcapitata* A. BRAUN (see also icon 178 and 187 in Wood and Imahori 1964).

Ecology: In Alaska *N. flexilis* has only been found in fresh water lakes and ponds from sea level to 700 m a.s.l. The species has been found to depths of 0.5 m on sandy or muddy bottoms. *N. flexilis* is found fertile from June onwards and with ripe oospores from July onwards.

Distribution: *Nitella flexilis* is a widespread species, common in Europe, and also found around the Great Lakes, California and British Columbia in North America (Corillion 1957). In Alaska this species seems to be common along the south coast, but also occurs north of the Arctic Circle indicating a wider distribution (Text-fig. 2).

Specimens examined:

1. Cordova Quad, Copper River Delta, near USFS Tiedeman Slough cabin, 9 July 1977. Lat. 60°25'N, Long. 145°28'W. Leg. A. R. Batten and S. Murphy (ALA).
Specimens to 11 cm high. Monoecious. Richly fertile with some ripe oospores.
2. Aleutian Islands. Adak Island. Medium sized lake (c. 60 m diameter) between enlisted Navy personnel barracks and White Alice Station, elevation c. 90 m, 22 June 1974. Leg. Michael K. Hein (CAN).
3. Aleutian Islands. Unalaska: 25 July 1891. Leg. J. M. Macoun (CAN).
4. McGrath Quad: vic. Post Lake and Post River, c. 700 m a.s.l., 28 June 1983. Lat. 62°08'N, Long. 153°32'W. Leg. Carolyn Parker (ALA).
Plants to 15 cm long. Encrusted. Branchlets short and 3-4 mm long, and only 1/5 of the length of internodes. Fertile whorls forming heads. Sterile branchlets furcate to 1 cm. Monoecious. Very rich fertile but no ripe oospores. Antheridium 0.55 mm. Oo-

gonia smaller, unripe. This specimen matches *Nitella opacoides*, which is here considered an ecological form of *N. flexilis*.

5. Anchorage Quad., Small lake S. of Glenn Highway, Anchorage, 1 August 1965 Leg. R. D. Wood and Steven Wood (LE).

Plants to 6 cm long, compact. Monoecious. Ripe, black oospores, with prominent ridges. This specimen is similar to *N. atkahensis*.

Specimens reported in literature:

6. Lake 4 miles from Wiseman on Hammond River, 12 August 1951. Lat. 67°30'N, Long. 150°10'W. Leg. Hannah Croasdale (Herb. R. D. Wood) (Wood, 1965).

7. Aleutian Islands. Atka Island, 26 August 1891 (See *N. opaca* no. 2)

Leg. J. M. Macoun (Herb. NY) (Wood 1965). Reported as *Nitella atkahensis*.

8. Aleutian Islands. Unalaska, 25 July 1891. Leg. J. M. Macoun (Herb. NY) (Wood 1965). Reported as *N. opacoides*.

9. In a fresh water pond near Prince William Sound. According to Allen (1901) this is *Nitella acuminata subglomerata* A. Braun. This species are unsure for Alaska. I have placed the locality given by Allen here, as *N. flexilis* is found in the same area (Locality 1). The differences between the two species are so minor, that it will need a special study.

Nitella opaca C. AGARDH

Syn.

Nitella opaca differs from *N. flexilis* in being dioecious.

Ecology: *Nitella opaca* has ecology similar to *N. flexilis*, *Chara globularis* and *C. virgata*, which are commonly found in clear water of oligotrophic lakes. *N. opaca* is found fertile from June.

Distribution: The distribution of *N. opaca* is similar to *N. flexilis* (see also Wood (1948). In Alaska the species has only been found on islands in the Pacific Ocean (Text-fig. 3).

Specimens examined:

1. Aleutian Islands. Amchitka Island (Map on the sheet indication location). East end of Baker Runway, 28 June 1962. Leg. Robert J. Reich and John A. McCann (ALA, CANA).

Specimen c. 15 cm long. Dioecious. Both female and male plants are found. Antheridium 0.6 mm. Very rich fertile, but no ripe oospores.

2. Aleutian Islands. Atkah Island, 26 August 1891. Leg. J. M. Macoun (CANA).

Rich fertile specimen.

Specimens reported in literature:

3. In fresh water pond near Kodiak (Allen 1901). Allen has added a question mark after the locality.

Nitella opaca vel *flexilis*

In some lakes, probably with unfavorable conditions, one can find only sterile specimens, which must be named *Nitella flexilis* vel *opaca*. This is because the two species can only be separated in fertile status, since *Nitella opaca* is dioecious and *N. flexilis* is monoecious (Olsen 1944; Moore 1986). There are two such collections (Text-fig. 3).

Specimens examined:

1. Kenai Peninsula. Small subalpine lake with sand and silt bottom, 5 miles south of Summit. Lake along road to Seward. Altitude c. 300 m, 15 September 1954. Leg. Galen Smith (ALA).

Specimens to 8 cm long. Tuft with 45 specimens. Short distance between whorls. Sterile. Similar specimens have been found in similar localities here in Norway. R. D. Wood (20 February 1958) has determined these specimens to *Nitella flexilis* Ag., and he add: Sterile, thus not determinable from *N. opaca* with certainty. Note peculiar pluricellular branchlets which occur in some cases (= *Tolypella canadensis*).

Both *N. opaca* and *T. canadensis* is found on the same sheet.

2. Aleutian Islands. Amchitka Island (map on the sheet indicating the location, pond 37), 31 May 1962. Leg. Robert J. Reich and John A. McCann (ALA).

Plants to 10 cm. Sterile.

Tolypella canadensis SAWA

Syn.

Nitella mucronata f. *haplophylla* HASSLOW

The studied specimens are in generally bad conditions, but *T. canadensis* is easy to determine because of its *Tolypella*-structure, pluricellular branchlets and characteristic mucronate end-cells.

Ecology: *T. canadensis* has been found in "cold" oligotrophic lakes, and it seems to prefer fine sandy bottom. The species is found from 900 m a.s.l. to sea level. All specimens so far found in Alaska are sterile.

Distribution: The species seems to have a circumpolar, arctic-alpine distribution, and is found in the northern parts of Norway, Sweden and Finland and in Greenland and Canada (Langangen 1999). In Alaska the species is scattered, with three localities in coastal areas, and one inland locality. Further discussion of *Tolypella canadensis* can be found in Langangen (1999).

Specimens examined:

1. Alaska Range. Tangle Lakes, along Denali Highway c. 20 miles west of Paxson's (Richardson Highway), altitude 900 m, 22 August 1953. Leg. Galen Smith (ALA).

Plants in parts. Longest specimen c. 8 cm. Diameter of stem is 0.8 mm. Sterile. The stiff appearance with pluricellular undivided branchlets is characteristic for this species.

2. Kenai Peninsula. Small subalpine lake with sand and silt bottom, 5 miles south of Summit. Lake along road to Seward, Altitude c. 300 m, 15 September 1954. Leg. Galen Smith (ALA). 13 cm. Internodes to 4 cm long. Stiff appearance, pluricellular undivided branchlets. Branchlets with mucro, to 1.5 cm long. 6-7 whorls per plant. Sterile.

3. Nome, Base of Anvil Mts., 4 miles from Nome. Lat. 64°30'N, Long. 165°30'W, 8 June 1954. Leg. C. Heller (ALA).

Plants in parts. Typical branchlets with mucro. Sterile.

4. Aleutian Islands. North shore of Massacre Bay, Attu Island. 1 September 1949. Leg. Louis H. Jordal and Harvey Alfred Miller (CANA).

Chara contraria A. BRAUN

The specimens collected in Alaska seem to be relatively typical, and are always encrusted. The cortex is tylacanthous, and the spine-cells are short to papillose.

Ecology: This species seems to prefer alkaline waters with a high content of calcium (lime-rich), and is therefore generally highly encrusted (Langangen 1974; Mann 1989). Specimens with slightly encrusted or lacking encrustation are known (Langangen 1999).

gen unpublished data; Mann 1989). The species is in general reported from fresh water, but records from slightly brackish water are known (Stroede 1933; Långangen 1993).

The species is found fertile and with ripe oospores from June onward.

Distribution: *Chara contraria* is a cosmopolitan species (Corillion 1957; Wood and Imahori 1959). It is frequently dispersed throughout Europe and is common in USA and Canada (Corillion 1957). In Alaska the species is found near the coast, and in one inland locality at the Arctic Circle (Text-fig. 5).

Specimens examined:

1. Anchorage Quad: Coastal flats south of Knik River and west of Glenn Highway. Lat. 61°28'N, Long. 149°118'W, 4 m a. s. l., 23 June 1980. Leg. A. R. Batten and R. Ritchie (ALA). 17 cm. Diplostephanous. Tylacanthous cortex. Heavily encrusted. Whorls shorter than internodia 0.5 -0.3 times as long as these. Spine-cells papillous. Anterior bract-cells and bracteoles longer than oogonium to 11.5 mm long. Posterior bract-cells papillous. Rich fertile, but only few ripe oospores. Stipulodes slightly developed, papillous in lower row, short in upper row. Monoecious.
2. Anchorage Quad: Chugach, St. Park. Vicinity of Ekluta Lake, 25 August 1985. Leg. LuDean Marvin (ALA). Fertile. Ripe, black oospores.
3. Yukon, Porcupine River, Yukon Flats, c. 6 miles, downstream from mouth of Sheenjek River, 8 August 1983. Leg. P. Bogaers and A. Farjon (ALA).

River slough, at both ends connected to main channel, clay on bottom. Submerged vegetation of *Potamogeton* spp. and charophytes. Heavily encrusted. Small plants. Tylacanthous cortex. Rich fertile with possible ripe, black oospores.

4. Nome, Base of Anvil Mts., 4 miles from Nome. Lat. 64°30'N, Long. 165°30'W, 8 June 1954. Leg. C. Heller (ALA).

Plants in parts. Largest 12 cm. Strongly encrusted. Slightly tylacanthous to isostichous cortex. Spine-cells small to papillous. Slightly fertile. Posterior bract-cells papillous. Anterior bract-cells and bracteoles c. as long as oogonia.

5. Anchorage Quad., Cook Inlet lowlands, Gwen Lake. Lat. 61°17'55"N, Long. 149°40'45"W, 13 July 1994. Leg. R. W. Lichvar, C. H. Racine, Michael Duffy and Terry Tande (ALA). Several fine specimens. 13-14 cm long. Encrusted. Tylacanthous cortex. Spine-cells small. Stipulodes small. Anterior bract-cells and bracteoles c. as long as the oogonium. Posterior bract-cells papillous. Rich fertile, but no ripe oospores.

Specimens reported in literature:

6. In ponds and streams near Glacier Bay, very abundant (Allen 1901).

Chara globularis THUILL.

Syn.

Chara fragilis DESV.

Chara globularis has papillous stipulodes and isostichous cortex, in contrary to the similar species *C. virgata*, which has the stipulodes in upper row developed and tylacanthous cortex. Ecology: *Chara globularis* is well known from oligotrophic lakes, and is normally indifferent to the limecontent. It is found in waters with *Potamogeton* spp. and *C. virgata*, and found at elevations from 750 meters down to sea level.

The specimens found are mostly sterile or only slightly fertile. No ripe oospores have yet been found.

Distribution: *Chara globularis* is a cosmopolitan species and relatively common in USA, in southern parts of Canada (Corillion 1957), and in the northern parts of Alaska. It is rare

(only two localities) in the southern Alaska (Text-fig. 6). The identification of the specimens from Shumagin Island has not been confirmed, but it is probably correct as Allen (1888) accepted both *C. globularis* and *C. virgata*.

Specimens examined:

1. Table Mountain Quad: vic. 5 km north of Kuirzinjik Lake (Lobo Lake). Lat. 68°27'N, Long. 143°57'W, 700 m a.s.l., 5 August 1975. Leg. A. R. and C. G. Batten (ALA).

In 15-20 cm water in small lake. Small specimens, longest 4 cm. Isostichous cortex. Stipulodes papillous. Bract-cells papillous. Sterile.

2. Nome, Dexter Road, near large dredge at ditch crossing Dexter Road. Lat. 64°30'N Long. 165°30'W, 26 June 1954. Leg. C. Heller (ALA).

Specimens fragmented. Longest is 4.5 cm. Slightly encrusted, green. Isostichous cortex. Bract-cells, stipulodes and spine-cells rudimentary. Sterile.

3. Yukon. South end of Old John Lake, basin of Scheenjek and Chandalar rivers 90 miles due north of Fort Yukon, in small undrained marly pond 0.5 mile east of outlet. Altitude ca. 750 m, 3 August 1954. Leg. Galen Smith (ALA).

On the label R. D. Wood wrote on 20 February 1950: "*Chara globularis* Thuill. A compact form. Cortex appears isodiametric, but construction is compact and delicatuloid". According to my opinion this is a typical *Chara globularis*. Only small pieces are available.

4. Ahnewetut Creek just south of the Kobuk River, in shallow still water, 9 August 1974. Leg. C. H. Racine (ALA).

Small pieces. Mostly plants with oogonia, slightly fertile. Bracteoles 0.5 times as long as the oogonium. Monoecious. Small antheridia found under the oogonia.

5. Yukon, Porcupine River, Yukon Flats near «Shuman House» cabin. Oxbow lake c. 400 m north of the river in *Picea glauca* forest. Submerged vegetation of *Potamogeton* spp., 24 July 1983. Leg. P. Bogaers and A. Farjon (ALA).

Small pieces. Monoecious. Slight fertile. Typical characters of *C. globularis*.

6. Afognak Quad: Afognak Island, Upper Malina Lake, SE end of lake. Lat. 58°08'N, Long. 153°04'W, 290 m.s.m., 25 June 1992. Leg. Carolyn Parker (ALA).

Sandish lake shore, growing in shallow water. 7 cm. Sterile.

7. Fairbanks Quad: South of Birch Hill Ski Area, Ft. Wainwright. Lat. 64°51'N, Long. 147°37'W, 26 June 1995. Shallow water at margin of small pond. Leg. M. Duffy and J. Tande (ALA).

Fertile, ripe, black oospores.

8. Big Delta Quad: Birch Lake. Lat. 64°20'N, Long. 146°40'W, 29 August 1989. Leg. C. L. Parker (ALA).

Ripe, black oospores.

Specimens reported in literature:

9. In a fresh water pond, Shumagin Islands (Allen 1901).

Chara virgata KUTZING

Syn.

C. delicatula C. AGARDH

Many authors have treated *Chara globularis* and *Chara virgata* as one species (Olsen 1944; Långangen 1974; Moore 1986), while other have treated them as two species (Migula 1897; Corillion 1957).

Ecology: The ecology of *C. virgata* is similar to *Nitella flexilis* and *Chara globularis*.

It is found on muddy to gravelly bottom. Fertile specimens with ripe oospores have been found in June.

Distribution: Because of the confused taxonomy of this species, its distribution is only known in part. In Alaska *C. virgata* is found scattered, both inland and along the coast (Text-fig. 6).

Specimens examined:

1. Nome, Dexter Road, near large dredge at ditch crossing Dexter Road. Lat. 64°30'N, Long. 165°30'W, 26 June 1954. Leg. C. Heller (ALA).

Specimen only 2 cm long. Cortex slightly tylacanthous. Bracteoles two times the length of the oogonium. Posterior bract-cells papillous. Oogonium 0.75 mm long. Only two whorls with branchlets to 12 mm long. With ripe, black oospores.

2. Fairbanks. Harding Lake, c. 50 miles SE of Fairbanks. Lat. 64°25'N, Long. 146°55'W, 23 September 1966. Leg. Vernon L. Harms and B. Knoblock (ALA).

Submerged aquatic plant on lake bottom. Frequent in scattered tufts at 1-2 m depth. Lake bottom gravelly silt. Small plants, tufted (6), to 6 cm long. In one of the tufts the plants have root bulbils. Much sand on the plants means that the plant grows on sandy bottom. Stipulodes in upper row developed. Two ripe black oospores- 0.7 mm long, 0.35 mm wide and with 12 convolutions. Posterior bract-cells papillous, anterior bract-cells to 1 mm long. Bracteoles c. as long as oogonium. Slightly tylacanthous cortex.

3. Aleutian Islands. Amchitka Island, 19 May 1962. Leg. Robert J. Reich and John A. McCann (ALA).

Associated plants: *Nostoc pruniforme* (L.) Vauch. (alga balls), *Hippuris vulgaris* (L.), 5 cm. Many plants. Short stipulodes in upper row. Root-bulbils. Sterile.

4. Kanai NWR. Mosquito Lake. Lat. 60°30'N, Long. 159°49'W, 14 August 1991. Leg. Stephen S. Talbot (ALA).

Habitat: *Equisetum fluviatile* shallow marsh. 14 cm. Monoecious with ripe, black oospores.

Specimens reported in literature (Wood 1965):

5. Anchorage. South end of Goose Lake. In beds on muddy bottom under 0.3-0.5 m water, 4 July 1951. Leg. Hannah Croasdale (Herb. R. D. Wood).

6. Aleutian Islands. Unialaska. August 1899. Leg. W. A. Setchell (Herb. UC).

7. Glacier Bay, 10 June 1899. Leg. W. Trelease and D. A. Saunders (Herb. NY).

Chara aspera DETH. EX WILLDENOW

Syn.

Chara macounii (T. F. ALLEN) ROBINSON

The Alaskan specimens of *Chara aspera* do all belong to the taxon described as *C. macounii*. This taxon is here regarded as a form of *Chara aspera*. *Chara macounii* has many similarities to *Chara virgata*.

The specimens studied have very short spine-cells, which are not papillous as in *C. virgata*. Such forms are also described in Migula (1897), i.e. *f. pseudofragilis* MIGULA and *f. limosa* MIGULA. *f. pseudofragilis* has also been found in the Baltic Sea (Langangen et al. 2002). The cortex is tylacanthous in both taxa. The stipulodes are often well developed in upper row as in *C. virgata*. *Chara aspera* is dioecious while *C. virgata* is monoecious. The safest character is the occurrence of round, white bulbils, which are typical for *C. aspera*. This

character is used here. This means that specimens with the described characters, but lacking bulbils will be determined as *C. virgata*. Further investigations are necessary for deciding how the two taxa integrate and differ.

Ecology: *Chara aspera* has both fresh water and brackish water forms. The specimens from Alaska all belong to the brackish water form. In Alaska the species has been found in shallow water. Most studied specimens are sterile. Fertile specimens are found in July.

Distribution: *Chara aspera* is common in Europe, and is scattered in North America (Allen 1951; Corillion 1957). All localities for *C. aspera* in Alaska are on the southeast coast (Text-fig. 7).

Specimens examined:

1. Anchorage Quad.: Coffee Point- Duck Flats area. Lat. 61°30'N, Long. 149°22'W, 4 m a.s.l., 8 July 1980. Leg. A. R. Batten and P. Reed (ALA).

Locally common on bottom of pond complex on Duck Flats, in 50 cm deep water. 15 cm. Cortex tylacanthous. Few very short spine-cells bigger than papillous. Stipulodes developed in upper row. Bract-cells developed on some branchlets. Bracteoles long, to two times as long as the oogonia, in one plant to four times longer. The specimens are dioecious, and both female and male plants are found. Bulbils of *Chara aspera* type found, 1 mm in diameter.

2. Anchorage Quad, Cook Inlet lowlands, Eagle River Flats. Lat. 61°19'N, Long. 149°43'W, 18 August 1994. Leg. C. H. Racine (ALA).

Salt marsh and coastal sites. *Chara aspera* bulbils, 0.75 mm in diameter on one specimen. Stipulodes- upper row developed (as *C. virgata*). Cortex tylacanthous. Spine-cells bigger than papillous. Sterile.

3. Yakutat Quad, Mouth of Situk River, near ADFandG fish and wildlife protection cabin. Lat. 59°26'N, Long. 139°32'W, 28 June 1977. Leg. A. R. Batten and S. Murphy (ALA).

Coastal marsh. In 10 cm of water in pond or in mud on banks. Many damaged specimens, with much soil. Bulbils of *Chara aspera* type. Spine-cells papillous. Stipulodes in upper row developed. Encrusted. Slightly tylacanthous cortex.

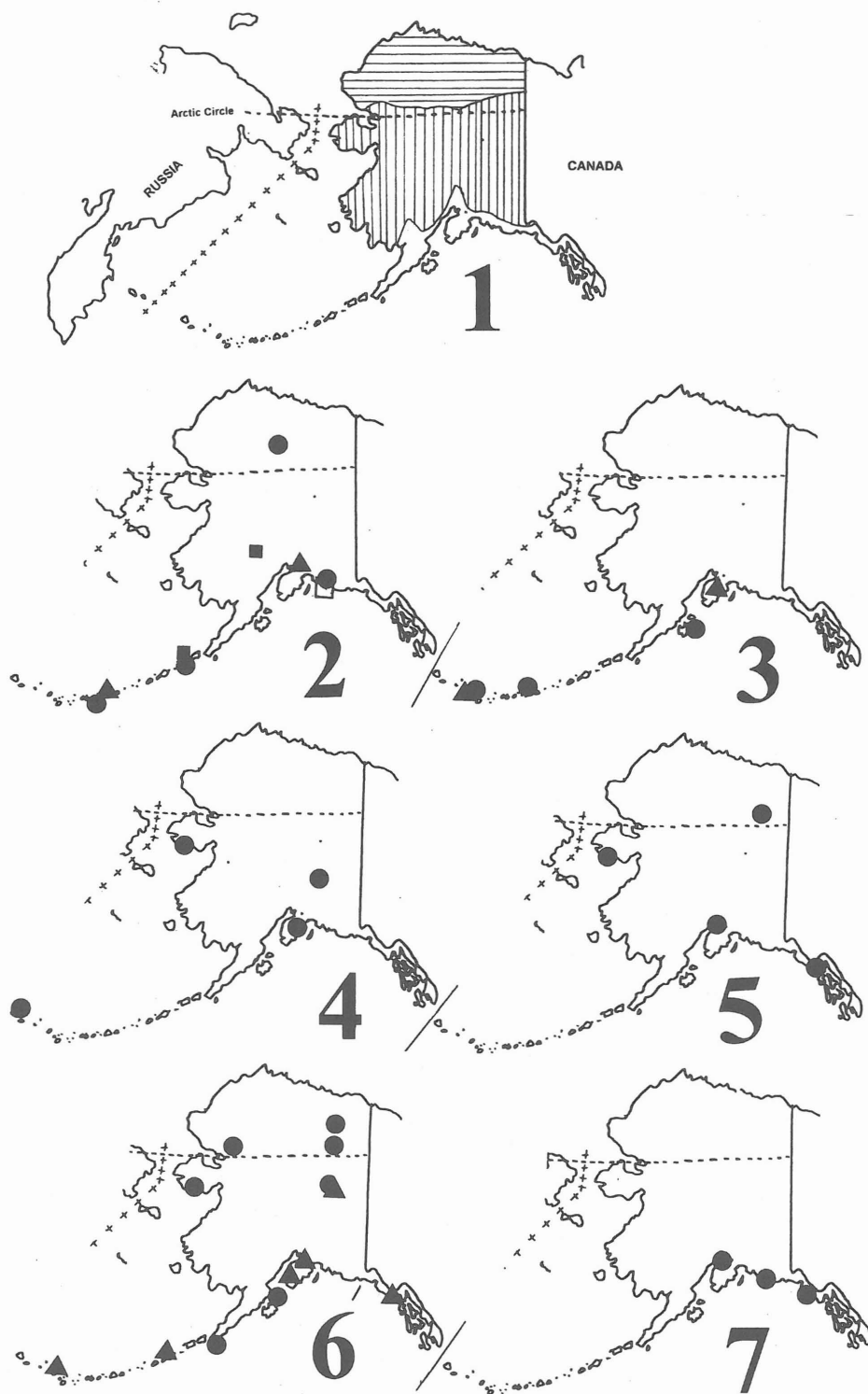
4. Cordova Quad, Copper River Delta, near USFS Tiedeman Slough cabin. Lat. 60°25'N, Long. 145°28'W, 9 July 1977. Leg. A. R. Batten and S. Murphy (ALA).

In pond, in 20 cm deep water. Plants in parts. 6-7 cm long. Bulbils of *Chara aspera* type, 0.55 x 0.35 mm in shape. Spine-cells small, short bigger than papillous indicate the relation to *C. aspera*. Sterile.

Conclusions

This paper gives a preliminary report on the charophytes of Alaska. According to ecological criteria the species can be grouped in three categories:

1. Oligotrophic species: *Nitella flexilis*, *N. opaca*, *Tolypella canadensis*, *Chara globularis* and *Chara virgata*. All these species have wide ecological amplitudes for most physical and chemical parameters (Langangen 1974; Mann 1989), and the Alaska material is consistent with these facts.
2. Species found in lime rich lakes: *Chara contraria*. The correlation between the lime content of the localities and the occurrence of this species is well documented (Langangen 1974; Mann 1989).
3. Brackish water species: *Chara aspera*.



Text-figs 1-7. Permafrost regions and distribution of some charophytes in Alaska.

1. Permafrost regions /Horizontal lines- continuous permafrost/ Vertical lines- discontinuous permafrost/ no lines - generally free of permafrost.

2. *Nitella flexilis*. The different forms of *N. flexilis* and *N. acuminata* have been marked with special signs as shown here.

● *N. flexilis* ■ *N. opacoides* ▲ *N. atkahensis* □ *N. acuminata*

3. *Nitella opaca* ● *N. opaca vel flexilis* ▲

4. *Tolypella canadensis* ●

5. *Chara contraria* ●

6. *Chara globularis* ● *Chara virgata* ▲

7. *Chara aspera* ●

Most localities for charophytes in Alaska are situated along the coasts, especially the south coast. Here the conditions are more favorable for these plants. *Nitella flexilis*, *Chara contraria* and *C. globularis* have also been found north of the Arctic Circle.

Nitella opacoides, *N. atkahensis* and *Chara macounii* have been reported from Alaska. However, these species do not appear to have taxonomic significance and are treated here as forms of *Nitella flexilis* and *Chara aspera*. These taxa can only be evaluated correctly after more intensive field studies; such studies are needed to understand the role of charophytes in different aquatic ecosystems of Alaska. More collections are needed to get a better knowledge of species ecology and distribution. The charophyte flora of Alaska has similarities to both the Canadian and Russian floras.

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