Vegetation of Amchitka Island, Aleutian Islands, Alaska

By HANSFORD T. SHACKLETTE *and others*

L. W. DURRELL
JAMES A. ERDMAN
JOHN R. KEITH
WILLIAM M. KLEIN
HILDUR KROG
HERMAN PERSSON
H. SKUJA
WILLIAM A. WEBER

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An account of the plant species and plant communities that occur in an oceanic island environment

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VEGETATION OF AMCHITKA ISLAND, ALEUTIAN ISLANDS, ALASKA

By HANSFORD T. SHACKLETTE and others

ABSTRACT

An *Empetrum* heath blankets the low plateaus of Amchitka Island, except where interrupted by streams, lakes, sand dunes, and man-made disturbances. This heath is composed of low shrubs of *Empetrum*, *Vaccinium*, *Loiseleuria*, and varying amounts of many species of sedges, grasses, forbs, lichens, and bryophytes. Lakes and pools contain the aquatics *Hippuris*, *Isoëtes*, *Ranunculus*, *Limosella*, and *Subularia*, and poorly drained areas around them support communities composed largely of *Carex* or *Sphagnum*. Moss mounds are abundant throughout, and bird-perch mounds occur near the coasts. The steep cliffs along the shores support a distinctive flora in which *Saxifraga*, *Potentilla*, *Draba*, *Eurhynchium*, and *Ramalina* are predominant. Dense stands of *Elymus* grow intermixed, at places, with *Anemone* and *Ligusticum* on the margins of the plateaus near the sea coasts. Beaches of sand and cobbles commonly have a band of *Honckenya* near the water and populations of a tall *Senecio* among the driftwood. Sand dunes are vegetated with dense stands of *Elymus* and other grasses or, if pebbly, with colonies of *Rhacomitrium*, *Schistidium*, *Ulota*, and *Andreaea*.

At altitudes between 400 and 600 feet the *Empetrum* mats lie in strips on unstable pebbly or rocky mineral soil; *Salix*, *Loiseleuria*, *Luzula*, *Cladonia*, and *Thamnolia* may also be common components of the mats. On the unstable soil between the strips, a few mosses (*Andreaea*, *Rhacomitrium*, and *Schistidium*), *Koenigia*, *Juncus*, and *Saxifraga* grow as scattered colonies or individual plants.

Solifluction ridges and frost-moved cobble deposits at altitudes between 600 and 900 feet are sparsely colonized with intermixed *Draba*, *Sibbaldia*, *Diapensia*, *Lupinus*, *Potentilla*, *Conostomum*, *Luzula*, *Veronica*, and *Rhacomitrium*. Mountain streamsides and late-melting snow beds have extensive cover of *Anthelia*, *Nardia*, and *Marsupella*, with *Saxifraga*, *Geum*, *Pyrola*, *Leptarrhena*, *Hippuris*, *Vahlodea*, and other vascular plants.

At altitudes between 900 and 1,100 feet most areas are covered with boulder fields in which only a few heath mats of *Empetrum*, *Salix*, *Rhododendron*, *Vaccinium*, and *Loiseleuria* occur. On the highest peaks, where winds commonly are very strong, only *Carex circinnata* and *Agrostis borealis* grow among the bolders and outcrops that support *Umbilicaria*, *Ocrolechia*, *Parmelia*, and other saxicolous lichens.

The following numbers of plant taxa are reported to occur on the island: Vascular plants, 198; bryophytes, 153, lichens, 84; fungi, 25; and algae, 173; total taxa reported, 633. These taxa are distributed among the 15 habitats and 41 plant communities that are described in this report. Numbers of taxa that are reported for the first time to occur on Amchitka Island are: Vascular plants, 47; bryophytes, 145; lichens, 75; fungi, 25 (no earlier reports known); and algae, 173 (no earlier reports known).

The following taxa were found for the first time in the Aleutian Islands: Vascular plants—*Diapensia lapponica* subsp. *obovata* and *Poa alpina;* bryophytes—*Aongstroemia longipes*, *Anastrophyllum sphenoloboides*, *Anomobryum concinnatum*, *Brachythecium acutum*, *B. salebrosum*, *Bryum arcticum*, *B. pallens*, *B. salinum*, *Dicranella subulata*, *Gymnocolea inflata*, *Hypnum imponens*, *Lophozia opacifolia*, *Lophozia incisa*, *Mielichhoferia macrocarpa*, *Polytrichum sphaerothecium*, *Sphenolobus saccatulus*, and *Tortula mucronifolia;* fungus—*Nidula candida*.

Of the taxa listed above, the following were also found for the first time in Alaska: *Anastrophyllum sphenoloboides*, *Brachythecium acutum*, *Hypnum imponens*, *Lophozia opacifolia*, *Nidula candida*, *Polytrichum sphaerothecium*, and *Sphenolobus saccatulus* (first report of its occurrence in North America).

Five new species and a new variety of protists are described in this report—*Chlamydomonas alaskensis*, *C. subangulosa*, *Oscillatoria facilis*, *Pseudanabaena granulifera*, *Raphidonema gracile*, and *Synechococcus cedrorum* var. *pallidus*.

INTRODUCTION

By HANSFORD T. SHACKLETTE

OBJECTIVES AND LIMITATIONS OF THESE STUDIES

The studies reported in this paper were designed to inventory land and aquatic plants that grow on Amchitka island and to describe the relationships of plant species and plant communities to climatic and edaphic factors. The fresh-water and soil algae and the fungi listed in this report were collected incidental to other studies; therefore, the lists do not represent the total microflora. The fungus *Nidula candida* (Peck) White, collected during these studies, was reported by Reeves (1968); other collections of fleshy fungi have not been identified. Marine algae were not included in this study.

At the time of the investigations, access to the mountainous parts of the island was difficult because of poor roads and generally inclement weather; accordingly, only a short time was spent at some mountain sites. Many sites on other parts of the island were studied in detail in both summer and winter. Plant communities in all major kinds of environments were examined after traveling on foot or by truck or helicopter to 40 study sites (fig. 1). Dense fog in summer and very strong cold

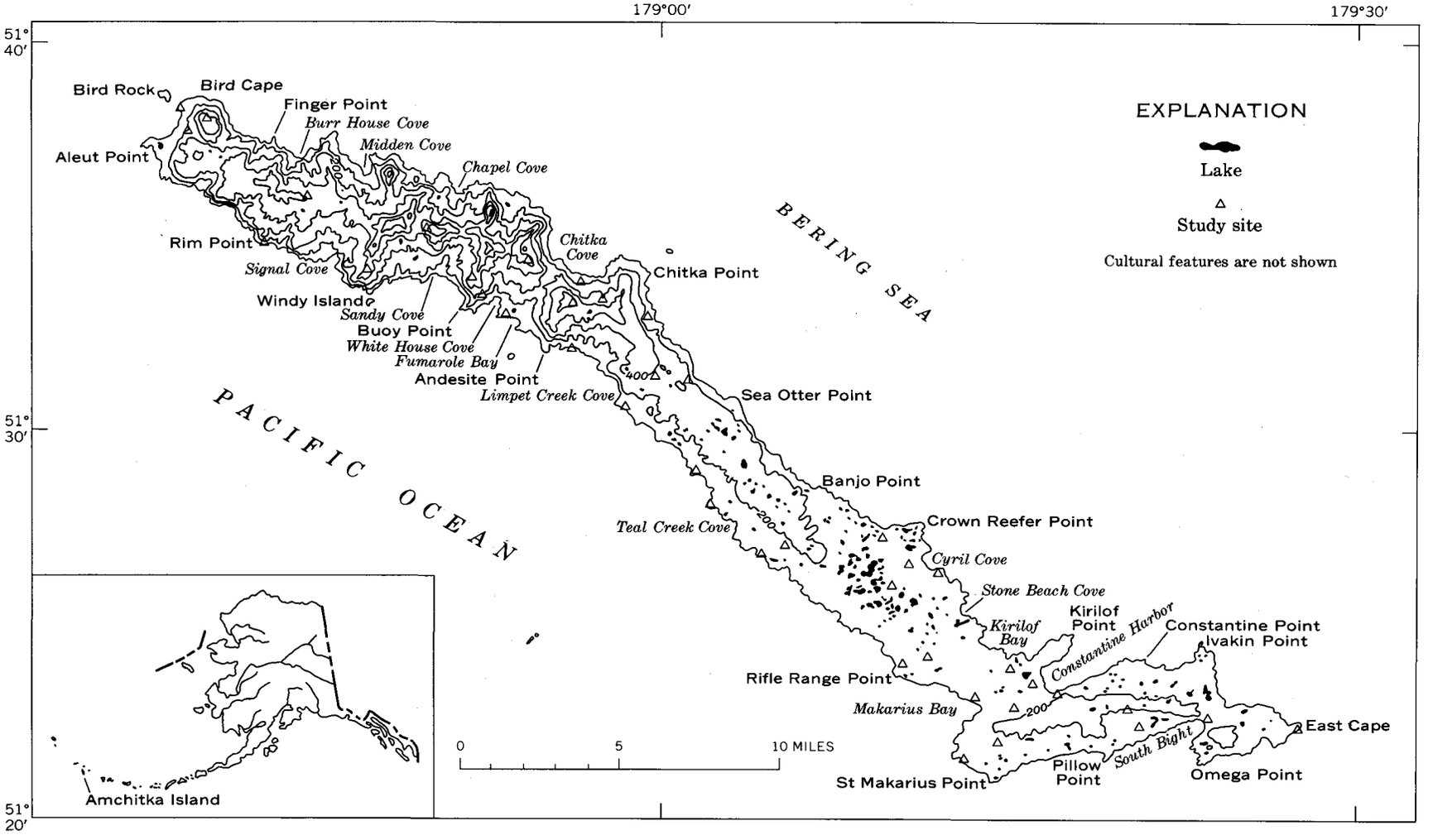

FIGURE 1.—Amchitka Island, Alaska, showing locations of vegetation study sites. Topographic base from U.S. Geological Survey Rat Islands quadrangle, Alaska. Scale 1 : 250,000. Contour interval 200 feet. Datum is mean sea level.

winds in winter at times prevented effective field studies, and good-quality photographs were difficult to obtain under the generally overcast sky. Quantitative ecological studies that were begun are incomplete and are not discussed in this report.

BOTANICAL STUDIES THAT HAVE BEEN CONDUCTED

The first known botanical investigation of Amchitka Island was made by W. H. Dall of the U.S. Coast Survey on July 30, 1873. His collection of plants is in the U.S. National Herbarium and the Gray Herbarium of Harvard University (Hultén, 1960, p. 12). No other plant collections were made until June 11–12, 1929, when Misao Tatewaki and K. Takahashi visited Constantine Harbor. This area was visited by Yoshio Kobayashi in the summer of 1931. The reports of these Japanese botanists were given by Akiyama (1933), Tatewaki and Kobayashi (1934), and Satake (1932). Eric Hultén collected plants on this island July 9, 1932, near "Square Bluff" (Bird Cape) and in the middle of the north shore. Reports of these collections, as well as sight records, are given in his "Flora of the Aleutian Islands" (Hultén, 1960). In 1936 O. J. Murie collected plants on Amchitka Island while studying the avifauna. Hutchison (1942, p. 783) spent 2 days at Constantine Harbor in the late summer of 1936 and collected about 50 species of flowering plants. These specimens are in the British Museum (Hutchison, 1937, p. 144–145). On August 22, 1949, George A. Llano collected lichens and bryophytes on this island.

The first systematic collecting of bryophytes, lichens, and vascular plants on Amchitka Island was done by H. T. Shacklette, in connection with U.S. Geological Survey investigations, in November and December 1965, August 1966, and June and July 1967. E. E. C. Clebsch collected vascular plants and made ecological observations on the island in late June 1967, and A. J. Sharp collected bryophytes in early July of the same year. J. A. Erdman, M. A. Heifner, J. R. Keith, W. M. Klein, and H. T. Shacklette collected plants and conducted ecological studies in July 1967; these studies were continued in August 1967 by Klein and Heifner, assisted by R. T. Ward and W. L. Slauson. In September and October 1967 and in January and early February 1968, C. A. Amundsen and Clebsch continued their ecological studies on the island. Shacklette and Erdman collected plants and studied the phytoecology of the island February 5–20, 1968. These studies were continued by Keith, Heifner, and Slauson during March 19–26, 1968, and by R. L. Dix, Kenneth Bierly, Richard Cooley, Heifner, David Putman, Slauson, and Walter Younkin for various periods during the summer of 1968.

NOMENCLATURE, AND NOTES ON COLLECTIONS

The nonmenclature of the plant species in this report generally adheres to that of the following sources: Vascular plants, Hultén (1968); mosses, Crum, Steere, and Anderson (1965); lichens, Hale and Culberson, (1966); and liverworts, algae, and fungi, from various sources as judged authentic by Herman Persson, H. Skuja, and L. W. Durrell. Some species found on Amchitka Island are not listed in the generally accepted references given above. For these species the nomenclature follows the usage of specialists in the particular taxonomic group.

Most plants listed in this report were collected by Shacklette, and they bear his collection numbers. He made approximately 790 numbered collections on Amchitka Island, each at least in triplicate, and one specimen of each is held in the U.S. Geological Survey herbarium in Denver, Colo., for eventual deposit in the U.S. National Herbarium. The other two specimens of each collection were distributed as follows: Vascular plants and bryophytes to the Herbarium of the Swedish Natural History Museum, Stockholm, and to the Herbarium of the University of Michigan Museums, Ann Arbor; and lichens to the Herbarium of the Botanical Museum, Oslo, and to the Herbarium of the University of Colorado Museum, Boulder. The algae collections were segregated from the bryophyte and *Isoëtes* collections, and the segregates are either being held at the University of Uppsala or being cultured from soil samples at Colorado State University.

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The critical studies of Amchitka Island specimens made by Drs. L. W. Durrell, Eric Hultén, Hildur Krog, Herman Persson, H. Skuja, and W. A. Weber included in this report were supported entirely by their own institutions. The author gratefully acknowledges this support and the invaluable assistance of these specialists.

DESCRIPTION OF THE ISLAND AND ITS VEGETATION

By Hansford T. Shacklette

GEOGRAPHY

Amchitka Island, the southernmost of the Rat Islands, has an area of 114.1 square miles and is the fifth largest Aleutian Island (Coats, 1956, p. 86). The island is about 35 miles long, in a northwesterly direction, and is 3 to 5 miles wide (Powers and others, 1960, p. 522). The Bering Sea is to the north, and the Pacific Ocean, to the south; therefore, the island is in a region of turbulent winds and waters.

The settlement of the island by the Aleuts occurred more than 4,000 years ago, and until Russian occupation the island apparently supported a relatively large native population (Powers and others, 1960, p. 552). The locations of 40 villages are indicated on a map by Guggenheim (1945, p. 22–23), who reported that many sites had been plundered during the military occupation of World War II. All known sites of Aleut huts (barabaras) are along the coasts, commonly on sandy deposits. At least one barabara was still habitable in February 1968, but all that remains to indicate the location of most huts is a rectangular pattern in the vegetation.

The Russian expeditions to the Aleutian Islands in the 18th century were for the purpose of obtaining furs of sea otter (Barbeau, 1958, p. 28–32). A Russian village, inhabited by Aleuts and people of Russian descent, was established at Constantine Harbor and apparently flourished for many years; however, when Hutchison (1937, p. 145) visited the island in 1936, it was entirely uninhabited, although the Russian church was in a good state of preservation. At present, the only remaining evidence of this early habitation is a small cemetery at the head of Constantine Harbor in which the most recent tombstone bears a death date of 1930.

In 1913 the entire Aleutian Island chain was set aside as a National Wildlife Refuge under the supervision of the Fish and Wildlife Service, U.S. Department of the Interior. From January 12, 1943, until early November 1950, Amchitka Island was used as a military base and, at times, was occupied by thousands of troops. Many square miles of the eastern part of the island are today littered with the ruins of military buildings, most of which are uninhabitable. During this occupation, an extensive network of roads and three airplane runways were built in the general area of Constantine Harbor, and one road was constructed from this area to the northwest point of the island—a distance of about 30 miles. Apparently, there have been no permanent residents or commercial establishments on the island since the military occupation of World War II.

From 1946 to 1963 the island was visited from time to time by personnel of the Fish and Wildlife Service, the U.S. Weather Bureau, and the U.S. Geological Survey (Coats, 1956, p. 84; Powers and others, 1960, p. 552). In 1964 work was begun to prepare a site for nuclear testing, and in October 1965 an 80-kiloton nuclear device, buried at a depth of 2,300 feet, was detonated (Army Research and Development Newsmagazine, 1966).

No native land mammals are on the island. Norway rats were introduced probably during World War II and are now abundant on the eastern half of the island, occurring most commonly along the coasts. Foxes, as well as feral dogs remaining from the military occupation, were exterminated after 1945 by the Fish and Wildlife Service as a measure to encourage birds to nest on the island. Sea otters, Stellar's sealions, and harbor seals are common in some coves and on the beaches. There are no ants on the island (Hultén, 1960, p. 29), mosquitoes (if present) are rare, and earthworms are not common, but certain species of Diptera and Hymenoptera are numerous. The avifauna was reported by Murie (1959), Kenyon (1961), and others; waterfowl, ocean birds, and eagles are abundant, and ptarmigans are frequently seen on the heath. The only trees on the island are several Sitka spruce (*Picea sitchensis*), now about 3 feet high, that were planted in front of military buildings during the war. Several species of weedy herbs were probably brought to the island by man, but they constitute an insignificant part of the present flora.

CLIMATE

The Amchitka Island climate is maritime, being cool, stormy, and cloudy throughout the year (Arctic Weather Central, 1950). Average temperatures range from 0°C in January and February to 9°C in August (extreme low, −9.5°C in January; extreme high 18.5°C in July). Partial to complete cloud cover is nearly constant; it ranges from 99.7 percent of the time in July to 96.8 percent of the time in October. During the summer, fog occurs more than 50 percent of the time, and complete overcast occurs more than 65 percent of the time. In the winter, there is less fog and overcast. Average wind speeds range from 22 knots in January to 14 knots in June and July (monthly maximums of 52–100

knots). Precipitation averages 35 inches annually, including snowfall of 70 inches. The above summary of the climate is based on records made from 1943 to 1948 at the airbase (alt 225 ft); doubtless, the mountainous part of the island is colder and windier.

In this study, soil temperatures were measured with a recording thermograph for 9-day periods in each of 4 months. For these periods, averages of hourly temperatures, measured at a depth of 20 cm (centimeters) below the surface of the organic mat (a depth considered to be within the zone of greatest root activity), follow: June, 5.0°C; July 7.7°C; August, 7.2°C; and February, 0°C.

Barometric pressures fluctuate frequently and often greatly. During the 2-week period February 9–19, 1968, high pressures of 29.48, 28.70, and 29.82 inches of mercury alternated with low pressures of 28.23 and 28.15. Abrupt changes in weather generally accompanied these barometric fluctuations.

PHYSIOGRAPHY AND GEOLOGY

The physiography and geology of Amchitka Island were described by Coats (1956) and by Powers, Coats, and Nelson (1960). The discussion that follows is based on these reports.

The three landforms on the island are, from east to west, low plateaus, rugged mountains, and high plateaus (fig. 1). This varied topography is thought to have been developed from plateaus of low relief that were somewhat disturbed by block faulting and were modified by dissection to greatly different degrees by marine, stream, and glacial erosion.

Elevated wave-cut platforms, at altitudes ranging from 135 to about 500 feet, constitute the lower plateaus of the island. Several successive marine benches commonly are present; many are poorly drained and have lakes of different sizes and shapes. On eastern Amchitka Island, glacial boulders occur beneath marine gravels at altitudes of more than 100 feet.

The mountainous part of the island is between Chitka Point and Windy Island and is a sinuous ridge that divides the drainage to the Pacific Ocean and to the Bering Sea. This ridge has several summits exceeding 1,100 feet in altitude, and the summits are separated by four passes at altitudes of about 750 feet. Five prominent spurs extend from the main ridge and form divides between major compound amphitheater valleys that head in the main ridge. Parts of the ridge and spur summits are gentle slopes eroded across the local rock structure and are remnants of an erosional surface of very low relief, but it is not known whether the cut surface has been glaciated or even whether it is subaerial or submarine in origin. At the base of the steep slopes leading from the headwalls of the amphitheater valleys are benches or remnants of valley floors at altitudes of 700 to 800 feet in most places. Most of the bedrock surface of the benches is grooved and striated, and tarns are present on some benches and valley floors.

High plateaus occur in the segment of the island northwest of Windy Island, at altitudes between 700 and 800 feet. Two separate areas of undissected surface form the two mesas at the west end of the island. The high-plateau surface is underlain by colluvium of angular rock fragments.

The oldest rocks, probably early Tertiary in age, are volcanic ash, tuff, breccia, and lava flows generally of andesitic composition that apparently were largely erupted and emplaced under the ocean. These rocks were deformed, uplifted, and eroded before and during deposition of the interbedded conglomerate, basaltic breccia, and tuff of a later sequence of Oligocene or possibly early Miocene age. Erosion reduced the mass to a surface of low relief, now at an altitude of about 1,100 feet, that was possibly a submarine shoal. Marine sands and cobble conglomerate are now exposed at altitudes of up to 600 feet.

During late Tertiary and Quaternary times, uplift of at least 500 feet, and possibly more than 1,100 feet, took place differentially and spasmodically. Abandoned sea cliffs and beach deposits are inferred to be structurally dislocated remnants of shoreline features of a late Pleistocene interglacial sea level, judged from the fact that the fauna of the beach deposit is characteristic of water warmer than that which now surrounds the island.

SOILS

The soils of Amchitka Island have been insufficiently studied to be classified by soil series; hence, at present they can be placed only in the great soil groups to which they appear to belong. The following outline of these soil groups that are represented by the soils on this island is based on the classification of Alaskan soils by Kellogg and Nygard (1951, p. 33) and on certain concepts of tundra soils on Kodiak Island that were proposed by Rieger and Wunderlich (1960, p. 27–32).

A. Zonal soils
   1. Tundra
      a. Without permafrost (Ando soils of Rieger and Wunderlich)

B. Intrazonal soils
   1. Bog
   2. Half Bog

C. Azonal soils
   1. Alluvial
      a. From local alluvium
   2. Lithosol
   3. Regosol

Rieger and Wunderlich (1960, p. 27) classified certain soils as Ando soils; these same soils were classified earlier by Kellogg and Nygard (1951) as "Tundra without permafrost." Inasmuch as microclimates and soils on Kodiak Island are similar in many respects to those on Amchitka Island, it is possible that some of the Tundra without permafrost soils of the latter island should be named Ando soils. They are, however, not so strongly influenced by volcanic ash as are those of Kodiak Island.

In 1960 the Soil Survey Staff, U.S. Department of Agriculture, published a new system of soil classification and in 1967 they expanded and refined the system in a supplement. Their definition of soil requires that plant life be supported; however, an area covered with water that supports only floating plants or with rocks that support only lichens is not considered to have soil. The lower boundary of soil is considered to be (Soil Survey Staff, 1960, p. 1) "the vague lower limit of common rooting of the dominant native perennial plants, or the vague lower limit of the genetic horizons, whichever is the deeper." Within the limits of this definition, an extensive system of classification and nomenclature was developed on the premise that soils should be classified by their properties rather than by their genesis. (For a review, see Shacklette, 1961.) If the soils of Amchitka Island are to be fully classified by the system of the Soil Survey Staff, a much more intensive study of their properties than has yet been made will be necessary. This new system classifies soils into so many more groups than is possible under the old system that only examples considered to be typical of a Great Soil Group are classified below—that is, there probably is more than one subgroup in an order on Amchitka Island. The correlation of the old and the new systems of classification, insofar as it can be done at present, is given below.

Tundra without permafrost.—If these soils on Amchitka Island are to be related to Ando soils, the following classification is suggested (Soil Survey Staff, 1960, p. 136–140; 1967, p. 89–90): Order, Inceptisols; suborder, Andepts; great group, Cryandepts; and subgroup, Lithic Cryandepts. If, however, the small amount of ash in their horizons as a whole is considered to be most characteristic, they are classified as follows (Soil Survey Staff, 1960, p. 136–143; 1967, p. 107–108): Order, Inseptisols; suborder, Umbrepts; great group, Cryumbrepts; and subgroup, Lithic Cryumbrepts.

Bog and Half Bog.—Because the new system is not yet complete, these soils can be classified only as being in the order Histosols (Soil Survey Staff, 1960, p. 247–248). However, some of the Half Bog soils may belong to a different order, and they could be classified further if sufficient data were at hand.

Alluvial.—These soils cannot be correlated with the new system on the basis of available data.

Lithosols.—The Amchitka Island lithosols are classified as follows (Soil Survey Staff, 1960, p. 136–139; 1967, p. 93): Order, Inseptisol; suborder, Aquepts; great group, Cryaquepts; and subgroup, Histic Cryaquepts.

Regosols.—These soils, at both high and low altitudes on Amchitka Island, are classified as follows (Soil Survey Staff, 1960, p. 136–143; 1967, p. 98): Order, Inseptisol; suborder, Ochrepts; great group, Cryochrepts; and subgroup, Lithic Cryochrepts.

The most recent worldwide classification of soils is that of Ball (1967), who devised a system for coding soils found in terrestrial biological communities that may be proposed for conservation in the International Biological Program. This classification recognizes 13 categories of soil that are designated by letter symbols with number subscripts. By eliminating the categories of soils that do not occur on Amchitka Island, the author has prepared a key to the soils of Amchitka Island, using the system of Ball (1967, p. 123–124), as follows:

1. Soil with dominantly organic surface horizon at least 50 cm deep. If total soil depth less than 50 cm, then surface organic horizon directly succeeded by unaltered rock—soil type O.
   Soil without dominantly organic surface horizon or with organic surface horizon succeeded by mineral soil at less than 50 cm depth—2.
2. Well drained (that is, no evidence of strong impedance or waterlogging above 40 cm depth)—3.
   Poorly drained (that is, evidence in mottled colors of strong impedance or waterlogging nearer surface than 40 cm)—Soil type P_2.
3. Immature profile (that is, with weakly developed shallow soil formation, possibly with little biological activity)—4.
   Well-developed horizon sequence with moderate to strong biological activity—5.
4. Immaturity resulting from climatic factors; for example, very low rainfall or temperature, or both—soil type I_1
   Immaturity resulting from lack of time for soil formation to proceed; for example, on recent alluvium, dune sands, and eroded surfaces—soil type I_2

5. Shallow or simple profiles of A horizons overlying parent material—soil type F_3
   A(B)C profiles [1]—soil type F_4
   ABC profiles; that is, with a horizon accumulation of clay or iron oxides, or both—soil type F_5

Because the classification of the Soil Survey Staff (1960, 1967) cannot at present be fitted to all soils on the island, subsequent parts of this report will use the classification based primarily on Kellogg and Nygard's (1951) that was presented earlier, and the system of Ball (1967).

In 1946 Kellogg and Nygard (1951, p. 41, 43), of the U.S. Department of Agriculture, obtained soil samples and data for a profile description of a smooth, fairly well drained slope on Amchitka Island. They classified the soil as Tundra without permafrost and gave the following description of the soil profile:

A_{00} and A_0. 5 to 0 inches, dark-reddish-brown peaty mat.
A_1. 0 to 5 inches, nearly black humus-rich silty very fine sandy loam; the slick moist soil is held together by many roots.
B_2. 5 to 10 inches, nearly black granular silty very fine sandy loam.
B_3. 10 to 15 inches +, dark-grayish-brown silty very fine sandy loam. In the lower part, horizontal streaks suggest ash layers.
C. At 30 inches, yellowish-brown silty very fine sandy loam.

The low plateaus of Amchitka Island, because of their varied relief, bear soils that include all the soil groups on the island. The soil profile given above is probably typical of soils of the *Empetrum* heath on the undulating plateau surfaces. Land surfaces of steeper slope may have Half Bog soils and soil intergradations between Half Bog and Bog soils at the base of the slope. Small areas of local Alluvial soil are common near streams, and Bog soils occur at lake margins and on nearly flat areas of the plateaus. Sand dunes near the coasts and beach sands are considered to be Regosols. Shallow Lithosols develop on rock outcrops, both along the coasts and inland.

The mountain section of Amchitka Island, because of the predominance of rock outcrops and colluvium, contains most Lithosols. Bog and Half Bog soils, however, have developed along some of the high mountain streams and around the tarns of the large amphitheaters. Much of the total area of unconsolidated surficial deposits at high altitudes supports litle or no vegetation because of instability produced from steepness of slope and frost action; these deposits cannot be considered to be soil.

[1] (B) and B horizons are defined (Ball, 1967, p. 121) as, "Horizons lying between A horizons and the parent material C horizons, which show weathering and release of iron oxides without their transportation, (B); or which are horizons of deposition of transported sesquioxides and/or clay, B."

The surficial material on the high plateaus, owing to less relief, has greater stability than that on the mountain section, and large areas of sparse vegetation occur on the Lithosol of the rock fields. Interrupted vegetation mats, in which *Empetrum*, *Vaccinium*, and *Salix* predominate, develop a thin organic soil in and under them, but the profile of this soil has little in common with that of the Tundra soils at lower altitudes.

The author did not observe permafrost in any section of Amchitka Island. Kellogg and Nygard (1951, p. 11, 135) stated that there is none in the Aleutian Islands. However, local areas of perennially frozen ground possibly occur under the late-melting snow beds in the mountains of Amchitka Island, and Lithosols at the margins of permanent snowfields on some of the higher Aleutian Islands are probably underlain by frozen ground.

All soil profiles of the low plateaus of Amchitka Island examined in the present study contained an ash layer 1–1.5 cm thick in the upper part of the B horizon and two ash layers of about the same thickness in the lower part of the B horizon. A soil profile on Tanaga Island, about 115 miles east of Amchitka Island, was reported by Anderson and Bank (1952, p. 84) to have somewhat similar, but more numerous, ash layers. There have been no volcanoes on Amchitka Island since the present soil was formed, but recently active volcanoes on other islands in this region may have produced this ash. Powers (1958, p. 67) reported the activity of Cerberus Volcano on Semisopochnoi Island, which is about 40 miles north of Amchitka Island, as follows: 1772, smoke; 1790–92, smoke; 1830, smoke; 1873, active. He referred to smoke as "a word used in records; it refers to steam or steam-and-ash clouds." Therefore, it is possible that the ash deposits on Amchitka Island came from the Semisopochnoi Volcano or from volcanoes on other islands nearby. Powers (1958, p. 67) reported for Little Sitkin Island, "1776, active; 1828, smoke;" and for Segula and Kiska Islands, "steaming intermittent."

A trench that was dug through a peaty soil deposit of the *Empetrum* heath on Amchitka Island in 1965 exposed three ash layers in the profile. This trench was examined again in July 1967; a moss, *Pogonatum urnigerum*, had colonized only the ash layers. The peat part of the profile bore no mosses or other vegetation; therefore, the growth of the moss on the ash made the ash layers very conspicuous (fig. 2). The "preference" of this moss for a mineral soil was known from other observations, but only rarely is such a specific requirement for a particular substrate demonstrated so clearly.

Ash layers in the profile described above contained preserved stems of sedge and *Empetrum*. These stems were removed from the peat and ash matrix; radiocar-

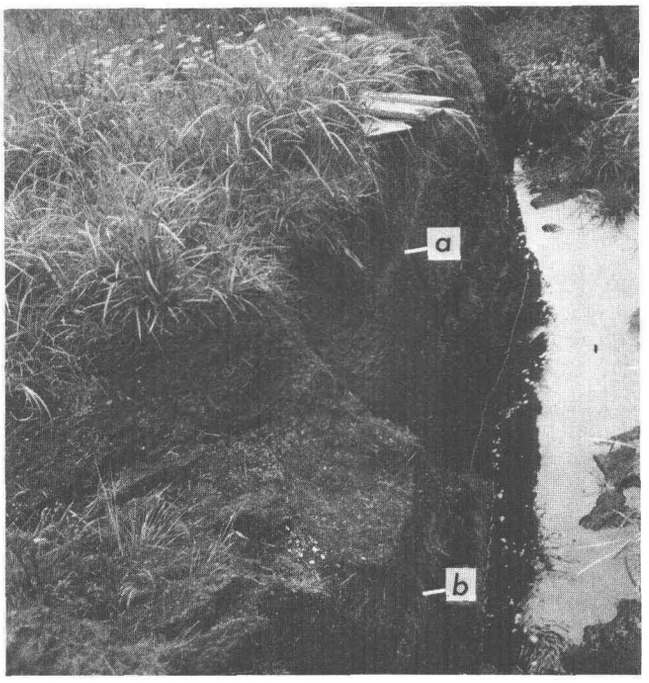

FIGURE 2.—Section of a peat deposit with an upper (*a*) and two lower (*b*) ash layers that are marked by a thick growth of the moss *Pogonatum urnigerum*. Timber (2 in. × 4 in.) in upper center provides scale. No other plants grew on the vertical bank, which was formed by excavation approximately 2 years before this photograph was made on July 28, 1967.

bon dates of samples from the top, middle, and lower ash layers were 750±250 years, 1,950±250 years, and 1,740±250 years B.P. (before present), respectively. The middle and lower ash layers were so close together, and the stems in them were so intermixed, that satisfactory separation of the stems was not possible. The dates of these stem samples, therefore, were averaged as 1,845 years B.P. (Shacklette and Rubin, 1969).

Although mechanical properties of soils related to engineering operations have been studied on Amchitka Island, results have not been published. Such studies, because of the broad definition of soil that is used, have but little relevance to ecological investigations.

An evaluation of the soils of this island as media for the support of native plants is best made by observing the vegetation that grows on the soils. From this standpoint, the soils appear to be fertile, because most land surfaces—especially those of the low plateaus—are covered with dense mats of vegetation. This dense plant growth, however, does not indicate that the soils meet the requirements for optimum growth of most plant species that are present, nor does it indicate that the soils are fertile, as judged by agricultural standards. The effects of a soil that is more fertile than the average soil on the island can be seen by the vigorous growth of many plant species on bird-perch mounds, calcareous dunes, kitchen middens, barabara sites, and recently formed soil banks (fig. 3). The Amchitka Island soils, if compared with agricultural soils or with the soils of most temperate-zone plant communities, are low in nutrient elements, especially calcium, phosphorus, and nitrogen.

Kellogg and Nygard (1951, p. 41) gave a chemical analysis of a soil sample from Amchitka Island and wrote, "The data * * * show a high exchange capacity but a very low base saturation. The magnesium is low, but very high in relation to calcium. Available phosphorus is exceedingly low." They (1951, p. 43, 116) reported the following phosphorus content, in parts per million, of samples from this island:

Ash of a sedge-grass sample	24
Soil samples [presumably not ashed]:	
A_{10} horizon	12
A_{11} horizon	2
B to C horizons [4 samples]	0

A similar trend in calcium and potassium content of soils and plants from Amchitka Island was reported by Kellogg and Nygard. They also reported a carbon-nitrogen ratio (1951, p. 14) of 15 to 1 in the A_1 soil horizon, as compared with that of 26 to 1 in the B_2 horizon, which suggests the formation of peat in place accompanied by a loss of nitrogen by leaching.

FIGURE 3.—Effects of soil fertility on the growth of the grass *Calamagrostis nutkaënsis*. Soil banks had been formed in digging-in a pyramidal tent; later a latrine was located on this tent site and was closed February 4, 1944. The grass is least vigorous on the thin rocky soil in the foreground, more vigorous on the soil banks, and most vigorous on the latrine site, where the grass tussocks are about 1 meter high. Photographed February 16, 1968

Soil profile samples were collected from an *Empetrum* heath on Amchitka Island by Shacklette on August 13, 1965. Descriptions of these samples, which were taken at 4.5-cm intervals of a soil profile 0.5 m (meter) thick; their percentages of ash; and their chemical contents, expressed as percent of ash, follow:

Sample description	Ash	Calcium	Potassium	Phosphorus	SO_4 radical
Living heath plants, mixed	5.7	7.5	7.2	2.0	3.6^8
Dead heath plants (A_{00} horizon)	6.2	8.2	2.2	1.6	4.1^2
Peat	11.0	3.8	1.7	.8	3.24
Mucky peat	13.7	3.5	1.7	.9	3.93
Peaty muck	26.7	3.4	1.4	.4	2.14
Muck (including ash layer)	57.2	3.7	1.3	.16	.93
Muck	21.5	2.2	1.1	.6	2.05
Muck (including ash layer)	44.2	3.3	.9	.3	1.33
Muck (including ash layer)	45.0	2.3	1.1	.2	1.17
Muck	31.1	1.7	1.0	.4	1.17
Organic and mineral soil	46.5	2.1	.6	.3	.97

These samples were analyzed by T. F. Harms and C. S. Papp, U.S. Geological Survey, Denver, Colo.

The concentration of these elements in plants is clearly shown by these data, and a greatly abbreviated biogeochemical cycling of these elements is indicated. That is to say, although the supply of these essential nutrients is deficient in the pedosphere as a whole, the amounts that are present are held where they have the greatest beneficial effects on plants—in the upper root zones and in the plants themselves. The trends in nutrient-element concentration in plants and soil horizons shown in the samples just described were supported by those found by analyses of other similar samples.

PLANT HABITATS AND PLANT COMMUNITIES

Plant communities of the Aleutian Islands have been described by Hultén (1933, 1960), Tatewaki and Kobayashi (1934), Walker (1945), and Bank (1951, 1956). These authors, however, almost entirely neglected the bryophytes and lichens in the communities or associations that they established; yet these two groups of cryptogams are very important and, at places, dominant elements of plant communities in the Aleutian Islands. One objective of the present study was to give full consideration to all these groups of plants in describing the vegetation of Amchitka Island; therefore, the ecological units of the former investigators were not adopted in full, although there is a general correspondence of many plant communities described in this paper to those of the earlier writers.

The organization of vegetation that is given in this paper is intended neither to form a hierarchical system nor to establish plant communities as formal taxonomic entities in a phytosociological system. It is, on the other hand, a method of naming groups that are easily recognized in the field to be composed of species that have nonrandom association, although many species, if considered individually, appear to be somewhat randomly distributed throughout one or more types of habitat. Groups of plants that are composed largely of vascular plants, of bryophytes, or of lichens were given equal consideration in establishing the communities. Some communities that are described are much larger than others in a real extent and number of component species. The size of a community is determined largely by the areal extent of habitat factors in particular combinations. Quantitative studies of the compositional elements of a community have not been completed; the present establishment of the communities is subjective to a high degree and is likely to be modified when quantitative data are available.

The vegetation of Amchitka Island can be described conveniently by presenting the species according to their natural occurence in plant communities, then relating these communities to distinct habitats in which they occur. Causal factors in the development of plant communities may be implied in this method of describing the organization of the vegetation, but they are not stated more positively than this investigation warrants. Detailed measurements of physical factors of the habitats are at present almost entirely lacking; likewise, the responses of many plant species to these factors are largely unknown. Within these limitations imposed on ecological interpretations, however, the communities and habitats may be described in such a manner that the kinds of substrates and microclimates essential for the formation of the communities are suggested. At the same time, the occurrence of individual species in only one or in several communities is an indication of their ecological amplitude, whatever their specific requirements and tolerances may be.

Some plant communities are separated by ecotones that are as great in extent as the adjacent communities themselves; hence, the exact delimitations of each community can be made only arbitrarily. An example of communities that have this relationship are the *Empetrum-Carex*-lichen and the *Carex*-lichen meadow communities. Similarly, the latter community may intergrade, through a broad ecotone, with a wet-sedge meadow community.

The vegetation on this island is mainly one layered; there are but few examples of one plant species regularly overtopping another, if a few tall herbs and some of the minute liverworts and mosses are excluded. There are no native trees, and the low shrubs are intertwined with herbs, mosses, and lichens in a manner that allows one, then another, to lie on top of the intricate mat of vegetation. For example, *Empetrum* may overgrow, or be overgrown by, certain mosses and lichens. The pros-

trate willows have leafy stems that may temporarily suppress mosses and lichens, but eventually these stems are completely buried by the moss and lichen mat. In some places, saxicolous mosses and lichens grow over each other.

An adequate description of community dynamics on Amchitka Island must await further study. If phases of succession are believed to be evident, however, they are so stated. The roles of some biotic, edaphic, and microclimatic agents in the establishment and perpetuation of certain communities are strongly indicated by characteristics that can be observed in the field. Likewise, the interaction of species in a community can, at places, be appraised. The interpretations of community dynamics presented in this paper are, however, only provisional.

The names of plant communities have been derived from either their characteristic species or their distinctive site features, according to which terminology is more useful for recognizing the communities in the field. In this paper, usage of the term "characteristic species" agrees in general with that of Oosting (1956, p. 74–75) and of other writers who include in this term the species with a high degree of fidelity (exclusiveness) to a particular community. An estimate of the quantitative characters abundance and cover, however, was also used in some of the more complex communities to select species that are considered to be characteristic of a community, even though their fidelity to the community is low. For example, *Elymus arenarius* subsp. *mollis* var. *mollis* is considered to be a characteristic species of two communities, being dominant in one and codominant with *Ligusticum* and *Anemone* in the other; moreover, it is listed as occurring in several other communities. Similarly, *Empetrum nigrum* subsp. *nigrum* is a characteristic species in two communities and occurs in nine others. To ignore these species as characteristic of some communities because their degree of fidelity is low would not be a realistic use of the word "characteristic" in its less restrictive meaning and would not convey the importance of the species in the community. If quantitative data were available, the importance of species in a community could be more accurately stated than by using the term "characteristic species" in these ecological discussions.

In contrast to the examples given above, some of the species that grow on sea cliffs and in snow beds occur only in a single type of community. They have, therefore, the highest degree of fidelity and, also, are considered to be characteristic species.

Other species that occur in a community also are listed. The species list given for each community is complete only insofar as collected specimens and field notes indicate the presence of the species. An enumeration of all species that occur in some communities would add new names to the list but perhaps would not contribute significantly to a better characterization of the community.

The land habitats of Amchitka Island and the communities of plants that occur in these habitats are outlined as follows:

1. Strand
    a. *Honckenya-Senecio* community
2. Dune
    a. *Poa-Deschampsia-Festuca* community
    b. *Elymus* community
    c. *Rhacomitrium-Schistidium-Ulota* community
3. Sea cliff
    a. *Eurhynchium-Puccinellia-Caloplaca* community
    b. *Potentillea-Draba-Saxifraga* community
    c. *Xanthoria-Ramalina* community
    d. *Elymus-Ligusticum-Anemone* community
4. *Empetrum* heath
    a. *Empetrum–Carex*-lichen community
    b. *Cladonia-Carex* meadow community
    c. Moss mound community
    d. Organic bird-perch mound community
    e. Streamside community
    f. Peat-bank community
    g. Frost-scar community
5. Bog
    a. *Sphagnum* bog community
    b. *Philonotis-Parnassia* community
    c. *Scapania-Nardia-Marsupella* community
6. Marsh
    a. Wet sedge-meadow community
    b. *Caltha-Claytonia* community
7. Lake
    a. *Hippuris-Ranunculus* community
    b. *Isoëtes-Ranunculus-Limosella* community
8. Pool
    a. *Juncus-Eriophorum* community
    b. *Subularia-Callitriche* community
    c. *Siphula-Scapania* community
9. Stream
    a. *Fontinalis-Ranunculus* community
10. Ruderal
    a. *Calamagrostis* community
    b. *Lupinus-Arnica* community
    c. *Equisetum-Sagina-Ceratodon* community
11. Discontinuous heath
    a. *Salix-Empetrum* community
    b. *Andreaea-Schistidium-Rhacomitrium* community
12. Solifluction
    a. Fell-field community
    b. Solifluction terrace community
13. Alpine meadow
    a. Snow-bed community
    b. Alpine meadow community
14. Inland bedrock
    a. Low-altitude bedrock community
    b. High-altitude bedrock community

15. Miscellaneous habitats, substrates, and communities
    a. Carcasses
    b. Imported wood
    c. Plantings
    d. Burned areas

The most recent classification of vegetation on a worldwide basis is that of Fosberg (1967), who devised a system for use in coding vegetation of terrestrial biological communities that may be proposed for conservation in the International Biological Program. This system uses a combination of vegetational features that may be grouped under "structure" (the arrangement in space of the components of vegetation), and "function" (features that suggest special adaptation to past or present environmental situations), and relies on "composition" (the species comprising the vegetation) only for the lowest categories. In this system, vegetation is first classified in one of three "Primary Structural Groups"—closed, open, and sparse or desert.

I have constructed an outline of classification, based on Fosberg's system, for the plant communities of Amchitka Island that eliminates the categories of vegetation that do not occur on this island. Fosberg's system, as presently organized, does not permit all plant communities of this island to be fully classified to Formation or Subformation. The outline that follows classifies these communities only insofar as is possible without devising new categories.

PRIMARY STRUCTURAL GROUP 1

[Closed vegetation (crowns or peripheries of plants touching or overlapping)]

CLASS 1C. Dwarf scrub (closed predominantly woody vegetation less than 0.5 m high).
GROUP 1C1. Evergreen dwarf scrub.
FORMATION 1C12. Evergreen broad sclerophyll dwarf scrub.
SUBFORMATION 1C12c. Microphyllous evergreen dwarf scrub.
Community: *Empetrum-Carex*-lichen.
GROUP 1C2. Deciduous dwarf scrub.
FORMATION 1C21. Deciduous orthophyll dwarf scrub.
SUBFORMATION 1C21a. Deciduous orthophyll dwarf scrub.
Community: *Salix-Empetrum.*

CLASS 1L. Tall grass (closed herbaceous vegetation more than 1 m high, predominantly graminoid).
GROUP 1L2. Seasonal tall grass (turning brown in winter).
FORMATION 1L21. Seasonal orthophyll tall grass.
Communities: *Elymus-Ligusticum-Anemone; Elymus.*

CLASS 1M. Short grass (closed herbaceous vegetation, less than 1 m high, predominantly graminoid).
GROUP 1M2. Seasonal short grass.
Community: Organic bird-perch mound.
FORMATION 1M21. Seasonal orthophyll short-grass meadows.
Communities: *Poa-Deschampsia-Festuca;* wet sedge meadow; *Calamagrostis.*
FORMATION 1M22. Seasonal orthophyll marsh.
Community: *Juncus-Eriophorum.*

CLASS 1N. Broad-leafed herbaceous vegetation (closed vegetation predominantly of broad-leafed herbaceous plants).
GROUP 1N2. Seasonal broad-leafed herbaceous vegetation.
Community: *Honckenya-Senecio.*
FORMATION 1N21. Seasonal broad-leafed herbaceous vegetation.
Communities: Streamside; *Caltha-Claytonia;* alpine meadow; low-altitude bedrock.

CLASS 1O. Closed bryoid vegetation.
GROUP 1O1. Closed bryophyte vegetation.
Communities: Moss mound; peat bank; *Scapania-Nardia-Marsupella.*
FORMATION 1O11. *Sphagnum* bog.
Community: *Sphagnum* bog.
FORMATION 1O12. Moss meadow.
Communities: *Philonotis-Parnassia;* snow bed.
GROUP 1O2. Closed lichen vegetation.
FORMATION 1O21. Lichen bog.
Community: *Siphula-Scapania.*
FORMATION 1O22. Lichen meadow.
Community: *Cladonia-Carex* meadow.

CLASS 1P. Submerged meadows (vegetation of rooted aquatic herbs).
GROUP 1P1. Evergreen submerged meadows.
Community: *Subularia-Callitriche.*
FORMATION 1P11. Evergreen watergrass.
Communities: *Isoëtes-Ranunculus-Limosella; Fontinalis-Ranunculus.*
GROUP 1P2. Seasonal submerged meadows (plants, at least their shoots, disappearing in winter).
FORMATION 1P21. Seasonal watergrass.
Community: *Hippuris-Ranunculus.*

PRIMARY STRUCTURAL GROUP 2

[Open vegetation (plants or tufts of plants not touching, but crowns not separated by more than their diameters; plants, not substratum, dominating the landscape)]

CLASS 2G. Steppe (open herbaceous vegetation, tufts or plants discrete, yet close enough to dominate the landscape).
GROUP 2G2. Seasonal steppe.
Communities: *Potentilla-Draba-Saxifraga; Equisetum-Sagina-Ceratodon.*

CLASS 2H. Bryoid steppe.
GROUP 2H2. Open lichen vegetation.
Community: *Xanthorea-Ramalina.*

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PRIMARY STRUCTURAL GROUP 3

[Sparse vegetation or desert (plants so scattered that substratum dominates landscape)]

CLASS 3B. Desert scrub (scattered shrubs in an otherwise bare or only ephemerally vegetated landscape).
GROUP 3B1. Evergreen desert scrub.
Community: Fell-field.
CLASS 3C. Desert herbaceous vegetation (scattered herbaceous plants only).
GROUP 3C1. Evergreen desert herbaceous vegetation.
Communities: *Eurhynchium-Puccinellia-Caloplaca; Andreaea-Schistidium-Rhacomitrium;* high-altitude bedrock.
FORMATION 3C12. Evergreen psammophyte desert.
Community: *Rhacomitrium-Schistidium-Ulota.*
FORMATION 3C13. Lichen tundra sparse phases.
Community: Solifluction terrace.

The occurrence of most species in the communities was determined by collecting specimens in the field. Some of the easily recognized species were, however, included in the community descriptions on the basis of sight records. In both the community descriptions that follow and the annotated check lists of species, the communities are designated by letters and the habitats by numbers; therefore, the communities and habitats in which each species was found can easily be determined. The community name is followed by the community classification according to the system of Fosberg (1967).

The great soil group, or groups, and the soil classification, according to the system of Ball (1967) of the substrate on which the community occurred, follow the community classification. The approximate pH value, or range in values, is given for the substrates of most communities. The pH of the water in which aquatic or semiaquatic communities occur also is provided. These values were determined for soils by making a slurry, or extract, consisting of two parts, by volume, neutral water and one part soil or other substrate and by measuring pH with a potentiometer. The pH of water was measured directly with the same instrument. These tests were performed at base camp soon after the samples were collected.

The photographs of habitats and communities were made by Shacklette, except as noted.

1. STRAND HABITAT

Occurs around the island wherever a shoreline bench bears a deposit of sand, pebbles, or cobbles. The presence of abundant driftwood in this habitat indicates that this habitat is inundated by sea water from time to time.

a. *Honckenya-Senecio* community (1N2).

Soil: Regosol; type P_2; pH, 6.8–7.0. This community forms a distinct zone of dense vegetation near sea level (fig. 4). The Senecio may be as much as 15 dm (decimeters) high at places and so closely spaced that passage through the community is difficult. Stands of *Lathyrus* occur on sand banks of the beach, and scattered plants of *Galium* commonly grow in the piles of driftwood.

Characteristic species: *Honckenya peploides* subsp. *major* and *Senecio pseudo-arnica.*

Other species: *Cerastium fischerianum, Ceratodon purpureus, Claytonia sibirica, Cratoneuron filicinum, Eurhynchium praelongum, Galium aparine, G. trifidum* subsp. *columbianum, Heracleum lanatum, Juncus arcticus* subsp. *sitchensis, Lathyrus maritimus* subsp. *pubescens, Mertensia maritima, Peltigera spuria, Rumex obtusifolius, Sagina occidentalis,* and *Stellaria calycantha* subsp. *calycantha.*

2. DUNE HABITAT

This habitat type designates sandy and pebbly deposits that occur most commonly on top of seacoast bluffs that are from 25 to 100 feet above sea level, where the sand is moved by wind.

a. *Poa-Deschampsia-Festuca* community (1M21).

Soil: Regosol; type P_2; pH, 6.7—6.8. On elevated beach deposits of sand and shells that are 100 to

FIGURE 4.—Zonation of *Honckenya* (nearest the bare beach) and *Senecio at* Makarius Bay. Photographed June 17, 1967.

200 feet above the present sea level. Calcium derived from the shells probably favors the development of this community that is composed almost entirely of grasses and *Equisetum*.

Characteristic species: *Poa eminens*, *Deschampsia beringensis*, and *Festuca rubra* subsp. *aucta*.

Other species: *Agrostis exarata*, *Bromus sitchensis* var. *aleutensis*, *Elymus arenarius* subsp. *mollis*, *Equisetum arvense*, and *Poa lanata*.

b. *Elymus* community (1L21).

Soil: Regosol; type I_2 pH, 6.6–7.0. On dunes composed of dark-colored sand derived from volcanic rocks (fig. 5).

Characteristic species: *Elymus arenaris* subsp. *mollis* var. *mollis*. This community is dominated by a dense growth of this grass which at places forms tussocks that are as much as 12 dm high and are separated from each other a distance of 14–30 cm. Inasmuch as the distinct tussocks occur on steep slopes, soil slippage probably causes their separation. This community may extend to the sandy beaches and dominate the old beach terraces, as is shown in figure 5; more commonly, however, it occupies dunes at slightly higher altitudes.

Other species: Bryophytes that are able to grow on the almost bare soil between the grass tussocks include *Antitrichia curtipendula*, *Bryum pseudotriquetrum*, *Cephaloziella arctica*, *Ceratodon purpureus*, *Eurhynchium praelongum*, *Lophocolea cuspidata*, *Nardia scalaris*, *Plagiothecium roeseanum*, *Pogonatum urnigerum*, *Pohla cruda*, *Rhytidiadelphus squarrosus*, and *Tortula mucronifolia*. The flowering plants *Claytonia sibirica*, *Geum macrophyllum* subsp. *macrophyllum*, and *Heracleum lanatum* are sparsely scattered among the tussocks. The lichens *Caloplaca* sp. and *Peltigera canina* were found on moss-covered driftwood in this community.

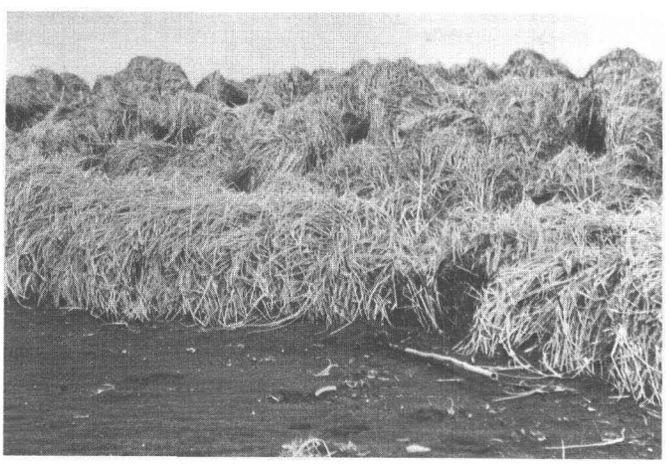

FIGURE 5.—Sand dune with cover of *Elymus* community at the seashore, Rifle Range Point. Grass clumps (at top) are about 3 feet high. Photographed February 17, 1968.

c. *Rhacomitrium-Schistidium-Ulota* community (3C12).

Soil: Regosol; type I_2; pH, 6.8–6.9. On dunes composed of dark-colored sand, pebbles, and cobble. *Rhacomitrium* and *Ulota* grow on the cobbles and pebbles, and *Schistidium* grows on the sand. This community and its unattached moss polsters of *Schistidium* were described and illustrated by Shacklette (1966).

Characteristic species: *Rhacomitrium lanuginosum*, *Schistidium apocarpum*, and *Ulota phyllantha*.

Other species: *Andreaea rupestris*, *Brachythecium albicans*, *Ceratodon purpureus*, *Drepanocladus uncinatus*, *Lecanora atra*, *L. aleutica*, *Lecidea macrocarpa*, *Ligusticum scoticum* subsp. *hultenii*, *Pogonatum urnigerum*, *Rhacomitrium fasciculare*, *R. ericoides*, *Stereocaulon alpinum*, *Tortula mucronifolia* and *Umbilicaria proboscidea*.

3. SEA-CLIFF HABITAT

The island is almost completely bordered with precipitous sea cliffs of andesite, breccia, and other igneous rocks. At a few locations on the southeast end of the island, the cliffs are composed of sedimentary deposits that give but little support for plants. The cliffs range in height from only a few feet to at least 100 feet above sea level on the central and southeastern parts of the island; commonly, they are higher on the northwestern shores. Plant communities on these cliffs are subjected to waves and spray of sea water and have but little protection from the strong winds (fig. 6). The cliffs are partly covered with ice from time to time during the winter months.

a. *Eurhynchium-Puccilennia-Caloplaca* community (3C1).

Very little, or no, soil present. Occurs on beach boulders, rock pinnacles, and on cliff faces to the cliff summits (fig. 7). The characteristic species of this community have great tolerance to salt water, and the moss and the grass are nitrophilous in that they grow very luxuriant where manured by birds.

Characteristic species: *Eurhynchium praelongum*, *Puccinellia langeana* subsp. *alaskana*, and *Caloplaca granulosa*.

Other species: *Blastenia* sp., *Bryoerythrophyllum recurvirostrum*, *Buellia punctata*, *Draba hy-*

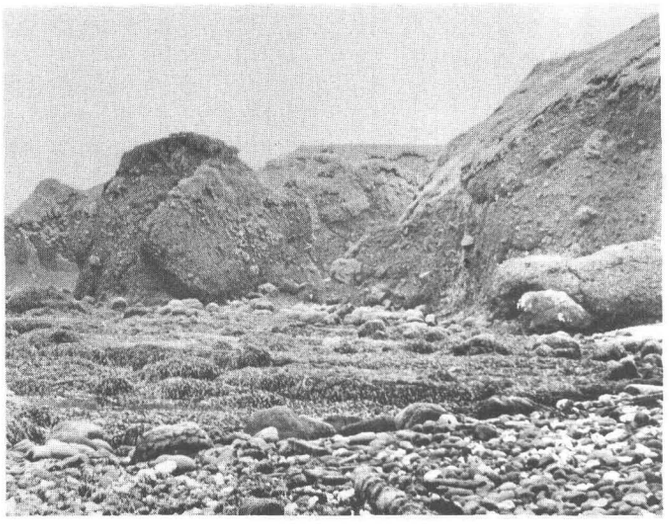

FIGURE 6.—Sea-cliff habitat on the Pacific Ocean coast at Makarius Bay. Dense growths of marine algae cover the rocks of the intertidal zone. The *Elymus-Ligusticum-Anemone* community covers the upper slopes and summits of the cliffs. Photographed June 17, 1967.

perborea, *Lecanora aleutica*, *L. straminea*, *Physcia caesia*, *Potentilla villosa*, *Schistidium maritimum*, *Ulota phyllantha*, *Verrucaria maura*, *Xanthoria candelaria*, and *X. elegans*.

b. *Potentilla-Draba-Saxifraga* community (2G2).

Soil: Lithosol, in rock crevices; type I_2; pH, ≈ 7.0. Occurs on the vertical cliff faces and rock pinnacles from about 10 feet above the beach, or sea level, to the tops of the cliffs. The vascular plants are rooted in rock crevices, and the bryophytes most commonly occur under shallow shelves of the cliff faces (figs. 6, 7).

Characteristic species: *Potentilla villosa*, *Draba hyperborea*, and *Saxifraga bracteata*.

Other species: *Amphidium lapponicum*, *Barbula cylindrica*, *Bartramia ithyphylla*, *Bryum lapponicum*, *B. stentotrichum*, *Cardamine umbellata*, *Cephaloziella arctica*, *Claytonia sibirica*, *Cochlearia officinalis* subsp. *oblongifolia*, *Cratoneuron filicinum*, *Cystopteris fragilis* subsp. *fragilis*, *Eurhynchium praelongum*, *Lophocolea cuspidata*, *Luzula tundricola*, *Marchantia polymorpha*, *Mielichhoferia macrocarpa*, *Montia fontana* subsp. *fontana*, *Platydictya jungermannioides*, *Plantago maritima* subsp. *juncoides*, *Pohlia cruda*, *Pottia heimii*, *Rhacomitrium fasciculare*, *Sagina crassicaulis*, *Schistidium maritimum*, *Taraxacum trigonolobum*, *Tortula mucronifolia*, and *Ulota phyllantha*.

c. *Xanthoria-Ramolina community* (2H2).

Soil: Lithosol, or rock surfaces; type I_2. Occurs principally near the summits of high cliffs and on "sea stacks" offshore. *Xanthoria* appears to require fertilization by birds, and *Ramalina* grows only where there is free air movement; both requirements commonly are met on cliff summits (fig. 7).

Characteristic species: *Xanthorea candelaria*, *Ramalina scoparia*, and *R. almquistii*.

Other species: *Amblystegium serpens*, *Cardamine umbellata*, *Caloplaca granulosa*, *Cystopteris fragilis* subsp. *fragilis*, *Eurhynchium praelongum*, *Ochrolechia frigida*, *Parmelia saxatilis*, *P. sul-*

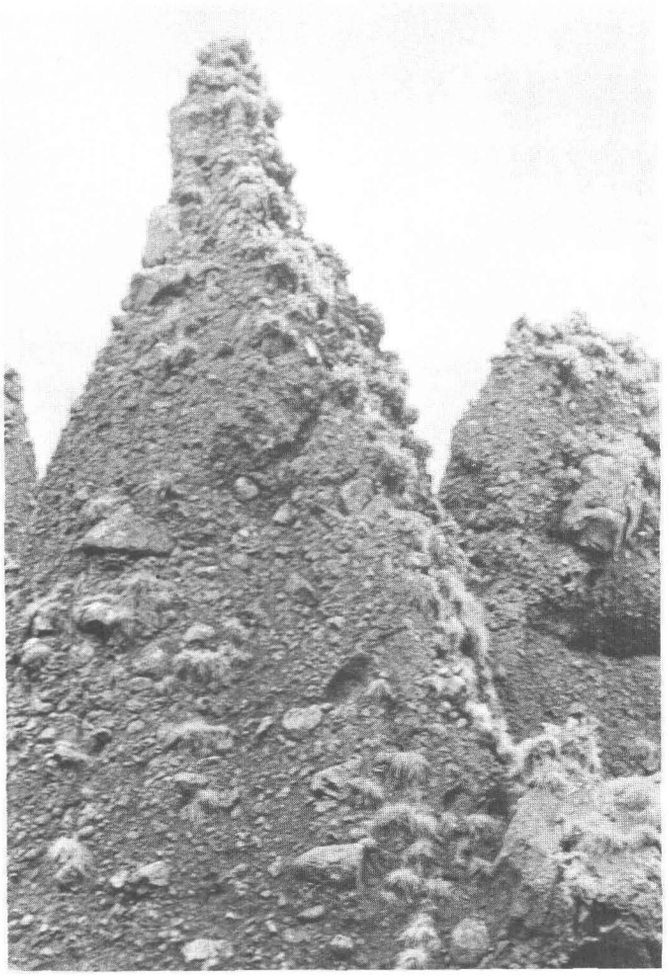

FIGURE 7.—Rock pinnacles ("sea stacks"), Makarius Bay. *Xanthorea-Ramalina* community is on and near the summit, the *Potentilla-Draba-Saxifraga* community is near the middle, and the *Eurhynchium-Puccinellia-Caloplaca* community is near the base of the higher pinnacle. Grass clumps (foreground) are about 6 inches high. Photographed June 17, 1967.

cata, *Potentilla villosa*, *Physcia caesia*, *P. dubia*, *Schistidium maritimum*, and *Ulota phyllantha*.

d. *Elymus-Ligusticum-Anemone* community (1L21).

Soil: Lithosol, and tundra without permafrost; type F_4; pH, 6.4–6.6. On sloping faces of the less steep cliffs, and at the brink of vertical cliffs (fig. 6). The soil generally is highly organic but at places may be sandy or rocky. This community is dominant also on large flat-topped sea stacks around the island, where *Elymus* commonly is more abundant than either *Anemone* or *Ligusticum*.

Chacteristic species: *Elymus arenarius* subsp. *mollis* var. *mollis*, *Ligusticum scoticum* subsp. *hultenii*, and *Anemone narcissiflora* subsp. *villosissima*.

Other species: *Agrostis alaskana*, *Amblystegium serpens*, *Athyrium filix-femina* subsp. *cyclosorum*, *Bryum stenotrichum*, *Calamagrostis nutkaënsis*, *Conioselinum chinense*, *Dactylorhiza aristata*, *Eurhynchium praelongum*, *Festuca rubra*, *Hierochloë odorata*, *Leptobryum pyriforme*, *Ochrolechia frigida*, *Plantago maritima* subsp. *juncoides*, *Ranunculus occidentalis* subsp. *insularis*, *Salix arctica* subsp. *crassijulis*, and *Viola langsdorffi*.

4. EMPETRUM HEATH HABITAT

The undulated surfaces of the old elevated marine platforms that occur on the southeastern third of the island are covered with a heath composed largely of *Empetrum*, with sedges, grasses, lichens, and mosses occurring in various proportions. This habitat occurs also in low-lying valleys in the mountainous part of the island, and near Aleut Point, at altitudes ranging from about 100 to 600 feet above sea level. The plant communities at places are very complex in composition and structure, commonly having broad ecotones and many interruptions (fig. 8).

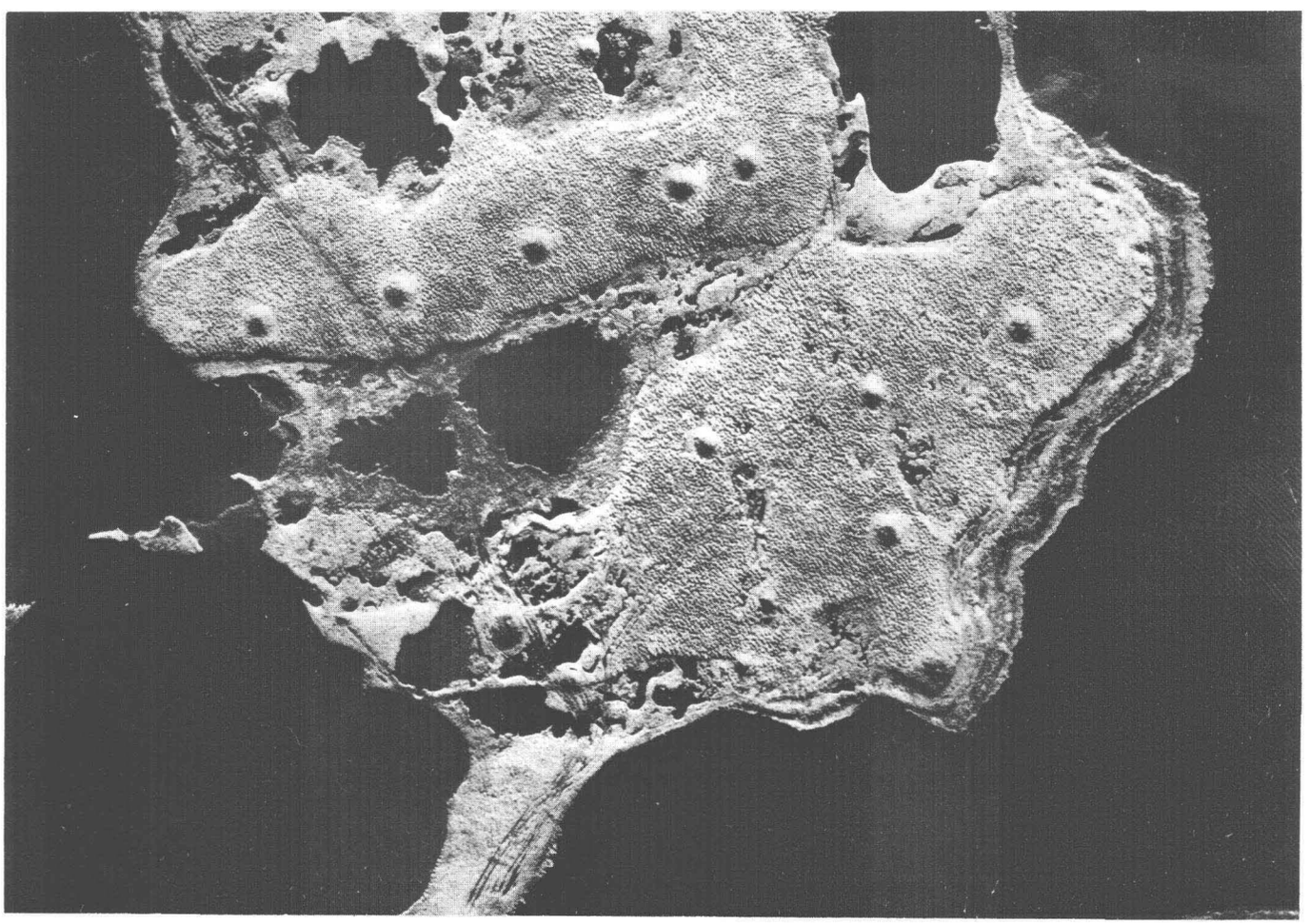

FIGURE 8.—Aerial photograph of the *Empetrum* heath in an area of many lakes, with the *Empetrum-Carex*-lichen community predominating. A wet sedge-meadow community surrounds the two small lakes in left center. At least 14 well-developed moss mounds are shown. The trail of a tracked military vehicle is clearly visible in the upper left, although it was made at least 20 years ago. The area shown here is on the low plateau about midway between Rifle Range Point and Crown Reefer Point. Large moss mounds are about 25 feet in diameter. Photographed October 20, 1965, by the U.S. Air Force.

a. *Empetrum-Carex*-lichen community (1C12c).

Soil: Tundra without permafrost; type O; pH, 5.9–6.0. This community is characteristic of the summits and slopes of the low ridges and commonly is hummocky and interdigitated with ecotonal variants and interrupted by pools and lakes. At the upper altitudinal limit, the continuity of the community is broken by areas of virtually bare pebbly ground. In the more hummocky areas, dense stands of *Cladonia pacifica* occupy the depressions that surround the hummocks composed of *Empetrum*, *Carex*, and *Sphaerophorus* (fig. 9). At other places, *Empetrum*, several species of pleurocarpous mosses, and lichens form a dense mat of vegetation that is fairly smooth and has few surface depressions. Herbaceous flowering plants and *Lycopodium* are scattered throughout this community, but they rarely form dense stands. Commonly, the substrate is a fibrous peat, ranging in thickness from a few centimeters to at least 6 dm, which overlies fragmented andesite and breccia bedrock, or, at places, deposits that resemble till, colluvium, or old beach gravel. A thin (2–6 cm) layer of bluish-gray to grayish-brown mineral soil generally occurs on these rock substrates. The organic mat and the underlying peat and muck are nearly saturated with water throughout the year, even during the infrequent days in summer when the surface vegetation is dry and crisp.

FIGURE 9.—Hummocky *Empetrum-Carex*-lichen community in the vicinity of Cyril Cove. The light snow cover emphasizes the irregularity of the surface. Photographed December 2, 1965.

Characteristic species: *Empetrum nigrum* subsp. *nigrum*, *Carex pluriflora*, *C. macrochaeta*, *Cladonia pacifica*, and *Sphaerophorus globosus*.

Other species: *Alectoria ochroleuca*, *Anemone narcissiflora* subsp. *villosissima*, *Antitrichia curtipendula*, *Arnica unalaschcensis*, *Aulacomnium palustre*, *Brachythecium acutum*, *B. asperrimum*, *Calamagrostis nutkaënsis*, *Calypogeia sphagnicola*, *Campanula lasiocarpa* subsp. *lasiocarpa*, *Cardamine umbellata*, *Carex anthoxanthea*, *C. dioica* subsp. *gynocrates*, *C. lyngbyaei*, *C. stylosa*, *Cassiope lycopodioides*, *Chrysanthemum arcticum* subsp. *arcticum*, *Cladonia bellidiflora*, *C. coccifera*, *C. gracilis*, *Coptis trifolia*, *Cornicularia divergens*, *Cornus suecica*, *Dicranum elongatum*, *D. groenlandicum*, *D. howellii*, *Elymus arenarius* subsp. *mollis* var. *mollis*, *Equisetum arvense*, *Erigeron peregrinus* subsp. *peregrinus*, *Eurhynchium praelongum*, *Festuca brachyphylla*, *F. rubra*, *F. rubra* subsp. *aucta*, *Galium trifidum* subsp. *columbianum*, *Geum calthifolium*, *Hylocomium splendens*, *Hypnum dieckii*, *Linnaea borealis* subsp. *borealis*, *Listera cordata* var. *nephrophylla*, *Lobaria linita*, *Loiseleuria procumbens*, *Lophozia* cf. *groenlandica*, *Luzula multiflora* subsp. *multiflora* var. *frigida*, *Lycopodium annotinum* subsp. *annotinum*, *L. clavatum* subsp. *clavatum*, *L. selago* subsp. *selago*, *Microlepidozia makinoana*, *Mnium glabrescens*, *Mycoblastus alpinus*, *Mylia taylori*, *Ochrolechia frigida*, *Orthocaulis binsteadii*, *Pedicularis chamissonis*, *Peltigera canina*, *P. malacea*, *Phleum commutatum* var. *americanum*, *Plagiothecium undulatum*, *Platanthera chorisiana*, *P. convallariaefolia*, *P. dilatata*, *Pleurozium schreberi*, *Pogonatum alpinum*, *Polygonum viviparum*, *Primula cuneifolia* subsp. *saxifragifolia*, *Ptilium crista-castrensis*, *Pyrola asarifolia* var. *purpurea*, *Rhacomitrium lanuginosum*, *Rhytidiadelphus loreus*, *R. triquetrus*, *Rubus arcticus* subsp. *stellatus*, *R. chamaemorus*, *Salix arctica* subsp. *crassijulis*, *S. cyclophylla*, *Saxifraga punctata* subsp. *insularis*, *Sphagnum capillaceum*, *S. subsecundum*, *Sphenolobus saccatulus*, *Thamnolia vermicularis*, *Tofieldia coccinea*, *Trientalis europaea* subsp. *arctica*, *Vaccinium vitis-idaea*, *Vahlodea atropurpurea* subsp. *latifolia*, *Veronica stelleri*, and *Viola langsdorffii*.

b. *Cladonia-Carex* meadow community (1O22).

Soil: Tundra without permafrost; type O; pH, 5.1–6.5. This community generally occurs adjacent to the *Empetrum-Carex*-lichen community, and the two communities merge in a narrow to wide eco-

tone. The chief distinctions of the *Cladonia-Carex* meadow community from the adjacent community are its location on the more level areas or lower parts of gentle slopes, the less prominent role of *Empetrum*, and greater abundance of *Carex lyngbyaei*. In general, forbs are more plentiful, and the vegetation mat is wetter in this community than in the *Empetrum-Carex*-lichen community (fig. 10, 11).

Characteristic species: *Cladonia pacifica*, *Carex lyngbyaei*, and *C. macrochaeta*.

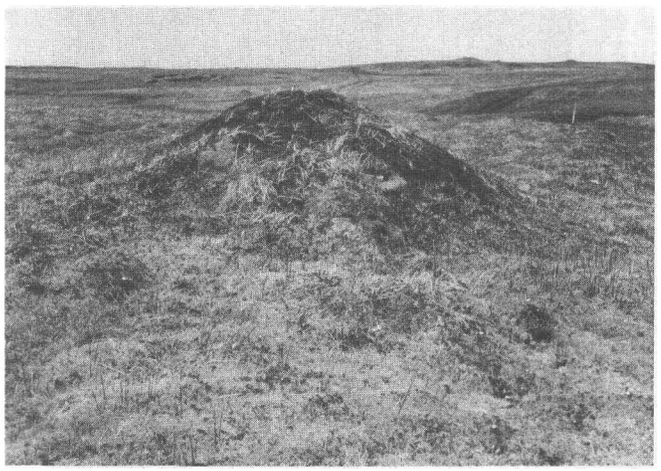

FIGURE 10.—Well-developed moss mound in a *Cladonia-Carex* meadow near Cyril Cove. Mound is about 5 feet high. Photographed June 10, 1967.

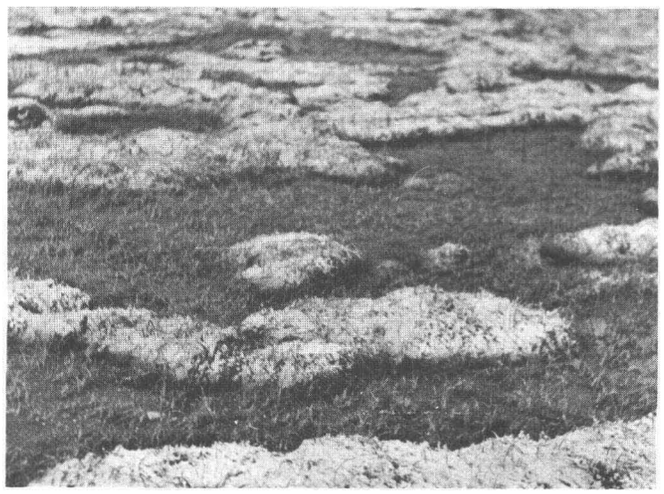

FIGURE 11.—Ecotone of an *Empetrum-Carex*-lichen community (irregular patches of snow-covered vegetation) and a *Cladonia-Carex* meadow, near Cyril Cove. Contrast between the two communities was enhanced by a light snowfall, the snow having melted on the wetter, *Cladonia-Carex* meadow. Strip of snow-covered vegetation (center foreground) is about 18 inches wide. Photographed December 7, 1965.

Other species: *Brachythecium asperrimum*, *Calamagrostis nutkaënsis*, *Calypogeia trichomanis*, *Cardamine umbellata*, *Carex anthoxanthea*, *Ceratodon purpureus*, *Claytonia sibirica*, *Deschampsia beringensis*, *Diplophyllum albicans*, *Drepanocladus revolvens*, *Empetrum nigrum* subsp. *nigrum*, *Eriophorum russeolum* subsp. *rufescens*, *Festuca brachyphylla*, *Gymnocolea inflata*, *Juncus triglumis* subsp. *albescens*, *Lophozia* cf. *groenlandica*, *Lycopodium annotinum* subsp. *annotinum*, *Mylia taylori*, *Oncophorus wahlenbergii*, *Orthocaulis binsteadii*, *Petasites frigidus*, *Pinguicula vulgaris* subsp. *macroceras*, *Platanthera convallariaefolia*, *P. dilatata*, *Pogonatum alpinum*, *Scapania irrigua*, *S. paludosa*, *Trichophorum caespitosum*, and *Viola langsdorffii*.

c. Moss mound community (1O1).

Conical mounds covered with vegetation are characteristic of many of the central and western Aleutian Islands. These mounds were first reported by Hultén (1933, p. 17–18); he considered them to be bird-perch mounds caused by the deposition of bird manure. This explanation of their origin was accepted by the following subsequent investigators: Hutchison (1937); Walker (1945); Bank (1951), 1956); and Fraser and Barnett (1959). These mounds were described in more detail in a later publication by Hultén (1960, p. 29–30).

There are two basic types of conical mounds on Amchitka Island—moss mounds (fig. 10) and rock mounds (fig. 33). If either of these mounds is used extensively by birds for perches, the heavy manuring by the birds causes a change in the vegetation of the mound. Many of the original plant species are killed by the manure, and coprophilous species that can thrive in the enriched substrate occupy the mound. Bird-perch mounds are characterized by a dense turf of grass at the summit (figs. 12, 32).

On the low plateaus the thousands of moss mounds are the most conspicuous features of the landscape (figs. 8, 10). The mounds range in size from single polsters of moss 15 to 20 cm high to conical plant communities as much as 2 m high and 10 m in diameter. They are organic throughout and originate from single polsters of vertical-growing mosses. The manuring by birds plays no part in their early development. The plant community on the mounds is largely composed of the same species that grow on the adjacent heath. The substrate, 15 cm below the mound apex, ranges in pH from 5.1 to 6.5.

A well-developed moss mound has a zonal arrangement of plant species that surrounds the apex because certain combinations of species follow in succession up the sides of the mound. The invading plants eventually suppress the vertical-growing mosses at the apex, thus destroying the impetus toward development of the mound, and the mound finally begins to break apart. The zonal arrangement of species in a well-developed moss mound is given below.

Apex of mound: One of the following species ordinarily forms the dominant vegetation—*Rhacomitrium lanuginosum*, *Dicranum elongatum*, *D. groenlandicum*, *D. howellii*, *D. fuscescens*, and *Oncophorus wahlenbergii*. Intermixed with these mosses are a few strands of leafy liverworts, including *Anastrophyllum sphenoloboides*, *Bazzania tricrenata*, *Calypogeia sphagnicola*, *Cephalozia bicuspidata*, *C. leucantha*, *Microlepidozia makinoana*, *Odontoschisma elongatum*, *Orthocaulis binsteadii*, *Riccardia latifrons*, and *Sphenolobus minutus*. Usually, a spreading mat of *Antitrichia curtipendula* eventually grows over the vertical-growing moss of the apex. This moss gives the summit of the mound a conspicuous yellow color and tends to restrict further vertical development of the mound.

Sides of mound: *Calamagrostis nutkaënsis*, *Carex macrochaeta*, *C. pluriflora*, *Cladonia amaurocraea*, *C. arbuscula* subsp. *beringiana*, *C. bellidiflora*, *C. pacifica*, *C. scabriuscula*, *Coptis trifolia*, *Cornicularia divergens*, *Cornus suecica*, *Drepanocladus uncinatus*, *Eurhynchium praelongum*, *Gymnocolea inflata*, *Hylocomium splendens*, *Loiseleuria procumbens*, *Mycoblastus alpinus*, *Mylia taylori*, *Parmelia omphalodes*, *Peltigera aphthosa*, *Pleurozium schreberi*, *Pogonatum alpinum*, *Polytrichum commune*, *P. strictum*, *Ptilidium ciliare*, *Rhytidiadelphus loreus*, *R. triquetrus*, *Rubus arcticus* subsp. *stellatus*, *R. chamaemorus*, *Salix arctica* subsp. *crassijulis*, *Sphaerophorus globosus*, *Tofieldia coccinea*, *Vaccinium vitis-idaea* subsp. *minus*, and *Vahlodea atropurpurea* subsp. *latifolia*.

Base of mound: *Empetrum nigrum* subsp. *nigrum*, *Calamagrostis nutkaënsis*, and *Carex lyngbyaei*.

d. Organic bird-perch mound community (1M2).

Substrate pH, 6.4–6.7. The mounds that support this community (fig. 12) are in the *Empetrum* heath habitat and are organic throughout, in contrast to the bird-perch mounds formed over boulders and the conical projections of bedrock that occur at higher altitudes on Amchitka Island. The vegetation of the two types of mounds is composed of virtually the same species, if the mounds are equally manured. Organic bird-perch mounds are located mostly along the coasts, but because the island is narrow, sea birds at some inland locations have caused these mounds to develop. These mounds originate as moss mounds that are described in 4c; when the mounds reach a certain height (probably about 6 dm) birds may begin to use them as lookout perches. Bird manure favors the growth of coprophilous plants and, at the same time, kills the noncoprophilous species that formerly covered the apex and sides of the moss mound. The vertical-growing mosses and the characteristic *Antitrichia* at the summit are replaced by a dense cylindrical turf composed of a grass species. On mounds where *Dicranum elongatum* forms the apex, however, the moss summit may persist for an unknown length of time, but it becomes abnormally green.

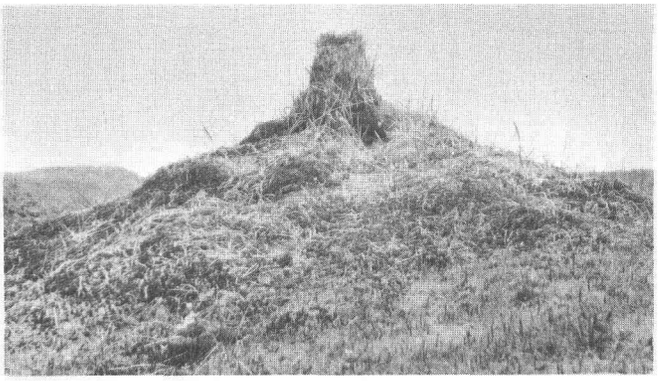

FIGURE 12.—Organic bird-perch mound showing characteristic columnar summit composed of *Poa arctica* subsp. *williamsii*, near White House Cove. The grass on the sides of the mound is mostly *Calamagrostis nutkaënsis*, but a few plants of *Elymus arenarius* subsp. *mollis* var. *mollis* are present. Columnar summit is about 8 inches in diameter. Photographed June 11, 1967.

In time, the influence of the manure extends down the sides of the mound, killing most species of mosses and lichens; these plants are replaced by *Calamagrostis* and several species of forbs. Eventually, the sides of the mound collapse, leaving a cylinder of grass turf 6 to 9 dm high protruding from an irregular, hummocky base (fig. 12). On neighboring Rat Island, foxes were observed to have caused virtually the same transformation of moss mounds, but the fox-mound lookouts do not have cylindrical summits.

Listed below are the species of plants found on these mounds.

Apex of mounds: *Festuca brachyphylla*, *Poa arctica subs. williamsiip Puccinellia langeana*

subsp. *alaskana*, *Rinodina turfacea*, *Cladonia alpestris*, *Eurhynchium praelongum*, and *Dicranum elongatum*.

Sides of mound: *Antitrichia curtipendula*, *Brachythecium albicans*, *Calamagrostis nutkaënsis*, *Cladonia scabriuscula*, *Diplophyllum albicans*, *Drepanocladus uncinatus*, *Elymus arenarius* subsp. *mollis* var. *mollis*, *Eurhynchium praelongum*, *Heracleum lanatum*, *Macrodiplophyllum plicatum*, *Peltigera canina*, *Ranunculus occidentalis* subsp. *insularis*, *Rhacomitrium lanuginosum*, *Rinodina turfacea*, *Sagina crassicaulis*, *Sphaerophorus globosus*, *Ulota phyllantha*, *Xanthoria candelaria*, and some species listed in 4c that have not yet succumbed to the effects of the manure.

Base of mound: *Calamagrostis nutkaënsis*, *Carex lyngbyaei*, *Empetrum nigrum* subsp. *nigrum*, *Icmadophila ericetorum*, *Polypodium vulgare* subsp. *occidentale*, and *Psoroma hypnorum*.

e. Streamside community (1N21).

Soil: Tundra without permafrost and alluvial; type O; pH, 5.0–6.5. The narrow, deeply entrenched streams of gentle slopes and valleys support a distinctive plant community that is especially conspicuous in June, when the bright green of the streamside plants contrasts strongly with the brown tones of the adjacent *Cladonia-Carex* meadows. The vegetation is composed principally of tall forbs and sedges. An understory of lesser forbs, bryophytes, and lichens that are adapted to reduced light grows on the steep stream banks (fig. 13).

Characteristic species: *Athyrium filix-femina* var. *cyclosorum*, *Carex lyngbyaei*, *Heracleum lanatum*, *Geum macrophyllum* subsp. *macrophyllum*, and *Dryopteris dilatata* subsp. *americana*.

Other species: *Brachythecium asperrimum*, *Bryum pallens*, *B. pseudotriquetrum*, *Calliergon sarmentosum*, *Calypogeia trichomanis*, *Campylium stellatum*, *Cardamine umbellata*, *Cephalozia bicuspidata*, *C. media*, *Chiloscyphus pallescens*, *Claopodium crispifolium*, *Climacium dendroides*, *Conioselium chinense*, *Conocephalum conicum*, *Cystopteris fragilis* subsp. *fragilis*, *Dicranum howellii*, *Diplophyllum albicans*, *Eurhynchium praelongum*, *Fritillaria camschatcensis*, *Lecanora castanea*, *Luzula parviflora* subsp. *parviflora*, *Marsupella emarginata*, *Mnium glabrescens*, *M. pseudopunctatum*, *Nardia scalaris*, *Peltigera aphthosa*, *P. canina*, *Petasites frigidus*, *Platydictya jungermannioides*, *Ranunculus occidentalis* subsp. *insularis*, *Riccardia pinguis*, *Saxifraga punctata* subsp. *insularis*, *Scapania paludosa*, *S. undulata*, *Sphagnum girgensohnii*, *S. teres*, and *Streptopus amplexifolius*.

FIGURE 13.—Streamside community near Cyril Cove. The stream has been dammed by the aquatic moss *Fontinalis;* the small pool above the dam is about 45 cm deep. *Streptopus amplexifolius* is just beginning to grow on the top of the dam. The vegetation on the streambanks includes *Carex lyngbyaci*, *Heracleum lanatum*, *Ranuculus occidentalis* subsp. *insularis*, and *Athyrium filix-femina* subsp. *cyclosorum*. Photographed June 14, 1967.

f. Peat-bank community (1O1).

Soil: Tundra without permafrost; type O; pH, 5.4–6.1. Numerous peat banks were formed on this island by excavations related to military operations during World War II. The bare banks, commonly 1 to 2 m high, were opened to primary invasion by plants that were adapated to a saturated organic substrate, strong winds, and full exposure to light. Apparently, only bryophytes and a few lichens are early invaders, for after 20 years vascular plants have become established in only a few locations. Areas of seepage on the vertical or overhanging surfaces may support conical or curtainlike growths of bryophytes (principally *Cephalozia bicuspidata*) at the drip points (fig. 14). All the naturally formed peat banks observed had passed the primary stages of colonization, and their plant communities resembled those of the *Empetrum* heath. The flowering plant *Majanthemum dilatatum*, however, appears to grow only on old well-vegetated peat banks, never on the more nearly level areas of the heath.

Characteristic species: *Pogonatum alpinum*, *Polytrichum commune*, *Cephalozia bicuspidata*, and *Dicranella heteromalla*.

Other species: *Agrostis alaskana*, *Anomobryum concinnatum*, *Brachythecium albicans*, *Bryum arc-*

FIGURE 14.—Peat-bank community in the *Empetrum* heath near Constantine Harbor. The elongated bryophyte colonies, composed principally of *Cephalozia bicuspidata*, form at drip points on the saturated bank that is about 2.5 m high. The colony of large mosses, shown near the upper left, is composed of *Polytrichum sphaerothecium*. Photographed June 5, 1967.

ticum, *Blasia pusilla*, *Bryoerythrophyllum recurvirostrum*, *Calypogeia mülleriana*, *Cephalozia ambigua*, *C. pleniceps*, *Cephaloziella arctica*, *Cladonia degenerans*, *C. gracilis*, *Dichodontium pellucidum*, *Dicranella heteromalla*, *D. subulata*, *Diplophyllum albicans*, *Lophozia alpestris*, *L.* cf. *groenlandica*, *L. incisa*, *Majanthemum dilatatum*, *Mnium glabrescens*, *M. insigne*, *Nardia scalaris*, *Orthocaulis floerkei*, *Pannaria pezizoides*, *Plagiothecium* cf. *undulatum*, *Plectocolea* cf. *obovata*, *Pogonatum contortum*, *P. urnigerum*, *Pohlia annotina*, *P.* cf. *cruda*, *P. nutans*, *Polytrichum formosum*, *P. sphaerothecium*, *Rhacomitrium fasciculare*, *Scapania scandica*, *Sphagnum compactum*, *S. papillosum*, and *Toninia lobulata*.

g. Frost-scar community (3C2).

Soil: Tundra without permafrost, or lithosol; type P_2; pH 6.0–6.3 Frost scars as much as 1 m or more in diameter occur throughout the *Empetrum* heath from which the organic mat has been removed, and mineral soil is exposed. Frost heaving is active during the winter and is intensified by frequent cycles of freezing and thawing of the soil (fig. 15). This unstable substrate of soil, gravel, and cobbles, or at places angular bedrock fragments, provides a suitable niche for species unable to compete with the vegetation of the unbroken heath.

Characteristic species: *Antennaria dioica*, *Cardamine umbellata*, *Deschampsia beringensis*, and *Oncophorus wahlenbergii*.

Other species: *Cephaloziella arctica*, *Chiloscyphus pallescens*, *Dicranella palustris*, *Dicranum fuscescens*, *Diplophyllum albicans*, *Epilobium glandulosum*, *Geum calthifolium*, *Ionaspis epulotica*, *Lecidea* cf. *vernalis*, *Leptobryum* cf. *pyriforme*, *Luzula multiflora* subsp. *multiflora* var. *frigida*, *Microlepidozia makinoana*, *Mnium insigne*, *M. pseudopunctatum*, *Nardia scalaris*, *Philonotis fontana*, *Rhytidiadelphus loreus*, *Riccardia sinuata*, *Rubus arcticus* subsp. *stellatus*, *Scapania paludosa*, *Sibbaldia procumbens*, *Stellaria calycantha* subsp. *calycantha*, *S. sitchana* var. *bongardiana*, and *Veronica serpyllifolia* subsp. *humifusa*.

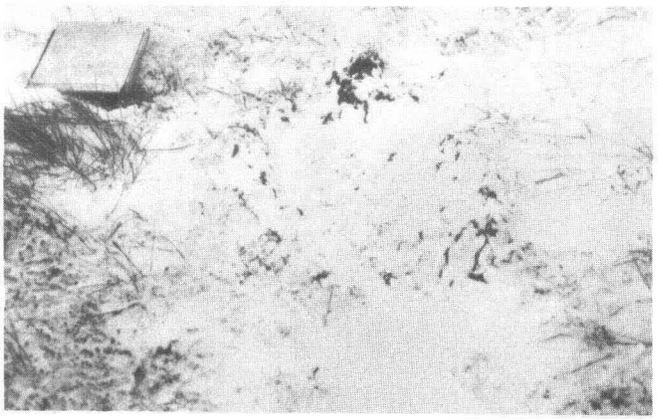

FIGURE 15.—Frost scar in the *Empetrum* heath near Cyril Cove. The light snow cover had fallen before the soil had frozen; subsequent frost heaving is indicated by the cracks (black lines) in the snow. Field notebook gives indication of scale. Photographed November 29, 1965.

5. BOG HABITAT

Most bogs on this island are soligenous and occur on gentle to moderately steep slopes. The borders of lakes and pools do not support bogs, probably because the strong winds agitate the water too violently for *Sphagnum* and other bog plants to grow; therefore, there are no floating bogs on the island. At a few locations the bogs have an unstable surface and may be termed "quaking bogs." Bogs are more common and of larger size on the low plateaus of the eastern part of the island than in the mountains, where they are ordinarily restricted to small areas in drainage ways.

a. *Sphagnum* bog community (1O11).

Soil: Bog; type O; pH, 6.1–6.2. Water pH, $\approx$ 5.9. These bogs are neither abundant nor large, and at places they intergrade with wet sedge

meadows. Isolated colonies of *Sphagnum*, commonly *S. capillaceum* and *S. subsecundum*, occur in small water-filled depressions in the *Empetrum* heath. Typically, this community is best developed in seepage channels or broader areas of gentle slope (fig. 16), where stands composed largely of several species of *Sphagnum* limit the invasion of other plants.

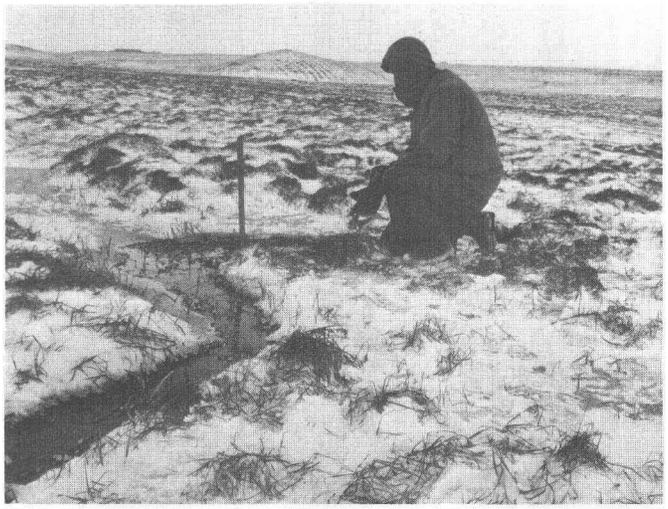

FIGURE 16.—Spring issuing from the margin of a large soligenous bog in a broad valley near Cyril Cove. A wet sedge-meadow community is in the foreground, and a *Sphagnum* bog community is in the center and background of the picture. At the time this photograph was made, water temperature in the spring was 3.3°C, and under the ice of nearby pools, 0.7°C; air temperature was −2.3°C. Photographed February 10, 1968.

Characteristic species: *Sphagnum teres*, *S. squarrosum*, *S. magellanicum*, *S. compactum*, *S. papillosum*, and *S. girgensohnii*.

Other species: *Aulacomnium palustre*, *Brachythecium asperrimum*, *Calypogeia sphagnicola*, *Carex anthoxanthea*, *C. lyngbyaei*, *C. pluriflora*, *Dicranum angustum*, *Drepanocladus revolvens*, *Eriophorum russeolum* subsp. *rufescens*, *Mnium pseudopunctatum*, *Philonotis americana*, *Pinguicula vulgaris* subsp. *macroceras*, *Plantago maritima* subsp. *juncoides*, *Riccardia latifrons*, *Selaginella selaginoides*, and *Siphula ceratites*.

b. *Philonotis-Parnassia* community (1O12).

Soil: Bog; type P_2; pH, 6.5–6.8. Water pH, 6.3–7.0. Requirement for the development of this community appears to be a saturated inorganic substrate of very gentle slope through which water moves. The water is less acid than that of *Sphagnum* bogs. The largest observed community of this type is on sandy soil below the large spring near Makarius Bay, where an almost unbroken mat of *Philonotis* covers an area of a hectare or more.

Characteristic species: *Philonotis americana* and *Parnassia kotzebuei*.

Other species: *Amblystegium serpens*, *Carex kelloggii*, *C. lyngbyaei*, *Cerastium fontanum* subsp. *triviale*, *Dicranella heteromalla*, *D. subulata*, *Epilobium sertulatum*, *Juncus triglumis* subsp. *albescens*, *Jungermannia sphaerocarpa*, *Limosella aquatica*, *Lophozia* cf. *groenlandica*, *Lupinus nootkatensis*, *Platanthera convallariaefolia*, *P. dilatata*, *Pogonatum urnigerum*, *Pottia heimii*, *Saxifraga punctata* subsp. *insularis*, and *Veronica serpyllifolia* subsp. *humifusa*.

c. *Scapania-Nardia-Marsupella* community (1O1).

Soil: Bog; type P_2; pH, 6.1–6.8. Although small colonies of each of the characteristic species occur in wet areas of the *Empetrum* heath, these three liverworts commonly form a distinctive community that occupies drainage channels and wet areas only at altitudes above 400 feet. These species also grow in the snow-bed community, but there they have different vascular-plant associates. The brownish red to bright red of the *Scapania* and *Marsupella* and the bright green of the *Nardia* make the community conspicuous, even at a distance. The saturated organic mat formed by this community is as much as 20 cm thick.

Characteristic species: *Scapania paludosa*, *Nardia scalaris*, and *Marsupella emarginata*.

Other species: *Anthelia julacea*, *Aulacomnium palustre*, *Brachythecium asperrimum*, *Dicranella palustris*, *Drepanocladus revolvens*, *Lycopodium annotinum* subsp. *annotinum*, *L. sabinaefolium* var. *sitchense*, *Oncophorus wahlenbergii*, *Philonotis fontana*, and *Saxifraga punctata* subsp. *insularis*.

6. MARSH HABITAT

A marsh on this island can be distinguished from a bog during any season of the year by its abundance of sedges and forbs, whereas a bog has a preponderance of bryophytes. If the substrate of a marsh is stirred up, even in winter, it gives off a strong odor of hydrogen sulfide. The substrate of a bog however, is virtually odorless. Probably chemical compounds in the bryophytes of bogs inhibit the production of hydrogen sulfide by bacteria.

a. Wet sedge-meadow community (1M21).

Soil: Bog and Half Bog; type O; pH, 5.9–6.2. Water pH, ≈ 6.3. This is the most abundant community in the marsh habitat and occurs typically at the borders of lakes (figs. 8, 17), but it also

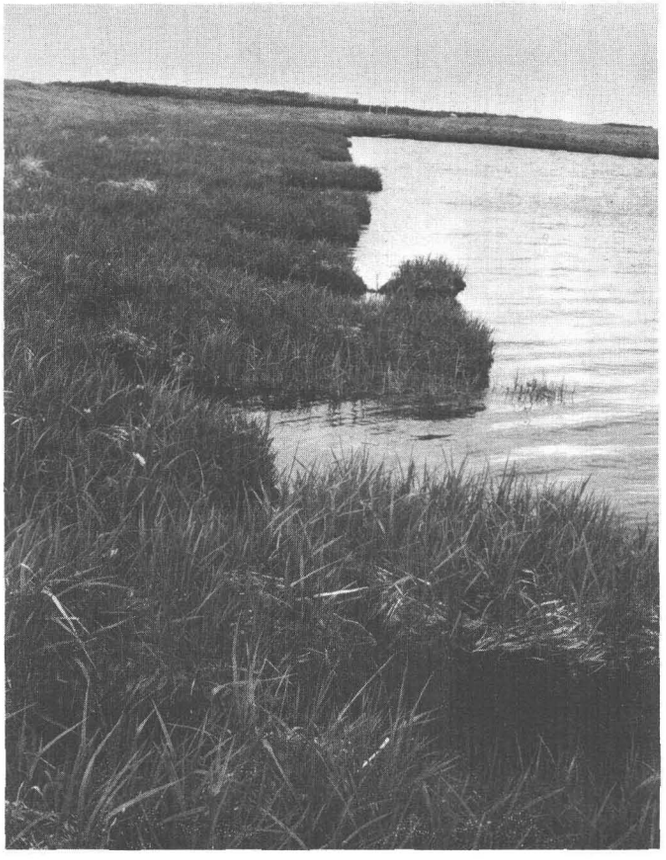

FIGURE 17.—Wet sedge-meadow community at the margin of a large lake near Cyril Cove. The projecting mats of *Carex* are as much as 2 m from base to tip and 30–60 cm wide but are being undercut and are thus destroyed by wave action. A line of new sedge growth is in the center of the picture. Numerous projections of sedge mats encircle some large lakes and give a fimbriate appearance to the shoreline, as seen in aerial photographs. Photographed June 13, 1967.

develops on very wet slopes and beside streams in the *Empetrum* heath (fig. 18).

Characteristic species: *Carex lyngbyaei*, *C. pluriflora*, *C. anthoxanthea*, *C. macrochaeta*, *Eriophorum russeolum* subsp. *rufescens*, and *Juncus triglumis* subsp. *albescens*.

Other species: *Aongstroemia longipes*, *Aulacomnium palustre*, *Claytonia sibirica*, *Drepanocladus fluitans*, *D. revolvens*, *Epilobium glandulosum*, *Festuca rubra*, *Galium trifidum* subsp. *columbianum*, *Geum macrophyllum* subsp. *macrophyllum*, *Lophozia alpestris*, *Mnium glabrescens*, *Nardia scalaris*, *Pedicularis chamissonis*, *Pellia neesiana*, *Philonotis americana*, *Plantago macrocarpa*, *Pleurozium schreberi*, *Polytrichum longisetum*, *Ranunculus occidentalis* subsp. *nelsoni*, *Rhinanthus minor* subsp. *borealis*, *Rhytidiadelphus loreus*, *Sphagnum girgensohnii*, *S. papillosum*, *S. squarrosum*, *S. teres*, and *Viola langsdorffii*.

FIGURE 18.—Wet sedge meadow near Cyril Cove. This area has a dense stand of *Carex lyngbyaei* forming a wide border by the stream. A *Fontinalis-Ranunculus* community is in the stream. Photographed November 23, 1965.

b. *Caltha-Claytonia* community (1N21).

Soil: Half Bog; type P_2; pH, 6.1–6.9. Water pH, 6.2–6.9. This community occurs most commonly on a wet inorganic substrate that has sufficient movement of water through it to prevent freezing in winter. An area about 2 hectares in extent is occupied by this community near Constantine Harbor, and many smaller areas support this community where water upwells through the *Empetrum* heath mat.

Characteristic species: *Caltha palustris* subsp. *asarifolia* and *Claytonia sibirica*.

Other species: *Carex lyngbyaei*, *Epilobium glandulosum*, *E. sertulatum*, *Petasites frigidus*, *Ranunculus occidentalis* subsp. *insularis*, and *Rumex obtusifolius*.

7. LAKE HABITAT

In this report, lakes are distinguished from pools by their being sufficiently large for wind to strongly agitate the surface and waves to pound the shore, thus influencing the kind of community that can develop in and around them (fig. 17). The ice on some large wind-swept lakes affects the formation of the lake banks.

If a sudden lowering of the air temperature to a point below freezing occurs when gale-velocity winds are blowing, water is lifted from the lake surface, frozen in midair, and dropped on the leeward side of the lake. A covering of rough ice then develops from the leeward to the windward side of the lake until the entire lake surface finally is frozen, with thicker ice on the leeward side.The thick ice appears to exert pressure on the vegetation mat of the bank such that this mat (largely unfrozen) is pushed out and up to form the elevated rims characteristic of many lakes (fig. 19). Moreover, the suspended inorganic materials in the windblown water are deposited on the banks. This process, especially active in the more shallow lakes, tends to deepen the lakes and to elevate the lake banks.

Hamelin and Cook (1967, p. 99) evoked a different process in explaining the formation of lake ramparts: "A rise in temperature causes the ice to expand, induces considerable stresses and crowds the edge of the shore, the material [gravel and cobbles, in their illustration] is pushed, overriding the low shore, for many feet where it is deposited upon contraction or melting of the ice." This process may also be active on Amchitka Island.

Two kinds of lakes are on the low plateaus of the island—those that have a geologic origin, are relatively deep, and have a bedrock or cobble bottom, and those that develop on the peneplaned area of the heath habitat, are shallow, and have a muck or soil bottom (Powers and others, 1960, p. 526). With but few exceptions, only the latter type of lake contains vascular plants, which are emergent or immersed bottom-rooted aquatics.

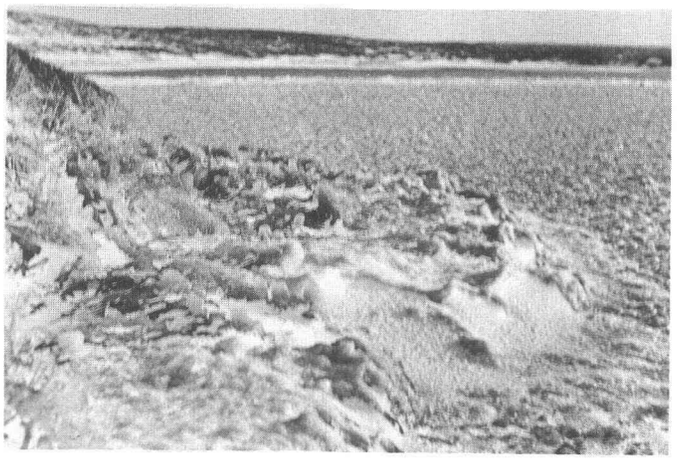

FIGURE 19.—Ice ridge on the leeward bank of a large lake near Cyril Cove. The water near the distant shore is not frozen. Strong winds lift this water, which is frozen in midair and then dropped on the leeward bank and the lake surface. Top of the tundra bank is about 6 feet above water level. Photographed December 3, 1965.

a. *Hippuris-Ranunculus* community (1P21).

Soil: Type P_2; pH, 5.8–6.3. Water pH, 5.1–6.7. The *Hippuris* grows in water as much as 1 m deep; in summer the upper part of the plant emerges from the water. Dense stands of this plant occur in some lakes. Commonly, the *Ranunculus* is intertwined with the *Hippuris*.

Characteristic species: *Hippuris vulgaris* and *Ranunculus trichophyllus* var. *trichophyllus*.

Other species: None, although a band of sedges (principally *Carex lyngbyaei*) may surround the lake and extend into the water.

b. *Isoëtes-Ranunculus-Limosella* community (1P11).

Soil: Type P_2; pH, 6.4–6.6. Water pH, $\approx$ 6.6. The plants of this community commonly grow in lake water 45 to 60 cm deep. *Isoëtes* grows completely submerged in the deeper water, but the other characteristic species grow in shallow water near the shore and may be emergent. All are tenaciously rooted in mud of the lake bottom and grow throughout the year.

Characteristic species: *Isoëtes muricata* subsp. *maritima*, *Ranunculus reptans*, and *Limosella aquatica*.

Other species: Commonly none; however, at one lake *Scapania subalpina* and *Sphagnum squarrosum* grew as submerged aquatics. At some lakes *Ranunculus hyperboreus* subsp. *hyperboreus* grows on mud along the shore.

8. POOL HABITAT

Pools usually are formed in depressions of the vegetation and peat mantle on the *Empetrum* heath, although some are in depressions of bedrock or colluvium, and some are formed by bryophyte dams (fig. 13). Because the pools have a periodic fluctuation of water level, emergent aquatic plants most commonly grow in them and in the mud along the pool banks.

Small pools appear to become enlarged by the process of "swamping," and when they reach a diameter of about 3 m (if in an exposed location) wind becomes active in "digging" them deeper. The agitated water holds much silt or humus from the pool bottom in suspension, and the wind blows this water from the pool to the adjacent heath. Deposits of silt on the leeward side of pools was observed to be sufficiently thick to obscure the green color of the *Empetrum* mat at a distance of 3 m from the pool.

a. *Juncus-Eriophorum* community (1M22).

Soil: Tundra without permafrost and Alluvial; type P_2; pH, 5.0–6.4. Water pH, 4.8–6.3. This community commonly occurs in shallow pools on the *Empetrum* heath (fig. 20) and less commonly in roadside pools and very wet areas of stream alluvium. The vegetation along the pool shores is included here because it is generally inundated after heavy rains or snow melt.

Characteristic species: *Juncus triglumis* subsp. *albescens* and *Eriophorum russeolum* subsp. *rufescens*.

Other species: *Alopecurus aequalis*, *Aulacomnium palustre*, *Campylium stellatum*, *Carex kelloggii*, *Chiloscyphus pallescens*, *Deschampsia caespitosa* subsp. *orientalis*, *Diplophyllum albicans*, *Drepanocladus revolvens*, *Juncus ensifolius*, *Marchantia polymorpha*, *Marsupella emarginata*, *Mnium glabrescens*, *Nardia scalaris*, *Parnassia kotzebuei*, *Pinguicula vulgaris* subsp. *macroceras*, *Pogonatum alpinum*, *Ranunculus trichophyllus* var. *trichophyllus*, *Rhacomitrium aciculare*, *Riccardia pinguis*, *Scapania paludosa*, *S. undulata*, *Selaginella selaginoides*, *Sparganium hyperboreum*, *Veronica americana*, and *V. serpyllifolia* subsp. *humifusa*.

b. *Subularia-Callitriche* community (1P1).

Soil: Lithosol; type P_2; pH, $\approx$ 6.6. Water pH, 6.9–7.2. This community occurs in shallow seasonal pools that have bedrock bottoms. The two characteristic plants can grow as submersed or emergent aquatics or can persist on damp soil if the pools dry up (fig. 21).

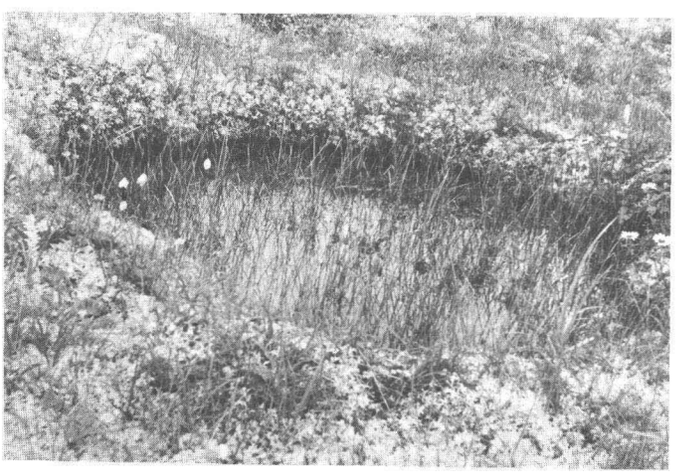

FIGURE 20.—Small pool supporting a *Juncus-Eriophorum* community, surrounded by a *Cladonia-Carex* meadow, near Cyril Cove. Sedges in the pool extend about 1 foot above water surface. Photographed June 17, 1967.

FIGURE 21.—Bottom of a dry pool near Constantine Harbor bearing a dense growth of *Subularia aquatica* that was flowering abundantly. *Callitriche anceps* grows in similar shallow rock-bottomed pools. Utility pole (background) provides scale. Photographed June 17, 1967.

Characteristic species: *Subularia aquatica* and *Callitriche anceps*.

Other species: *Alopecurus aequalis*, *Bryum* sp., *Carex kelloggii*, *Cladonia bellidiflora*, and *Ranunculus reptans*.

c. *Siphula-Scapania* community (1O21).

Soil: Tundra without permafrost and Lithosol; type P_2; pH 6.0–6.4. Water pH, 6.3–6.6. Common in small (60–120 cm in diameter) pools on the *Empetrum* heath, but most extensive in shallow bedrock pools of larger size. *Scapania* forms a dense dark mat on the pool bottom, generally in 5 to 15 cm of water, and *Siphula* grows as an emergent aquatic for much of the year (fig. 22). Both plants can thrive, however, if the pool dries up. *Siphula* is the most hydric lichen on the island and is the only one observed to grow completely submersed.

Characteristics species: *Siphula ceratites* and *Scapania paludosa*.

Other species: *Anthelia julacea*, *Cladonia amaurocraea*, *Isoëtes* sp., *Lophozia incisa*, and *Sphagnum compactum*.

9. STREAM HABITAT

Most streams are narrow, swift, and short; and the water, generally clear and colorless, has percolated through the vegetation mat. The streams flow throughout the year at a fairly steady rate, even under an ice covering, except for periods of greatly increased flow

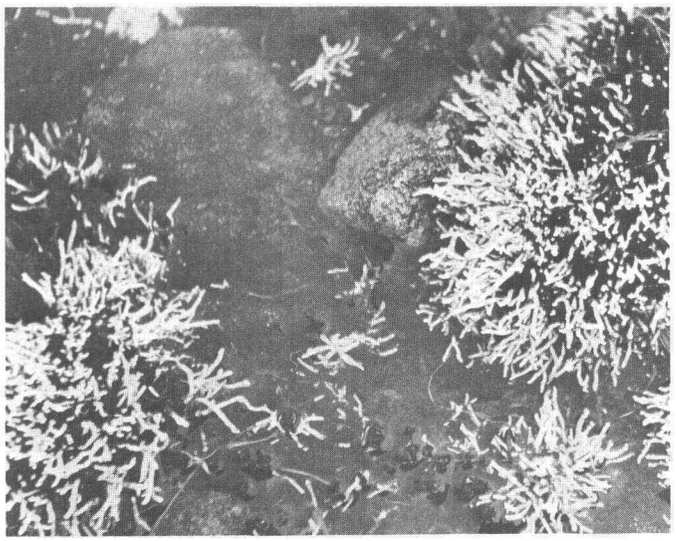

FIGURE 22.—Vertical view of a *Siphula-Scapania* community in a shallow rock-bottomed pool near Crown Reefer Point. Dark colonies of *Scapania* can be seen on pebbles in the water and at the bases of the *Siphula* thalli. White thalli are about 2 inches long. Photographed February 18, 1968.

following heavy rainfall and snow melt. They commonly are deeply entrenched in the vegetation and peat mantle (fig. 23) and have a bedrock, gravel, or colluvium bottom. At places the vegetation mat has closed over the stream trenches and formed "bridges" that may not support the weight of a man. The trenches are periodically filled with snowdrifts in winter and are a hazard to foot travelers. The streams appear to have been entrenched by the growth and deposition of vegetation at their margins; thus they differ from "haggs" of the British moors, defined by Pearsall (1950, p. 249) as erosion channels in peat. Streams draining broad valleys generally have alluvial fans at their mouths that are bordered by sedge marshes (fig. 18), whereas those draining the more nearly level plateaus descend over the sea cliffs in a series of rapids.

FIGURE 23.—Deeply entrenched stream in the *Empetrum* heath near Chitka Point. The narrow stream flows on a bedrock bottom between nearly vertical banks, 1 to 2 m high, of peat and vegetation. Photographed November 22, 1965.

a. *Fontinalis-Ranunculus* community (1P11).

Soil: Type I_2; pH, 6.5–6.9. Water pH, 6.8–7.2. Occurs commonly in rapid, entrenched streams where the light intensity is low. *Fontinalis* grows attached to bedrock or stones in water as much as 1 m deep and develops fronds as much as 60 cm long. *Brachythecium* and *Hygrohypnum* also grow attached to rocks, but they form dense mats in shallow water, especially in cascades. These mosses are shown forming a dam in figure 13. The *Ranunculus* is rooted in soil and produces underwater flowers and fruits throughout the winter.

Characteristic species: *Fontinalis neomexicana* and *Ranunculus trichophyllus* var. *trichophyllus*.

Other species: *Brachythecium asperrimum*, *Bryoerythrophyllum recurvirostrum*, *Chiloscyphus pallescens*, *Hygrohypnum bestii*, *H. ochraceum*, *Scapania irrigua*, and *S. undulata*. *Montia fontana* subsp. *fontana* grows in the shallow water of cascades but not in deeply entrenched streams. Shallow parts of the stream margins, if not shaded by high banks, support the emergent aquatics *Mimulus guttatus*, *Veronica americana*, and *Carex lyngbyaei*.

10. RUDERAL HABITAT

Soils of this habitat are classified only by type. Many substrates have the surface qualities of a lithosol or regosol, and some substrates are not soil. The extensive disturbance of the ground surfaces by military operations and by recent construction on the island has opened many new areas for colonization by plants that are adapted to a mineral soil and that can withstand the effects of microclimatic extremes. The species of the ruderal communities are, with very few exceptions, native plants that also grow in other habitats on the island but that commonly grow more vigorously in the areas which have been disturbed by man. For example, the largest plants of *Lupinus nootkatensis* on the island grow along roadsides, although smaller plants occur in many habitats. *Loiseleuria procumbens* commonly is a depauperate plant in the *Empetrum-Carex*-lichen community; yet a plant that grew in the center of an unused

gravel road had, in about 20 years, formed a dense prostrate shrub 30 cm in diameter.

The communities of this habitat described below are not so clearly defined and discrete at all places as are some of the more "natural" communities on the island—probably because many of the component species of the ruderal communities have a wide ecological amplitude. There is, nevertheless, a tendency toward grouping of certain species in niches that may be only slightly separated spatially.

a. *Calamagrostis* community (1M21).

Soil: Type I_2; pH, ≈5.9. In the construction of roads during World War II, the organic mantle and some of the mineral soil below it were pushed aside to form banks ½–1 m high that paralleled the roads. These banks are covered with an almost unbroken turf of tall grass intermixed with very few forbs. After about 20 years of dominance by the grass, there is now some invasion on the banks of the low plateaus by *Empetrum*, and at a few places the banks are somewhat similar in appearance to the *Empetrum-Carex*-lichen community. At altitudes of about 400 to 600 feet, wind has severely eroded the soil banks so that only fragments of the banks remain. The fragments are held in place only so long as the turf is sufficiently strong to resist wind erosion (fig. 24).

Characteristic species: *Calamagrostis nutkaënsis.*

Other species: *Antennaria dioica*, *Bryum stenotrichum*, *Carex macrochaeta*, *Cephalozia bicuspidata*, *Ceratodon purpureus*, *Dicranella subulata*, *Ditrichum heteromallum*, *Gentiana amarella* subsp. *acuta* var. *plebeja*, *Heracleum lanatum*, *Hylocomium splendens*, *Luzula multiflora* subsp. *multiflora* var. *frigida*, *L. parviflora* subsp. *parviflora*, *Nardia scalaris*, *Pogonatum urnigerum*, *Pohlia nutans*, *Primula cuneifolia* subsp. *saxifragifolia*, and *Rhacomitrium ericoides.*

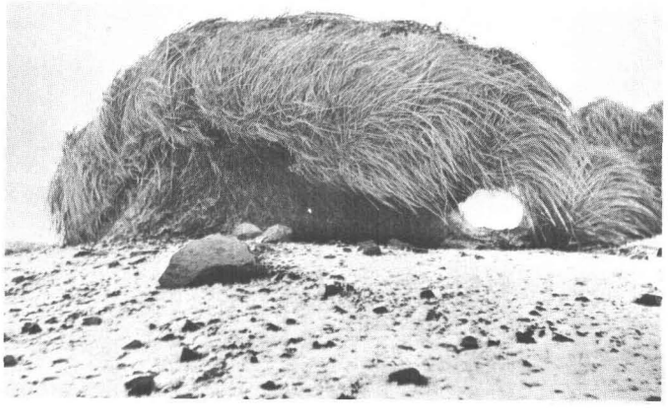

FIGURE 24.—Fragments of a roadside bank severely eroded by wind. This remnant of a bank, held in place by a dense turf of *Calamagrostis nutkaënsis*, is near Sea Otter Point. Bank, including turf, is about 4 feet high. Photographed November 22, 1965.

b. *Lupinus-Arnica* community (3C2).

Soil: Type I_2; pH, 6.7–7.0. The community is common along many roadsides and on disturbed areas; it is very showy in midsummer because of the large size of the plants and the profusion of flowers on the two characteristic species (fig. 25).

FIGURE 25.—*Lupinus nootkatensis* and *Deschampsia caespitosa* subsp. *orientalis* growing on the graveled shoulder of an unused road near Constantine Harbor. Lupine flower spikes are about 8 inches high. Photographed June 15, 1967.

These plants grow in the loose gravel and mineral soil of road shoulders, relatively dry ditches, and similar sites. Other species occupy the wetter ditches and lower parts of roadside banks. The substrate is not greatly compacted and is subjected to strong frost heaving in winter. Heavy rains severely erode the surfaces; therefore, bryophytes and lichens are rare, but large colonies of the moss *Philonotis* occur at some places in the wet roadside ditches.

Characteristic species: *Lupinus nootkatensis* and *Arnica unalaschcensis.*

Other species: *Achillea borealis*, *Anaphalis margaritacea*, *Angelica lucida*, *Antennaria dioica*, *Cardamine umbellata*, *Cerastium fontanum* subsp. *triviale*, *Deschampsia caespitosa* subsp. *orientalis*, *Epilobium sertulatum*, *Gentiana aleutica*, *Marchantia polymorpha*, *Mnium glabrescens*, *Dactylorhiza aristata*, *Philonotis americana*, *Polygonum viviparum*, and *Potentilla egedii* subsp. *grandis.*

c. *Equisetum-Sagina-Ceratodon* community (2G2).

Soil: Type I_2; pH, 5.8–6.5. The characteristic substrate of this community has a hard, very compact, often stony surface that resists frost heaving. This community occurs on unused well-compacted roads, graveled parking lots and service areas, fractured concrete slabs, and cracked macadam runways. Some species are rooted in fine-gravel accumulations 2 cm or less thick or unbroken concrete or macadam surfaces. Many old gravel-road surfaces have an almost unbroken growth of *Equisetum*. *Sagina occidentalis* forms dense rosettes rooted in pavement cracks or very compact road centers. *Rhinanthus*, *Luzula*, *Hieracium*, and *Lycopodium* occur most commonly on well-packed stony animal trails.

Characteristic species: *Equisetum arvense*, *Sagina occidentalis*, and *Ceratodon purpureus*.

Other species: *Antennaria dioica*, *Brachythecium acutum*, *B. albicans*, *B. asperrimum*, *Bryum stenotrichum*, *Cladonia pyxidata*, *Drepanocladus uncinatus*, *Empetrum nigrum* subsp. *nigrum*, *Eurhynchium praelongum*, *Hieracium gracile* var. *alaskanum*, *Lecidea macrocarpa*, *Loiseleuria procumbens*, *Luzula multiflora* subsp. *kobayasii*, *L. parviflora* subsp. *parviflora*, *Lycopodium selago* subsp. *selago*, *Nardia scalaris*, *Ochrolechia frigida*, *Placopsis gelida*, *Platanthera chorisiana*, *Poa alpina*, *P. turneri*, *Polytrichum formosum*, *Rhacomitrium ericoides*, *Rhinanthus minor* subsp. *borealis*, *Sagina intermedia*, *Saxifraga punctata* subsp. *insularis*, *Sibbaldia procumbens*, *Stellaria calycantha* subsp. *calycantha*, *Stereocaulon intermedium*, *S. tomentosum* var. *alpestre*, and *Veronica serpyllifolia* subsp. *humifusa*.

11. DISCONTINUOUS HEATH HABITAT

A distinct change in habitats occurs at an altitude of about 400 feet, where the extensive *Empetrum* heath of the low plateaus becomes fragmented into small strips and patches that alternate with almost bare ground (fig. 26). This disruption of the heath mat probably is caused mostly by wind erosion, but frost heaving doubtless accelerates the process, once the vegetation cover is broken. Hultén (1960, p. 40–41) wrote, "It is quite clear that the mosaic of plant communities in the Aleutians is to a large extent regulated by the wind." He noted a very sharp change in vegetation at levels where the full force of the wind was felt, which he reported to be the boundary that separates the meadows from the heath. He referred to this boundary as the "wind plane." On the low plateaus of Amchitka

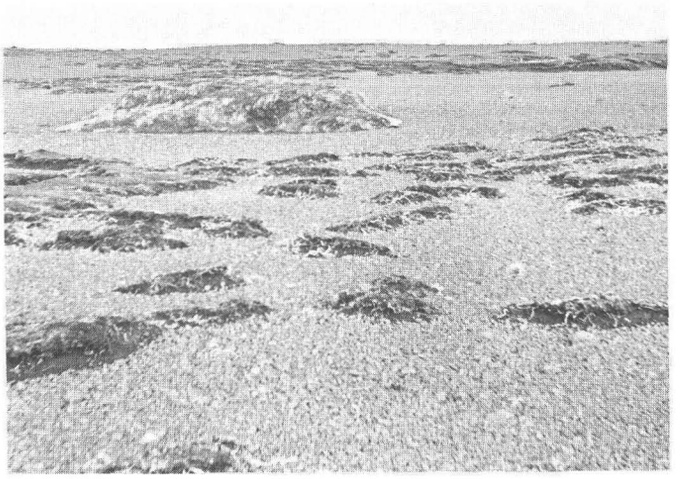

FIGURE 26.—Discontinuous heath habitat, with scattered patches of the *Salix-Empetrum* community. Large mound (center) is a densely vegetated bedrock outcrop. The area is between Sea Otter Point and Chitka Point at an altitude of about 400 feet. Bedrock outcrop is about 15 feet wide. Photographed November 22, 1965.

Island, the boundary between these two communities is determined more by the degree of drainage than by wind action. The heath at many places extends almost to the lowest points of sheltered valleys, if drainage is adequate. Conversely, throughout the highest levels of the low plateaus, sedge meadows occur everywhere that drainage is poor. The streamside community and the alpine meadow community are the ones that most clearly require shelter from wind.

The striking boundary on Amchitka Island that is related to wind is the ecotone between the *Empetrum* heath and the alpine region; it is about 400 to 600 feet above sea level. At this altitude, wind erosion probably is more active than frost action in determining which plant communities survive (fig. 24).

The strips of vegetation ordinarily are eroded on the windward side until the roots and subterranean stems of the dwarf shrubs are exposed and finally die, but on the leeward side, new plant growth slowly extends the mat outward. Two lichen species, *Ochrolechia frigida* and *Mycoblastus alpinus*, are associated with the dead margins of the strips; however, it was not determined whether the lichen growth causes, or is the result of, death of the vegetation at the edge of the strips. The vegetation mats, therefore, appear to "move," in time, with the wind, but this supposition has not been proved by actual measurements. The concept of patches of vegetation "moving" in this manner was described by Watt (1947) and by Pearsall (1950, p. 83) as observed in British moorlands, and the floristic composition and successional changes in these mats were given by Metcalfe (1950, p. 53).

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There is no one direction of prevailing winds on Amchitka Island as a whole. In the mountains and high plateaus, topography exerts a controlling effect on prevailing wind directions at specific locations. On slopes, the strongest winds commonly are upslope, regardless of compass direction, and the vegetation mats tend to erode on the lower side and advance on the upper side. On more nearly level areas the local topographic features appear to determine the direction of this "movement." More careful observations than have yet been made and measurements throughout the year are necessary if these processes are to be defined more accurately.

The substrate between and under the vegetation patches is composed of volcanic rock fragments in a matrix of fine mineral "soil" and is subjected to moderate frost heaving, but patterned ground generally is not formed. This substrate between vegetation patches is largely devoid of vascular plants, although some scattered bryophyte colonies occur. Bedrock outcrops in this area are discussed separately in this report.

a. *Salix-Empetrum* community (1C21a).

Soil: Tundra without permafrost and Lithosol; type F_3; pH, 6.0–6.1. The fabric of the vegetation patches is composed largely of interwoven stems and branches of *Salix* and *Empetrum*, which hold in place a thin organic soil that supports a few herbs, lichens, and mosses. Some of the woody stems of *Salix arctica* subsp. *crassijulis* are almost 1 cm in diameter and appear to be many years old. The shrubs form roots throughout the length of their buried stems; therefore, they may continue to grow at the stem tips while dying at the basal end of the stems.

In the more sheltered locations of the discontinuous heath, areas between the heath patches develop a conspicuous growth of lichens. Species of *Cladonia* grow on the summits and sides of the small hummocks, and dense stands of *Thamnolia* are present in the depressed areas between the hummocks.

Characteristic species: *Salix arctica* subsp. *crassijulis*, *S. rotundifolia*, and *Empetrum nigrum* subsp. *nigrum*.

Other species: *Alectoria* cf. *irvingii*, *A. ochroleuca*, *Campanula lasiocarpa* subsp. *lasiocarpa*, *Cassiope lycopodioides*, *Cerastium fischerianum*, *Cladonia alpestris*, *C. pacifica*, *Dicranum howellii*, *Epilobium behringianum*, *Gymnomitrion corallioides*, *Hieracium triste*, *Loiseleuria procumbens*, *Luzula arcuata* subsp. *unalaschcensis*, *L. tundricola*, *Lycopodium alpinum*, *L. selago* subsp. *selago*, *Mycoblastus alpinus*, *Ochrolechia frigida*, *Peltigera aphthosa*, *Polygonum viviparum*, *Rhacomitrium fasciculare*, *R. lanuginosum*, *Sphaerophorus globosus*, and *Thamnolia vermicularis*.

b. *Andreaea-Schistidium-Rhacomitrium* community (3C1).

Soil: Lithosol; type I; pH, 5.8–6.0. Although the area between the heath mats that is covered with rock fragments and soil may appear to be barren, small moss polsters grow on many rocks and in the mineral soil (fig. 26). *Andreaea* generally is attached to small rocks, but at places it grows on the soil, and the polsters are undercut by wind erosion (Shacklette, 1966, p. 349). *Schistidium* and *Rhacomitrium* ordinarily grow on rock fragments, and frost heaving and thawing only raise and lower the rocks without disrupting the moss polsters.

Characteristic species: *Andreaea rupestris*, *Schistidium apocarpum*, and *Rhacomitrium lanuginosum*.

Other species: A few colonies of *Brachythecium albicans*, *Conostomum tetragonum*, and *Drepanocladus uncinatus* and rosettes of *Draba aleutica* and *Cerastium aleuticum*, which characteristically occur on solifluction terraces, are widely scattered through this community.

12. SOLIFLUCTION HABITAT

At altitudes between 600 and 1,100 feet, the effects of strong frost action are conspicuous in all but the most sheltered locations (figs. 27, 28). The land surface is composed largely of scree slopes and colluvial boulder fields in which the surface rocks are arranged in terraces, rock stripes, and weakly developed boulder polygons. Solifluction terraces and rock stripes occur in pebbly ground and are presently active in reshaping the ground surface, but observations of the weak boulder polygons were inconclusive in determining whether the process of rearrangement was currently active, or whether the polygons are relics of frost action of former times. High-altitude rock outcrops and sheltered valleys are discussed separately in this report.

a. Fell-field community (3B1).

Soil: Lithosol; type I; pH, 6.0–7.0. This community is most extensive on the high plateaus of the western part of Amchitka Island (fig. 1), but smaller areas occur throughout the mountains. Lithosol development is very slight, and many rock surfaces have only a partial covering of lichens (fig. 29).

FIGURE 27.—High-altitude land surfaces that are strongly influenced by solifluction processes, between Chitka Cove and Andesite Point. A light snow cover emphasizes the surface features. Slopes are covered with an almost continuous vegetation mat; they develop a microrelief in which the ridges and furrows parallel the direction of slope. (Compare with fig. 28.) Photographed February 7, 1968.

Small patches and fragments of a heath community are scattered through some boulder fields; these are more common on the steep slopes, where the rare *Rhododendron camtschaticum* subsp. *camtschaticum* is a component of the vegetation patches. On the nearly level high plateaus, *Lupinus* is the principal initiator of vegetation mats. Single plants become established between the boulders on the almost barren plateaus, and mosses and lichens grow in the loose debris and soil that accumulates in the shelter of these plants. Vegetation mats, as much as 10 dm in diameter, that contain a significant number of heath plants were observed to have developed around large and obviously very old lupine plants.

Characteristic species: *Salix rotundifolia*, *S. cyclophylla*, *Cassiope lycopodioides*, *Empetrum nigrum* subsp. *nigrum*, and *Lupinus nootkatensis*.

Other species: *Alectoria ochroleuca*, *A. pubescens*, *Andreaea rupestris*, *Antitrichia curtipendula*, *Arctoa fulvella*, *Bryum stenotrichum*, *Calypogeia sphagnicola*, *Campanula lasiocarpa* subsp. *lasiocarpa*, *Carex circinnata*, *Cephalozia* cf. *bicuspidata*, *C. pleniceps*, *Cetraria nigricans*, *Conostomum tetragonum*, *Diapensia lapponica* subsp. *obovata*, *Dicranum howellii*, *Diplophyllum albicans*, *D. taxifolium*, *Drepanocladus revolvens*, *D. uncinatus*, *Hypogymnia subobscura*, *Luzula tundricola*, *Ochrolechia frigida*, *Parmelia omphalodes*, *Pohlia nutans*, *Rhacomitrium brevipes*, *R. ericoides*, *R. lanuginosum*, *Rhododendron camtschaticum* subsp. *camtschaticum*, *Salix arctica* subsp. *crassijulis*, *Scapania scandica*, *Sibbaldia procumbens*, *Sphaerophorus globosus*, *Umbilicaria proboscidea*, *Vaccinium uliginosum* subsp. *microphyllum*, and *Veronica grandiflora*.

b. Solifluction terrace community (3C13).

Soil: Lithosol; type I_1; pH, 6.6–6.7. The ground surface occupied by this community is composed of pebbles, generally not more than 3 cm in diameter, in a matrix of very loose wet mineral soil. Frost

FIGURE 28.—Rock stripes that developed on a moderate slope between Chitka Cove and Andesite Point. A light drifted snow cover emphasizes the surface features. Distance between the summits of adjacent ridges is about 30 cm. Ridges are perpendicular to the direction of slope. (Compare with fig. 27.) Photographed February 7, 1968.

FIGURE 29.—Fell-field at the summit of a mountain near Chitka Cove. Very little soil forms at this site; vegetation is sparse, and strong winds remove most of the fine rock particles. Photographed February 7, 1968.

action has arranged these materials into rock stripes (fig. 28) and terraces (fig. 30) that are perpendicular to the direction of slope. The brinks of the low terraces may have a weakly developed strip of heath plants, but the pebbly ground of rock stripes supports only single plants or polsters spaced widely apart. Lichens can scarcely become established on the most unstable surfaces, and only one moss, *Conostomum tetragonum*, is well adapted to this substrate.

FIGURE 30.—Solifluction terraces on the high plateau near Rim Point. The terraces support depauperate heath mats, and the stony ground between the terraces bears a scattered cover of *Luzula tundricola* and a few other plants. An animal trail leads from the foreground to the helicopter. Photographed June 11, 1967.

Characteristic species: *Potentilla hyparctica*, *Koenigia islandica*, *Cerastium aleuticum*, *Draba aleutica*, *Juncus biglumis*, and *Conostomum tetragonum*.

Other species: *Andreaea rupestris*, *Antitrichia curtipendula*, *Brachythecium albicans*, *Cardamine bellidifolia*, *Cassiope lycopodioides*, *Cladonia alpestris*, *Claytonia arctica*, *Dicranum howellii*, *Diapensia lapponica* subsp. *obovata*, *Diplophyllum albicans*, *Drepanocladus uncinatus*, *Herberta adunca*, *Hypnum plicatulm*, *Jungermannia atrovirens*, *Luzula tundricola*, *Marsupella emarginata*, *Poa lanata* var. *vivipara*, *Ranunculus occidentalis* subsp. *insularis*, *Rhacomitrium fasciculare*, *R. lanuginosum*, *Sagina intermedia*, *Salix cyclophylla*, *Saxifraga punctata* subsp. *insularis*, *S. foliolosa* var. *foliolosa*, *Sphagnum compactum*, *Stellaria ruscifolia* subsp. *aleutica*, *Stereocaulon vesuvianum*, and *Tritomaria quinquedentata*.

13. ALPINE MEADOW HABITAT

In the narrow valleys in the mountains, wind velocity is greatly reduced, and in some places snow accumulations may persist until mid-June. The valleys afford protection from strong frost action, desiccating winds, and severely cold weather and thereby permit growth of species that are not found elsewhere on the island. The wettest parts of the valleys, where snow melt water saturates the ground, and the margins of small streams that drain the slopes and valleys (fig. 31) support snowbed communities. The more mesic valley walls, slopes,

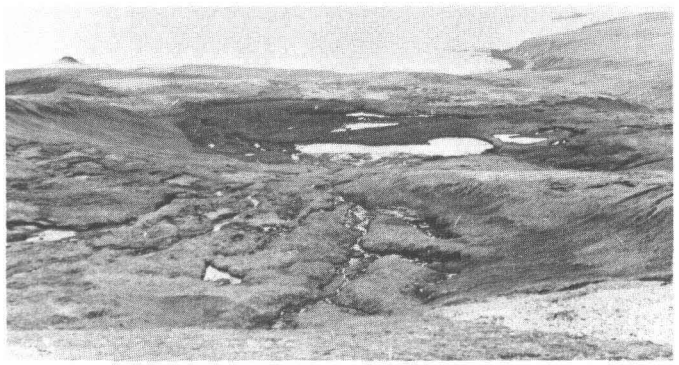

FIGURE 31.—Abrupt transition from fell-field (lower right) to discontinuous heath at Chitka Cove. The streams (foreground) are bordered with snow-bed communities; a large wet sedge meadow surrounds the lake; and a moss mound marks the narrow *Empetrum* heath above the sea cliffs. Photographed August 16, 1966.

and streamside terraces bear a profusion of showy flowering plants, ferns, and mosses that characterize the alpine meadows. Lichens are not abundant in this habitat. The ecotone between the alpine meadow and the solifluction terraces, or boulder fields, is at places very narrow; for example, the distance (measured up the steep valley sides) from the stream bed, through the alpine meadow, to the almost bare terraces and rock fields may be as little as 10 m.

a. Snow-bed community (1O12).

Soil: Type P_2; pH, 5.8–6.2. Water pH, 5.4–6.6. The substrate of this community is saturated with water, and large patches of the gray liverwort *Anthelia* make the community conspicuous. This liverwort is characteristic of snow-bed communities in many parts of the northern hemisphere. The yellow-flowered *Saxifraga hirculus* grows in the liverwort mats with the diminutive *Hippuris montana* and the rare shrub *Geum pentapetalum*. Colonies of *Sphagnum* and other hydric bryophytes complete the mosaic of the snow-bed community, which extends along some of the small streams that flow through the discontinuous heath habitat (fig. 31). Many species listed below were found only in this community.

Characteristic species: *Anthelia julacea*, *Scapania paludosa*, *Saxifraga hirculus*, and *Leptarrhena pyrolifolia*.

Other species: *Andreaea rupestris*, *Carex bigelowii*, *C. physocarpa*, *Cephalozia ambigua*, *C. bicuspidata*, *Dicranella palustris*, *Diplophyllum albicans*, *Drepanocladus revolvens*, *Geum pentapetalum*, *Gymnocolea inflata*, *Hippuris montana*, *Lophocolea cuspidata*, *Lophozia alpestris*, *Marsupella emarginata*, *Mylia anomala*, *Nardia compressa*, *N. scalaris*, *Oligotrichum hercynicum*, *O. parallelum*, *Oxyria digyna*, *Pellia neesiana*, *Primula cuneifolia* subsp. *saxifragifolia*, *Radula polyclada*, *Rhytidiadelphus squarrosus*, *Riccardia pinguis*, *Sparganium hyperboreum*, *Sphagnum compactum*, *S. papillosum*, *S. squarrosum*, *Takakia ceratophylla*, and *Veronica serpyllifolia* subsp. *humifusa*.

b. Alpine meadow community (1N21).

Soil: Tundra without permafrost or Half Bog; type F_5; pH, 6.2–6.4. Although all vascular plants of this community (except *Pyrola minor*) were also found in the *Empetrum* heath, the distinctive features of this community are in the predominance of large-flowered forbs, the sparsity of *Empetrum* and other shrubs, and the lesser importance of lichens, sedges, grasses, and bryophytes in the structure of the community. This community is limited to the higher altitudes, generally above 600 feet, in well-sheltered valleys; at lower altitudes the *Empetrum* heath predominates in the valleys.

Characteristic species: *Achillea borealis*, *Arnica unalaschcensis*, *Chrysanthemum arcticum* subsp. *arcticum*, *Claytonia sibirica*, *Geum calthifolium*, and *Ranunculus occidentalis*.

Other species: *Carex pluriflora*, *Cephalozia ambigua*, *C. bicuspidata*, *Cetraria ericetorum*, *Cladonia rangiferina*, *Cornus suecica*, *Drepanocladus revolvens*, *D. uncinatus*, *Empetrum nigrum* subsp. *nigrum*, *Erigeron peregrinus*, *Listera cordata* var. *nephrophylla*, *Lophozia alpestris*, *L. opacifolia*, *Lupinus nootkatensis*, *Nardia geoscyphus*, *N. scalaris*, *Plagiothecium undulatum*, *Plantago maritima* subsp. *juncoides*, *Platanthera convallariaefolia*, *P. dilatata*, *Pleurozium schreberi*, *Polygonum viviparum*, *Pyrola minor*, *Rhytidiadelphus loreus*, *Sphaerophorus globosus*, *Sphagnum lindbergii*, *S. magellanicum*, *Thelypteris limbosperma*, *T. phegopteris*, and *Vahlodea atropurpurea* subsp. *latifolia*.

14. INLAND BEDROCK HABITAT

Bedrock outcrops at inland locations throughout the island support plant communities different from those of the sea cliffs. The inland outcrops are remnants of an earlier landform and are resistant to erosion. At places they project only slightly above the general ground level; elsewhere they form irregular masses or symmetrical cones that are conspicuous landmarks (figs. 32, 33). The plant communities of the outcrops are low growing and do not completely cover the rock

FIGURE 32.—Low-altitude rock outcrop that is used as a bird perch, near Banjo Point. The thick turf at the summit is composed of *Festuca brachyphylla*. Photographed August 17, 1966.

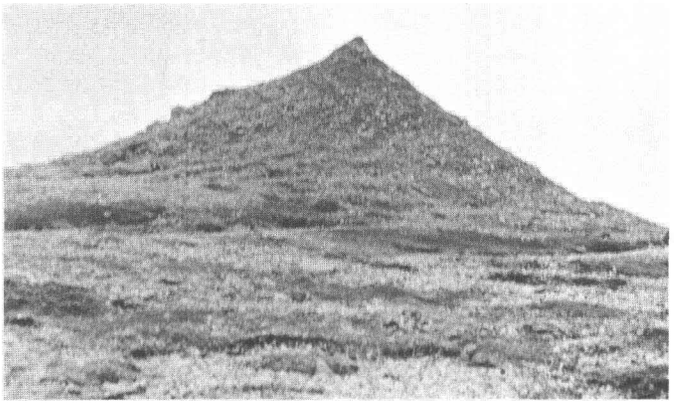

FIGURE 33.—High-altitude bedrock outcrop near Chitka Cove. The fell-field (foreground) has patches of heath plants on the unstable rocky substrate. Although much of this conical outcrop is covered with talus, the loose rocks are not subjected to strong frost action because of the underlying bedrock. Outcrop is about 40 feet wide at the base. Photographed August 16, 1966.

surfaces, unless fertilized by birds. The species composition of the communities appears to be controlled largely by factors associated with altitude; accordingly, two communities are recognized.

a. Low-altitude bedrock communities (1N21).

Soil: Weakly developed Lithosol; type I_2; pH, 6.0–6.6. Sites of these communities range in altitude from about 150 to 600 feet above sea level; outcrops at lower altitudes are on the seacoasts. Some conical outcrops are used by birds as perches and are recognizable by the thick turf of grass at the summits and sides of the mounds (fig. 32).

Characteristic species: *Veronica stelleri*, *Cassiope lycopodioides*, *Tofieldia coccinea*, and *Salix rotundifolia*.

Other species: *Agrostis borealis*, *Alectoria ochroleuca*, *A. pubescens*, *Andreaea rupestris*, *Angelica lucida*, *Antennaria dioica*, *Antitrichia curtipendula*, *Bacidea* sp., *Campanula chamissonis*, *C. lasiocarpa* subsp. *lasiocarpa*, *Carex macrochaeta*, *Ceratodon purpureus*, *Cetraria cucullata*, *Chrysanthemum arcticum* subsp. *arcticum*, *Cornicularia divergens*, *Dicranum howellii*, *Drepanocladus uncinatus*, *Empetrum nigrum* subsp. *nigrum*, *Festuca brachyphylla*, *Gentiana aleutica*, *Heracleum lanatum*, *Ionaspis epulotica* var. *arctica*, *Lecidea aleutica*, *L. macrocarpa*, *Loiseleuria procumbens*, *Lophozia* cf. *wenzelii*, *Luzula arcuata* subsp. *unalaschcensis*, *Lycopodium sabinaefolium* var. *sitchense*, *Lycopodium selago* subsp. *selago*, *Mnium glabrescens*, *Nardia scalaris*, *Ochrolechia frigida*, *Parmelia saxatilis*, *P. sulcata*, *Peltigera aphthosa*, *Pertusaria coriacea*, *Placopsis gelida*, *Platanthera chorisiana*, *Poa arctica* subsp. *williamsii*, *Pogonatum urnigerum*, *Polytrichum juniperinum*, *Primula cuneifolia* subsp. *saxifragifolia*, *Ramalina almquistii*, *Rhacomitrium fasciculare*, *R. lanuginosum*, *Rhizocarpon hochstetteri*, *Salix arctica* subsp. *crassijulis*, *S. cyclophylla*, *Thamnolia vermicularis*, *Umbilicaria cylindrica*, *U. proboscidea*, *Viola langsdorffii*, and *Xanthoria candelaria*.

b. High-altitude bedrock community (3Ç1).

Soil: Weakly developed Lithosol; type I; pH, 6.4–6.6. This community contains few vascular plants but many cryptogams; a large part of the rock surfaces, however, is not vegetated (fig. 34). Mosses and lichens can colonize the relatively stable rocks of outcrops, whereas the rocks of adjacent

FIGURE 34.—Rock outcrops on a mountain summit about 1 mile west of Chitka Cove. Strong winds and almost constant fog characterize the summits. Vegetation consists of one species of *Carex*, one of *Agrostis*, and several species of lichens and mosses. Photographed July 29, 1967, by J. A. Erdman.

solifluction terraces and fell-fields are so unstable, due to frost action, that fewer of these plants can grow on them. The conical outcrops at high altitudes (fig. 33) are used very little as perches by birds. At high altitudes, sea birds and ptarmigans do not congregate, and raptorial and passerine birds are not abundant; therefore, coprophilous species of plants are not common on high-altitude outcrops.

Characteristic species: *Carex circinnata*, *Umbilicaria proboscidea*, and *Agrostis borealis*.

Other species: *Alectoria* cf. *irvingii*, *A. nigricans*, *Andreaea rupestris*, *Anthelia julacea*, *Cephalozia leucantha*, *Cerastium aleuticum*, *Cetraria ericetorum*, *Cladonia bellidiflora*, *Conostomum tetragonum*, *Cornicularia divergens*, *Diplophyllum albicans*, *Empetrum nigrum* subsp. *nigrum*, *Festuca brachyphylla*, *Gymnomitrion corallioides*, *Haematomma ventosum* subsp. *lapponicum*, *Hypnum cupressiforme*, *Lecidea armeniaca*, *L. elegantior*, *L. flavocaerulescens*, *L. macrocarpa*, *Lophozia* cf. *groenlandica*, *L. incisa*, *Luzula tundricola*, *Mycoblastus alpinus*, *Ochrolechia frigida*, *Orthocaulis binsteadii*, *Parmelia alpicola*, *P. omphalodes*, *Pertusaria hultenii*, *Platysmatia lacunosa*, *Pogonatum alpinum*, *Pohlia nutans*, *Rhacomitrium fasciculare*, *R. lanuginosum*, *Rhizocarpon atroalbescens*, *R. geographicum*, *Sphaerophorus globosus*, *Sphenolobus minutus*, *Thelypteris limbosperma*, and *Umbilicaria proboscidea*.

15. MISCELLANEOUS HABITATS, SUBSTRATES, AND COMMUNITIES

a. Carcasses.

Nitrophilous mosses of the family Splachnaceae most commonly grow on dung of herbivorous mammals. These animals do not occur on Amchitka Island, however, and the only splachnaceous moss that is present, *Tetraplodon mnioides*, grows on decomposed carcasses of birds and rats. This moss can be found on any part of the island (except possibly at high altitudes) where carcasses happen to lie. *Tetraplodon* colonies are conspicuous because of the density and reddish-brown color of the sporophytes and the abundance of greenish-yellow spores that are produced. *Byrum stenotrichum* was found growing on a rat carcass, and *Pleurozium schreberi*, on a bird carcass, but these mosses do not commonly grow on this type of substrate. No other plants were found on carcasses.

b. Imported wood.

No native trees grow in the Aleutian Islands; therefore, all wood on the islands was brought in by man or by ocean currents. Military and other operations on Amchitka Island have resulted in the importation of much wood for buildings, utility poles, and other uses. The plants which grow on this wood are as follows: *Baeomyces placophyllus*, *Brachythecium acutum*, *Ceratodon purpureus*, *Cetraria ciliaris*, *Drepanocladus uncinatus*, *Eurhynchium praelongum*, *Hypogymnia enteromorpha*, *H. physodes*, *Lecanora allophana*, *Lecidea* cf. *symmicta*, *L. vernalis* (on tar paper over a wooden roof), *Mnium glabrescens*, *M. pseudopunctatum*, *Parmelia saxatilis*, *P. sulcata*, *Parmeliopsis ambigua*, and *Pertusaria* sp.

c. Plantings.

Several *Picea sitchensis* trees planted in front of buildings during World War II are still living, are about 1 m high, and had about 3 cm of new growth in 1967 (fig. 35). Similar plantings of this species were observed to have been made on Shemya Island, and four of the trees were still alive in 1967. On Amchitka Island the window boxes of a military building were planted with *Anemone narcissiflora* subsp. *villosissima*, and these plants are still living. No other evidence of plant cultivation was seen on this island.

d. Burned areas.

An area of *Empetrum* heath approximately 1 square kilometer in extent was burned during World War II. Apparently, only the aerial parts

FIGURE 35.—Sitka spruce (*Picea sitchensis*) planted in front of a club building during World War II. Tree is about 3 feet high. Photographed February 19, 1968.

of plants were burned, whereas the saturated substrate protected the crowns and roots. After 20 years the burned area still contrasts strongly to adjacent unburned areas because of the abundance of *Calamagrostis nutkaënsis* and other grasses that revegetated the area after the burn. The grass disclimax that develops after a heath fire was described by Pearsall (1950, p. 145, 155). Lichens, including *Cladonia coccifera*, *C. degenerans*, *C. gracilis*, *C. pacifica*, *C. pyxidata*, and *Empetrum nigrum* subsp. *nigrum* are beginning to revegetate the burned area. Probably many more years will be required for this area to recover completely from the fire damage.

PLANT SPECIES OF AMCHITKA ISLAND

ANNOTATED LIST OF VASCULAR PLANTS

By HANSFORD T. SHACKLETTE, JAMES A. ERDMAN, and JOHN R. KEITH

Duplicates of specimens cited in this list have been identified or their names verified, with but few exceptions, by Dr. Eric Hultén (written commun., 1967), and the nomenclature follows that of his new flora (1968). Species from Amchitka Island that were reported by Hultén (1960) but were not found during this study are cited, but without habitat notes. Collection numbers, in italics, are those of Shacklette unless otherwise specified; they follow the species name. The habitat and plant community from which a collection was taken, designated by numbers and letters as set forth in the section of this report on the description of the island and its vegetation, follow the collection number. One asterisk before the species name indicates that this is a report of the first collection of this species on Amchitka Island; two asterisks indicate a first collection of the species in the Aleutian Islands.

BORAGINACEAE

Mertensia maritima subsp. *maritima* Hult. *8196*, 1a. This plant occurs only on sandy beaches and was found at only a few locations on the island.

CALLITRICHACEAE

**Callitriche anceps* Fern. *7631*, 8b. Grows in shallow roadside pools; rare.

Callitriche hermaphroditica L. (Hultén, 1960, p. 257).

CAMPANULACEAE

Campanula chamissonis Federov. *7549*, 14a; *7550*, 14a. Found only at altitudes above 300 feet. The common form has violet corollas, but at places colonies of many plants with lavender to pink corollas occur. Flowers in August.

Campanula lasiocarpa subsp. *lasiocarpa* Hult. *7397*, 4a; *7653*, 14a; *Erdman 580*, 12a. Most abundant in the *Empetrum* heath, but it occurs also throughout the mountains except on the highest peaks. Flowers in August.

CAPRIFOLIACEAE

Linnaea borealis subsp. *borealis* Hult. *7298*, 4a; *7500*, 4a; *Erdman 564*, 4a. Occurs commonly on banks in a mat of *Empetrum* and mosses; flowers in mid-August.

CARYOPHYLLACEAE

Cerastium aleuticum Hult. *7573*, 12b; *8226*, 14b; *Erdman 563*, 11b. Found only on unstable soil at high altitudes; flowers in mid-August.

Cerastium beeringianum var. *beeringianum* Hult. (Hultén, 1960, p. 178).

Cerastium fischerianum Ser. *7496*, 1a; *7995*, 11a. This plant has slender light-red stems that are very brittle.

**Cerastium fontanum* subsp. *triviale* (Link) Jalas. *7470*, 10b; *8040*, 5b. Common on roadsides and sand dunes.

Honckenya peploides subsp. *major* (Hook.) Hult. *7490*, 1a. Found only on sandy or rocky beaches; forms a zone of dense vegetation near the high-tide level.

Sagina crassicaulis S. Wats. *7618*, 4d; *7619*, 4d. Found only in wet crevices of sea cliffs.

Sagina intermedia Fenzl. *7575*, 12b; *8037*, 10c; *Erdman 578*, 12b. Occurs on solifluction slopes and rocky roadsides; forms very dense rosettes on hard soil or in pavement cracks.

**Sagina occidentalis* S. Wats. *7471*, 10c; *7654*, 1a. Found on upper beach terraces and on old gravel roads.

Stellaria calycantha subsp. *calycantha* Hult. *7443*, 4g; *7633*, 1a; *8034*, 10c. On disturbed soil at low altitudes.

Stellaria media (L.) Vill. (See Hultén, 1960, p. 176.)

**Stellaria ruscifolia* subsp. *aleutica* Hult. *7580*, 12b; *8223*, 12b. A rare plant of solifluction slopes. Leaves rigid, glaucous, and sharp pointed. Flowers very sparingly, in mid-August.

Stellaria sitchana var. *bongardiana* (Fern.) Hult. *7546*, 4g. On frost scars and other sites of disturbed soil in the *Empetrum* heath.

COMPOSITAE

Achillea borealis Bong. *7439*, 10b. Common on roadsides and on disturbed soil in the *Empetrum* heath.

Anaphalis margaritacea (L.) Benth. & Hook. f. *7423*, 10b. Grows in dense colonies on compacted road shoulders. Probably an adventive species.

Antennaria dioica (L.) Gaertn. *7255*, 14a; *7395*, 10c; *7440*, 10b; *7613*, 4g; *7871*, 10a. Characteristic of frost scars and other areas of disturbed soil, but was not found above an altitude of 800 feet.

Antennaria pallida E. Nels. Cited by Tatewaki and Kobayashi (1934, p. 84) as *A. alpina* Gaertn.; Hultén (1960, p. 346) considered this citation to refer to *A. pallida* but did not cite a collection from Amchitka Island.

Arnica unalaschcensis Less. *7479*, 10b. Abundant on roadsides and disturbed soil of the *Empetrum* heath. Begins to flower in early August.

Chrysanthemum arcticum subsp. *arcticum* Hult. *7625*, 4a. Common throughout the island except at high altitudes. Begins to flower in late July.

Erigeron peregrinus subsp. *peregrinus* Hult. *7469*, 4a. The large pink flowers are showy and resemble some cultivated asters. Abundant and widespread; flowering from late July to mid-August.

**Hieracium gracile* var. *alaskanum* Zahn. *7433*, 10c. Not common; found only at altitudes of no more than 200 feet.

Hieracium triste Willd. *7561*, 11a. Not common; found only at altitudes above 300 feet.

**Petasites frigidus* (L.) Franch. *7624*, 4e; *7845*, 4b. Not common. Flowers the first of June, before the leaves are well developed.

Senecio pseudo-arnica Less. *7503*, 1a. Abundant on all sandy or pebbly beaches; at places forms dense stands of tall (as much as 1.3 m) succulent plants; never found inland. Flowers in mid-August.

Taraxacum trigonolobum Dahlstedt. *7491*, 3b. Usually grows in crevices of sea cliffs, but occasionally occurs on roadsides. Tatewaki and Kobayashi (1934, p. 89–90) described a new species, *T. aleuticum* Tatewaki & Kitamura, from Amchitka Island, but Hultén (1960, p. 366) considered it to be *T. trigonolobum*.

CORNACEAE

Cornus canadensis L. x *suecica* L. (See Hultén, 1960, p. 274–275.) No specimens of *Cornus* that matched Hultén's description of this hybrid were found.

Cornus suecica L. *7404*, 4a. Abundant in the moss and lichen mats at medium to low altitudes. Flowers in mid-June to early July and produces bright-red fruits abundantly.

CRUCIFERAE

Aphragmus eschscholtzianus Andrz. (See Hultén, 1960, p. 206.)

**Cardamine bellidifolia* L. *Erdman 567*, 12b. Rare; apparently restricted to unstable, nearly bare, rocky soil at high altitudes.

Cardamine umbellata Greene. *7474*, 10b; *7846*, 4b; *7903*, 3c; *7997*, 4e. Abundant in a wide variety of habitats at altitudes below 400 feet.

Cochlearia officinalis subsp. *oblongifolia* (DC.) Hult. *7614*. 3b. Occurs typically on the thin wet soil cover of coastal cliffs.

**Draba aleutica* Ekman. *7571*, 12b. Rare; apparently restricted to solifluction slopes, where it forms dense rosettes.

Draba hyperborea (L.) Desv. *7615*, 3b; *8022*, 3b. A characteristic species of crevices in sea cliffs. Flowers in June and July; the large petals are cream colored.

**Subularia aquatica* L. *8028*, 8b. Found flowering the middle of June in a shallow rock-bottomed pool. Petals of the minute stellate corolla are white on the upper side and light blue on the lower side.

CYPERACEAE

Carex anthoxanthea Presl. *7465*, 4b; *7657*, 6a. Grows on ridges in the *Empetrum* heath and in wet sedge meadows; nonstooling; never forms large colonies.

**Carex bigelowii* Torr. *7587*, 13a. Apparently very rare, occurring only in snow-bed communities. Tatewaki and Kobayashi (1934, p. 108) reported *C. rigida* Good. from Amchitka Island; this report probably should be referred to *C. bigelowii*.

Carex circinnata C. A. Mey. *7606*, 14b; *7891*, 12a; *8228*, 14b. This is one of two vascular plant species that can endure the most severe weather of mountain summits, and although it fruits very sparingly, at places it forms large colonies.

**Carex dioica* subsp. *gynocrates* (Wormsk.) Hult. *Klein 2710*, 4a. Found on a hummock in the center of a pond.

Carex kelloggii W. Boott. *7485*, 8a; *8031*, 8b. Commonly occurs in wet sandy soil at low altitudes, where it forms dense stools.

Carex lyngbyaei Hornem. *7451*, 6a; *7467*, 4a; *7473*, 4b; *7537*, 4c; *7658*, 6a; *8199*, 5b. Occurs in many different habitats at low altitudes and ranges in height from about 10 cm at unfavorable locations to nearly 2 m where growing in streamside alluvium.

Carex macrochaeta C. A. Mey. *7478*, 10a; *7610*, 14a. Widespread and abundant on the low plateaus.

Carex nesophila Holm. Questioned as occurring on Amchitka Island by Hultén (1960, p. 122–123) on the basis of the report of *C. macrochaeta* var. *subrigida* Kuek. *apud* Macoun by Tatewaki and Kobayashi (1934, p. 107).

Carex pluriflora Hult. *7536*, 4c; *7656*, 6a; *8221*, 13b. Common in the *Empetrum* heath.

Carex saxatilis subsp. *laxa* (Trautv.) Kalela. *7586*, 13a. Apparently rare; found only in a snow-bed community.

Carex stylosa C. A. Mey. *8185*, 4a. Found only in the *Empetrum* heath on the low plateaus.

Eriophorum russeolum subsp. *rufescens* (Anders.) Hyl. *7428*, 6a; *7534*, 8a; *7655*, 6a; *8026*, 6a. The heads range in color from white to slightly tawny. The rhizomes are deeply buried in a tough layer of fibrous peat.

Eriophorum russeolum var. *majus* Sommier. Collected on Amchitka Island by Hutchison (1937, p. 229) who wrote, "A very handsome species of bog-cotton with large pale golden tufts." This collection was identified by Hultén but was not recorded from Amchitka Island in his flora. The species was reported from Amchitka Island by Tatewaki and Kobayashi (1934, p. 110). It was not found during the present study, although especially sought.

**Trichophorum caespitosum* (L.) Hartm. *8283*, 4b. Found only in moss and lichen mats on the lower terrace at Chitka Cove.

DIAPENSIACEAE

***Diapensia lapponica* subsp. *obovata* (F. Schm.) Hult. *7570*, 12b; *Klein 2829*, 12a. This collection provides an important range extension for the species. Found growing among andesite pebbles of a wet solifluction slope and in a fell-field. The flowering season was past in mid-August.

EMPETRACEAE

Empetrum nigrum subsp. *nigrum* Hult. *7295*, 4a; *7535*, 4c; *8054*, 14a, *Erdman 547*, 4a. The most abundant and characteristic plant on the island. It flowers in early May, and on June 5 the green fruits were almost full size.

EQUISETACEAE

Equisetum arvense L. *7434*, 10c; *7495*, 2a; *7626*, 4a; *7914*, 10c. Abundant and widespread in many habitats, but best developed as colonies on sand dunes and disturbed mineral soil. The sporangia mature in early June and are produced in abundance.

ERICACEAE

Cassiope lycopodioides (Pall.) D. Don. *7254*, 14a; *7567*, 12a; *7852*, 12b; *8053*, 14a. Common in the *Empetrum* heath, but usually depauperate. At high altitudes it is a major component of the discontinuous heath patches. Flowers in June and early July.

Loiseleuria procumbens (L.) Desv. *7264*, 14a; *7867*, 10c. Common and well developed in the *Empetrum* heath; flowers profusely in mid-June.

**Rhododendron camtschaticum* subsp. *camtschaticum* Hult. *8216*, 12a. Apparently occurs only in small patches of heath near the mountain tops. Flowers in late July.

Vaccinium uliginosum subsp. *microphyllum* Lange. *8217*, 12a. Found only with *Rhododendron*; neither flowering nor fruiting.

Vaccinium vitis-idaea subsp. *minus* (Lodd.) Hult. *7296*, 4c. Most commonly occurs in moss mats of the *Empetrum* heath and on moss mounds. Flowers very sparingly and none was observed to bear fruits. Some leaves turn brilliant red and persist through the winter.

GENTIANACEAE

**Gentiana amarella* subsp. *acuta* var. *plebeja* (Cham. & Schlecht.) Hult. *7400*, 10a. Found only on a disturbed soil bank. The corolla is dull blue to lavender and is produced in early August.

**Gentiana aleutica* Cham. & Schlecht. *7862*, 10b; *7683*, 10b; *8191*, 14a. Two color forms occur together—one with white, the other with dull purple, corollas. Flowers in late July and early August.

GERANIACEAE

Geranium erianthum DC. (Hultén, 1960, p. 256, listed as a sight record only.) This very conspicuous plant was sought during the present study without success. If it occurs on this island now, it is rare. It was not found on Rat Island, but was common on Shemya Island.

GRAMINEAE

Agrostis alaskana Hult. *7515*, 4f. Found only on a peat bank near Constantine Harbor. Considered by Klein, in his discussion of plant species in this report, to be *A. borealis* Hartm.

**Agrostis borealis* Hartm. *8230*, 14b. Found only at altitudes above 900 feet.

**Agrostis exarata* Trin. *7438*, 2a; *7794*, 2a. The culms of this plant spread horizontally and are closely appressed to the sandy deposits on which they grow.

Alopecurus aequalis Sobol. *7460*, 8b; *Erdman 555*, 8a. Found only in shallow pools and other very wet locations.

Bromus sitchensis var. *aleutensis* (Trin.) Hult. *7492*, 2a. On sand and shell deposits at South Bight.

Calamagrostis nutkaënsis (Presl) Steud. *7213*, 4c; *7291*, 4c; *7294*, 4c; *7383*, 10a; *7519*, 3d; *7538*, 4c. The most common and widespread grass on the island. It forms almost pure stands on roadside banks, but is not abundant at high altitudes.

Deschampsia alpina (L.) Roem. & Schult. Cited from Amchitka Island by Tatewaki and Kobayashi (1934, p. 97). Hultén (1960, p. 85), however, doubted that this species occurs in Alaska.

Deschampsia beringensis Hult. *7475*, 4b; *8188*, 2a. Common in open areas of the *Empetrum* heath. The spikelets are purplish red. Considered by Klein, in the section on plant species in this report, to be *D. caespitosa* (L.) Beauv.

Deschampsia caespitosa subsp. *orientalis* Hult. *7412*, 8a Occurs at the margins of shallow pools, as well as on compacted roads.

Elymus arenarius subsp. *mollis* var. *mollis* Hult. *7289*, 2b; *7520*, 3d. Occurs in large stands only near the coasts, although single plants are widespread at low altitudes. At some locations it forms many dense cylindrical stools, as much as 0.5 m high, that are separated by narrow passages between the stools. The development of this unusual type of growth pattern was observed only on slopes and probably is caused by soil creep.

Festuca brachyphylla Schult. *7612*, 14a; *7999*, 14b. A coprophilous species on this island, found only on the summits of bird-perch mounds, where it forms a very dense turf. Considered by Klein, in his section on plant species in this report, to be *F. ovina* var. *brachyphylla* (Schult.) Piper.

**Festuca rubra* L. *7297*, 6a; *7408*, 4a; *7518*, 3d. Found in several habitats on the low plateaus.

Festuca rubra subsp. *aucta* (Krecz. & Bobr.) Hult. *7408*, 4a; *7463*, 4a; *8189*, 2a. Vegetative plants are abundant in the *Empetrum* heath; fruiting plants are not common in the heath, but are abundant at some sites of disturbed soil. Klein, in his section on plant species in this report, includes this form in the species listed above.

Hierochloë odorata (L.) Wahlenb. *7849*, 3d. Occurs as individual plants or small colonies in the *Empetrum* heath.

Phleum commutatum var. *americanum* (Fourn.) Hult. *7466*, 4a. Common in the *Empetrum* heath and on disturbed soil at low altitudes.

***Poa alpina* L. 8032, 10c. This collection represents an important range extension for this species. The specimens grew in the rocky soil of an old trail, and Hultén (written commun., 1968) remarked that they were "The smallest specimens I have seen." Klein, in his section on plant species in this report, placed *Poa hispidula*, *P. komarovii*, *P. lanata*, and *P. turneri* and their varieties in the *P. alpina* species complex.

**Poa arctica* subsp. *williamsii* (Nash) Hult. *7609*, 14a. Apparently a coprophilous plant. Found only on the summit of a bird-perch mound.

Poa eminens Presl. *7342*, 2a; *7493*, 2a; *8190*, 2a. The short blades are thick and rigid, and the entire plant light purple. Found only on the deposit of sand and shells at South Bight and on sand dunes near Crown Reefer Point.

Poa hispidula var. *aleutica* Hult. (See Hultén, 1960, p. 94–95.)

Poa hispidula var. *vivipara* Hult. (See Hultén, 1960, p. 95.)

Poa malacantha Kom. (*P. komarovii* Roshev., Hultén, 1960, p. 96).

**Poa lanata* Scribn. & Merr. *8187*, 2a. Found only on the deposit of sand and shells at South Bight.

**Poa lanata* var. *vivipara* Hult. *7566*, 12b. Found only in gravelly soil of a roadside ditch at an altitude of about 650 feet.

Poa turneri Scribn. *8186*, 10c; *Erdman 548*, 10c. Found only on rock rubble on an old road near Constantine Harbor.

Puccinellia langeana subsp. *alaskana* (Scribn. & Merr.) Sørens, *7504*, 3a; *7617*, 4d. Apparently a coprophilous species. Found only in drain channels of bird perches on the coastal cliffs and on the summits of bird-perch mounds.

Trisetum spicatum subsp. *alaskanum* (Nash) Hult. (See Hultén, 1960, p. 90.) Tatewaki and Kobayashi (1934) recognized both this taxon and the variety *molle* Scribn. & Merr. in the Amchitka Island flora.

Vahlodea atropurpurea subsp. *latifolia* (Hook.) Pors. *7464*, 4a; *8220*, 13b. Occurs in the *Empetrum* heath and in alpine meadows. Considered by Klein, in his section on plant species in this report, to be *Deschampsia atropurpurea* (Wahl.) Sheele.

Vahlodea atropurpurea subsp. *paramushirensis* (Kudo) Hult. (See Hultén, 1968, p. 115; Amchitka Island occurrence indicated by a dot on the distribution map.)

HALORAGACEAE

**Hippuris montana* Ledeb. *8227*, 13a; *8261*, 13a. This plant has the appearance of a *Galium* or a *Pogonatum;* the stems are about 10 to 15 cm long, but only the leafy part, about 1 to 4 cm long, protrudes from the mud. This plant was also found in a *Sphagnum* mat of a small mountain stream that issued from a spring.

Hippuris vulgaris L. *7627*, 7a. Common in lakes and pools at low altitudes; the leafy stems commonly emerge from the water, which can be as much as 1 m deep.

Myriophyllum spicatum L. (See Hultén, 1960, p. 268.) Not found during the present study, although extensively sought. Its superficial resemblance to the common *Ranunculus trichophyllus* may have caused it to be overlooked.

IRIDACEAE

Iris setosa subsp. *setosa* Hult. Reported to occur at Chitka Cove (sight record, by W. M. Klein).

ISOËTACEAE

Isoëtes muricata subsp. *maritima* (Underw.) Hult. *7373*, 7b; *7396*, 7b; *Erdman 575*, 7b. Found only in lakes, growing in water about 0.5 m deep. The plants are robust, with corms as much as 3 cm in diameter; many sporelings also were found.

Isoëtes sp. *8192*, 8c. A slender plant with only slight corm development; occurs in shallow rock-bottomed pools. Its aspect and habitat suggest that it may be a different taxon from that listed above.

JUNCACEAE

Juncus arcticus subsp. *sitchensis* Engelm. *7634*, 1a. A common species at wet sites; occurs at low to medium-high altitudes.

**Juncus biglumis* L. *7576*, 12b; *Erdman 579*, 12b. These collections are from unstable soil at high altitudes. The plants are from 1 to 8 cm high.

**Juncus ensifolius* Wikstr. *7685*, 8a; *7882*, 8a. Found only at pool margins at low altitudes. Even when sterile, plant can be recognized by its ensiform leaves.

**Juncus triglumis* subsp. *albescens* (Lange) Hult. *7484*, 8a; *8210*, 8a. A densely caespitose species that grows in shallow pools at low altitudes. The culms are about 15 cm high.

Luzula arcuata subsp. *unalaschcensis* (Buchenau) Hult. *7563*, 11a; *7608*, 14a; *8194*, 14a. Found only at altitudes above 600 feet.

Luzula multiflora subsp. *kobayasii* (Satake) Hult. *7461*, 10c. Found on disturbed mineral soil near Constantine Harbor.

Luzula multiflora subsp. *multiflora* var. *frigida* (Buchenau) Sam. *7419*, 10a; *7659*, 4a. Specimens of the *multiflora* complex are abundant on disturbed sites on the low plateaus.

Luzula parviflora subsp. *parviflora* Hult. *7472*, 10a; *7686*, 4e; *8030*, 10c. Found only at low altitudes on banks and roadsides; not common.

Luzula tundricola Gorodk. *7883*, 12a; *7907*, 12b; *7994*, 11a. Found only at altitudes above 1,100 feet in exposed fellfields and on solifluction terraces.

Luzula wahlenbergii subsp. *piperi* (Cov.) Hult. Amchitka Island occurrence shown on the distribution map by Hultén (1968, p. 297). Listed from this island as *L. divaricata* Watson by Tatewaki and and Kobayashi (1934, p. 112).

LEGUMINOSAE

Lathyrus maritimus subsp. *pubescens* (Hartm.) C. Regel. *7489*, 1a. Common on beaches and sand banks near the coasts; flowers and fruits are produced abundantly.

Lathyrus palustris subsp. *pilosus* (Cham.) Hult. Hultén (1960, p. 255) wrote, "Amchitka, according to Tatew. & Kobay." This report was verified by Hultén (1968, p. 673). Not found during the present study, although often sought.

Lupinus nootkatensis Donn. *7486*, 10b; *8044*, 5b; *8228*, 13b. An abundant and very showy plant, especially common along roadsides; occurs at all altitudes. Two colonies of plants found had pale-pink to nearly white flowers; these may be referred to f. *leucanthus* Lepage.

**Trifolium repens* L. One clone of this adventive plant was found on a disturbed site by W. L. Slauson and M. A. Heifner.

LENTIBULARIACEAE

Pinguicula vulgaris subsp. *macroceras* (Link) Calder & Taylor. *7414*, 5a; *Erdman 753*, 4b. Occurs only at low altitudes at very wet sites in the *Empetrum* heath.

LILIACEAE

Fritillaria camschatcensis (L.) Ker-Gawl. *Klein 2718*, 4e. Abundant in streamside communities throughout the low plateaus.

**Majanthemum dilatatum* (How.) Nels. & Macbr. *7866*, 4f. Found only on peat banks and is only locally abundant.

Streptopus amplexifolius (L.) DC. *7543*, 4e. Found only in streamside communities, but was not abundant at any location.

Tofieldia coccinea Richards. *7262*, 14a; *7410*, 4a. Common in a wide variety of habitats throughout the island.

LYCOPODIACEAE

Lycopodium alpinum L. *Keith 108*, 11a. Found only in moss and liverwort mats in a small stream.

Lycopodium annotinum subsp. *annotinum* Hult. *7236*, 5c; *7284*, 4a; *7680*, 4a; *Keith 107*, 4a. Locally abundant in the heath of the low plateaus.

Lycopodium clavatum subsp. *clavatum* Hult. *7283*, 4a; *7681*, 4a; *Keith 109*, 4a. Grows with the species listed above.

Lycopodium sabinaefolium var. *sitchense* (Rupr.) Fern. *7237*, 5c; *7263*, 14a. Found commonly on low-altitude bedrock outcrops.

Lycopodium selago subsp. *selago* Hult. *7253*, 14a; *7432*, 10c; *7870*, 4a. Widely distributed, although not abundant, throughout the island.

ONAGRACEAE

Epilobium behringianum Haussk. *7560*, 11a. Apparently common on the island; however, because of confusion in nomenclature with the following species, its abundance is not known with certainty.

Epilobium glandulosum Lehm. *7448*, 6a; *7547*, 4g. A robust plant as much as 40 cm high if growing in wet sedge meadows; much smaller if growing in the *Empetrum* heath.

Klein, in his section on plant species in this report, refers this species to *E. boreale* Haussk.

Epilobium sertulatum Haussk. *7436*, 10b; *7437*, 10b; *8039*, 5b. A low-growing plant occurring along roadsides and on disturbed soil. Plants at a site may either have green leaves and pale-pink flowers or be dark red throughout.

ORCHIDACEAE

Dactylorhiza aristata (Fisch.) Soó. *7417*, 3d; *8027*, 10b. A showy species that is locally common at low altitudes, especially on compacted mineral soil. The lip is pale magenta spotted with purple; other petals are deep lavender. One white-flowered specimen was found (*Klein 1744*).

Listera cordata var. *nephrophylla* (Rydb.) Hult. *7416*, 4a; *7679*, 4a. This very small orchid occurs as scattered individuals in the moss mat of banks in the *Empetrum* heath and in alpine meadows. Plants with either green or purplish-brown flowers grow intermixed.

**Platanthera chorisiana* (Cham.) Rchb. *7418*, 4a; *7497*, 14a; *8210*, 10c. Found only on lithosol or on sparsely vegetated mineral soil. The petals and sepals at anthesis are greenish yellow with narrow whitish margins; they soon become brown tipped or brown dotted and streaked.

Platanthera convallariaefolia (Fisch.) Lindl. *7426*, 4b. This and *P. dilatata* are common in wet places at low altitudes; usually both species occur intermixed. The flowers are green.

Platanthera dilatata (Pursh) Lindl. *7468*, 4a. Very similar to *P. convallariaefolia*, but has pure-white flowers. The flowers of Amchitka Island specimens are not fragrant, contrary to the report of Hutchison (1937, p. 231).

Platanthera tipuloides var. *behringiana* (Rydb.) Hult. (See Hultén, 1968, p. 323.)

PAPAVERACEAE

Papaver alaskanum Hult. Collected in the mountains of Amchitka Island; the specimen is preserved in the Colorado State University herbarium.

PLANTAGINACEAE

**Plantago macrocarpa* Cham. & Schlecht. *7427*, 6a. Occurs in wet sedge meadows on the low plateaus.

Plantago maritima subsp. *juncoides* (Lam.) Hult. *7660*, 5a; *7974*, 3b. Occurs in bogs and on soil of coastal cliffs.

POLYGONACEAE

**Koenigia islandica* L. *7574*, 12b; *Erdman 562*, 12b; *Erdman 577*, 12b. Found only on wet mineral soil of solifluction slopes at high altitudes.

**Oxyria digyna* (L.) Hill. *7582*, 13a. Rare; found only at high altitudes.

Polygonum viviparum L. *7435*, 10b; *7562*, 11a; *8218*, 13b. Widely distributed but nowhere abundant on the island.

Rumex fenestratus Greene. (See Hultén, 1960, p. 167–170.) Hutchison (1937, p. 232) reported this species to be "very luxuriant and fairly common on Amchitka."

**Rumex obtusifolius* L. *7544*. 1a. This European and Asiatic species is adventive in the Aleutian Islands (Hultén, 1960, p. 168). It occurs as isolated individuals on wet disturbed soil, usually in areas of human habitation.

POLYPODIACEAE

Athyrium filix-femina subsp. *cyclosorum* (Rupr.) Christens. *7517*, 3d; *7687*, 4e. The common tall fern of streamside communities; it also occurs widely scattered through the *Empetrum* heath.

Cystopteris fragilis subsp. *fragilis* Hult. *7690*, 4e; *7904*, 3c. Most common in crevices of the sea cliffs, but also occurs on shaded peat banks.

Dryopteris dilatata subsp. *americana* (Fisch.) Hult. *7688*, 4e. A tall fern that occurs sparingly in streamside communities.

Gymnocarpium dryopteris (L.) Newm. (See Hultén, 1960, p. 50, as *Dryopteris linneana* C. Chr.)

**Polypodium vulgare* subsp. *occidentale* (Hook.) Hult. *8268*, 4d. Found only at the base of a bird-perch mound above the Pacific Ocean cliffs near the entrance to South Bight. On February 8 the leaves were green and bore many sori, although the sporangia were empty.

Thelypteris limbosperma (All.) Fuchs. *8244*, 14b; *8245*, 13b. Found only at high altitudes; in alpine meadows or rock slides.

Thelypteris phegopteris (L.) Slosson. *8243*, 13b. Found only in alpine meadows.

PORTULACACEAE

**Claytonia arctica* Adams. *Klein 2820*, 12b. Found only in a fell-field community; occurs as scattered individuals. The corolla is white.

Claytonia sibirica L. *7406*, 4b. Very abundant, usually in wet locations; on low plateaus and in alpine meadows. Plants with white or pink petals occur together. The white-flowering form was named var. *albiflora* by Tatewaki and Kobayashi (1934, p. 34) and was reported from Amchitka Island.

**Montia fontana* subsp. *fontana* Hult. *7632*, 3b; *7684*, 9a; *8198*, 3b. Found only in cascades and on dripping sea cliffs.

PRIMULACEAE

Primula cuneifolia subsp. *saxifragifolia* (Lehm.) Sm. & Forrest. *7421*, 10a; *7430*, 4a; *7583*, 13a; *7848*, 10a; *7869*, 4a; *Erdman 551*, 14a. Occurs at all altitudes on the island and is most abundant on disturbed soil. Flowers in late May and early June on the low plateaus and in late July and early August at high altitudes. The variety *albiflora* Koidzumi was reported for Amchitka Island by Tatewaki and Kobayashi (1934, p. 72).

Trientalis europaea subsp. *arctica* (Fisch.) Hult. *7501*, 4a. Common in the *Empetrum* heath at low altitudes; flowers in mid-August. Tatewaki and Kobayashi (1934, p. 73–74) described the variety *aleutica* and designated the Amchitka Island specimen as the type. Hultén (1960, p. 298) considered this variety to be "a common form of the plant."

PYROLACEAE

**Pyrola asarifolia* var. *purpurea* (Bunge) Fern. *7611*, 4a. Only one plant was found, although the species was sought extensively. Flowers in mid-August.

**Pyrola minor* L. *8219*, 13b. Found only along streams in the mountains; locally abundant. Flowers the latter part of July.

RANUNCULACEAE

Anemone narcissiflora subsp. *villosissima* (DC.) Hult. *7413*, 3d; *7844*, 4a. One of the earliest flowering herbs, and very abundant and conspicuous throughout the low plateaus.

Caltha palustris subsp. *asarifolia* (DC.) Hult. *7200*, 6b; *7629*, 6b. Produces new leaves under water in November and December that emerge in early spring; fully developed leaves and flowers are present in early June.

Coptis trifolia (L.) Salisb. *7222*, 4a; *7628*, 4c; *8052*, 4a. The firm shiny leaves persist through the winter, some becoming red, and are replaced by new leaves at the time of flowering in late June.

**Ranunculus hyperboreus* subsp. *hyperboreus* Hult. *7429*, 7b. Found only by a small pool, growing on mud; flowers the first half of August.

Ranunculus occidentalis subsp. *insularis* Hult. *7909*, 12b. Common throughout the island, except at high altitudes.

Ranunculus occidentalis subsp. *nelsoni* (DC.) Hult. *7450*, 6a. Found only in wet sedge meadows.

Ranunculus reptans L. *7398*, 7b; *7399*, 7b; *Erdman 553*, 8b. Grows as a submersed or emergent aquatic, or on muddy lake shores. The leaf shape ranges from linear to spatulate, and is very similar to that of *Limosella aquatica*.

Ranunculus trichophyllus var. *trichophyllus* Hult. *7206*, 8a; *7444*, 9a; *7674*, 9a; *8266*, 9a. Grows submersed in rapidly flowing streams, in pools of wet sedge meadows, and in lakes.

ROSACEAE

Geum calthifolium Menzies. *7462*, 4a. Abundant on the *Empetrum* heath and in alpine meadows; flowers from late July to mid-August.

Geum macrophyllum subsp. *macrophyllum* Hult. *7449*, 6a. One of the few tall forbs on the island, reaching a height of 1 m at places. It may be an adventive species (Hultén, 1960, p. 247).

Geum pentapetalum (L.) Makino. *8215*, 13a. This low plant occurs only at high altitudes in wet snow-bed communities. The white flowers appear in mid-July.

Potentilla hyparctica Malte. *7572*, 12b; *7605*, 12b; *7993*, 12b. This species is restricted to unstable soil at high altitudes.

Potentilla egedii subsp. *grandis* (Torr. & Gray) Hult. *7630*, 10b. Found only on gravelly soil of a lake shore. Flowers in mid-August.

Potentilla villosa Pall. *7487*, 3c; *7913*, 3c; *8021*, 3c. A very conspicuous plant with silvery pubescent leaves and stems; the yellow flowers are produced from early June to mid-August. Found only on sea cliffs, where it is abundant.

Rubus chamaemorus L. *7409*, 4a. Abundant in the *Empetrum* mat; fruits freely, the fruits not yet ripe at the end of August.

Rubus arcticus subsp. *stellatus* (Sm.) Boiv. emend. Hult. *7405*, 4a; *7476*, 4g. The red flowers are produced the first week of August, but none that produced fruit was observed.

Sibbaldia procumbens L. *7411*, 4g; *7987*, 12a; *8029*, 10c. Occurs throughout the island; usually grows on disturbed mineral soil.

RUBIACEAE

**Galium aparinc* L. *8195*, 1a. Found only in ruderal habitats, usually in driftwood deposits.

Galium trifidum subsp. *columbianum* (Rydb.) Hult. *7652*, 1a; *7678*, 4a; *8045*, 6a. Found only at low altitudes; most common in deposits of driftwood or in wet sedge meadows near the ocean.

SALICACEAE

Salix arctica subsp. *crassijulis* (Trautv.) Skvortz. *7420*, 3d; *7551*, 14a; *7988*, 12a; *7996*, 11a; *Erdman 549*, 4a. The largest native woody plant on the island. The prostrate stems are as much as 0.5 m long and 1 cm in diameter. Widely distributed, but most abundant at sites near the ocean.

Salix cyclophylla Rydb. *7548*, 14a; *7851*, 12b; *7884*, 12a; *8209*, 4a. Widely distributed, but most abundant in patches of discontinuous heath at high altitudes.

Salix polaris subsp. *pseudopolaris* (Flod.) Hult. Collected on this island by Tatewaki and Takahashi, according to Hultén (1960, p. 161).

Salix rotundifolia Trautv. *7558*, 14a; *7885*, 12a; *7986*, 12a; *7998*, 11a; *Erdman 560*, 11a. Found only at altitudes of 800 feet or more; commonly grows with *S. cyclophylla*.

SAXIFRAGACEAE

**Leptarrhena pyrolifolia* (D. Don) Ser. *7584*, 13a; *8222*, 13a. Restricted to high-altitude snow beds; locally common. Flowers in mid-July.

Parnassia kotzebuei Cham. & Schlecht. *7477*, 8a; *8042*, 5b. Found only on wet mineral soil at low altitudes. Flowers from mid-July to mid-August.

Saxifraga bracteata D. Don. *7488*, 3b; *7616*, 3b; *7881*, 3b; *7912*, 3b. A common and characteristic plant of coastal cliffs.

**Saxifraga foliolosa* var. *foliolosa* Hult. *7579*, 12b. Rare; found only on wet solifluction slopes. The plant bears many bulbils in the branches of the inflorescence.

**Saxifraga hirculus* L. *8225*, 13a. Found only in moss and liverwort mats of snow beds. This is the only report of this species from the central and western Aleutian Islands.

Saxifraga punctata subsp. *insularis* Hult. *7445*, 4e; *7577*, 12b; *7578*, 12b; *7868*, 10c; *7985*, 4a; *8043*, 5b; *8224*, 12b; *Erdman 554*, 5b. Common and widespread, usually occurs in sheltered locations.

SCROPHULARIACEAE

**Castilleja unalaschcensis* (Cham. & Schlecht.) Malte. *Slauson*, 15c. Found growing with the introduced *Picea sitchensis* that is shown in figure 35.

**Limosella aquatica* L. *7221*, 7b; *7394*, 7b; *8200*, 5b. Was not found flowering. The vegetative organs are similar to those of *Subularia aquatica* and to submersed forms of *Ranunculus reptans*.

Mimulus guttatus DC. *7622*, 9a. Found flowering in late July to mid-August in shallow streams of the *Empetrum* heath and in cascades at the coastal cliffs.

Pedicularis chamissonis Stev. *7422*, 4a; *Erdman 552*, 6a. The large spikes of reddish-purple flowers, produced in

late July to early August, are conspicuous in the *Empetrum* heath.

**Rhinanthus minor* subsp. *borealis* (Sterneck) Löve. *7431*, 10c; *Erdman 574*, 6a. Grows in disturbed mineral soil at low altitudes; flowers in late July and early August.

Veronica americana Schwein. *7239*, 9a; *7446*, 9a; *7516*, 8a. Common along margins of swift streams. Flowers from late July until December, the latest flowers being produced entirely under water.

Veronica grandiflora Gaertn. *7986b*, 12a. A rare plant of high-altitude unstable lithosol. The dark-violet flowers are borne on very small plants in mid-June.

Veronica serpyllifolia subsp. *humifusa* (Dickson) Syme. *7403*, 8a; *7545*, 4g; *7581*, 13a; *8033*, 10c; *8041*, 5b. Abundant on mineral soil at low altitudes; flowers all summer.

Veronica stelleri Pall. *7499*, 14a; *Erdman 550*, 14a; *Erdman 561*, 12b. A small pubescent plant that grows on disturbed soil and lithosol. Bears lavender campanulate flowers from late July to mid-August.

SELAGINELLACEAE

**Selaginella selaginoides* (L.) Link. *7415*, 5a; *8191*, 8a. Found only as scattered plants on the low plateaus.

SPARGANIACEAE

Sparganium hyperboreum Laest. *7585*, 13a; *8193*, 8a. The plants are very slender and depauperate and grow on the mud at snow-bed sites and in shallow pools. Flowers sparingly in late July.

UMBELLIFERAE

Angelica lucida L. *7480*, 10b. A common plant of the *Empetrum* heath; flowers in early to mid-August.

Conioselinum chinense (L.) BSP. *7623*, 4e; *8197*, 3d. Occurs as scattered plants on banks and streamsides; flowers sparingly in late July and early August.

Heracleum lanatum Michx. *7635*, 1a. An abundant coarse plant of many habitats on the low plateaus.

Ligusticum scoticum subsp. *hultenii* (Fern.) Calder & Taylor. *7502*, 2c. Found only on soil banks at the top of sea cliffs; locally abundant.

VIOLACEAE

Viola langsdorffii Fisch. *7442*, 6a; *7498*, 14a; *7677*, 4a; *7847*, 4b. Common to locally abundant in the *Empetrum* heath and alpine meadows; flowers from early June to mid-August.

ANNOTATED LIST OF BRYOPHYTES

By HERMAN PERSSON[2] and HANSFORD T. SHACKLETTE

Duplicate packets of specimens cited in this list have been examined, and the species have been identified by me (Persson), except as noted. I (Persson, 1968) have also examined the entire collection of many specimens, if critical specimens were found in the duplicated packets, and have published an account of the new or otherwise noteworthy bryophytes from Amchitka Island. Many collections, especially of liverworts, are mixtures of several to many species; the same collection number is used for all members of each species that were segregated from the mixture.

In the list that follows, the collection numbers, in italics, following the species name are those of Shacklette, except as noted. The habitat and plant community in which a species was found, designated by numbers and letters as set forth in the section on the island and its vegetation, follow the collection numbers. The habitat notes and community assignments were provided by Shacklette. Species listed as newly reported for the Aleutian Islands (Persson, 1968) are preceded by one asterisk; those newly reported for Alaska are indicated by two asterisks.

I (Persson) am indebted to Dr. T. Amakawa, Shyukan High School, Fukuoka, Japan, for the determination of a *Plectocolea* that was in poor condition for study; to Dr. Eustace W. Jones, Oxford University, Oxford, England, for confirmation of my determinations of two *Anthelia* specimens; to Dr. N. Kitagawa, Nara University of Education, Nara, Japan, for confirmation of my determination of a *Cephaloziella* specimen and for determination or confirmation of some critical and poorly represented *Lophozia* specimens of the section Ventricosae; to Dr. Elsa Nyholm, Naturhistoriska Riksmuseum, Stockholm, Sweden, for determination of a *Sphagnum* specimen; to Dr. E. R. B. Little, Kingston Upon Hull, England, for naming two *Riccardia latifrons* specimens and confirming the determination of another; and to Dr. M. Mizutani, Hattori Botanical Laboratory, Obi-Nichinan-shi, Japan, for his critical study of a *Riccardia* specimen.

Identification of the Amchitkan hepatic specimens has been rather difficult because these plants often are represented only by single stems that creep through tufts of other bryophytes; this condition of growth is common in alpine and similar regions. In addition, the sterility of the bryophytes, particularly the hepatics, is especially pronounced in these specimens and doubtless is caused by the severe climate that is characteristic of the Aleutian Islands.

HEPATICAE

Order TAKAKIALES

TAKAKIACEAE

Takakia ceratophylla (Mitt.) Gro. [*Lepidozia ceratophylla* Mitt.]. 7591, 13a. Collected August 16, 1966, and first segregated from a packet of *Andreaea rupestris* by Dr. Howard Crum. This plant grew in a drain of a snow-bed community at an altitude of about 650 feet and was associated with large colonies of *Anthelia julacea*, *Scapania paludosa*, *Sphagnum compactum*, and other snow-bed bryophytes. Reported for Amchitka Island by Sharp and Hattori (1967), Hattori, Sharp, Mizutani, and Iwatsuki (1968), and Persson (1968).

[2] Paleobotaniska avdelningen, Naturhistoriska Riksmuseum, Stockholm, Sweden.

Order JUNGERMANNIALES

ADELANTHACEAE

Odontoschisma elongatum (Lindb.) Evans. *7338*, 4c. Found only on the summit of a small moss mound that developed on wet frost-heaved soil.

ANTHELIACEAE

Anthelia julacea (L.) Dum. *7235*, 5c; *7564*, 13a; *7592*, 13a; *7593*, 13a; *8011*, 14b; *8019*, 14b. A characteristic species of drains from snow-beds at high altitudes and very conspicuous because of the large gray colonies that it forms. Dr. E. W. Jones has kindly confirmed the determinations of Nos. 7592 and 7593.

CALYPOGEIACEAE

Calypogeia mülleriana (Schiffn.) K. Müll. *7261a*, 4f. On a shaded peat bank above a small stream in the *Empetrum* heath, with *Cephalozia media*, *Mnium glabrescens*, and *Peltigera canina*.

Calypogeia sphagnicola (Arn. & Perss.) Warnst. & Loeske. *7209*, 5a; *7214*, 4a; *7258*, 4c; *7341*, 4c; *7455*, 5a; *8281*, 12a. In bogs at low altitudes, intermixed with *Sphagnum capillaceum*, *S. magellanicum*, and *Riccardia latifrons* and on small moss mounds with *Dicranum elongatum*.

Calypogeia trichomanis (L). Corda. *7540*, 4b; *7862*, 4e. In the *Empetrum* heath, intermixed with *Oncophorus wahlenbergii*, *Diplophyllum albicans*, and *Gymnocolea inflata*.

CEPHALOZIACEAE

Cephalozia ambigua Massal, *7524*, 4f; *7564*, 13a; *8232*, 13b. On a peat bank in the *Empetrum* heath, intermixed with *Mnium glabrescens*, *Lophozia* cf. *groenlandica*, *Dicranella heteromalla*, *Nardia scalaris*, and *Scapania scandica*, and at altitudes of about 500 feet with *Lophozia alpestris* and *Nardia geoscyphus*.

Cephalozia biscuspidata (L.) Dum. *7258*, 4c; *7265*, 4f; *7300*, 10a; *7340*, 4c; *7386*, 10a; *7522*, 4f; *7526*, 4f; *7528*, 4f; *7564*, 13a; *7688*, 4f; *7670*, 4f; *7981* (cf.), 12a; *7978*, 4e; *8233*, 4e; *8235*, 13b; *8262*, 4f. One of the most common leafy liverworts on the island; grows in a wide variety of habitats. It is the principal component of the pendant bryophyte colonies of a peat bank shown in figure 14.

Cephalozia leucantha Spruce. *7242*, 4c; *7258*, 4c; *8281*, 14b. Found on the summits of moss mounds, intermixed with *Dicranum elongatum*, *D. groenlandicum*, *Microlepidozia makinoana*, *Cephalozia bicuspidata*, *Anastrophyllum sphenoloboides*, and *Sphenolobus minutus;* also found on bedrock outcrops.

Cephalozia media Lindb. *7261a*, 4c; *8087*, 4e; *8091*, 4e; *8275*, 4e. Found on shaded peat banks, intermixed with *Mnium glabrescens*, *Calypogeia mülleriana*, and *Peltigera canina*.

Cephalozia pleniceps (Aust.) Lindb. *7874*, 4f; *7899*, 12a; *8264*, 4f. Found on peat banks and in a mixture of leafy liverworts from a fell-field community.

CEPHALOZIELLIACEAE

Cephaloziella arctica Bryhn & Douin. *7300*, 4g; *7345*, 2b; *7640*, 3b; *7641*, 3b; *7642*, 3b; *7643*, 3b; *7644*, 3b; *7673*, 4f. Grows as dense polsters on sandy banks above the seashore and in wet crevices of breccia sea cliffs, intermixed with *Bryum lapponicum*, *Schistidium maritimum*, *Barbulacylindrica*, and *Bartramia ithyphylla*.

HERBERTACEAE

Herberta adunca (Dicks.) Gray [*H. hutchinsiae* (Gottsche & Rabenh.) Evans]. *7567a*, 12b. Found only at the base of a boulder on a solifluction terrace, with *Tritomaria quinquedentata*, *Marsupella emarginata*, *Diplophyllum albicans*, and *Jungermannia atrovirens*.

JUNGERMANNIACEAE

Jungermannia atrovirens Dum. *7567a*, 12b. Found only on a wet solifluction terrace, growing with *Herberta adunca* and its associated species.

Jungermannia sphaerocarpa Hook. *8208*, 5b. Found only on ridges in wet sandy soil, mixed with *Pogonatum urnigerum*, *Lophozia* cf. *groenlandica*, and *Dicranella subulata*.

Mylia anomala (Hook.) Gray. *7564*. 13a. Found only in a drain channel at an altitude of 650 feet near Chitka Point, intermixed with *Sphagnum papillosum*, *S. squarrosum*, *Anthelia julacea*, *Cephalozia ambigua*, *Pellia neesiana*, *Gymnocolea inflata*, *Lophozia alpestris*, and *Cephalozia bicuspidata*.

Mylia taylori (Hook.) Gray. *7335*, 4c; *7338*, 4c; *7424*, 4b. Found only on moss mounds in the *Empetrum* heath and in wet areas of the heath, where it formed tufts with *Lophozia* cf. *groenlandica* and *Orthocaulis binsteadii*.

Nardia compressa (Hook.) Gray. *8282*, 13a. Found only on the bottom of a snow-bed pool, where it formed a dense polster.

Nardia geoscyphus (DeNot.) Lindb. *8232*, 13b; *8235*, 13b. Found inly in alpine meadows; grows with *Lophozia opacifolia*.

Nardia scalaris (Schrad.) Gray. *7265*, 4f; *7300*, 4g; *7359*, 2b; *7375*, 14a; *7387*, 10a; *7389*, 8a; *7523*, 4f; *7524*, 4f; *7526*, 4f; *7593*, 13a; *7667* 4f; *7668*, 4f; *7841*, 4f; *7842*, 4f; *7877*, 4f; *7879a*, 4f; *8036*, 10c; *8050*, 6a; *8232*, 4e; *8233*, 4e; *8358*, 4f. Abundant in many habitats.

Plectocolea cf. *obovata* (Nees) Mitt. *7525*, 4f. Found only in a peat bank community. I (Persson) had, with hesitation, identified this specimen as *P. obovata*. This specimen was examined by Doctor Amakawa (written commun., 1968), who expressed his opinion that is must belong to this species.

LEPIDOZIACEAE

Bazzania tricrenata (Wahlenb.) Trevis. *7227*, 4c. *7341*, 4c. Found only on moss mounds in the *Empetrum* heath.

Microlepidozia makinoana (St.) Hatt. [*Lepidozia trichocladus* K. Müll. *Microlepidozia silvatica* (Evans) Jörg.]. *7242*, 4c; *7261a*, 4g; *7341*, 4c; *7343*, 4a. Found only in the *Empetrum* heath.

LOPHOCOLEACEAE

Chiloscyphus pallescens (Ehrh.) Dum. *7177*, 9a; *7179*, 9a; *7202*, 4g; *7288*, 9a; *7391*, 8a; *7857*, 4e. Forms mats in shallow rapid streams with *Brachythecium asperrimum;* also grows on frost scars with *Scapania paludosa*, and along pool banks in the *Empetrum* heath.

Lophocolea cuspidata (Nees) Limpr. *7352*, 2b; *7353*, 2b; *7639*, 3b; *7644*, 3b; *7863*, 13a. Grows as pure colonies or intermixed with *Plagiothecium roeseanum* on sandy banks above the seashore; also in crevices of wet breccia sea cliffs, and with *Rhytidiadelphus squarrosus* and *Radula polyclada* in a stream margin at Bird Cape.

LOPHOZIACEAE

****Anastrophyllum sphenoloboides*** Schust. (See Schuster, 1969. p. 741.) *7242*, 4c; *7243*, 4c; *7258*, c. per., 4c. Found only at the summits of small moss mounds, intermixed with *Dicranum groenlandicum*, *Cephalozia leucantha*, and *Microlepidozia makinoana*. This species was represented in the entire material by only a few stems scattered through tufts of other bryophytes. I (Persson), with hesitation, identified it as *Lophozia porphyroleuca* (Nees) Schiffn.; the leaves were similar to those of the latter species, and the trigons of the leaf cells were very prominent. Later, I found a fertile stem with a perianth in one of the specimens (No. *7258*). Dr. N. Kitagawa (written commun., 1968) examined this specimen and wrote, "Shacklette No. *7258*, which was identified by you as *Lophozia porphyroleuca*, seems to be very different from the latter species in the brownish coloration of the plants, the rounded leaves (not longer than wide), and especially in the *paroicous* inflorescence. I have never before seen such a species. I think that it is a new species related to *Isopaches bicrenatus*, from which it differs chiefly in the female bract and the perianth mouth. However, the material is too scanty to describe a new species."

Several weeks later, Dr. Kitagawa, while examining specimens in Dr. Sinske Hattori's herbarium, discovered that the Amchitkan hepatic was a species of *Anastrophyllum* which Dr. Rudolph M. Schuster had discovered earlier in northern Greenland. Dr. Schuster (written commun., 1968) examined the fertile specimen (Shacklette No. *7258*) and confirmed Dr. Kitagawa's identification of it.

Gymnocolea inflata (Huds.) Dum. forma. *7338*, 4c; *7540*, 4b; *7564*, 13a. On wet areas in the *Empetrum* heath, intermixed with *Oncophorus wahlenbergii*, *Calypogeia trichomanes*, and *Diplophyllum albicans*, and in drain channels at an altitude of 650 feet.

In my first report of these collections from Amchitka Island (Persson, 1968), I referred them to *Gymnocolea acutiloba* (Kaal.) K.M. After a renewed study of the extremely polymorphous *Gymnocolea inflata* complex, I have formed the opinion that *G. acutiloba* represents only a modification of *G. inflata;* this opinion is shared with several other taxonomists.

The Amchitkan form seems to resemble even more closely the form that Kitagawa (1966), in his monograph of Japanese Lophoziaceae, called *G. marginata* (St.) Hatt., under which he placed the entire material of Japanese *Gymnocolea* and stated that this taxon is endemic to Japan (Hokkaido, Honshu, and Kyushu). The synonyms that he gives are of interest: *Sphenolobus marginatus* St., 1917; *Cephalozia montana* Horik., 1932; *Gymnocolea montana* (Horik.) Hatt., 1948; *Gymnocolea inflata* (Huds.) Dum. subsp. *montana* (Horik.) Hatt., 1958; and *Gymnocolea montana* (Horik.) Hatt. var. *acuta* Hatt. According to Kitakawa (1966, p. 113), the species grows "on muddy soil and mires at high altitudes."

I have studied good material of the Japanese *Gymnocolea* and, with Kitagawa, have observed that it is possible to find forms in some specimens which, according to Kitagawa (1966, p. 113). ". . . are quite similar to *G. inflata*, another polymorphic species." Kitagawa (1966, p. 111–112) also stated, "*Gymnocolea* contains only three species, *G. inflata*, *G. acutiloba*, and *G. marginata*, all of which range from the arctic to temperate regions in the Northern Hemisphere. They are all polymorphic and related so closely to each other that *G. acutiloba* and *G. marginata* could be regarded as varieties or subspecies of *G. inflata*." He added (1966, p. 113), "However, most forms including the type specimens of *G. marginata* and *G. montana* are rather definitely different from *G. inflata* in the following features: The plants are less flaccid, the leaves are broader and more or less concave (sometimes even canaliculate), and the leaves are rather regularly arranged (leaves on a shoot spread at similar angles) and dorsally secund. These differences seem to be sufficient to make *G. marginata* specifically distinct from *G. inflata*."

The Amchitkan *Gymnocolea* (the first report of this genus in the Aleutian Islands) has the broad, more or less concave leaves of the Japanese form. With the form that has been called *G. acutiloba*, it shares the only important character of this taxon—the fairly acute leaf lobes. It is noteworthy that Hattori (1958) described a variety *acuta* of *G. montana* which Kitagawa (1966) placed as a synonym of *G. marginata* but otherwise did not describe. The Aleutian form differs from both *G. acutiloba* and *G. marginata* in the distinctly stronger walls, especially at the corners, of its leaf cells. The broad leaves, as found in the Amchitkan material, are occasionally found also in European specimens; the only leaf of *Gymnocolea inflata* which Macvicar (1960) illustrated in his well-known hepatic flora of Great Britain could as well have been taken from a figure of the Japanese *Gymnocolea*. The floras also commonly note that the leaves can be concave and even canaliculate. Because the habitat of *G. inflata* ranges from xerophytic to very hydrophytic, the species is extremely variable. Apart from the more commonly used handbooks and floras, the work of Jörgensen (1934) on the hepatics of Norway is recommended for his treatment of the ecology and taxonomy of *G. inflata*. Unfortunately, this outstanding study of northern hepatics is written in Norwegian and, therefore, is too little known outside Scandinavia.

Gymnocolea inflata is widely distributed in the Northern Hemisphere; it is found, among other places, in Siberia, Greenland, and Iceland. In North America it occurs throughout the continent; its northernmost known locality in Alaska is Mount McKinley National Park, and it is also reported from Yukon Territory.

In summarizing, I consider the *Gymnocolea inflata* complex to be extremely plastic, and I believe that other taxa in the genus probably will prove to be environmental modifications. Experiments in the growth of these taxa on substrates of different pH, possibly in water culture, would be of great interest, especially because *G. acutiloba* is generally regarded as one of the so-called copper mosses.

Lophozia alpestris (Schleich.) Evans, *7524*, 4f; *7564*, 13a; *7593*, 13a; *7665*, 6a; *8232*, 13b; *8233*, 13b; *8234*, 13b; *8235*, 13b. Commonly occurs in alpine meadows or snowbed communities, but it was also found in a wet sedge meadow with *Pellia neesiana* and on a peat bank.

Lophozia cf. *groenlandica* (Nees) Bryhn. *7424*, 4b; *7425*, 4b; *7524*, 4f; *7525*, 4f; *7528*, 4f; *8018*, 14b; *8202*, 5b. Most common on the low plateaus but also found on a high-altitude bedrock outcrop. No. *7525* was named by Dr. Kitagawa, who also studied No. *7528* and agreed with me (Persson) on its identification. Kitagawa (written

commun., 1968) wrote that the specimens "agree well with [R.M.] Schuster's description of the species, except for the somewhat larger leaf cells."

**Lophozia incisa* (Schrad.) Dum. (See Persson, 1968.) *7879*, 4f; *8018*, 14b; *8019*, 14b; *8285*, 8c. Found on peat banks and andesite rock outcrops at both high and low altitudes.

***Lophozia opacifolia* Culmann. (See Persson, 1968.) *8233*, 13b; *8234*, 13b; *8235*, 13b. Found only on wet soil by a stream in an alpine meadow, intermixed with *Lophozia alpestris*, *Nardia geoscyphus*, and *Cephalozia bicuspidata*.

Lophozia cf. *wenzelii* (Nees) Steph. *7556*, 14a; *7568*, 12a. (Specimen *7568* was identified by Dr. Kitigawa.) Found in patches of turf on a solifluction terrace and on a high-altitude bedrock outcrop.

Orthocaulis binsteadii (Kaal.) Buch. *7338*, 4c; *7340*, 4c; *7341*, 4c; *7424*, 4b; *7425*, 4b; *8281*, 14b. Found in the *Empetrum* heath, usually intermixed with many other bryophytes on moss mounds, and on a high-altitude bedrock outcrop.

Orthocaulis floerkei (Web. & Mohr) Buch. *8262*, 4f. Found only on a peat bank above a small spring at Chitka Cove.

Sphenolobus minutus (Crantz) Steph. *7241*, 4c; *7242*, 4c; *7244*, 4c; *7341*, 4c; *8281*, 14b. Found on moss mounds in the *Empetrum* heath and on high-altitude bedrock outcrops.

***Sphenolobus saccatulus* (Lindb.) K.M. 1906–14 [*Jungermannia minuta* var. *grandis* Gottsche Mss.; *J. rigida* Lindb. *β grandis* Lindb. 1879; *J. saccatula* Lindb. 1883; *Cephaloziopsis saccatula* Schffn. 1893; *Sphenolobus minutus* var. *grandis* S. Arn. & O. Mårtensson 1959]. *7424*, 4a. Found in the *Empetrum* heath in tufts of *Pogonatum alpinum*, intermixed with *Lophozia* cf. *groenlandica*, *Mylia taylori*, and *Orthocaulis binsteadii*. This is the first report of the occurrence of this species in North America.

Tritomaria quinquedentata (Huds.) Buch. *7569*, 12b; *7567a*, 12b. Occurs as small round polsters on loose unstable soil among the pebbles of solifluction slopes.

MARSUPELLACEAE

Gymnomitrion corallioides Nees. *7554*, 11a; *7594*, 14b; *Erdman 612, 11a*. Found as single polsters on almost bare, rocky soil of the discontinuous heath habitat and on high-altitude rock mounds.

Marsupella emarginata (Ehrh.) Dumort. *7220*, 8a; *7234*, 5c; *7567a*, 12b; *7569*, 12b; *7854*, 4e. Found as extensive colonies in a *Philonotis-Parnassia* bog, and common in smaller quantities at many other sites.

PTILIDIACEAE

Ptilidium ciliare (L.) Nees. *7338*, 4c. Found at only one location—on a moss mound. Surprisingly, this conspicuous liverwort was not found at other locations; apparently, it is actually rare on the island.

RADULACEAE

Radula polyclada Evans. *7863*, 13a; *7864*, 13a. Found only at the margin of a small stream at Bird Cape, with *Rhytidiadelphus squarrosus* and *Lophocolea cuspidata*.

SCAPANIACEAE

Diplophyllum albicans (L.) Dum. *7241*, 4f; *7334*, 4g; *7392*, 8a; *7540*, 4b; *7567*, 12a; *7569*, 12b; *7593*, 13a; *7900*, 12a; *7978*, 4e; *8016*, 14b; *8019*, 4d; *8280*, 14b. Grows in a wide variety of habitats, usually as single stems intermixed with other bryophytes.

Diplophyllum taxifolium (Wahlenb.) Dum. *7853*, 12a. Found only in a volcanic rubble fell-field.

Macrodiplophyllum plicatum (Lindb.) H. Perss. (See Persson, 1968.) *8010*, 4d; *8016*, 4d; *8017*, 4d; *8020*, 4d. Found on an andesite bird-perch mound at an altitude of 950 feet.

Scapania irrigua (Nees) Dum. *7482*, 4b; *8264*, 9a. Grows on wet peat banks and in small drain channels in peat.

Scapania paludosa K. Müll. *7202*, 4g; *7217*, 13a; *7219*, 5c; *7225*, 4b; *7226*, 4b; *7459*, 8c; *7589*, 13a; *7864*, 4e; *8212*, 8a. Occurs at wet locations on the *Empetrum* heath; at places forms mats in small pools that support *Siphula ceratites;* also in snow-bed communities.

Scapania scandica (Arn. & Buch) Macvic. *7265*, 4f; *7524*, 4f; *7525*, c. per., 4f; *7879*, 4f; *7999*, 12a. Found in a peat-bank community, associated with *Mnium glabrescens*, *Cephalozia ambigua*, and *Lophozia* cf. *groenlandica;* on an almost bare peat and soil bank with *Pogonatum urnigerum*, *Cephalozia bicuspidata*, and *Nardia scalaris;* and in a fell-field community.

Scapania subalpina (Nees) Dum. *8293*, 7b. Found only in a rock-bottomed pond; grows submersed with *Limosella aquatica*.

Scapania undulata (L.) Dum. *7287*, 9a; *7288*, 9a; *7390*, 8a; *7856*, 4e. Found in water of small pools with *Nardia scalaris* and *Chiloscyphus pallescens*, and in streams with *Brachythecium asperrimum* and *Chiloscyphus pallescens*.

Order METZGERIALES

ANEURACEAE

Riccardia latifrons Lindb. *7338*, 4c; *7455*, 5a. On a small moss mound, with *Ptilidium ciliare*, *Mylia taylori*, *Odontoschisma elongatum*, and *Orthocaulis binsteadii;* also found in a bog with *Sphagnum magellanicum*, *S. squarrosum*, and *S. teres*. Dr. E. R. B. Little (written commun., 1968) wrote, "No. *7338* is good *Riccardia latifrons*, and I am almost sure that No. *7455* is the same species."

Riccardia pinguis (L.) Gray. *7185*, 8a; *7199*, 4e; *7593*, 13a. Occurs in very wet locations at pool and stream margins and in drains of snow beds.

Riccardia sinuata (Dum.) Trevis. *7201*, 4g. Found on wet mineral soil of a frost scar in the *Empetrum* heath. The determination of this specimen was confirmed by Dr. E. R. B. Little and also, with some hesitation, by Dr. M. Mizutani.

BLASIACEAE

Blasia pusilla L. *7667*, 4f. Found only in a peat-bank community with *Nardia scalaris*, *Dicranella subulata*, and *Cephalozia bicuspidata*.

DILAENACEAE

Pellia neesiana (Gottsche) Limpr. *7564*, 13a; *7665*, 6a. Found in wet sedge meadows with *Lophozia alpestris* and in snow-bed communities with *Sphagnum papillosum*, *S. squarrosum*, *Anthelia julacea*, *Mylia anomala*, and other bryophytes.

Order MARCHANTIALES

CONOCEPHALACEAE

Conocephalum conicum (L.) Dum. *7198*, 4e. Found only in streamside communities on sheltered banks in the *Empetrum* heath; easily identified in the field by its spicy odor after it has been crushed.

MARCHANTIACEAE

Marchantia polymorpha L. *7285*, 3b; *7402*, 8a; *7604*, 10b. Not common; found only on the mud bottom of a drained pool, in an open steel barrel, and on thin soil of coastal cliffs.

SPHAGNOBRYA

SPHAGNACEAE

Sphagnum capillaceum (Weiss) Schrank. *7214*, 4a. Found only near the base of a moss mound in the *Empetrum* heath.

Sphagnum compactum Lam. & DC. *7590*, 13a; *7676*, 8c; *7872*, 4f; *7970*, 5a; *7992*, 12b; *8236*, 13a. Found in the drain of a snow bed, and on wet soil in the *Empetrum* heath.

Sphagnum girgensohnii Russ. *7662*, 6a; *7858*, 4e. A principal component of bogs on the low plateaus.

Sphagnum lindbergii Schp. *8237*, 13b; *8238*, 13b. Found only in small streams of the alpine meadows.

Sphagnum magellanicum Brid. *7453*, 5a; *7455*, 5a; *8236*, 13b. A component of bogs on the low plateaus; also found in small streams of alpine meadows.

Sphagnum papillosum Lindb. *7564*, 13a; *7661*, 6a; *7663*, 5a; *7672*, 4f; *7969*, 5a. Most common at high altitudes in drains from snow beds, but also found on wet peat banks and wet sedge meadows of the low plateaus. Dr. Elsa Nyholm kindly determined specimen No. *7969*.

Sphagnum squarrosum Sw. *ex* Crome. *7452*, 5a; *7564*, 13a; *7661*, 6a; *8293*, 7b. A principal component of bogs on the low plateaus; also found in wet sedge meadows and in snow-bed communities.

Sphagnum subsecundum Nees *ex* Sturm. *7215*, 4a. Found only near the base of a moss mound in the *Empetrum* heath.

Sphagnum teres (Schimp.) Ångstr. *ex* C. Hartm. *7454*, 5a; *7663*, 6a; *8260*, 4e. Abundant in bogs and wet sedge meadows of the low plateaus; usually bright green in color.

ANDREAEOBRYA

ANDREACEAE

Andreaea rupestris Hedw. *7192*, 11b; *7256*, 14a; *7363*, 2c; *7591*, 13a; *7893*, 12b; *8280*, 14b. Found at all altitudes; usually grows on rocks, but at places in the mountains it forms mats in streams of alpine meadows and in snow-bed drains (Shacklette, 1966).

EUBRYA

AMBLYSTEGIACEAE

Amblystegium serpens (Hedw.) B.S.G. *8203*, 5b; *8204*, 3d. Found on a turf bank above the beach near Makarius Bay, growing with *Leptobryum pyriforme* and *Bryum stenotrichum;* also found in a wet sandy borrow pit with *Philonotis americana.*

Calliergon sarmentosum (Wahlenb.) Kindb. *8047*, 4e. Found on a concrete spillway at a large spring near Makarius Bay.

Campylium stellatum (Hedw.) C. Jens. *7975*, 4e; *8212*, 8a. Submerged in a small pool in the *Empetrum* heath, growing with *Drepanocladus revolvens* and *Scapania paludosa;* also found at the margin of a small stream in the heath.

Cratoneuron filicinum (Hedw.) Spruce. *7636*, 1a; *7644*, 3b; *7645*, 3b; *7647*, 3b; *7983*, 3b. Found on dripping sea cliffs, commonly with *Ulota phyllantha, Bryum lapponicum, Schistidium maritimum,* and *Platydictya jungermannioides;* also found at other sites on the seashore.

Drepanocladus fluitans (Hedw.) Warnst. *8284*, 6a. Found only in wet moss-lichen mats with *Polytrichum longisetum,* on the lower terrace at Cyril Cove.

Drepanocladus revolvens (Sw.) Warnst. *7219*, 13a; *7226*, 5c; *7567a*, 12a; *7975*, 13b; *8212*, 8a. Occurs at pool margins, in streams from snow beds and alpine meadows, and in fell-fields on the mountain summits.

Drepanocladus uncinatus (Hedw.) Warnst. *7188*, 11b; *7189*, 11b; *7249*, 14a; *7327*, 4c; *7358*, 2c; *7380*, 10c; *7567a*, 12b; *7887*, 12a; *7973*, 15b; *8006*, 4d; *8007*, 4d. Abundant in many different habitats and distributed throughout the island.

Hygrohypnum bestii (Ren. & Bryhn *ex* Ren.) Holz. *ex* Broth. *7178*, 9a; *7621*, 9a; *8048*, 9a. Found only at the margins of, or submersed in, swift streams on the low plateaus, commonly growing with *Hygrohypnum ochraceum, Brachythecium asperrimum,* and *Chiloscyphus pallescens.*

Hygrohypnum ochraceum (Turn. *ex* Wils.) Loeske. *7178*, 9a; *8269*, 9a. Found associated with the species listed above; also found with *Bryoerythrophyllum recurvirostrum* on a limonite deposit in a small stream.

Platydictya jungermannioides (Brid.) Crum. [*Amblystegiella sprucei* (Bruch) Loeske]. *7180*, 3b; *7182*, 3b; *7646*, 3b; *8275*, 4e. Occurs in crevices and under small rock shelves of breccia sea cliffs, at two locations growing with *Mielichhoferia macrocarpa* (Shacklette, 1967); also found on soil at the margin of a small stream in the heath.

AULACOMNIACEAE

Aulacomnium palustre (Hedw.) Schwaegr. *7231*, 5c; 7233, 5c; *7402*, 8a; *7482*, 6a; *7663*, 6a; *7850*, 6a. A common moss in *Sphagnum* bogs, wet sedge meadows, and liverwort mats in streams.

BARTRAMIACEAE

Bartramia ithyphylla Brid. *7641*, 3b. Found only on thin soil over breccia sea cliffs.

Conostomum tetragonum (Hedw.) Lindb. *7594*, 14b; *8231*, 12a. Found as small polsters on unstable rocky soil and bedrock mounds at high altitudes.

Philonotis americana Dism. *7441*, 10b, *7457*, 5a; *7482*, 6a; *8201*, 5b. Found in a wet sandy borrow pit, near Makarius Bay, where it formed a dense mat over a large area; also found on wet soil of a roadside ditch and in a wet sedge meadow.

Philonotis fontana (Hedw.) Brid. *7202*, 4g; *7203*, 4g; *7217*, 5c. On wet disturbed mineral soil, commonly forming large mats.

BRACHYTHECIACEAE

****Brachythecium acutum** (Mitt.) Sull. (See Persson, 1968.) *7380*, 10c; *7850*, 4a; *7973*, 15b. Found in *Empetrum* mats near Constantine Harbor, on broken macadam runways, and on wet boards in a World War II building.

Brachythecium albicans (Hedw.) B.S.G. *7189*, 11b; *7358*, 2c; *7381*, 10c; *7981*, 4d; *8002*, 12b; *8291*, 4f. Commonly found on sparsely vegetated rocky or sandy soil, with *Rhacomitrium lanuginosum*, *R. ericoides*, *Drepanocladus uncinatus*, and *Ceratodon purpureus*, but may also be found in other habitats.

Brachythecium asperrimum (Mitt.) Sull. *7177*, 9a; *7224*, 5c; *7287*, 9a; *7343*, 4a; *7380*, 10c; *7456*, 5a; *7691*, 9a; *7860*, 9a; *7983*, 9a. Occurs in a wide variety of habitats on the low plateaus.

Eurhynchium praelongum (Hedw.) B.S.G. *7197*, 4e; *7216*, 3a; *7258*, 4c; *7269*, 3a; *7270*, 3a; *7271*, 3a; *7343*, 4a; *7350*, 2b; *7351*, 2b; *7355*, 2b; *7382*, 10c; *7649*, 3b; *7902*, 4e; *7973*, 15b; *7977*, 4e. This species is widespread at low altitudes and is usually abundant on sea cliffs. At places on the Pacific Ocean coast cliffs, it is the only bryophyte found.

BRYACEAE

***Anomobryum concinnatum** (Spruce) Lindb. [*A. filiformis* (Dicks.) Solms var. *concinnatum* (Spruce) Loeske]. (See Persson, 1968.) *7670*, 4f. Found only on a wet peat bank near Constantine Harbor, with *Cephalozia bicuspidata*, *Bryoerythrophyllum recurvirostrum*, *Pohlia nutans*, *Pogonatum urnigerum*, and *Bryum arcticum*.

***Bryum arcticum** (B. Br.) B.S.G. (See Persson, 1968.) *7673*, 4f. Found only in the community listed immediately above.

***Bryum pallens** Sw. *sens. lat.* *7855*, c. fr., 4e. Found only in a streamside community about 100 feet above sea level at Bird Cape, growing with *Mnium glabrescens*, *Plectocolea* cf. *obovata*, *Pohlia nutans*, and *Scapania undulata*.

Bryum pseudotriquetrum (Hedw.) Gaertn., Meyers & Scherb. *7199*, 4e; *7348*, 2b. Found at the margin of a small stream in the heath, growing with *Climacium dendroides* and *Riccardia pinguis;* also found on a sandy bank at the seacoast.

***Bryum lapponicum** Hag Kaur. [*B. salinum* Hag.] (See Persson, 1968.) *7542*, 3b; *7640*, 3b; *7650*, 3b. Apparently restricted to sea cliffs that are subjected to salt spray or waves.

Bryum stenotrichum C. Müll. [*B. inclinatum* (Brid.) Bland.]. *7281*, 12a; *7483*, 10a; *7565*, 15a; *7648*, 3b; *8035*, 10c; *8206*, 3d. This moss, with *Tetraplodon mnioides* and *Pleurozium schreberi*, grew on decomposed animal carcasses; it grows also on mineral and organic soil on Amchitka Island.

Leptobryum pyriforme (Hedw.) Wils. *8205*, 3d; *8286*, cf., 4g. Found on a soil-covered sea cliff at Makarius Bay, with *Amblystegium serpens* and *Bryum stenotrichum;* also found on mineral soil of a frost scar.

***Mielichhoferia macrocarpa** (Hook. *ex* Drumm.) Bruch & Schimp, *ex* Jaeg. & Sauerb. (See Persson, 1968.) *7181*, 3b; *7182*, 3b; *7541*, 3b; *8208*, 3b. Shacklette (1967) discussed this "copper moss" as it occurs on Amchitka Island, where it is found on sea cliffs, growing only on narrow rock strata that have a greater concentration of metals than that found in adjacent strata. This moss was first collected in Alaska on Sitkalidak Island by Eyerdam (Persson, 1968)—not on Amchitka Island, as erroneously stated by Shacklette (1967).

Pohlia annotina (Hedw.) Loeske. *8258*, 4f. Found only near Constantine Harbor, on a peat and soil bank.

Pohlia cruda (Hedw.) Lindb. *7354*, 2b; *7651*, 3b; *8264*, cf., 4f. Found near the seacoast on sandy soil, breccia cliffs, and peat banks.

Pohlia nutans (Hedw.) Lindb. *7300*, 10a; *7672*, 4f; *7899*, 12a; *7901*, 12a; *8018*, 14b. Found on soil and peat banks at low altitudes, commonly growing with *Pogonatum urnigerum* and *Ditrichum heteromallum*.

CLIMACIACEAE

Climacium dendroides (Hedw.) Web. & Mohr. *7194*, 4e; *7195*, 4e. Found at only one location—on wet soil by a small stream in the *Empetrum* heath. Apparently scarce; this distinctive moss is very easy to recognize in the field.

DICRANACEAE

Amphidium lapponicum (Hedw.) Schimp. *7183*, 3b. Found only at Cyril Cove, growing below a breccia shelf with *Pottia heimii*, a few feet above sea level.

***Aongstroemia longipes** (Sommerf.) B.S.G. *8051*, 6a. Found only in a wet sedge meadow near Makarius Bay.

Arctoa fulvella (Dicks.) B.S.G. *7853*, c. fr., 12a. In a high-altitude fell-field, growing with *Diplophyllum taxifolium* and *Rhacomitrium brevipes*.

Dichodontium pellucidum (Hedw.) Schimp. *7521*, 4f. On a wet peat bank at Constantine Harbor, growing with *Cephalozia bicuspidata*, *Dicranella heteromalla*, and other bryophytes.

Dicranella heteromalla (Hedw.) Schimp. *7524*, 4f; *7526*, 4f; *7528*, 4f; *7877*, 4f; *8050*, c. fr., 5b. Commonly found on wet peat banks; also found on wet sandy soil near Clevenger Lake.

Dicranella palustris (Dicks.) Crundw. *ex* E. F. Warb. [*Anisothecium squarrosum* (Stark.) Lindb.]. *7201*, 4g; *7205*, 4g; *7218*, 5c; *7588*, 13a; *7859*, 5c; *7984*, 5c. Found in a wide variety of habitats that range in altitude from the low plateaus to snow beds.

***Dicranella subulata** (Hedw.) Schimp. (See Persson, 1968.) *7385*, 10a; *7386*, 10a; *7668*, 4f; *8201*, 5b; *8203*, 5b. This moss is fairly common on the island, and it is surprising that it has not been found earlier in the Aleutian Islands.

Dicranum angustum Lindb. *7453*, 5a. Found only in a low-altitude bog, with *Sphagnum magellanicum*, *S. squarrosum*, and *S. teres*.

Dicranum elongatum Schleich. *ex* Schwaegr. *7258*, 4c; *7339*, 4c; *7340*, 4c; *8246*, 4d. A common species at the summits of moss mounds. It was found on one organic bird-perch mound, where it was abnormally dark green and very robust.

Dicranum fuscescens Turn. *7316*, 4c; *7333*, *4g*. Found on moss mounds, although it is not a common component of the mound flora, and on frost scars.

Dicranum groenlandicum Brid. *7242*, 4c. The dominant moss on the summits of some small moss mounds.

Dicranum howellii Ren. & Lesq. *7233*, 4a; *7252*, 14a; *7325*, 4c; *7326*, 4c; *7977*, 4e; *8003*, 12b. Very common in a wide variety of habitats. According to Persson (1968), probably all Aleutian collections named *D. scoparium* belong to this species.

Oncophorus wahlenbergii Brid. *7223*, 5c; *7333*, 4g; *7540*, 4b. This moss forms hard, black conical polsters in wet heath and in sedge meadows that can develop into small moss mounds 0.5 m in diameter and as much as 40 cm high. These polsters are saturated with water and freeze into hard icy lumps that one often stumbles over while walking on the otherwise resilient vegetation mat.

DITRICHACEAE

Ceratodon purpureus (Hedw.) Brid. *7280*, 10c; *7348*, 2b; *7359*, 2c; *7376*, 14a; *7378*, 10c; *7402*, 4b; *7483*, 10a; *8289*, 1a. Common on compacted soil and on concrete and macadam walks and roads; also found on peat deposits and other organic substrates.

Ditrichum heteromallum (Hedw.) Brid. *7300*, 10a; *8050*, c. fr., 5b. Found in a dense growth of *Calamagrostis nutkaënsis* on a roadside bank of mineral soil, and on wet sandy soil in a *Philonotis-Parnassia* community.

ENTODONTACEAE

Pleurozium schreberi (Brid.) Mitt. *7309*, 4a; *7317*, 4c; *7328*, 4c; *7514*, 15a; *7663*, 6a; *7664*, 6a. Very abundant as a component of the *Empetrum* heath mat.

FONTINALACEAE

Fontinalis neomexicana Sull. & Lesq. *7176*, 9a; *7240*, 9a; *7447*, 9a; *8207*, 9a. Grows submersed in swift clear streams of the *Empetrum* heath. The "fronds" are as much as 60 cm long, and some of them fruit abundantly.

GRIMMIACEAE

Rhacomitrium aciculare (Hedw.) Brid. 7186, 8a. Only one polster was found; it was growing with *Riccardia pinguis* on the bottom of a small pool that had been drained.

Rhacomitrium brevipes Kindb. *ex* Mac. *7853*, 12a; *8267*, 12a. One of the two polsters found had formed a dense cylindrical cushion about 8 cm high in a fell-field community, where it had entrapped much windblown silt.

Rhacomitrium ericoides Brid. [*R. canescens* (Hedw.) Brid. var. *ericoides* (Brid.) B.S.G.] *7357*, 2c; *7361*, 2c; *7279*, 10c; *7666*, 10a; *7890*, 12a. Not common; found on sand dunes near the coast (Shacklette, 1966), on hard soil of a gravel road, and in a fell-field community.

Rhacomitrium fasciculare (Hedw.) Brid. *7373*, 14a; *7508*, 3b; *7556*, 11a; *7873*, 4f; *8001*, 12b; *8280*, 14b. Found on sea cliffs, low- and high-altitude rock mounds, and solifluction terraces.

Rhacomitrium lanuginosum (Hedw.) Brid. *7190*, 11a; *7191*, 11b; *7207*, 4c; *7247*, 14a; *7251*, 14a; *7314*, 4c; *7315*, 4c; *7362*, 2c; *7372*, 14a; *7568*, 12b; *7889*, 12a; *7892*, 12a; *7901*, 12a; *7990*, 12a; *8020*, 4d. Very abundant throughout the island. Probably initiates mound formation more commonly than any other moss on the island.

Schistidium apocarpum (Hedw.) B.S.G. [*Grimmia apocarpa* Hedw.]. *7366*, 2c. Unattached polsters of a spheroidal shape that were composed of this species were described from Amchitka Island (Shacklette, 1966), growing on a pebbly sand dune near Cyril Cove.

Schistidium maritimum B.S.G. [*Grimmia maritima* Turn.]. *7267*, 3a; *7272*, 3a; *7274*, 3c; *7507*, 3c; *7649*, 3b; *7650*, 3b; *8025*, 3a. Apparently a strict halophyte; grows only on rocks that receive sea spray or waves.

HYLOCOMIACEAE

Hylocomium splendens (Hedw.) B.S.G. *7208*, 4c; *7228*, 4a; *7307*, 10a; *7312*, 10a; *7329*, 4c; *7331*, 4c; *7649*, 4c. Found only on the low plateaus, usually mixed with the common mosses of the heath, or on moss mounds; at places it is the dominant moss on the collapsed summits of old mounds.

HYPNACEAE

Hypnum cupressiforme Hedw. (See Persson, 1968.) *8007*, 14b. Found only on an andesite bird-perch mound near Buoy Point, growing with *Drepanocladus uncinatus* and *Pogonatum alpinum*.

***Hypnum dieckii* Ren. & Card. (See Persson, 1968.) *7850*, 4a. Found only in the *Empetrum* heath near Constantine Harbor, growing with *Aulacomnium palustre*, *Brachythecium acutum*, and *Pogonatum alpinum*.

Hypnum plicatulum (Lindb.) Jaeg. *8002*, 12b. Found only at the margin of a vegetation mat on a solifluction terrace.

Ptilium crista-castrensis (Hedw.) DeNot. *7230*, 4a; *7306*, 4a. Usually sparse, but at several locations on the *Empetrum* heath it was observed to form almost pure colonies 5 sq m or more in size.

LEUCODONTACEAE

Antitrichia curtipendula (Hedw.) Brid. *7209*, 4c; *7210*, 4d; *7248*, 14a; *7250*, 14a; *7313*, 4c; *7318*, 4c; *7328*, 4c; *7330*, 4c; *7331*, 4c; *7343*, 2b; *7890*, 12b; *8002*, 12b; *8008*, 4d. Common, and at places very abundant, on the *Empetrum* heath; also found on bird-perch mounds and on solifluction terraces. Its yellow color makes it conspicuous as the summit moss on many "mature" moss mounds, visible even on aerial photographs (fig. 8). W. A. Weber (oral commun., 1967) suggested that in the treeless Aleutian Islands moss mounds substitute for trees in providing the elevated habitat characteristic of this moss throughout its range.

MNIACEAE

Mnium glabrescens Kindb. (See Persson, 1968.) *7261b*, 4e; *7388*, 10b; *7402*, 8a; *7483*, 4a; *7524*, 4f; *7526*, 4f; *7528* 4f; *7862*, 4e; *8264*, 4e; *8284*, 6a. A common species on many different substrates throughout the island.

Mnium insigne Mitt. *7261a*, 4g; *8288*, 4f. Found on stony soil of a frost scar in the *Empetrum* heath and on a shaded peat bank.

Mnium pseudopunctatum Bruch & Schimp. (See Persson, 1968.) *7196*, 4e; *7203*, 4g; *7260*, 4e; *7458*, 5a. Found only at low altitudes, usually on very wet soil and in bogs.

ORTHOTRICHACEAE

Ulota phyllantha Brid. *7271*, 3a; *7273*, 3c; *7364*, 2c; *7507*, 3b; *7638*, 3b; *7911*, 3b; *8024*, 4d. Found on rocks near the sea, and, at one location, on an organic bird-perch mound. A facultative halophyte.

PLAGIOTHECIACEAE

Plagiothecium roeseanum B.S.G. *7353*, 2b. Found only on sandy banks above the beach at Cyril Cove, growing with *Eurhynchium praelongum*, *Lophocolea cuspidata*, and *Pohlia cruda*.

Plagiothecium undulatum (Hedw.) B.S.G. *7227*, 4a; *8239*, 13b; *8273*, cf., 4f. Occurs sparingly as single strands in

the moss mat of the *Empetrum* heath and in alpine meadows.

POLYTRICHACEAE

Oligotrichum hercynicum (Hedw.) Lam. & DC. *8240*, 13a. Found on mineral soil in the bed of a stream that flowed from a snow field.

Oligotrichum parallelum (Mitt.) Kindb. *8234*, 13a. Found only on soil by a stream that flowed from a snow bed at Chitka Cove.

Pogonatum alpinum (Hedw.) Röhl. *7229*, 4a; *7252*, 14b; *7311*, 4a; *7384*, cf., 4f; *7402*, 8a; *7425*, 4b; *7523*, 4f; *7841*, 4f; *7850*, cf., 4a; *8006*, cf., 14b; *8257*, 4f. Found on low terraces of the *Empetrum* heath, usually growing in the thick moss mat, and on high-altitude bedrock outcrops. At one location it grew with *Marchantia polymorpha* on the peat bottom of a drained pond.

Pogonatum contortum (Brid.) Loeske. (See Persson, 1968.) *7206*, 4f. Found only on the vertical walls of a narrow deep trench that had been dug in peat during World II.

Pogonatum urnigerum (Hedw.) P. Beauv. *7261*, 14a; *7265*, 4f; *7300*, 10a; *7355*, 2b; *7356*, 2c; *7385*, 10a; *7481*, 10a; *7672*, 4f; *8201*, 5b; *8202*, 5b; *8213*, 10a; *8214*, 10a. This moss commonly grows on disturbed soil and peat banks (fig. 2).

Polytrichum commune Hedw. *7332*, 4c; *7377*, 4f. On moss mounds and peat banks of the low plateaus.

Polytrichum formosum Hedw. *7241*, 4f; *7299*, 4f; *7381*, cf., 10c. On peat banks and broken macadam pavement.

Polytrichum juniperinum Hedw. *7374*, 14a. Apparently rare; found only on an andesite outcrop at an altitude of about 400 feet.

Polytrichum longisetum Brid. [P. *gracile* Sm.]. *8284*, 6a. Found only in wet moss-lichen mats on the lower terrace at Cyril Cove, with *Drepanocladus fluitans*.

***Polytrichum sphaerothecium* (Besch.) Broth. [*Pogonatum sphaerothecium* Besch.]. (See Persson, 1968.) *7529*, 4f. This is the first collection of this moss in Alaska, and apparently the second collection in North America. Persson (1968) made the observation that this moss, in its worldwide distribution, is often associated with *Bryoxiphium norvegicum* and that these mosses are found only in nonglaciated regions of the world.

Polytrichum strictum Menz. *ex* Brid. *7335*, 4c. Found only on a small moss mound.

POTTIACEAE

Barbula cylindrica (Tayl. *ex* Mack.) Schimp. *ex* Boul. *7641*, 3b; *7642*, 3b; *7644*, 3b. Found only on breccia cliffs of the seacoast.

Bryoerythrophyllum recurvirostrum (Hedw.) Chen. *7671*, 4f; *8270*, 9a; *8276*, 3a. Found growing with *Anomobryum concinnatum*, *Pohlia nutans*, *Pogonatum urnigerum*, and *Dicranella subulata* on a peat bank at Constantine Harbor and in a spring on a deposit of limonite, where it was heavily incrusted with iron compounds.

Pottia heimii (Hedw.) Fürnr. *ex* Hampe *sens. lat*, *7184*, 3b; *8203a*, 5b; *8204*, 3b. Found growing with *Amphidium lapponicum* on breccia sea cliffs at Cyril Cove and on sandy soil of a borrow pit near Makarius Bay, associated with *Philonotis americana*. It also grew on turf banks at Makarius Bay, associated with *Amblystegium serpens*, *Leptobryum pyriforme*, and *Bryum stenotrichum*.

**Tortula mucronifolia* Schwaegr. (See Persson, 1968.) *7530*, 2b; *7531*, 2b; *7532*, 2b; *8247*, 3b. In loose sand of dunes near the coast and on breccia sea cliffs.

RHYTIDIACEAE

Rhytidiadelphus loreus (Hedw.) Warnst. *7204*, 4g; *7228*, 4a; *7232*, 4a; *7308*, 4a; *7327*, 4c; *7664*, 6a. Abundant, especially in wet locations in the *Empetrum* heath.

Rhytidiadelphus squarrosus (Hedw.) Warnst. *7344*, 2b; *7863*, 13a. On sandy soil near the seacoast, growing among dense stools of *Elymus*, and in a snow-bed community.

Rhytidiadelphus triquetrus (Hedw.) Warnst. *7309*, 4a. A common species in the moss mats on the low plateaus.

SPLACHNACEAE

Tetraplodon mnioides (Hedw.) B.S.G. *7514*, 15a; *7880*, 15a; *7968*, 15a; *8242*, 15a. Entirely restricted to decomposed carcasses of birds and rats; it forms dense polsters that fruit profusely.

THUIDIACEAE

Claopodium crispifolium (Hook.) Ren. & Card. *8274*, 4e. Found only on soil at the margin of a stream in the heath near Cyril Cove.

ANNOTATED LIST OF LICHENS

By WILLIAM A. WEBER,[3] JAMES A. ERDMAN, and HILDUR KROG[4]

Shown below is the only published list of lichens that grow on Amchitka Island, and all species on the list are new records for this island, unless otherwise noted. To our knowledge, the only former Amchitkan collections of significance are those made by Eric Hultén on July 9, 1932, and those of George A. Llano made on August 22, 1947. Inventories of lichens collected from the Aleutian Island chain were published by Hedrick (1936) and Degelius (1937).

Duplicates of specimens cited in this list that were collected by Hansford T. Shacklette in November and December 1965 were identified by Krog. All subsequent collections were identified by Weber, except those of *Stereocaulon* determined by I. Mackenzie Lamb, Harvard University, Cambridge, Mass.; several packets of *Umbilicaria* sent to George A. Llano, National Science Foundation, Washington, D.C.; and *Parmeliopsis ambigua* identified by Mason E. Hale, Jr., Smithsonian Institution, Washington, D.C. Identification of the rocks on which the saxicolous lichens grew was made by W. D. Quinlivan, U.S. Geological Survey.

Nomenclature follows that of Hale and Culberson (1966) insofar as possible. Collection numbers, in italics, are those of Shacklette, unless otherwise specified; they follow the species name. The habitat and plant community from which a species was taken, designated by numbers and letters, as set forth in the section "Description of the Island and Its Vegetation" of this report, follow the collection number.

CLADONIACEAE

Baeomyces placophyllus Ach. *Erdman 646*, 15b. On a wooden sill of a World War II hut above Constantine Harbor.

Cladonia alpestris (L.) Rabenh. *Hutchison s.n.*; *8023*, 4d; *Erdman 613*, 12b. Hutchison (1937, p. 144–145) reported:

[3] University of Colorado Museum, Boulder, Colo.

[4] Botanical Museum, Oslo, Norway.

"The yellow-grey *Cladonia alpestris*, one of the reindeer mosses, formed the groundwork of the moors [of Amchitka], into which the foot crunched as if walking on snow. It was mixed with empetrum * * *." She undoubtedly was referring to the dominant *Cladonia pacifica*, recently described by Ahti (1961) in his treatment of the reindeer-lichen complex. *Cladonia alpestris* occurs widely scattered over the heath mat, often in patches, but it is less abundant than *C. pacifica*.

Cladonia amaurocraea (Flörke) Schaer. *Erdman 653*, 4c; *Erdman 666*, 8c. Uncommon; found on a few moss mounds and at the edge of a tundra pool.

Cladonia arbuscula subsp. *beringiana* Ahti [*C. sylvatica* (L.) Hoffm.]. *Stevens s.n.*; *7539*, 4c. On the summit of a tundra mound above Cyril Cove. Merrill (1929, p. 42) stated that "D. H. Stevens found the species [*C. sylvatica* subsp. *sylvestris* Oed.] at Amchitka and Ilac Islands, and it has come to hand from Tanana crossing." No habitat was given.

Cladonia bellidiflora (Ach.) Schaer. *7245*, 4c; *7332*, 4c; *7513*, 4a; *7596*, cf., 14b; *7602*, 14b; *8012*, 4a; *Erdman 595*, 8b. Widespread but not abundant; found in a variety of habitats.

Cladonia coccifera (L.) Willd. *7301*, 15d; *7510*, 4a; *7511*, 4a; *7512*, 4a; *Erdman 620*, 15d. Fairly uncommon; however, it is more abundant and conspicuous in burned areas than elsewhere.

Cladonia degenerans (Flörke) Spreng. [*C. cerasphora* Vain.]. *7303*, 15d; *Erdman 608*, in part, 4f. Uncommon throughout the *Empetrum* heath.

Cladonia gracilis (L.) Willd. *7302*, 15d; *7509*, 4a; *7669*, 4f; *Erdman 608*, in part, 4f; *Erdman 609*, in part, 4f; *Erdman 617*, 15d; *Erdman 618*, 15d. Occurs in a variety of habitats on the low plateaus, but is common only in burned areas.

Cladonia pacifica Ahti [*C. impexa* Harm.]. *7210*, 4c; *7323*, 4c; *Erdman 568*, 4a. The dominant lichen in the *Empetrum* heath; forms pure clumps in surface depressions, thus giving a dotted appearance to the ground surface as seen from the air (fig. 8).

Cladonia pyxidata (L.) Hoffm. *7290*, 10c; *Erdman 619–A*, 15d. Sparse, except in burned areas, where it is abundant.

Cladonia rangiferina (L.) G. H. Web. *ex* Wigg. *Erdman 582*, 13b. Observed only on a thick *Empetrum* mat in a small valley above Chitka Cove; apparently uncommon.

Cladonia scabriuscula (Del. *ex* Duby) Leight. *7211*, 4c; *7324*, 4c; *Erdman 624*, 4d. A component species of moss mounds.

LECANORACEAE

Haematomma ventosum subsp. *lapponicum* (Räs.) Laund. [*H. lapponicum* Räs.]. *Erdman 586*, 14b. On a high-altitude rock outcrop.

Icmadophila ericetorum (L.) Zahlbr. *Erdman 633*, in part, 4d. At the base of an organic bird-perch mound.

Ionaspis epulotica var. *arctica* (Lynge) H. Magn. *Erdman 639*, in part, 14a; *Erdman 645*, 4g. On a latite boulder above Constantine Harbor and on basalt andesite scoria rocks in a frost scar.

Lecanora aleutica H. Magn. *ex* Hedrick. *7365*, 2c; *Erdman 630–D*, 3a. Common on boulders, primarily on those along the beaches. I. Mackenzie Lamb examined specimen *7365*, which grew on a sand dune, and wrote (written commun., 1968), "Apparently a *Lecanora* species that has gone from a crustose to semi-fruticose growth due to sand abrasion and deposition."

Lecanora allophana (Ach.) Röhl. [*L. subfusca* (L.) Ach., in part]. *Erdman 632*, 15b. On a small plank in the margin of a wet sedge meadow.

Lecanora atra (Huds.) Ach. *Erdman 641*, 2c. On a small boulder in a sand-dune blowout.

Lecanora castanea (Hepp) Th. Fr. *Erdman 670*, 4e. With bryophytes in a streamside community.

Lecanora straminea (Wahlenb.) Ach. *Erdman 630–B*, 3g. On andesite beach rocks.

Ochrolechia frigida (Sw.) Lynge. *Hultén s.n.* (Degelius, 1937, p 126); *7277*, 3d; *7555*, 14a; *7597*, 14b; *7895*, 12a; *7898*, 12a; *Erdman 565*, 4a; *Erdman 566*, 4a; *Erdman 610*, 11a; *Erdman 663*, 14b; *Erdman 673*, 10c. Occurs in a wide range of habitats, at places overgrowing the heath mat. Degelius (1937, p. 126) stated that it "seems to be a very common species on these [Aleutian] islands." This taxon is highly polymorphic.

Placopsis gelida (L.) Linds. [*Lecanora gelida* (L.) Ach.]. *Hultén s.n.* (Degelius, 1937, p. 125); *7297*, 14a; *Erdman 596*, 10c. Common, especially on loose cobbles of old roadbeds.

LECIDEACEAE

Bacidea sp. *Erdman 643*, 14a. On andesitic tuff breccia rocks.

Lecidea cf. *aleutica* Degel. *Erdman 629*, in part, 14a. On andesite sill or flow boulders.

Lecidea armeniaca (DC.) Fr. *Erdman 592*, 14b. Common on high-altitude basaltic rocks above Chitka Cove.

Lecidea elegantior H. Magn. *Erdman 589*, 14b. On high-altitude basaltic rocks above Chitka Cove. Not listed by Hale and Culberson (1966); first reported for North America by Weber and Viereck (1967).

Lecidea flavocaerulescens Hornem. *Erdman 587*, 14b. Common on high-altitude basaltic rocks above Chitka Cove.

Lecidea macrocarpa (DC.) Steud. [*L. platycarpa* Ach.; *L. steriza* (Ach.) Vain.]. *Erdman 590*, 14b; *Erdman 597*, 10c; *Erdman 639*, in part, 14a; *Erdman 642*, 2c. On breccia rocks, extending from sea level to high-altitude fell-fields.

Lecidea cf. *symmicta* (Ach.) Ach. *Erdman 604*, 15b. Found on the wind-eroded wooden frame of a World War II hut.

Lecidea vernalis (L.) Ach. *Erdman 603*, 15b; cf. *Erdman 667*, 4g. On tar-paper roofing of a hut at high altitude and in a frost scar of the *Empetrum* heath.

Mycoblastus alpinus (Fr.) Kernst. [*M. sanguinarius* (L.) Norm., in part]. *7597*, 15b; *Erdman 566*, 4a; *Erdman 611*, 11a; *Erdman 652*, 4c. Occasionally found intermixed with *Ochrolechia frigida*.

Rhizocarpon atroalbescens (Nyl.) Zahlbr. *Erdman 591*, 14b. Common on high-altitude basaltic rocks above Chitka Cove.

Rhizocarpon geographicum (L.) DC. *Hultén s.n.* (Degelius, 1937, p. 117); *Erdman 661*, 14b. On an andesite outcrop of a scree ridge above Chitka Cove.

Rhizocarpon hochstetteri (Körb.) Vain. *Hultén s.n.* (Degelius, 1937, p. 117); *Erdman 629*, in part, 14a; *Erdman 639*, 14a. Apparently common on rock outcrops throughout the island.

Toninia lobulata (Somm.) Lynge. *Erdman 640*, 4f. This lichen was found covering the peat banks of an old gun emplacement.

PANNARIACEAE

Pannaria pezizoides (G. Web.) Trev. *7843*, 4f; *7865*, 4f; *Erdman 607*, 4f. Collected from soil or peat banks at both ends of the island.

Psoroma hypnorum (Vahl) S. Gray. *Erdman 633*, in part, 4d. At the base of an organic bird-perch mound.

PARMELIACEAE

Cetraria ciliaris Ach. [*C. orbata* (Nyl.) Fink]. *Erdman 572*, 15b. On a felled utility pole; possibly an adventive species introduced during World War II occupation.

Cetraria cucullata (Bell.) Ach. *Erdman 656*, 14a. Found near the summit of a large rock mound.

Cetraria ericetorum Opiz [*C. crispa* (Ach.) Nyl.; *C. islandica var. crispa* (Ach.) Nyl.]. *Erdman 581*, 13b; *Erdman 615*, 14b. Observed and collected only above Chitka Cove; apparently uncommon.

Cetraria nigricans (Retz.) Nyl. *7897*, 12a. In the rubble of a high-altitude rock field.

Hypogymnia enteromorpha (Ach.) Nyl. *7282*, 15b. On a bridge timber near Cyril Cove; possibly introduced with construction materials.

Hypogymnia physodes (L.) Nyl. [*Parmelia physodes* (L.) Ach.; *P. duplicata* var. *doughlasiocla* Gyeln.]. *Erdman 570*, 15b. On a felled utility pole.

Hypogymnia subobscura (Vain.) Poelt [*Parmelia subobscura* Vain.]. *7897*, 12a. In the rubble of a high-altitude rock field, mixed with several fruticose lichens.

Parmelia alpicola Th. Fr. *Erdman 601*, 14b. On boulders at high altitudes.

Parmelia omphalodes (L.) Ach. *7603*, 14b; *7888*, 12a; *Erdman 655*, 4c. On rocks at high altitudes.

Parmelia saxatilis (L.) Ach. *7277a*, 3c; *Erdman 606*, 15b; *Erdman 621*, 14a. On rock outcrops above or on the beach, and on wooden supports of a World War II shed.

Parmelia sulcata Tayl, *7275*, 3c; *Erdman 605*, 15b; *Erdman 625*, 14a. On breccia outcrops above or on the beach, and on wooden supports of a World War II shed.

Parmeliopsis ambigua (Wulf.) Nyl. *Erdman 631*, 15b. On a small plank at the edge of a wet sedge meadow.

Platysmatia lacunosa (Ach.) Culb. & Culb. [*Cetraria lacunosa* Ach.]. *7601*, 14b. On a rock mound above Chitka Cove.

PELTIGERACEAE

Peltigera aphthosa (L.) Willd. *7259*, 4e; *7319*, 4c; *7321*, 4c; *Erdman 638*, 14a; *Erdman 651*, 11a. A fairly common terricolous lichen on shaded, often vertical, substrate surfaces.

Peltigera canina (L.) Willd. [*P. canina* var. *membranacea* Ach.; *P. membranacea* (Ach.) Nyl.]. *Hultén s.n.* (Degelius 1937, p. 110); *7261c*, 4e; *Erdman 623*, 4d; *Erdman 634*, 4a; *Erdman 669*, 2b. A common terricolous lichen on shaded, often vertical, substrate surfaces.

Peltigera malacea (Ach.) Funck. *Erdman 635*, 4a. At the base of a heath bank above Cyril Cove.

Peltigera spuria (Ach.) DC. [*P. canina* var. *spuria* (Ach.) Schaer.]. *7637*, 1a. Found on the soil of a second beach terrace at Constantine Harbor.

PERTUSARIACEAE

Pertusaria coriacea (Th. Fr.) Th. Fr. *Erdman 622*, 14a. On a flow breccia outcrop.

Pertusaria hultenii Erichs. *Erdman 588*, 14b. Saxicolous; on basaltic outcrop above Chitka Cove.

Pertusaria sp. *Erdman 571*, 15b. Corticolous; on a utility pole.

PHYSCIACEAE

Buellia punctata (Hoff.) Mass. [*B. pullata* Tuck.]. *Erdman 630–C*, in part, 3a. On andesite beach boulders.

Physcia caesia (Hoffm.) Hampe. *7276*, 3c; *Erdman 630–C*, in part, 3a. On sea cliffs and beach boulders.

Physcia dubia (Hoffm.) Lett. *7276*, 3c. Found growing with *P. caesia*.

Rinodina turfacea (Wahlenb.) Körb. *7982*, 4d; *Erdman 671*, 4d. A nitrophilous lichen found on a few organic bird-perch mounds.

SPHAEROPHORACEAE

Sphaerophorus globosus (Huds.) Vain. *Hultén s.n.* (Degelius, 1937, p. 107); *7246*, 4c; *7320*, 4c; *7595*, 14b; *7599*, 14b; *7897*, 12a; *7991*, 14b; *8014*, 4d; *8015*, 4d; *Erdman 569*, 4a; *Erdman 583*, 13b. Degelius (1937, p. 107) described this species as very common throughout the Aleutian Islands. It is the dominant lichen on the summits and ridges of the hummocks in the *Empetrum* heath.

STEREOCAULACEAE

Stereocaulon alpinum Laur. *7360*, 2c. On a sand dune above Cyril Cove.

Stereocaulon intermedium (Sav.) H. Magn. *Erdman 599*, 10c. Common on a gravel roadbed south of Constantine Harbor. I. Mackenzie Lamb (written commun., 1968) considered it to be "a stunted, subcrustose state of *S. intermedium*."

Stereocaulon tomentosum var. *alpestre* Flot. [*S. tomentosum* Fr.]. *Erdman 600*, 10c. Associated with *S. intermedium* on a gravel roadbed south of Constantine Harbor.

Stereocaulon vesuvianum Pers. [*S. denudatum* Flk.; *S. vesuvianum* var. *denudatum* (Flörke) Lamb]. *Erdman 612*, 12b. On upland slopes above the Pacific Ocean, opposite Chitka Cove.

STICTACEAE

Lobaria linita (Ach.) Rabenh. [*Sticta pulmonaria* var. *linita* (Ach.) Tuck.]. *Hultén s.n.* (Degelius, 1937, p. 108). *Erdman 636*, 4a. At the base of a heath bank above Cyril Cove.

TELOSCHISTACEAE

Blastenia sp. *Erdman 630–C*, in part, 3a. On andesite beach boulders.

Caloplaca granulosa (Müll. Arg.) Jatta. *Erdman 594*, 3a. A conspicuous saxicolous crustose lichen; common on supralittoral beach boulders and sea stacks.

Caloplaca sp. (*Ferruginea* group). *Erdman 668*, 2b. On the end of a large driftwood log.

Xanthoria candelaria (L.) Th. Fr. [*Teloschistes candelarius* (L.) Fink]. *7369*, 4d; *Erdman 627*, 14a; *Erdman 630–C*, in part, 3a; *Erdman 649*, 14a. On rock outcrops fertilized by birds.

Xanthoria elegans (Link) Th. Fr. [*Caloplaca elegans* (Link) Th. Fr.]. *Erdman 637*, 3a. Occurs on beach boulders and sea cliffs. Tatewaki and Kobayashi (1934, p. 6) stated that "This saxicolous association is developed on such precipitous cliffs that the vascular plants cannot

grow. The beautiful red colour of *Caloplaca elegans* adorns the monotonous gloomy rock surface."

UMBILICARIACEAE

Umbilicaria cylindrica (L.) Del. [*Gyrophora cylindrica* (L.) Ach.]. *7367*, 14a; *Erdman 628*, 14a. On an andesite boulder pile near Cyril Cove. Although Llano (1950) cited no collections from Amchitka Island, he did state (p. 11) that, in the Aleutian Islands, *U. cylindrica* is "the dominating *Umbilicaria* on all exposed lava rocks, in association with *U. proboscidea*, *U. hyperborea*, and *U. torrefacta* * * *."

Umbilicaria proboscidea (L.) Schrad. *7367a*, 14a; *7506*, 2c; *7607*, 14b; *7894*, 12a; *Erdman 585*, 12a; *Erdman 602*, 14b; *Erdman 650*, 14b; *Erdman 660*, 14a; *Erdman 664*, 14a. Common on rocks in a wide variety of habitats.

USNEACEAE

Alectoria cf. *irvingii* Llano. *8013*, 14b. Found on an andesite bird perch on a high peak north of Buoy Point. We have not compared this collection with the type from Anaktuvuk Pass, but it appears to agree well with the type description—that is, it resembles *Cornicularia divergens*, medulla Pd-, with long fissural pseudocyphellae.

Alectoria nigricans (Ach.) Nyl. *7596*, 14b. Mixed with *Cladonia bellidiflora* at the base of an andesite rock mound south of Chitka Cove.

Alectoria ochroleuca (Hoffm.) Mass. *7193*, 14a; *7368*, 14a; *7552*, 14a; *7553*, 14a; *7886*, 12a; *Erdman 567*, 4a. A conspicuous fruticose lichen that apparently is of wide ecological amplitude, for it occurs as scattered clumps on breaks in the *Empetrum* heath, as well as on rocks at the highest altitudes on the island.

Alectoria pubescens (L.) R. H. Howe [*Parmelia lanata* (L.) Wallr.]. *7371*, 14a; *7897*, 12a; *Erdman 657*, 14a. On rocks in outcrops or rubble fields, in many places mixed with other fruticose lichens.

Cornicularia divergens Ach. [*Alectoria divergens* (Ach.) Nyl.]. *7247a* 14a; *7598*, 14b; *Erdman 614*, 14b; *Erdman 647*, 4a; *Erdman 654*, 4c; *Erdman 659*, 14a. Widespread, but most common on rock mounds and outcrops.

Ramalina almquistii Vain. *7370*, 14a; *7906*, 3c; *Erdman 626*, 14a. On breccia cliffs and inland outcrops.

Ramalina scoparia Vain. *7278*, 3c; *7505*, 3c. Commonly occurs with *R. almquistii*.

Siphula ceratites (Wahlenb.) Fr. *7266*, 8c; *7675*, 8c.; *Erdman 665*, 8c. Forms dense colonies along the edges of small pools.

Thamnolia vermicularis (Sw.) Ach. *ex* Schaer. [*T. subuliformis* (Ehrh.) W. Culb.]. *7257*, 14a; *7559*, 14a; *Erdman 672*, 4a. Common throughout the island in a wide variety of habitats but is best developed in the uplands, where it forms pure stands in the eroded *Empetrum* heath. All material fluoresces under ultraviolet light.

VERRUCARIACEAE

Verrucaria maura Wahlenb. *ex.* Ach. *Erdman 630–A*, 3a. A dominant but inconspicuous lichen on the rocks of the beaches. In describing the plant communities of the Aleutian Islands, Tatewaki and Kobayashi (1934) placed *Verrucaria* in the supralittoral belt, which is just above the mean high-water level, where the plant is washed by occasional high tides. They stated (p. 6), "*Verrucaria maura*, the calcivorous [sic] lichen, is distributed over the supralittoral rocks, giving a dark aspect to this belt."

SOME ALGAE AND OTHER PROTISTS

By H. Skuja [5]

Collections of algae from three types of habitat on Amchitka Island were sent to me for identification. The habitat descriptions and the annotated list, including descriptions of new taxa, follow.

The following taxa, found in a liverwort polster (mostly *Marsupella emarginata*), were collected (No. *7234*) by H. T. Shacklette, November 22, 1965, from a small stream near Chitka Point:

CYANOPHYCEAE

Chroococcus varius A. Br.
Gloeocapsa magma (Bréb.) Kütz.
Schizothrix calcicola (Ag.) Gom.
Schizothrix lardacea (Ces.) Gom.
Scytonema mirabile (Dillw.) Born.
Stigonema minutum (Ag.) Hass.
Stigonema ocellatum Lyngb.

DESMIDIACEAE

Actinotaenium cucurbita (Bréb.) Teiling. Cells 28μ–30μ long, 13μ–15μ broad. (Pl. 1, fig. 1.)

Cosmarium cyclicum Lund. var. *arcticum* Nordst.

Cosmarium decedens (Reinsch) Racib. Cells 45μ–48μ long, 24μ–26μ broad, and 17μ–19μ thick; breadth of isthmus 18μ–20μ. (Pl. 1, fig. 7.)

Cosmarium obliquum Nordst. Cells 20μ–23μ long, 17μ–18μ broad, and 13μ–14μ thick; breadth of isthmus 14μ–16μ. (Pl. 1, figs. 8–9.)

Cosmarium tatricum Racib. Cells 41μ–52μ long, 23μ–27μ broad, and 17μ–20μ thick; breadth of isthmus 18μ–21μ. (Pl. 1, figs. 4–6.)

Cosmarium variolatum Lund. Cells 45μ–52μ long, 25μ–27μ broad, and 17μ–20μ thick; breadth of isthmus 12μ–15μ. (Pl. 1, figs. 2, 3.)

Cylindrocystis brebissonii Menegh.

Cylindrocystis brebissonii var. *minor* W. et G. S. West.

Cylindrocystis crassa De Bary.

Mesotaenium micrococcum Kütz.

Staurastrum punctulatum Bréb. var. *pygmaeum* (Bréb.) W. et G. S. West. A quadrangular form. Length 36μ–40μ, breadth 34μ–40μ; isthmus 18μ–20μ broad; cell wall uniformly granulate, granules minute and acute.

DIATOMACEAE

Achnanthes spp.
Caloneis silicula (Ehrnb.) Cl.
Epithemia turgida (Ehrnb.) Kütz.
Eunotia arcus Ehrnb.
Eunotia gracilis (Ehrnb.) Rbh.
Eunotia lunaris (Ehrnb.) Grun. var. *capitata* Grun. Length 50μ–86μ, breadth 4μ.
Eunotia praerupta Ehrnb. var. *muscicola* Boye-Pet.

[5] Uppsala Universitets Institution för Systematisk Botanik, Uppsala, Sweden.

Eunotia praerupta var. *bidens* (W. Sm.) Grun. Cells 15μ–75μ long, 5μ–10μ wide; striae 10–12 in 10μ.

Eunotia robusta Ralfs var. *diadema* (Ehrnb.) Ralfs.

Frustulia rhomboides (Ehrnb.) D.T. var. *saxonica* (Rbh.) D.T.

Gomphonema angustatum (Kütz.) Rbh. var. *productum* Grun. Length 38μ–45μ, breadth 10μ–12μ.

Melosira distans (Ehrnb.) Kütz. var. *alpigena* Grun. Breadth 7μ–9μ, height of the whole cell 10μ–12μ; striae obsolete, valvae conspicuously dotted.

Pinnularia gibba Ehrnb.

Pinnularia lata (Bréb.) W. Sm. Length 85μ–103μ, breadth 28μ–30μ; striae 4 in 10μ.

Pinnularia microstauron (Ehrnb.) Cl.

Pinnularia viridis (Nitzsch) Ehrnb. var. *rupestris* (Hantzsch) Cl.

Tabellaria flocculosa (Roth.) Kütz.

DINOPHYCEAE

Gloeodinium montanum Klebs. Diameter of cells with integument 41μ–58μ, without integument 25μ–38μ; integument or cell wall thick and lamellose, colorless or yellowish or brownish; cell content brown; 2-celled aggregates with integument 57μ–60μ×60μ–85μ. (Pl. 1, figs. 20–23.)

Peridinium cinctum (O.F.M.) Ehrnb.

The following taxa were found in a shallow pool on andesite bedrock at a quarry near Banjo Point, with *Isoëtes* sp. (44 chromosomes). Collected by H. T. Shacklette, July 28, 1967.

CYANOPHYCEAE

Aphanothece castagnei (Bréb.) Rbh.

Oscillatoria amoena (Kütz.) Gom. Trichomes straight, with more or less attenuated and frequently curved ends, 4μ–6μ broad, not constricted or only slightly constricted at the crosswalls, and grayish blue green or olivaceous and pale violet; cells nearly quadrate or slightly shorter, or longer than broad, granulated at dissepiments; end cells capitate, with broadly conical apex. (Pl. 2, fig. 25*a–d*.)

Oscillatoria amphibia Ag. Trichomes nearly straight or coiled, 2μ–2.5μ broad, ends nonattenuated and not capitate, not constricted at the joints, and pale blue green; cells 4μ–7.5μ long, with two granules at the septa; end cells rounded.

Synechococcus maior Schröt. Cells oblong or ellipsoidal with rounded apices, 19μ–21μ broad, and 24μ–34μ long; contents homogeneous and blue green.

CHLOROPHYCEAE s.l.

Chlorella ellipsoidea Gerneck.

Chlorella vulgaris Beyerinck.

Cosmarium humile (Gay) Nordst.

Cosmarium laeve Rbh. forma. Cells 24μ–26μ long, 17μ–18μ broad, and 11μ–12μ thick, with 4μ–5μ broad isthmus; certain specimens have one semicell of the type, the other one of var. *septentrionale* Wille. (Pl. 1, fig. 13.)

Cosmarium margaritiferum Menegh.

Cosmarium meneghini Bréb. var. *concinnum* Rbh. Cells. 25μ–27μ long, 19μ–20μ broad, and 13μ–14μ thick; apex 13μ–14μ, isthmus 4μ–5μ broad; cell ends truncate or often slightly convex, rarely conspicuously depressed. (Pl. 1, fig. 12.)

Cosmarium nitidulum De Not.

Cosmarium subcrenatum Hantzsch forma. Cells 30μ–33μ long, 25μ–26μ broad, and 17.5μ–18.5μ thick; isthmus 11μ–12μ broad; semicells subtrapezo-rectangular, with flattened 4-crenate ends and 4–5 crenae at each side; the low frontal swelling above the isthmus with generally 5, rarely 4 or 6, strong rows of 3–5 angular granules. (Pl. 1, fig. 11.)

Cosmarium subpachydermum Schmidle forma. Cells 38μ–41μ long, 28μ–32μ broad, and 20μ–22μ thick; isthmus 13μ–14μ broad; cell wall scrobiculate, but without a refractive thickening in the center of each semicell. (Pl. 1, fig. 14.) Compare also *C. pseudonitidulum* Nordst.

Cosmarium subundulatum Wille. Cells 60μ–65μ long, 42μ–45μ broad, and 28μ thick; isthmus 20μ–22μ broad; semicells high semicircular with a 10-undulate margin; membrane distinctly punctato-scrobiculate with a large but low lenticular inflation in the center of each semicell. (Pl. 1, fig. 10.)

Cylindrocystis brebissonii Menegh.

Cylindrocystis crassa De Bary.

Euastrum ansatum Ehrnb. Cells 78μ–87μ long, 39μ–44μ wide, and 27μ–29μ thick; apex 20μ–22μ, isthmus 13μ–15μ broad.

Euastrum bidentatum Näg. Cells 53μ–61μ long, 24μ–26μ broad, and about 20μ thick; apex 22μ, isthmus 10μ–12μ broad.

Euastrum denticulatum (Kirchn.) Gay. Cells 33μ–35μ long, 22μ–26μ broad, and 15μ–17μ thick; apex 16μ–20μ, isthmus 5μ–6μ broad.

Euastrum denticulatum var. *quadrifarium* Krieger. Cells about 20μ long, 16μ broad, and 10μ thick; apex 13μ, isthmus 4μ broad.

Euastrum didelta Ralfs. Cells 125μ–135μ long, 64μ–66μ broad, and 37μ–39μ thick; apex 30μ–31μ, isthmus 20μ–21μ broad.

Euastrum elegans (Bréb.) Kütz. A typical form; cells 30μ–32μ long, 20μ–21μ broad, and 12μ thick; isthmus 5μ–6μ broad.

Euastrum oblongum (Grev.) Ralfs.

Euastrum pectinatum Bréb. Cells 74μ–76μ long, 46μ–48μ broad, and 34μ–35μ thick; width of the polar lobe 27μ–29μ, width of the isthmus 19μ–21μ.

Hormidium flaccidum A. Br. Filaments ≈ 4μ–5μ broad, not constricted at the crosswalls; cells 2–3½ times longer than wide; chloroplast a unilateral plate with a pyrenoid.

Mougeotia sp. ster.

Oocystis parva W. et G. S. West. Solitary or in families of 2–4 cells, inclosed by the enlarged mother cell wall; cells ellipsoidal or fusiform with pointed poles, 3μ–7μ broad, 7μ–10μ long; chloroplasts 1–2 parietal discs, usually without pyrenoids. (Pl. 1, fig. 15.)

Pediastrum braunii Wartm. Coenobia 7- to 10-celled, cells 10μ–16μ in diameter.

Scenedesmus acutus (Meyen) Chod.

Scenedesmus ecornis (Ralfs) Chod.

Scenedesmus spinosus Chod.

Scotiella nivalis (Shuttlew.) Fritsch. Cells solitary, ellipsoidal, 12μ–14μ broad and 20μ–24μ long; cell wall colorless, with 6–8 longitudinal ribbons or low wings; single parietal chloroplast with one pyrenoid.

Zygogonium ericetorum Kütz.

DIATOMACEAE

Caloneis silicula var. *longissima* Schirschow. Cells linear, with an evident widening in the middle, 80μ–85μ long and 10μ–14μ broad; striae about 10 in 10μ.

Caloneis silicula var. *alpina* Cl. Cells oblong, with conspicuously triundulate sides, 32μ–37μ long and 12μ–15μ broad.

Cymbella aequalis W. Sm. Cells 17μ–25μ long and 6μ–8μ broad; striae 13–15 in 10μ.

Cymbella angustata (W. Sm.) Cl.

Cymbella angustata var. *hybrida* (Grun.) R. Ross.

Cymbella cuspidata Kütz. Cells 50μ–62μ long and 15μ–20μ–23μ broad; striae 10–13 in 10μ.

Cymbella delicatula Kütz. Cells 25μ–36μ long and 4μ–5μ broad.

Cymbella gracilis Cl. Cells 56μ–60μ long and 8μ–10μ broad; striae 12–13 in 10μ.

Cymbella hebridica (Greg.) Grun. Cells 29μ–37μ long and 7μ–8μ broad; striae 10–12 in 10μ.

Cymbella naviculiformis Anersw. Cells 38μ–50μ long and 12μ–16μ broad; striae 14–18 in 10μ.

Cymbella perpusilla A. Cl. Cells 16μ–20μ long and 3μ–4μ broad.

Cymbella pusilla Grun.

Cymbella tumidula Grun. Cells 28μ–32μ long and 7μ–9μ broad.

Cymbella ventricosa Kütz.

Eunotia diodon Ehrnb. Cells 52μ–70μ long and 10μ–15μ wide; striae 12–14 in 10μ.

Eunotia pectinalis (Kütz.) Rbh. var. *minor* (Kütz.) Rbh. Cells 10μ–17μ long and about 4μ wide; striae 15–18 in 10μ.

Eunotia praerupta var. *bidens* (W. Sm., Grun. Cells 15μ–75μ long and 5μ–10μ wide; striae 10–12 in 10μ.

Eunotia robusta Ralfs var. *diadema* (Ehrnb.) Ralfs. Cells 47μ–50μ long and 20μ–21μ broad, with 6-undulate dorsal margin; striae about 10 in 10μ.

Eunotia septentrionalis Östr. Cells 20μ–23μ long, 4μ–5μ broad; striae 17–18 in 10μ.

Fragilaria construens (Ehrnb.) Grun. var. *binodis* (Ehrnb.) Grun.

Fragilaria construens var. *subsalina* Hust.

Fragilaria nitzschioides Grun.

Frustulia rhomboides var. *saxonica* (Rbh.) D.T. Cells 50μ–105μ long and 13μ–20μ broad.

Gomphonema angustatum var. *productum* Grun.

Hantzschia amphioxys (Ehrnb.) Grun.

Melosira distans var. *alpigena* Grun. Breadth 6μ–10μ, height of the whole cell 5μ–17μ; striae 16–18 in 10μ; valvae conspicuously dotted.

Navicula contenta Grun. Cells 8μ–14μ long and 2μ–3μ broad.

Navicula cryptocephala Kütz. Cells 25μ–40μ long and 5μ–8μ broad; striae 16–18 in 10μ.

Navicula minima Grun. Cells 10μ–16μ long and 3μ–4μ broad.

Navicula minima var. *atomoides* (Grun.) Cl. Cells 10μ–16μ long and 3μ–4μ broad.

Neidium affine (Ehrnb.) Cl. var. *minus* Cl. 38μ–45μ long and 8μ–10μ broad; striae 20–23 in 10μ.

Neidium iridis (Ehrnb.) Cl. var. *amphigomphus* (Ehrnb.) V.H. Cells 70μ–130μ long and 28μ–33μ broad; striae 16–18 in 10μ.

Nitzschia palea (Kütz) W. Sm.

Nitzschia stagnorum Rbh.

Pinnularia appendiculata (Ag.) Cl. Cells 28μ–33μ long and 4μ–6μ broad; striae about 16 in 10μ.

Pinnularia brevicostata Cl. Cells 83μ–92μ long and 13μ–15μ broad; striae 8–9 in 10μ.

Pinnularia divergens W. Sm. Cells 58μ–66μ long and 15μ–17μ broad; striae 10–12 in 10μ.

Pinnularia gentilis (Donk.) Cl. Cells 200μ–205μ long, 34μ–36μ broad; striae 6–7 in 10μ.

Pinnularia gibba Ehrnb. Cells 65μ–90μ long, 10μ–13μ broad; striae about 10 in 10μ.

Pinnularia interrupta W. Sm.

Pinnularia lata (Bréb.) W. Sm. Cells 80μ–85μ long and 30μ–33μ broad; striae 3–4 in 10μ.

Pinnularia maior (Kütz.) Cl.

Pinnularia microstauron (Ehrnb.) Cl. Cells 34μ–72μ long and 8μ–13μ broad; striae 10–12 in 10μ.

Pinnularia microstauron forma *biundulata* O. Müll. Cells 34μ–72μ long and 8μ–13μ broad; striae 10–12 in 10μ.

Pinnularia viridis (Nitzsch) Ehrnb.

Pinnularia viridis var. *sudetica* (Hilse) Hust.

Stauroneis anceps Ehrnb. Cells 48μ–57μ long and 10μ–13μ broad; striae about 20–23 in 10μ.

Stauroneis anceps forma *linearis* (Ehrnb.) Cl.

CHRYSOPHYCEAE

(Only cysts were found.)

The following taxa were found in a tundra lake about 50 cm deep near Cyril Bay, with *Isoëtes* sp. (66 chromosomes). Collected by H. T. Shacklette, July 28, 1967.

CYANOPHYCEAE

Lyngbya rivulariarum Gom.

Merismopedia elegans A. Br.

Merismopedia glauca (Ehrb.) Näg.

Nostoc microscopicum Carm.

Oscillatoria amoena (Kütz.) Gom.

Oscillatoria amphibia Ag.

Oscillatoria facilis Skuja, sp. nov.

Trichomata solitaria vel in strata expansa, tenuia, arachnoidea, olivacea vel sordide fusco-viridia agglomerata, aut plusminusve recta aut subflexuosa et elongata, ad genicula leniter constricta, apice breve attenuata et paullo curvata, 1μ–1.3μ crassa; cellulis diametro trichomatis 2–4 plo longioribus, protoplasto homogeneo sed cum chromatoplasmate a centroplasmate sat limitato, pallide griseo-aerugineo vel olivaceo et subfusco; cellula apicali elongato conoidea, superne parum obtusata. (Pl. 2, fig. 26*a–e.*)

Trichomes single or forming a flat arachnoid, olivaceous or brownish-green thallus, more or less straight or slightly flexuous, slightly constricted at the cross-walls, 1μ–1.3μ broad, and short at the ends but clearly attenuated and curved; cells 2–4 times as long as wide, with a homogeneous, pale-grayish-blue-green or olivaceous and brownish protoplast; end cell elongate, conoid with slightly obtusate apex, not capitate and without a calyptra. (Pl. 2, fig. 26*a–e.*)

This species resembles *O. neglecta* Lemm. but has both curved and attenuated apices, longer cells, and a different color of thallus and trichomes; compare also *O. exilis* Skuja (Skuja, 1964, p. 51, table 7, figs. 1–3), which is considerably thicker, more constricted at the crosswalls, and of a different color. Also different are *O. deflexa* W. et G. S. West, *O. subtilissima* Kütz., *O. limnetica* Lemm. with var. *acicularis* Nygaard, and others.

Oscillatoria grossegranulata Skuja.

Trichomes solitary among other filamentous algae, elongate, nearly straight or slightly flexuous, not attenuated or curved at the ends, and distinctly constricted at the crosswalls, thus torulose, 5.5μ–6μ broad; cells cylindrical, 1–1½ times longer than wide, 6μ–12μ, rarely 16μ, long with clear- and pale-olivaceous or light-grayish-blue-green coarsely granulated protoplast, and at times with granulated septa. (Pl. 2, fig. 28.)

Oscillatoria splendida Grev.

A very characteristic species, with straight or flexuous trichomes 1.7μ–2μ broad which usually are not constricted at the crosswalls but are rather short and abruptly attenuated at the more or less curved ends; cells 2–4 times longer than broad, with often granulated septa and a clear blue-green homogeneous protoplast; end cell very elongated and pointed, more or less bent, capitate at the apex, without calyptra. (Pl. 2, fig. 27.)

The thallus of this alga also has a characteristic intense odor which resembles that of fertile soil.

Oscillatoria sp.

Trichomes nearly straight or slightly bent, unconstricted at the joints and not attenuated or capitate at the ends, 0.5μ–0.7μ broad; cells mostly 2–4 times, rarely 5 times, as long as wide, with a homogeneous pale-blue-green protoplast but with 2 granules at the dissepiments; end cell simply rounded.

Only a few trichomes seen; probably a small form of *O. amphibia*. (Pl. 2, fig. 29.)

Phormidium frigidum F. E. Fritsch.

Pseudanabaena catenata Lauterb.

Pseudanabaena granulifera Skuja, sp. nov.

Trichomata solitaria, inter algas benthonicas sparsa, sat brevia, plerumque 6–20-cellularia, 15μ–50μ longa, fere recta vel leviter arcuata, 1.5μ–1.8μ crassa, apices versus non attenuata, ad dissepimenta hyalina sat crassa evidenter constricta, motu proprio praedita; cellulis 1–1½ plo raro 2½ plo longioribus quam latis, breve cylindricis, lateribus haud concavis; protoplasto pallide olivaceo vel dilute viridi-aerugineo, granulato, granulis sat grossis praecipue peripheriter locatis; cellula apicali superne late conoidea. (Pl. 2, figs. 30–32.)

Trichomes solitary among other benthonic algae, short, usually 6- to 20-celled and 15μ–50μ long, mobile, nearly straight or slightly curved, 1.5μ–1.8μ broad, not attenuated at the ends, distinctly constricted at the joints, dissepiments hyaline, rather thick; cells short-cylindrical 1–1½–2½ times longer than wide, with pale olivaceous or light-greenish-blue coarsely granulated protoplast, granules mostly peripheral; end cell at apex conoid. (Pl. 2, figs. 30–32.)

This species perhaps resembles most nearly *P. minuta* Skuja forma (Skuja, 1956, p. 70, table 6, figs. 27–28), from which it is distinguished by its considerably shorter and smaller trichomes and differently colored, coarsely granulated protoplast. The typical *P. minuta* (Skuja, 1948, p. 57, table 5, figs. 6–7) is also closely allied but is broader and has more rounded cells usually with homogeneous or only finely granulated protoplast. Compare further *P. galeata* Böcher and *P. bipes* Böcher.

Synechococcus cedrorum Sauv. var. ***pallidus*** Skuja var. nov.

Cellulae solitariae, motu proprio praeditae, singulae vel geminatae, breve cylindricae vel ellipsoideae, apicibus rotundatis, 2.5μ–3μ raro 3.5μ latae et 3.5μ–6μ longae; membrana tenuissima, perspicua; contentu cellularum pallidissime aerugineo, fere achroo, homogeneo vel granulis subtilis, sparsis ornato; multiplicatio fit divisione transversali. (Pl. 2, fig. 24.)

A forma genuina cellulis paullo minoribus, colore pallidissimo primum differt.

Cells solitary, mobile, single or two together after division, short cylindrical or ellipsoidal with rounded apices, 2.5μ–3.5μ broad and 3.5μ–6μ long; membrane delicate and hyaline; contents very pale blue green, almost colorless, homogeneous or with some minute granules; multiplication by transverse division. (Pl. 2, fig. 24.)

This variety is well characterized by its smaller size and the very pale protoplast.

Compare also *S. notatus* Skuja forma (Skuja, 1964, p. 24, table 1, figs. 39–40), which is considerably larger, entirely colorless, and with a differently constituted protoplast.

Synechococcus maior Schröt.

CHLOROPHYCEAE s.l.

Ankistrodesmus braunii (Näg.) Collins var.

Cells may be fusiform but usually slightly curved or lunate with more or less acutely pointed ends, solitary or after division (forming of autospores) in pairs or in fours contacting each other, 7μ–14μ long, 1μ–2μ broad; cell wall thin, smooth, and colorless; chloroplast single, parietal, usually unilateral and with a small rounded medial excavation, without a pyrenoid. (Pl. 2, fig. 49.)

Only a few cells were seen. Considerably smaller than the typical *A. braunii*, but otherwise similar; compare with Vischer's (1920) description. Perhaps also it is a relative of some *Koliella* species (Hindák, 1963).

Ankistrodesmus spiralis (Turner) Lemm.

Chaetoplaca nom. nov. genericum. Syn. *Chaetopedia* Skuja 1948 non Pascher 1939. Fam. Chaetoplacaceae nom. nov. fam.

Chaetoplaca crassiseta Skuja var. *puella* Skuja (Skuja, 1964, p. 110, table 16, figs. 29–33). Has characteristic 4- and 8-celled colonies.

Chlamydomionas alaskensis Skuja, sp. nov.

Cellulae rotundato ellipsoidales et ovoideae vel interdum fere globosae, 12μ–18μ–21μ longae, 10μ–15μ–19μ latae, flagellis binis aut cellulae aequilongis aut paullo brevioribus praeditae; membrana modice crassa, plerumque distincte porosa raro fere laevi, achroa, papilla antica parva nonnunquam vix evoluta instructa; chromatophoro parietali crasso, bursaeformi, multipartito sed cum partibus inter se dense contiguis, pyrenoide destitutis; stigmate fuscorubro, mediocri, breve baculiformi in parte anteriore; vacuolis contractilibus binis, parvis in polo antico ad basin flagellorum, nucleo nucleolato media in cellula sito. Multiplicatio divisione protoplasti cellulae matricali in duas vel frequenter quattuor cellulas filiales. (Pl. 2, figs. 33–41.)

Cells rounded ellipsoidal or sometimes almost globose, 12μ–18μ–21μ long and 10μ–15μ–19μ wide, with two flagella which are as long as or slightly shorter than the cell; cell wall moderately thick, distinctly porous or almost smooth, colorless, with anterior semicircular small papilla which sometimes are entirely lacking; chloroplast parietal, thick but divided into a number of separate closely joined bodies, without a pyrenoid; eyespot brownish red, small, short sublinear, in the anterior half of the cell; contractile valuoles two, small, at the base of the flagella; nucleus more or less

centrally placed. Asexual reproduction by the division of the cell protoplast usually into 4 or more, rarely 2, daughter cells or zoospores. (Pl. 2, figs. 33–41.)

C. alaskensis is in the subgenus *Chloromonas*. This species is similar to *C. vulgaris* Anachin but is considerably smaller and has a porous cell wall, a smaller papilla, and a higher placed, shorter eyespot. It is also somewhat like *C. jemtlandica* Skuja but differs in being almost twice as large and in having a porous cell wall, shorter flagella, and a higher placed sublinear eyespot. Should also be compared with some other chloromonads.

Chlamydomonas subangulosa Skuja sp. nov.

Cellulae subanguloso-ovales vel late-ellipsoideae, 13μ–16μ longae, 9μ–14μ latae, flagellis binis cellulae circiter aequilongis vel paullo brevioribus instructae; membrana delicata, achroa levisve, papilla antica mediocri hemisphaerica vel truncato-rotundata praedita; chromatophoro poculiformi in parte anteriore extus longitudinaliter striato-carinato, parte postriore valde incrassato et pyrenoide depresso-globoso sat magno donato; stigmate fuscorubro mediocri, rotundo vel elliptico in parte anteriore; vacuolis contractilibus binis in polo antico ad basin flagellorum locatis; nucleo nucleolato in excavatione chromatophori sito. Multiplicatio divisione protoplasti cellulae maternae plerumque in 4 cellulas filiales. (Pl. 2, figs. 42–46.)

Cells slightly rectangular or broad-ellipsoidal, 13μ–16μ long and 9μ–14μ wide, with paired flagella which are as long as, or slightly shorter than, the cell; cell wall thin, smooth and colorless, with anterior semicircular medium-sized papilla; chloroplast cup shaped, striped on the outside of the anterior part, the posterior portion massive and with one rather large pyrenoid; eyespot brownish red, small, at the anterior end of the chloroplast. Asexual reproduction by division of the cell protoplast to form 4 zoospores or daughter cells. (Pl. 2, figs. 42–46.)

This species is in the subgenus ***Euchlamydomonas***, and is in some respects most similar to *C. angulosa* Dill but differs in its smaller size, its only medium-sized papilla, and the longitudinally-striped chloroplast on the outside, punctiform stigma, and the not angular but more or less rounded smaller pyrenoid. *C. leptobasis* Skuja is somewhat similar, but it is smaller, more rounded-ovoid, with longer flagella, and it has a thinner, simple cup-shaped chloroplast with a small globose pyrenoid. *C. subangulosa* should also be compared with *C. saxonensis* Skuja and with some other species of the subgenus ***Euchlamydomonas***.

Chlorococcum humicola (Näg.) Rbh.

Typical form. Cells globose, solitary or often gregarious in small amorphous clumps, variable in size within the same aggregation—namely 7μ–20μ–25μ in diameter; cell wall thin or moderately thick, colorless and smooth but in an older state sometimes more or less evidently lamellose; chloroplast cup shaped, thin, covering the whole wall or nearly so, with one pyrenoid in a thickened part of the plastid. Reproduction by the forming of usually 8–16, rarely as many as 32, aplanospores in a mother cell. (Pl. 1, figs. 16–19.)

Closterium acutum Bréb. Typical form; cells 100μ–123μ long and 4μ–4.5μ broad.

Euastrum denticulatum (Kirchn.) Gay.

Euastrum elegans (Bréb.) Kütz.

Gloeocystis rupestris (Lyngb.) Rbh. Compare also Skuja (1964, p. 106, table 15, fig. 11.)

Hormidium flaccidum A. Br.

Mougeotia sp. ster.

Oedogonium sp. ster.

Pediastrum braunii Wartm.

Planctococcus sphaerocystiformis Korschik.

Free-floating spherical colonies, 25μ–30μ in diameter; the gelantinous nonlamellate and colorless envelope relatively wide, including a central group of 4 globose cells, 9μ–12μ in diameter. Cells have a thin smooth wall and a thin or only moderately thick parietal multipartite chloroplast covering most of the wall; and lack a pyrenoid. (Pl. 2, fig. 47.)

Probably not a separate intraspecific taxon but only a 4-celled form of *P. sphaerocystiformis*.

Raphidonema gracile Skuja, sp. nov.

Cellulae solitariae vel post divisionem factam binatae, elongatae et cylindraceo-fusiformes, 1.7μ–2.3μ latae, 12μ–25μ longae, apicibus subito angustatis, polis subacuto rotundatis, plerumque plusminusve curvatis; membrana tenui, achroa laevisve; chromatophoro parietali, plusminusve unilaterali, sine pyrenoide sed cum excavatione ventrali media in cellula ubi nucleus locatus. Propagatio fit cellularum divisione in duas partes. (Pl. 2, fig. 48*a*–f.)

Cells free floating, solitary, or in pairs after division, elongate fusiform to somewhat cylindrical, with slightly tapering and subacute rounded ends, usually more or less curved, 1.7μ–2.3μ broad and 12μ–25μ long; cell wall thin, smooth, and colorless; chloroplast single, parietal, and more or less unilateral, without a pyrenoid but commonly with a rounded ventral sinus in the middle where the nucleus is located. Reproduction by a transverse division into two daughter cells that remain connected for some time. (Pl. 2, fig. 48*a–f.*)

This form perhaps most nearly resembles *Koliella corcontica* Hindák (Hindák, 1963, p. 107, table 2 (20), fig. 1), although it differs considerably because of its smaller and less cylindrical cells. I believe now that the main differences between *Koliella* Hindák and *Raphidonema* Lagerheim are not of a general but of an entirely gradual character and, therefore, of only secondary value taxonomically. Compare in this respect also the key to both genera by Hindák (1963, p. 99) and the figures in his plates 1–6, figures 19–24).

Scenedesmus acutus (Meyen) Chod.

Scenedesmus armatus (Chod.) G. M. Smith

Scenedesmus brevispina (G. M. Smith) Chod.

Scenedesmus ecornis (Ralfs) Chod.

Scenedesmus quadricauda (Turp.) Bréb.

Scenedesmus quadricauda var. *maximus* W. et G. S. West

Scenedesmus spinosus Chod.

Sphaerozosma granulatum Roy et Biss.

Staurastrum margaritaceum (Ehrnb.) Menegh. Granulation of the cell wall more or less reduced.

EUGLENOPHYCEAE

Anisonema acinus Duj.

Euglena pisciformis Klebs.

Euglena viridis Ehrnb. var. *olivacea* Klebs.

Menoidium incurvum (Fres.) Klebs.

CHRYSOPHYCEAE

Bodo minimus Klebs.

Monas uniguttata Skuja.

Pleuromonas jaculans Perty.

DIATOMACEAE

Achnanthes minutissima Kütz.
Cymbella austriaca Grun.
Cymbella delicatula Kütz.
Cymbella hebridica (Greg.) Grun.
Cymbella ventricosa Kütz.
Fragilaria construens var. *binodis* (Ehrnb.) Grun.
Melosira distans var. *pfaffiana* (Reinsch) Grun.
Neidium dubium (Ehrnb.) Cl. Cells 40μ–48μ long, 10μ–12μ broad.
Neidium iridis var. *amphigomphus* (Ehrnb.) V. H. Cells 80μ–120μ long, 27μ–30μ broad.
Nitzschia gracilis Hantzsch.
Pinnularia cardinaliculus Cl. A slightly larger form—length of the cells 100μ–115μ, breadth 21μ–22μ; striae 9–10 in 10μ.
Pinnularia dactylus Ehrnb. Length of the cells 230μ–250μ, breadth 46μ–48μ; striae 5–6 in 10μ.
Pinnularia gentilis (Donk.) Cl.
Pinnularia gibba Ehrnb.
Pinnularia gibba forma *subundulata* A. Meyer.
Pinnularia interrupta W. Sm.
Pinnularia interrupta forma *minutissima* Hust.
Pinnularia maior (Kütz.) Cl.
Pinnularia microstauron (Ehrnb.) Cl.
Pinnularia microstauron var. *ambigua* Meist.
Pinnularia viridis (Nitzsch) Ehrnb.
Stauroneis alabamae Heiden var. *angulata* Heid. Length 75μ–80μ, breadth 17μ. According to Cleve-Euler (1953, p. 211–212) Heiden's taxon is identical with *S. nobilis* Schumann, but see also Cleve (1894, p. 148).
Stauroneis anceps Ehrnb. Length of the cells 63μ–71μ, breadth 14μ–15μ; striae about 25 in 10μ.
Stenopterobia intermedia (Lewis) Fricke. Length of the cells 200μ–215μ, breadth 11μ–13μ; costae short, 4–5 in 10μ; transverse striae very delicate, about 20 in 10μ.
Tabellaria flocculosa (Roth.) Kütz.

CHLOROMONADOPHYCEAE

Vacularia virescens Cienk. Mostly encysted.

CRYPYOPHYCEAE

Cryptaulax vulgaris Skuja.
Cyathomonas truncata (Fres.) Fisch.

DINOPHYCEAE

Peridinium cunningtonii Lemm. tab. *contactum* Lef.

RHIZOPODA

Paulinella chromatophora Lauterb. The ovoid test with a low collar around the aperture, 29μ–31μ long and 25μ–26μ wide; cyanells 2, about 25μ long and 4.5μ–5μ broad.

HYPHOMYCETES

Tetracladium marchalianum De Wildem.

Mycelium of this swamp species was found on decaying leaves of *Isoëtes* sp. The evidently septate hyphae are sparsely or moderately branched and irregularly undulate or are more or less nodulose (constricted always at the septa), colorless or pale brownish; older hyphae as much as 6μ broad, the terminal hyphae about 1.5μ broad, with cells that are 3–8 times as long as broad; sporo- or conidiophores lateral, relatively short and usually unicellular thus without septa, the terminal parts slightly capitate with many short, budlike protruding branchlets from which subsequently the terminal more or less tetraradiate hyaline spore or conidium arises. (Pl. 2, figs. 50–53.)

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SOIL FUNGI AND ALGAE

By L. W. Durrell[6]

The fungi and algae were cultured from soils that surrounded the roots of several grasses (*Alopecurus*

[6] Professor Emeritus of Botany and Plant Pathology, Colorado State University, Fort Collins, Colo.

aequalis, *Deschampsia caespitosa*, *Phleum alpinum*, and *Trisetum spicatum*) that had been collected for transplanting in a common garden in order to study their ecotypic variation. The grasses, together with the upper 3–4 inches of soil that adhered to their roots, were collected on August 7, 1967, from upland sites and were placed in plastic bags to keep them moist during shipment. While collecting the specimens, no special precautions were taken to prevent contamination of the soil by foreign microorganisms; the preliminary inventory of species that were found in the soil samples may, nevertheless, be indicative of the microflora at the sites.

To isolate the fungi from the soil samples, small fragments of soil were planted on Rose-Bengal agar. This method of culture gives a more reliable index of the fungi that are present than does the old dilution technique. Table 1 gives a list of the fungi that were isolated from the 21 samples. Fungi were cultured from all but one of the samples, and two or more taxa were identified from more than half of the samples. Sample 7, in which six taxa representing as many genera were found, was the richest sample. In some of the genera, notably *Phoma*, *Fusarium*, and *Cephalosporium*, it is difficult if not impossible to make determinations of species.

In my studies of Alaskan soil samples from Peters Lake in the Brooks Range, Barter Island, the shores of the Arctic Ocean, and Matanuska, I have isolated 28 species of fungi. Judged from those and hundreds of other samples from throughout the world, none of the taxa found on Amchitka Island can be considered to represent unique distributions—all are widespread taxa. Much more intensive and careful sampling would be required to reveal unique elements of the microflora, if they are present.

Algae were cultured from 10 of the 21 soil samples by placing soil fragments on white quartz sand that had been autoclaved in small Erlenmeyer flasks. The sand was then wetted with modified Bristol-Roach solution (Bold, 1949) to add some nutrients and to stimulate

TABLE 1.—*Fungi and algae cultured from soil samples taken on Amchitka Island, Alaska*

[× indicates the presence, ---- the absence, and ? the questionable presence of the organism in the soil sample]

Organism	Soil sample																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Fungi																					
Alternaria tenuis auct. Wiltshire	----	----	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----
Aspergillus nidulans (Nidan) Winter	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	----
terreus Thom	----	----	----	----	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----
Cephalosporium sp	----	×	----	×	----	----	×	----	----	×	----	×	×	----	----	----	----	----	----	----	----
Curvularia sp	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Fusarium sp	----	×	×	×	×	×	----	----	----	----	----	----	×	----	×	----	×	----	----	×	×
Montospora brevis (Gilman & Abott) Mason	×	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	----	----
Mortierella vinacea Dixon-Steuart	×	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Mucor corticolus Hagen	×	×	×	----	----	----	----	----	----	----	----	----	----	----	----	----	----	×	----	----	----
racemosus Fresenius	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
varians Povah	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	----	----
sp	----	----	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----
Penicillium cambertii Thom	----	----	----	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----
citrinum Thom	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----
frequentans Westling	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	----
oxalticum Thom	×	----	----	×	----	----	×	----	----	----	×	----	----	----	----	----	----	----	----	----	----
sp	----	----	×	----	----	----	----	----	×	----	----	----	----	----	×	----	×	----	----	----	----
Phoma sp	×	----	----	----	----	----	×	----	----	----	----	×	----	----	----	----	----	----	----	----	----
Pythium sp	----	----	----	----	?	----	×	----	----	----	----	----	----	----	----	----	----	----	×	----	----
Stachybotrys atra Corda	----	×	----	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----
Stemphylium ilicis Tengwall	----	----	----	×	----	----	×	----	----	----	----	----	×	----	×	----	----	----	----	----	----
Trichoderma viride Pers. ex Fries	----	----	----	----	----	----	----	----	----	×	----	×	×	----	----	----	----	----	----	----	----
Verticillium sp	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	×	----	----	----	----
Algae																					
Anabaena variabilis Kuetz	----	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----
Chlorella vulgaris Beyerinck	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	×	×	----	----	----	----
Chlorococcum humicola (Naeg.) Rabenhorst	----	----	----	----	----	×	----	----	×	×	×	----	----	----	----	×	×	×	×	----	----
Cladophora (fragment)	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	----
Gloeocystis ampla (Kuetz.) Lagerheim	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Nostoc paludosum Kuetz	----	----	----	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	----
Palmella sp	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	?	----	----	----	----	----
Phormidium antarcticum W. et G. S. West	----	----	----	----	×	----	×	----	----	----	----	----	----	----	----	----	×	----	----	----	----
crouani Gom	----	----	----	----	×	----	×	----	×	----	----	----	----	----	----	----	----	----	×	----	----
molle (Kuetz.) Gom	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	×	----	----	----
subcapitatum Boye P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	×	----	----	----
Stichococcus subtilis (Kuetz.) Klercker	----	----	----	----	----	×	×	----	×	----	×	----	----	----	----	×	×	----	----	----	----
Stigonema turfaceum (Berk.) Cooke	----	----	----	----	----	----	×	----	----	----	----	----	----	----	----	----	----	----	----	----	----

SOIL SAMPLES

1. Black sandy loam, pH 7.0.
2. Black sandy loam, pH 6.0.
3. Gray organic clay, pH 6.0.
4. Gray organic clay, pH 5.9.
5. Gray organic clay, pH 5.5.
6. Black sandy loam, pH 6.4.
7. Black sandy loam, pH 6.2.
8. Black sandy loam, pH 5.9.
9. Black sandy loam, pH 6.4.
10. Black sandy loam, pH 6.5.
11. Gray sandy loam, pH 6.5.
12. Gray sandy loam, pH 6.6.
13. Loam (muddy), pH 6.6.
14. Dark sandy loam, pH 6.8.
15. Gray organic matter and clay, pH 6.5.
16. Gray sandy loam, pH 6.2.
17. Gray organic matter and clay, pH 6.5.
18. Black sandy loam, pH 6.2.
19. Black sandy loam, pH 6.5.
20. Gray organic matter and clay, pH 6.5.
21. Gray organic matter and clay, pH 6.9.

growth. In about 60 days, algae, if present in the sample, will form a green growth on the sand. As in fungi, sample 7 was among the richest in algae of those examined, having four species that represent three genera. The absence of algae from 11 of the samples may have been because of limited soil sampling. Growth in a culture frequently originates from a single propagule; therefore, more extensive sampling at a site would have increased the likelihood of including these single reproductive bodies.

OBSERVATIONS ON THE FLORA [7]

By WILLIAM M. KLEIN [8]

Since 1965 several Government agencies have supported studies of the vegetation and ecology of Amchitka Island. Botanists of the U.S. Geological Survey and others have collected extensively on the island, with vascular plants, bryophytes, and lichens having received the most attention. I collected vascular plants on this island during the summer of 1967 to provide taxonomic support for ecological investigations. These recent studies have resulted in the accumulation of a large number of plant specimens, and the Amchitka Island flora is now probably more thoroughly collected than that of any other island in the Near Island and Rat Island groups.

After I had critically studied some of these collections, it became apparent that the recent collecting efforts had brought the understanding of this flora to a new level and that certain binomials could no longer be applied. The observations in this report indicate the progress that has been made in these floristic studies and emphasize the need for a clarification of certain vascular plant names as applied to this flora.

The floristic studies of the Aleutian Islands have followed the usual course of events as described by Davis and Heywood (1963). The first and so-called pioneering phase in the Aleutian Islands was led by Hultén (1960). In this stage taxonomic decisions must be based upon limited material, and judgments regarding the status of a particular taxon must at times be arbitrary. Through more comprehensive collections and herbarium studies knowledge of the flora enters the second or consolidation phase where many of the variants described as species are found to be variants of previously described taxa. Intensified exploration, also in this phase, may lead to the discovery of new species and may make possible conclusions regarding phytogeographic relationships. The floristic studies of Amchitka Island have now approached this second phase, as is indicated by the comments on the taxa that follow. The third and fourth phases, biosystematic and encyclopedic, are mostly in the future, although some work has now begun which might appropriately be called biosystematic.

The collections of the Gramineae were compared with those in the U.S. National Herbarium. The names that I suggest are based primarily upon these studies and reflect my own views regarding the application of specific and subspecific categories which may be summarized as follows:

1. When two taxa intergrade over a considerable part of their distribution range there can be, in my opinion, no real justification for recognizing them as distinct species. The occurrence of intermediate types commonly indicates genetic continuity between populations which are best treated as conspecific. A satisfactory treatment, however, will come only after the geography and pattern of variation are more thoroughly understood. Until such time, it seems best to follow a conservative course in the application of new names.
2. Intraspecific taxa should be recognized where this appears to be an appropriate way of dealing with the variation pattern. Recognition of such taxa usually requires intensive field and herbarium studies, and if possible these studies should be correlated with experimental findings. In most instances where intraspecific taxa are distinguished, there is geographic and ecological differentiation, and taxa can be delimited on the basis of morphology.
3. The occurrence of two or more distinct morphological forms in the same populations throughout the range of a taxon may indicate the polymorphic nature of the population rather than fundamental differences. The application of names to the virtually endless number of variants can only burden the taxonomic system and inevitably obscure the more important relationships.

Determinations of *Epilobium* were made by Dr. P. A. Munz of the Rancho Santa Ana Botanic Garden, Claremont, Calif. Collections of *Salix* were sent to Dr. G. W. Argus of the W. P. Fraser Herbarium, University of Saskatchewan, Saskatoon, Saskatchewan. Collections of *Carex* were sent to Dr. F. J. Hermann of the U.S. Forest Service. The assistance of these specialists is gratefully acknowledged.

In the vegetation studies and the annotated list of vascular plants of this report, Shacklette, Erdman, and Keith used the names that are given in Hultén's flora

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[8] Department of Botany and Plant Pathology, Colorado State University, Fort Collins, Colo.

(1968), except for some references to Amchitka Island taxa that were not collected in the present study. Hultén's 1968 nomenclature was adopted because of the advantages gained by following a comprehensive modern treatment of the Alaskan flora. Results of taxonomic studies that I report below are preliminary to more complete morphological and cytological investigations of certain critical groups of taxa from this island.

The following list includes only the families on which some critical work has been done and the taxa that have binomials whose proper application was in doubt. Suggested names for species of four families in the Amchitka Island flora follow.

CYPERACEAE

Hermann's determinations of species in this family agreed with those of Hultén for all but one species, *Carex kelloggii* Boott. Two collections of this species, 7485 and 8031, were made by Shacklette. Collection 7485 was determined as *C. hindsii* C. P. Clark and collection 8031 as possibly *C. aquatilis* Wahl., although it was noted that the material of the latter was too immature for a critical identification to be made.

GRAMINEAE

Agrostis borealis Hartm. [*A. alaskana* Hult. (Hultén, 1960, p. 78; 1968, p. 99)]. *Agrostis alaskana* is noted by Hultén (1960, p. 77) to be the most common species of the genus in the Aleutian Islands. It intergrades with *A. borealis* and should be placed in that complex.

Deschampsia atropurpurea (Wahl.) Sheele [*Vahlodea atropurpurea* (Wahl.) Fr. (Hultén, 1960, p. 88; 1968, p. 115)]. *Vahlodea* is treated as a segregate of *Deschampsia* in the U.S. National Herbarium and in most American works.

Deschampsia caespitosa (L.) Beauv. [*D. beringensis* Hult. (Hultén, 1960, p. 85–87; 1968, p. 114)]. *Deschampsia beringensis* is cited by Hultén (1960, p. 86) as "one of the most common grasses on the Aleutians." This species cannot be distinguished from *D. caespitosa*, and Kawano (1963) treats it in that complex. Hultén (1968) noted that many specimens show "hybrid influence from *D. caespitosa*."

Festuca ovina var. *brachyphylla* (Schult.) Piper [*F. brachyphylla* Schult. (Hultén, 1960, p. 103–104; 1968, p. 168)]. *Festuca brachyphylla* intergrades widely with *F. ovina* and affinities are best shown by maintaining it in this complex, which may also include *F. ovina* subsp. *alaskensis* Holmen (Hultén, 1968).

Festuca rubra L. [*F. rubra* subsp. *acuta* (Krecz & Bobr.) Hult. (Hultén, 1960, p. 104; 1968, p. 171)]. *Festuca rubra* is a highly variable species and some of the variants that have been described appear to represent expressions of polymorphic systems and should not be accorded formal taxonomic recognition.

Phleum alpinum L. [*P. alpinum* var. *americanum* Fourn. (Hultén, 1960, p. 74–75); *P. commutatum* Gandoger var. *americanum* (Fourn.) Hult. (Hultén, 1968, p. 88)]. The recognition of infraspecific taxa and the application here of another specific epithet does not appear to be justified on the basis of existing evidence.

Poa alpina L. [*P. hispidula* Vasey; *P. komarovii* Roshew; *P. lanata* (Scribn.) Merr.; *P. turneri* Scribn.]. An extremely complex group; the above-listed taxa cited by Hultén (1969, 1968) for Amchitka Island probably can all be assigned to the *P. alpina* complex .All of these taxa produce viviparous forms that appear to be environmentally induced.

ONAGRACEAE

Epilobium boreale Hausskn. [*E. ?glandulosum* Lehm. (Hultén, 1960, p. 263–264; 1968, p. 690)]. Material determined by P. A. Munz to be *E. boreale* is very common on Amchitka Island, although this species is not reported by Hultén for any of the Aleutian Islands. It seems likely that this plant is being called *E. glandulosum*, which is reported to be common along the entire island chain.

SALICACEAE

Salix arctica Pall. [*S. crassijulis* Trautv. (Hultén, 1960, p. 158–160); *S. arctica* Pall. subsp. *crassijulis* (Trautv.) Skvortz. (Hultén, 1968, p. 340)]. *Salix arctica*, according to G. W. Argus (written commun., 1968), is a highly variable species and it is impossible at this point to distinguish intraspecific taxa.

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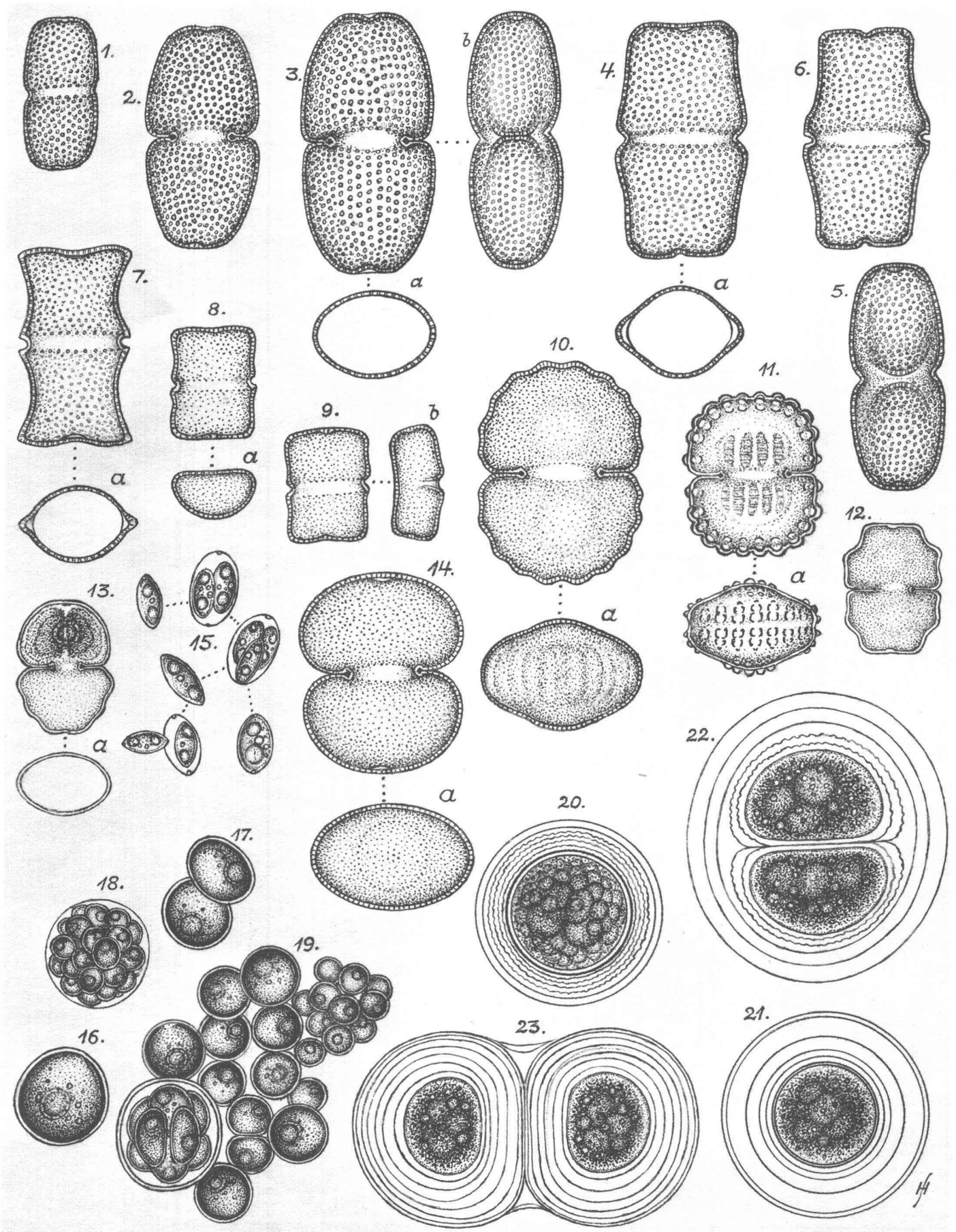
4–6. *C. tatricum* Racib.
7. *C. decedens* (Reinsch) Racib.
8, 9. *C. obliquum* Nordst.
10. *C. subundulatum* Willie.
11. *C. subcrenatum* Hantzsch forma.
12. *C. meneghini* Bréb. var *concinnum* Rbh.
13. *C. laeve* Rbh. forma.
14. *C. subpachydermum* Schmidle forma.
15. *Oocystis parva* W. et G. S. West.
16–19. *Chlorococcum humicola* (Näg.) Rbh.
20–23. *Gloeodinium montanum* Klebs.



DRAWINGS OF ALGA SPECIES

PLATE 2

FIGURE

24. *Synechococcus cedrorum* Sauv. var. *pallidus*, var. nov.
25. *Oscillatoria amoena* (Kutz.) Gom.
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27. *O. splendida* Grev.
28. *O. grossegranulata* Skuja.
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49. *Ankistrodesmus braunii* (Nag.) Collins var.
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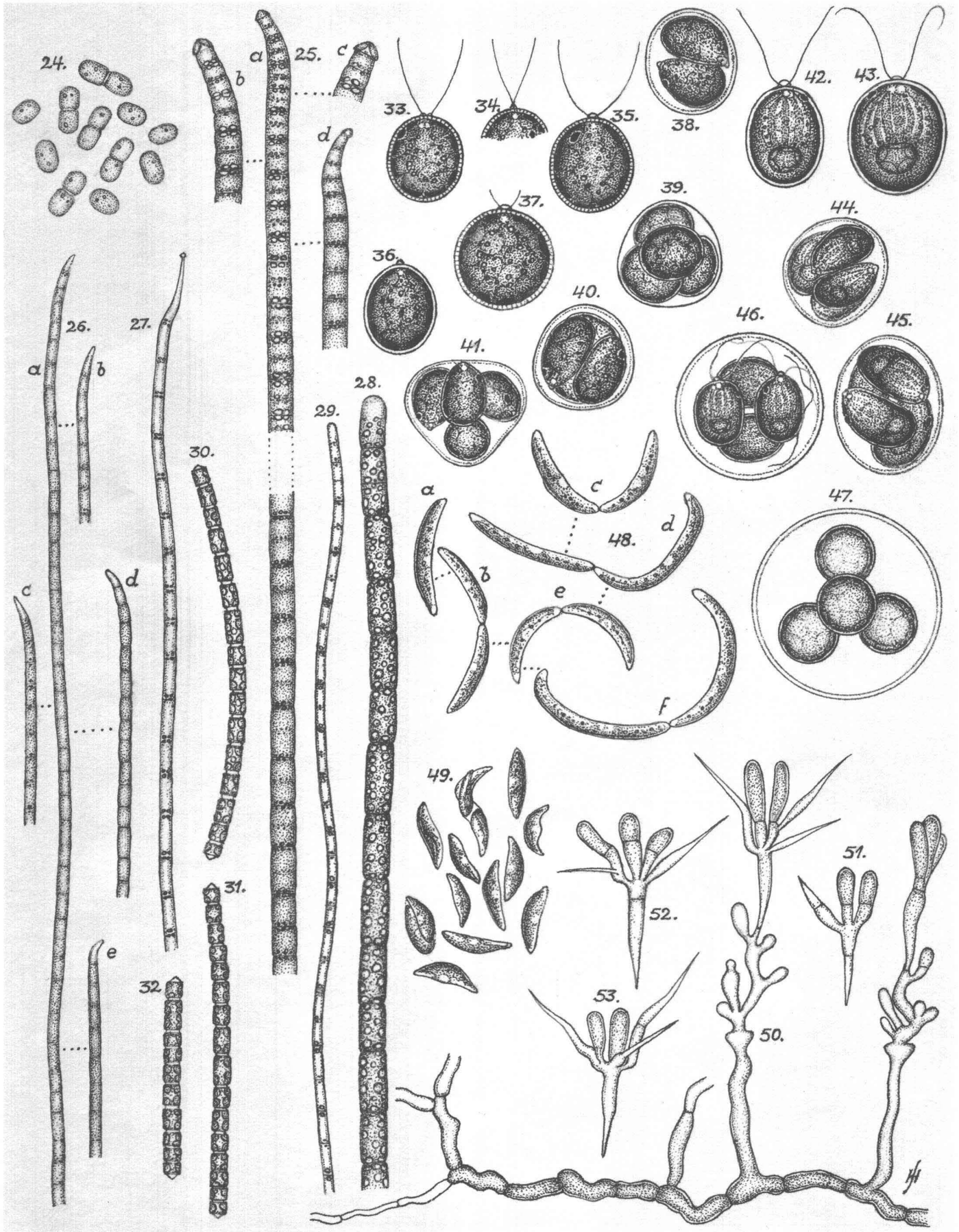

DRAWINGS OF ALGAE AND OTHER PROTISTS