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Marine macroalgae of the Aleutian Islands: I. Bangiales

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We sequenced the *rbc*L gene in more than 100 collections of foliose Bangiales made in the Aleutian Islands and western Alaska Peninsula during the past 25 years. This work allows us to recognize four previously undescribed species, two in the genus *Boreophyllum* and two in *Pyropia*. *Boreophyllum aleuticum* appears to be endemic to the Aleutian Islands, whereas *B. ambiguum* is known to occur from the Yakutat area to the tip of the Alaska Peninsula. The two previously undescribed species of *Pyropia* are more broadly distributed. *Pyropia taeniata*, which was previously identified under the name *Py. pseudolinearis*, occurs from northern Southeast Alaska through the Aleutian Islands. *Pyropia unabbottiae*, which is sister to *Py. abbottiae*, occurs from southern Vancouver Island to Attu Island. Collections throughout the Aleutian Islands allow us to document the distribution of another dozen species of foliose Bangiales in this region, including *Boreophyllum aestivale*, *Fuscifolium tasa*, *Pyropia fallax*, *Py. fucicola*, *Py. gardneri*, *Py. kurogii*, *Py. nereocystis*, *Py. pseudolanceolata*, *Py. torta*, *Wildemania amplissima*, *W. norrisii*, and *W. variegata*. We were unable to confirm the occurrence of the following species previously recorded from the Aleutian Islands: *Porphya ochotensis*, *Pyropia abbottiae*, *Py. perforata*, *Py. pseudolinearis*, *P. purpurea*, *P. umbilicalis*, *Py. yezoensis* and *Wildemania schizophylla*. At least two undescribed filamentous Bangiales also occur in the Aleutian Islands.

Key Words: Aleutian Islands; Bangiales; *Boreophyllum*; *Porphyra*; *Pyropia*; *rbc*L

INTRODUCTION

The Aleutian Islands, an archipelago of more than 300 islands, stretch more than 1,600 km from the western tip of the Alaska Peninsula at 163° W latitude (Unimak Island) to beyond the International Dateline at 172° E longitude (Attu Island) and span over 425 km of latitude (between 51 and 55° N). This remote archipelago is uniquely situated between the American and Asian continents and between two major bodies of water, the North Pacific Ocean and the Bering Sea (Fig. 1). The easternmost islands are situated on continental crust, whereas those west of Samalga Pass are distinctly oceanic. The islands are grouped in five major clusters, which are separated by increasingly wider and deeper passages from east to west (Stabeno et al. 2005). Ocean mixing and transport along the archipelago are driven by upwelling, tidal action through passes, and three major currents: the Alaska Coastal Current and the Alaska Stream flow westward on the Pacific side, and the Aleutian North Slope Current flows eastward on the

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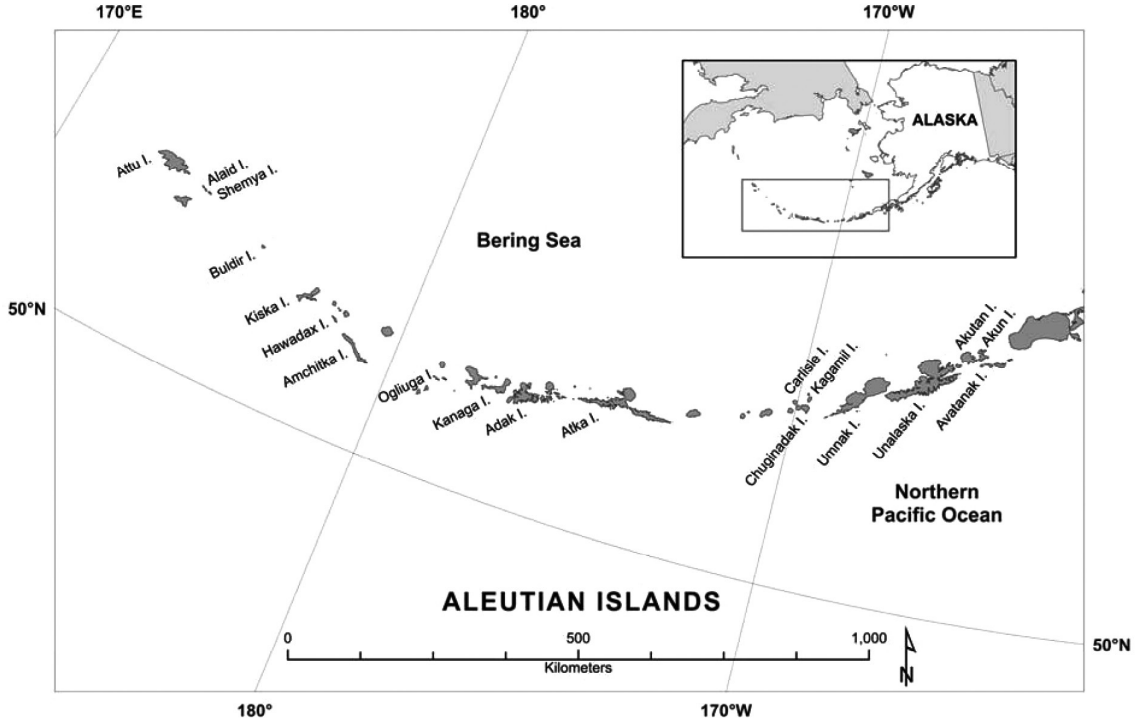

Fig. 1. Map of the Aleutian Islands showing islands where Bangiales were collected in this study.

Bering side (Ladd et al. 2005). Sea surface temperatures range from 5 to 10°C in summer and drop to near 0 in winter (Rodionov et al. 2005).

The shores of the Aleutian archipelago offer some of the most exposed habitats of any rocky coastline on earth and experience a cool, wet and windy marine climate. Extreme winter storms are fueled by the notorious low-pressure area known as the Aleutian Low, and moisture-laden fog often blankets the coast in summer (Rodionov et al. 2005). Coastal areas are generally characterized by high cliffs with rock ramps (≥100 m wide) or steep bedrock, boulder, and cobble beaches. Substrates range from basaltic lava flows to tuffs, breccia, conglomerates, and sandstone (Gard 1977). Oceanic ground swells constantly carve shorelines, forming wave-cut channels, rounding boulders and cobble, eroding sea cliffs, and creating extensive spray zones. In addition to wind, weather and waves, the islands are also home to 37 extant volcanoes, and eruptions impacting coastal habitats are common (Jewett and Drew 2014). The archipelago's vast and complex physical setting creates highly variable and isolating conditions between island groups and even neighboring islands. Endemism can be expected along this extensive but narrow chain of islands (Kawai et al. 2008, Jewett and Clark 2011).

Despite this forbidding environment, marine macroalgae thrive in the Aleutian littoral zone, including members of the Bangiales (Lebednik and Palmisano 1977). In fact, the wide spray zone of the upper intertidal is ideal habitat for many species of Bangiales, which favor cool waters with frequent disturbances that not only provide cleared substrate for colonization but also challenge the tenacity of invertebrate herbivores. Species of Bangiales often form a distinct band visible from offshore and can be an abiding feature of the Aleutian littoral zone. Although species of Bangiales are commonly found throughout the Aleutian Islands, their identity and distribution have been poorly documented because of the lack of collection due to remoteness and the challenging environment of the archipelago and the application of appropriate methods of determination. Wynne (1972) published the only study that focused on foliose Bangiales in this region, but his efforts were limited to Amchitka Island. Conway et al. (1975) included a number of records of Bangiales from the Aleutian Islands in their work. Both of these studies, however, were done at a time when morphology was still the main method for seaweed identification. Today, DNA sequencing is essential for identification of species such as foliose Bangiales, which have few morphological characters to distinguish them (Sutherland et al. 2011). Lindstrom (2008) and Lindstrom et al. (2015) included records of foliose Bangiales from the Aleutian Islands, but that

region was not the focus of their studies.

We have now sequenced the *rbc*L gene of over 100 collections of foliose Bangiales made in the Aleutian Islands and the western Alaska Peninsula during the past 25 years, and we have examined several hundred additional specimens of Bangiales collected during this period. Below we provide records of these species in the region, including descriptions of previously unnamed or incorrectly identified species. This baseline information will aid future studies in biodiversity and phytogeography, especially as this region faces climate-related changes (e.g., ocean warming, acidification, and changing weather patterns).

MATERIALS AND METHODS

Specimens were collected in the Aleutian Islands in 1990, 1992, 1993, 1999, and 2000 by D. A. Guthrie, in 2004, 2005, and 2008 by S.C. Lindstrom, and in 2006 and 2007 by M. R. Lindeberg. Some of these were included in earlier publications (Lindstrom 2008, Lindstrom et al. 2015); the rest are listed in Appendix 1. Specimens were pressed fresh on herbarium paper with a small portion of the 2004-2008 specimens desiccated in silica gel for later extraction of DNA. These herbarium vouchers are deposited in the UBC herbarium. DNA extraction, amplification and sequencing followed Lindstrom (2008) with the replacement of the forward primer F57 with KitoF1 (5′-TGTCTCAATCCGTAGAATCA-3′) and the use of Bangiales-specific primers for material not desiccated in silica gel or otherwise difficult to amplify (Table 1).

RESULTS

We identified 17 species of Bangiales in our Aleutian collections based on DNA sequencing (Table 2). Twelve of these have been described previously. Two *Bangia*-like species await descriptions of the genera in which they occur before the species can be described (see Sutherland et al. 2011). Three foliose species from the Aleutians are new to science, and we describe these below. We also describe a third Alaskan species of *Boreophyllum*; although it is thus far unknown from the Aleutians, it occurs nearby at the western end of the Alaska Peninsula.

Boreophyllum aleuticum S. C. Lindstrom & M. R. Lindeberg sp. nov. (Fig. 2A)

This species was identified as Unknown #4 in Lindstrom (2008).

Description. Thalli to 1 m in length and width although usually much smaller, broadly ovate, obovate, or nearly orbiculate, often lacerated or even lobed, with margin very slightly but deeply ruffled. Base cuneate to umbilicate. Monostromatic, with a single chloroplast per cell. Dark red, brown to nearly black, oily-looking when alive; dusky purple when dried. Adhering well to paper. Vegetative thalli 50-85 μm thick. Male and female reproductive cells on separate plants. Spermatangia in irregular marginal sections of thalli, mostly distal, occurring according to the Hus formula 2-4/a, 2-4/b, 8-16/c (Hus 1902); spermatangial thalli 75-100 μm thick. Zygotosporangia in nearly inconspicuous reddish marginal sections, occurring according to the Hus formula 1-2/a, 1-2/b, 2-4/c; zygotosporangial thalli ~75 μm thick.

Holotype. UBC A90644, Haycock Rock, Kiska Island, low intertidal, Jun 30, 2007, Leg. M. R. Lindeberg ALEUT07_119. GenBank KT936157. The holotype consists of two thalli, one spermatangial, the other zygotosporangial.

Isotype. ALEUT07_118 in UBC (A90643) consists of a single thallus, which is spermatangial.

Etymology. Thus far, this species has been collected only in the Aleutian Islands, hence its name.

Habitat. On cobble or larger rock in the mid to low intertidal zone.

Phenology. Specimens have been collected only in May, June, July, and August (the only months when Aleutian sites were visited). Spermantangia were observed in early June collections as well as later but zygotosporangia not until late June.

Table 1. Bangiales-specific *rbc*L primers used in this study

Name	Direction	Sequence	Tm (°C)	MW	No. of bases
F256	Forward	5′-GCAAAAGCRTAYMGWGTWGATCC-3′	55.1	7,069.2	23
R256	Reverse	5′-GGATCWACWCKRTAYGCTTTTGC-3′	55.1	7,017.6	23
R492	Reverse	5′-GGTCTGCCRAAYTTRTCCATRCG-3′	57.0	7,007.1	23
F973	Forward	5′-GGTGTTGACCATATTCAYGCAGG-3′	57.2	7,087.1	23
R973	Reverse	5′-CCTGCRTGAATATGGTCAAACACC-3′	57.2	7,000.6	23
R1432	Reverse	5′-GGAGTCTCAACGAARTCAGC-3′	54.4	6,143.0	20

Table 2. Verified Aleutian Islands distributions of species from this and previous studies (locations listed from east to west)

	Avatanak	Akun	Akutan	Unalaska	Umnak	Kagamil	Chuginadak	Carlisle	Atka	Adak	Kanaga	Ogliuga	Amchitka	Hawadax	Kiska	Buldir	Shemya	Alaid	Attu
'Bangia 2' sp. 1	g	-	-	g	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
'*Bangia* 3' sp. 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	g
Boreophyllum aestivale (S. C. Lindstrom & Fredericq) S. C. Lindstrom	-	e	e	e	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boreophyllum aleuticum S. C. Lindstrom & M. R. Lindeberg	-	-	e, g	-	-	-	-	-	-	g	-	g	g	-	g	-	-	-	-
Fuscifolium tasa (Yendo) S. C. Lindstrom	g	e	-	e	-	-	-	e	-	g	-	-	a, g	g	e, g	-	g	g	g
Pyropia fallax (S. C. Lindstrom & K. M. Cole) S. C. Lindstrom	f	e	e, f	e, g	-	-	-	-	f	-	-	-	g	-	-	-	-	-	f
Pyropia fucicola (V. Krishnamurthy) S. C. Lindstrom	g	e	e	e	-	-	-	-	-	g	-	-	-	-	-	-	g	-	g
Pyropia gardneri (G. M. Smith & Hollenberg) S. C. Lindstrom	-	-	-	-	-	-	d	-	-	c	-	-	c	-	-	-	-	-	c, g
Pyropia kurogii (S. C. Lindstrom) S. C. Lindstrom	-	-	e	e	-	-	-	-	-	g	-	-	-	-	-	-	-	-	-
Pyropia nereocystis (C. L. Anderson) S. C. Lindstrom	-	-	-	b	e	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyropia pseudolanceolata (V. Krishnamurthy) S. C. Lindstrom	f	-	e	b, e, f	-	-	-	-	-	b, g	f	-	-	-	-	-	g	f	g
Pyropia taeniata S. C. Lindstrom	g	g	e, g	e, g	-	-	-	e, g	-	g	g	-	a	g	-	g	g	g	g
Pyropia torta (V. Krishnamurthy) S. C. Lindstrom	g	g	-	e	-	-	-	-	-	-	-	-	-	g	-	-	g	g	g
Pyropia unabbottiae S. C. Lindstrom	g	e, g	-	e, g	-	-	-	-	-	g	-	-	-	-	-	-	g	-	g
Wildemania amplissima Foslie	-	-	-	e, g	-	-	-	-	-	g	-	-	a	-	-	-	-	-	g
Wildemania norrisii (V. Krishnamurthy) S. C. Lindstrom	-	e	e	b, e	-	-	-	-	-	-	-	-	-	-	-	-	g	-	b
Wildemania variegata De Toni	-	g	e	g	-	e	-	-	-	g	-	-	a	-	-	-	g	-	b, g

See Fig. 1 for location of islands.

[a]Wynne (1972).

[b]Conway et al. (1975).

[c]UBC specimens annotated by M. W. Hawkes in 1977.

[d]UBC A70807, A70808, Leg. & Det. K. A. Miller 4200, Jul 10, 1987, may include some *W. variegata*.

[e]Lindstrom (2008).

[f]Lindstrom et al. (2015).

[g]This study.

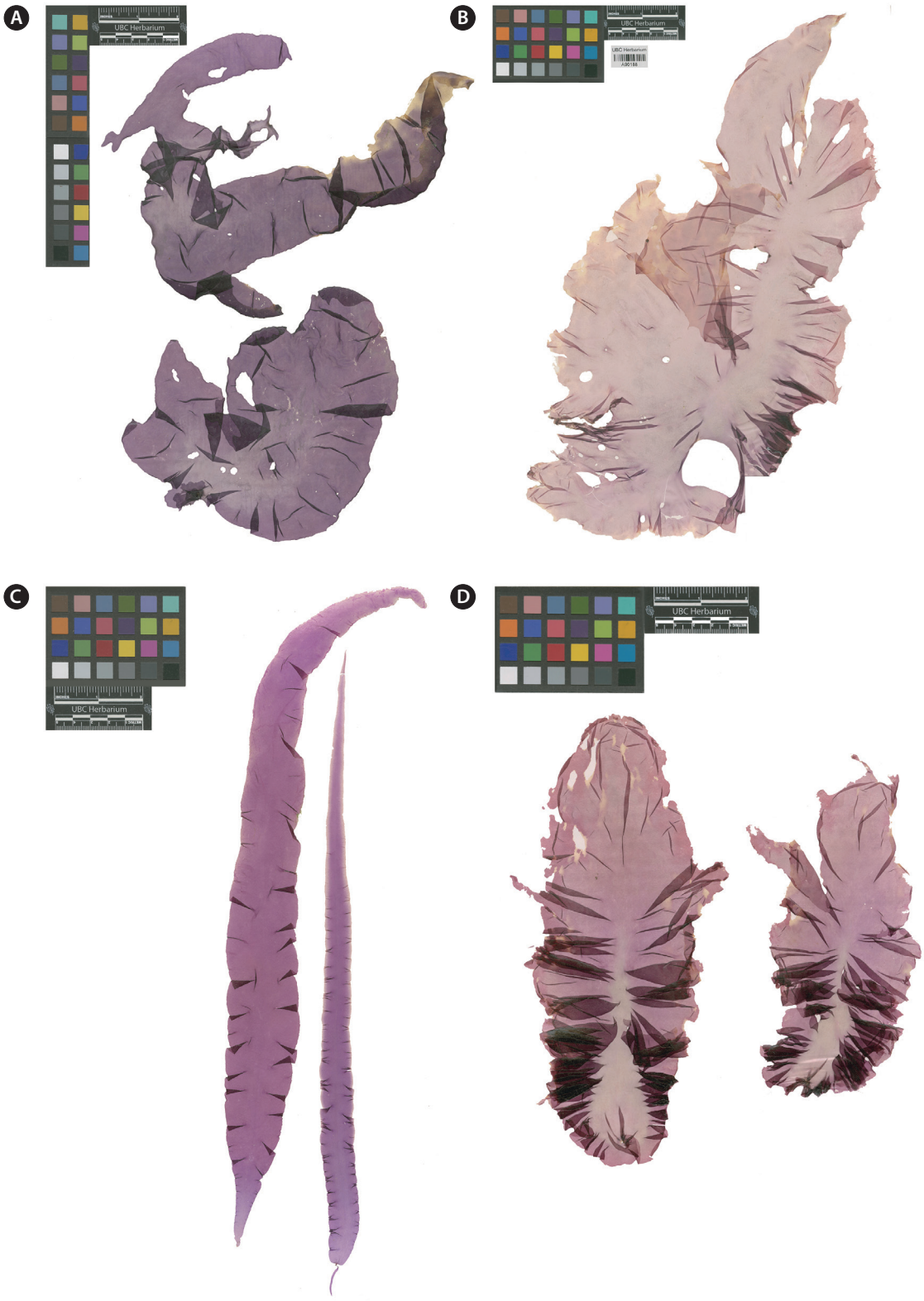

Fig. 2. (A) Holotype of *Boreophyllum aleuticum*, UBC A90644, Haycock Rock, Kiska Island, low intertidal, Jun 30, 2007, Leg. M. R. Lindeberg ALEUT07_119. (B) Holotype of *Boreophyllum ambiguum*, UBC A90188, head of Northeast Harbor, Sanak Island, Alaska, lower mid intertidal, on large boulder, Aug 31, 2012, Leg. S. C. Lindstrom 15128. (C) Holotype of *Pyropia taeniata*, UBC A90672, Sunshine Cove, Lynn Canal, Southeast Alaska, low intertidal bedrock, Apr 19, 2011, Leg. S. C. Lindstrom 14611. (D) Holotype of *Pyropia unabbottiae*, UBC A90681, Akun Bay, Akun Island, low intertidal boulder, Jun 13, 2008, Leg. S. C. Lindstrom 13780.

Known distribution. Thus far known only from the Aleutian Islands: Akutan, Adak. Ogliuga, Amchitka, and Kiska (Table 2, Appendix 1) although probably occurring on additional islands in the chain.

Comments. This species clearly belongs in the genus *Boreophyllum* based on *rbc*L and 18SrRNA gene sequences (Lindstrom 2008, Sutherland et al. 2011). It is sister to the clade containing the other species of *Boreophyllum* that have been described (*B. aestivale*, *B. birdiae*, and *B. pseudocrassa*).

Boreophyllum ambiguum S. C. Lindstrom sp. nov. (Fig. 2B)

Description. Thalli to at least 50 cm in length and width although usually much smaller, broadly ovate, obovate, or nearly orbiculate, often lacerated or even lobed, with margin moderately ruffled, particularly proximally. Base umbilicate. Monostromatic, with a single chloroplast per cell. Dusky purplish rose when dried. Mostly adhering well to paper. Male and female reproductive cells on the same thalli but on separate "halves," separated by a very irregular, often inconspicuous vertical line. Spermatangia in more or less solid smears across the distal end of thallus, occurring according to the Hus formula 2-4/a, 2-4/b, 8/c; spermatangial thalli 52-65 μm thick. Zygotosporangia in mottled, very slightly rosaceous smears, occurring according to the Hus formula 1-2/a, 2/b, 4/c, with clearly visible cell walls separating packets; zygotosporangial thalli 55-85 μm thick.

Holotype. UBC A90188, head of Northeast Harbor, Sanak Island, Alaska, lower mid intertidal, on large boulder, Aug 31, 2012, Leg. S. C. Lindstrom 15128. GenBank KT936164.

Isotypes. SCL 15130 in UBC (A90189). GenBank KT93 6165.

Etymology. The species epithet derives from the difficulty in differentiating this species from the other species of *Boreophyllum* in the Alaska flora.

Habitat. Mid intertidal boulder, cobble, and pebble.

Phenology. Specimens have been collected in July and August; so, like its sister taxon *B. aestivale*, this appears to be a summer species, likely extending into autumn.

Known distribution. Confirmed to occur from the eastern Gulf of Alaska (La Chausee Spit) to the tip of the Alaska Peninsula (Cold Bay, Sanak Island) (Appendix 1).

Comments. An earlier record of this species from Prince William Sound was published as *B. aestivale* (S. C. Lindstrom & Fredericq) S. C. Lindstrom (UBC A84436, GenBank AF452425) (Lindstrom and Fredericq 2003). *Boreophyllum aestivale* and *B. ambiguum* differ by 7 bp (0.5%) fixed differences. These differences are evident even between specimens that co-occur on the same rock. Specimens of *B. ambiguum* are often quite large and nearly orbiculate in contrast to the usual broadly lanceolate form of *B. aestivale*. This difference, however, may merely reflect that the former has usually been found in fairly protected habitats, whereas the latter is often seen on exposed shores.

Pyropia taeniata S. C. Lindstrom sp. nov. (Fig. 2C)

This species was identified as Unknown #2 in Lindstrom (2008).

Description. Thalli lanceolate to linear, usually tapering to a point when young, with finely ruffled margins (male thalli occasionally planar), reaching at least 44 cm in length and 14 cm in width although usually shorter (20-40 cm) and much narrower (1.2-3.0 cm); often distinctly stipitate. Monostromatic, with a single chloroplast per cell. Adhering well to paper. Color usually reddish pink, reddish brown, or reddish purple. Male and female reproductive cells usually on separate plants; when on the same thallus, sectored by a vertical line (UBC A90660) or even monoecious, with marginal spermatangial streaks adjacent to zygotosporangial patches (UBC A90661, A90669, A91706, A91709, A91711, A91742, A91743, A91744, and A91752). Spermatangia in a narrow band along the margin, occurring according to the Hus formula 2 /a, 2-4/b, 8/c; spermatangial thalli 45-70 μm thick. Zygotosporangia in reddish distal ends and along distal margins, becoming hieroglyph-like or mottled as spores are released, arranged according to the Hus formula 2-4/a, 2-4/b, 4/c; zygotosporangial thalli 45-50 μm thick.

Holotype. UBC A90672, Sunshine Cove, Lynn Canal, Southeast Alaska, low intertidal bedrock, Apr 19, 2011, Leg. S. C. Lindstrom 14611. GenBank KT936189. The holotype consists of two thalli, one spermatangial, the other zygotosporangial.

Isotypes. There are no isotypes, but there is abundant topotype material in UBC and ALAJ, the herbarium of the University of Alaska Southeast, Juneau (see Comments below).

Etymology. The specific epithet refers to the fine, ribbon-like nature of the thallus.

Habitat. This species occurs on low intertidal rock, usually bedrock or boulders, except in the western Aleutian Islands, where it occurs in the mid to high intertidal and may also occur epiphytically.

Phenology. This is a spring species, extending into

summer in colder regions. Most specimens were collected in April, May, and June, but July and August collections were also made in the Aleutian and Pribilof Islands.

Known distribution. Northern Southeast Alaska (near Juneau), Gulf of Alaska west through the Aleutian Islands to Kamchatka (Lindstrom 2008).

Comments. This Alaskan species has been identified as *Porphra pseudolinearis* Ueda since the work of Wynne (1972). Indeed, *Py. pseudolinearis* (Ueda) N. Kikuchi, M. Miyata, M. S. Hwang & H. G. Choi and *Py. taeniata* are related although they are not sister taxa according to Sutherland et al. (2011) despite their morphological similarity. Subsequent studies in Alaska of *P. pseudolinearis* have rather been of *Py. taeniata* (Stekoll et al. 1999, Lin and Stekoll 2007, Lin et al. 2008, Lindstrom et al. 2008). These studies were carried out primarily on material from Sunshine Cove, hence the decision to select a specimen from that location rather than the Aleutian Islands as the type of the species. Lindstrom (2008) called this species Unknown #2, and Lin and Stekoll (2011), *Porphyra* sp.

This species is very closely related to the North Atlantic *Py. thulae* (Munda & P. M. Pedersen) Neefus, differing from it by only 6 bp fixed differences (0.4%). That said, within the northeast Pacific region, this is the most genetically variable species of foliose Bangiales, with variation in at least 22 positions, all of which are third codons.

Pyropia unabbottiae S. C. Lindstrom sp. nov. (Fig. 2D)

This species was identified as Unknown #1 in Lindstrom (2008).

Description. Thallus broadly lanceolate to nearly orbiculate, to at least 30 cm tall and 20 cm wide but usually smaller. Margin very strongly ruffled, especially near the base (the distal end is often quite flat), the ruffles extending nearly to the center of the thallus, especially mid thallus. Center of proximal part also planar, often greenish, whereas rest of blade is dusky pink or purplish. Older thalli often extremely perforated (presumably from littorine grazing and subsequent growth of the blade). Monostromatic, with one chloroplast per cell. Adhering well to paper. Vegetative and reproductive thalli c. 50-60 μm thick. Male and female structures intermixed on same thallus, occurring along a broad marginal area in the distal region of the thallus. Spermatangia in streaks or distinctly patterned patches amid solid red to pale zygotosporangial areas, the solid red areas reminiscent of *Py. abbottiae* (V. Krishnamurthy) S. C. Lindstrom, the pale areas of *Py. fallax* (S. C. Lindstrom & K. M. Cole) S. C. Lindstrom. Spermatangia occurring according to the Hus formula 2-4/a, 4/b ,8/c, zygotosporangia, 2-4/a, 2-4/a, 4/c.

Holotype. UBC A90681, Akun Bay, Akun Island, low intertidal boulder, Jun 13, 2008, Leg. S. C. Lindstrom 13780. GenBank KT936200. The holotype consists of two thalli, both of which are fertile.

Isotypes. SCL 13781 in UBC (A90677). GenBank KT93 6203.

Etymology. The name is a combination of Unalaska, where many specimens were first collected and identified, and *abbottiae*, which is the species to which it is most closely related (they differ by 8 out of ~1,400 bp in the *rbc*L gene, or 0.6%).

Habitat. This species usually occurs on lower mid intertidal bedrock or boulders usually in areas subjected to some oceanic swell. It occasionally can be found higher or lower on the shore. It can also occur epiphytically on *Fucus* and possibly other mid intertidal algal hosts.

Phenology. Like its sister species, *Py. abbottiae*, this species appears to be a spring-summer species. Specimens have been collected in May, June, and July.

Known distribution. Vancouver Island (near Victoria and Malcolm Island), Kenai Peninsula (Chugach Bay), and the Aleutian Islands (Akun Island to Attu Island) (Lindstrom 2008) (Table 2, Appendix 1).

Comments. When co-occurring with *Py. abbottiae*, this species feels "softer." Also, in contrast to *Py. abbottiae*, this species can occasionally be epiphytic; *Py. abbottiae* has never been reported to be epiphytic. Kucera and Saunders (2012) also reported this species from the Victoria area of southern Vancouver Island (JN029000 and JN029001, both as *Pyropia* sp. 1POR).

DISCUSSION

Recent studies of the Bangiales on a global scale (Sutherland et al. 2011) as well as more localized studies in the northeast Pacific (Lindstrom 2008, Kucera and Saunders 2012, Lindstrom et al. 2015) allow us to update the distributions of the following species of Bangiales confirmed herein to occur in the Aleutian Islands:

1) Filamentous Bangiales. Two species of filamentous Bangiales have been confirmed from the Aleutian Islands. One, in 'Bangia 2' (*sensu* Sutherland et al. 2011), has been confirmed for the eastern Aleutian Islands. This species ('Bangia 2' sp. 1) is widely distributed in the northeast Pacific from southern British Columbia to the Eastern Aleutian Islands (Lindstrom in preparation). The other species, 'Bangia 3' sp. 3, has been confirmed from Attu I.

This species is widely distributed in northern waters, having been recorded for the Sitka area in Southeast Alaska and from eastern Canada, Greenland, and the northeast US (Müller et al. 1998).

2) Foliose Bangiales. *Boreophyllum*. We recognize two species of this genus in the Aleutian Islands, *B. aestivale*, which is confirmed only from the eastern Aleutian Is.: Akun I., Akutan I. and Unalaska I., and *B. aleuticum*, which is widely distributed along the chain (Table 2).

3) *Fuscifolium*. A single species, *F. tasa* (Yendo) S. C. Lindstrom, has been recorded across the Aleutian Islands. This species was originally reported by Wynne (1972) as *Porphyra tasa* (Yendo) Ueda, which has a type locality of Onetokan Island, Kurile Islands, Russia (Yendo 1920). The identity of the Aleutian species with Kurile Islands material has not been confirmed.

4) *Pyropia*. Nine species have been confirmed to occur in the Aleutian Islands: *Py. fallax*, *Py. fucicola*, *Py. gardneri*, *Py. kurogii*, *Py. nereocystis*, *Py. pseudolanceolata*, *Py. taeniata*, *Py. torta*, and *Py. unabbottiae* (Table 2, Appendix 1). Most of these are distributed throughout the islands of the chain. However, *P. kurogii* has been reported only as far west as Adak I., and *P. nereocystis* only to Umnak I., the same as its host, *Nereocystis luetkeana*.

5) *Wildemania*. Three species of *Wildemania* are confirmed to occur in the Aleutian Islands: *W. amplissima* [also sometimes identified as *W. cuneiformis* (Setchell & Hus) S. C. Lindstrom], *W. norrisii*, and *W. variegata*. These too have been found throughout the chain.

We were unable to confirm the occurrence of the following species in the Aleutian Islands: *Porphya ochotensis* Nagai, *Pyropia perforata* (J. Agardh) S. C. Lindstrom, *Py. pseudolinearis*, *P. purpurea* (Roth) C. Agardh, *P. umbilicalis* Kützing, *Py. yezoensis* (Ueda) M. S. Hwang & H. G. Choi (all recorded by Wynne 1972 at Amchitka I. as *Porphyra* spp.) and *Py. abbottiae* and *Wildemania schizophylla* (Hollenberg) S. C. Lindstrom (recorded by Conway et al. 1975 at various islands as *P. abbottiae* V. Krishnamurthy and *P. schizophylla* Hollenberg, respectively). We attempted to amplify DNA from several of Wynne's original collections, but only Lebednik AM343 in MICH (970724), originally identified by Wynne as *Porphyra yezoensis* Ueda, provided an unambiguous sequence, which indicated it to be *Boreophyllum aleuticum*. The identity of *P. ochotensis* has yet to be determined; its description suggests it may be a species of *Boreophyllum*. *Pyropia perforata* has been confirmed to occur as far west as Kodiak I., Alaska (Lindstrom 2008). *Pyropia pseudolinearis* is restricted to the northwest Pacific, where at least two species are identified under this name (Sutherland et al. 2011). *Porphyra purpurea* and *P. umbilicalis* are North Atlantic species; the former has been recorded in the northeast Pacific, where it occurs in harbors (Stiller and Waaland 1996 and Lindstrom 2008, as *P. rediviva* J. W. Stiller & J. R. Waaland; we have also collected it in Homer harbor: UBC A88285, GenBank KT936235, Homer, Alaska, S. C. Lindstrom 13403). Wynne's record of *P. purpurea* from Amchitka Island was likely a species of *Boreophyllum*, which can be morphologically indistinguishable from *P. purpurea*. We have verified the occurrence of *Py. abbottiae* as far west as Sanak Island, just east of the Aleutian Islands (SCL 15206, GenBank KT936246, Eagle Rock, Northeast Harbor, Sanak I., Sep 2, 2012). All specimens previously identified as *Porphyra* or *Wildemania schizophylla* from Alaska are currently included in *W. norrisii* (Sutherland et al. 2011; this species was identified as Unknown #5 in Lindstrom 2008).

There is a possibility that some of the Aleutian Bangiales are the same as some of the poorly known species from the northwestern Pacific Ocean. The northern Japanese species of *Porphyra bulbopes* (Yendo) Ueda, *P. ochotensis* and *P. punctata* Yamada & Mikami have yet to be studied in a molecular context (Kurogi 1972), as is also the case with the Russian *P. inaequicrassa* Perestenko (1980). Klochkova et al. (2009) provide descriptions and illustrations of a dozen foliose Bangiales from the Kamchatka region of Russia but without reference to type material or molecular sequencing.

Although the Aleutian Islands offer a near-ideal habitat for species of Bangiales (cold, high disturbance, limited herbivory), the numbers of species we were able to confirm is surprisingly low (2 filamentous and 15 foliose species). We suspect that a number of species have yet to be uncovered in the flora. Collecting opportunities are largely limited to summer months (May to August), and this may in part be responsible for these low numbers. However, the possibility remains that these numbers reflect the true diversity of Bangiales in the Aleutian Islands. Only further intense collecting will determine which is the case.

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Appendix 1. Newly reported specimens of Bangiales from the Aleutian Islands plus records of the newly described species from outside the Aleutian Islands region beyond those already published in Lindstrom and Fredericq (2003) and Lindstrom (2008)

Accession / Collection No.	GenBank No.	Collection location	Date collected	Collector and No.
'*Bangia* 2' sensu Sutherland et al. (2011) sp. 1				
UBC A87130	-	Sedanka Pt, Unalaska I.	Jun 3, 2005	S. C. Lindstrom 12141
-	KT936247	Cannery Bay, Unalaska I.	Jun 5, 2005	S. C. Lindstrom s/n
UBC A87145	-	Skan Bay, Unalaska I.	Jun 7, 2005	S .C. Lindstrom 12247
UBC A87381	KT936248	Avatanak I.	Jun 12, 2008	S. C. Lindstrom 13744
'*Bangia* 3' sensu Sutherland et al. (2011) sp. 3				
SCL 13436	KT936244	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13436
Boreophyllum aestivale (S. C. Lindstrom & Fredericq) S. C. Lindstrom				
UBC A90190	KT936245	Northeast Harbor, Sanak I.	Aug 31, 2012	S. C. Lindstrom 15129
Boreophyllum aleuticum S. C. Lindstrom & M. R. Lindeberg sp. nov. (this species was identified as Unknown #4 in Lindstrom 2008)				
UBC A90643	KT936157	Haycock Rock, Kiska I.	Jun 30, 2007	M. R. Lindeberg ALEUT07_118 [121]
UBC A90644	KT936157	Haycock Rock, Kiska I.	Jun 30, 2007	M. R. Lindeberg ALEUT07_119 [121]
UBC A90642	KT936158	Ogliuga I.	Jun 9, 2008	S. C. Lindstrom 13695
MICH 970724	KT936159	Amchitka I.	Jun 3, 1969	P. A. Lebednik AM343
UBC A91899, A91784	KU248444	Kuluk Bay, Adak I.	May 19, 1993	D. Guthrie s/n, 1104
UBC A91788, A91789	KT936160	Mouth of Clam Lagoon, Adak I.	May 20, 1993	D. Guthrie 1137, 1142
UBC A91789	-	Shagak Bay, Adak I.	May 22, 1993	D. Guthrie 1331
UBC A91896, A91695	KU248441, KU248443	Kuluk Bay, Adak I.	May 25, 1993	D. Guthrie H-31, 32
UBC A91890, A91891	KU248442	Akutan Island	Aug 14, 1999	D. Guthrie A
UBC A84389	-	Akutan I.	Aug 8, 2000	D. C. Lees s/n
Boreophyllum ambiguum S. C. Lindstrom sp. nov.				
ALA 1608	KT936163	Inside La Chausee Spit	Aug 6, 1971	G. J. Mueller
UBC A89054	KT936161	Cold Bay	Aug 9, 2009	S. C. Lindstrom 14175
UBC A89053	-	Cold Bay	Aug 9, 2009	S. C. Lindstrom 14176
UBC A89052	KT936162	Cold Bay	Aug 9, 2009	S. C. Lindstrom 14177
UBC A90188	KT936164	Northeast Harbor, Sanak I.	Aug 31, 2012	S. C. Lindstrom 15128
UBC A90189	KT936165	Northeast Harbor, Sanak I.	Aug 31, 2012	S. C. Lindstrom 15130
Fuscifolium tasa (Yendo) S. C. Lindstrom				
UBC A87883	KT936207	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13450
UBC A90022	KT936204	Haycock Rock, Kiska I.	Jun 30, 2007	M. R. Lindeberg ALEUT07_115 [124]
ALEUT07_135 [099]	KT936206	Harpoon Pt, Kiska I.	Jun 29, 2007	M. R. Lindeberg
UBC A87881	KT936213	Alaid Island	Jun 7, 2008	S. C. Lindstrom 13631
UBC A87340	KT936206	Rat Island[a]	Jun 8, 2008	S. C. Lindstrom 13639
UBC A89553	KT936205	Midden Pt, Amchitka I.	Jul 3, 2007	M. R. Lindeberg ALEUT07_211 [214]

Appendix 1. Continued

Accession / Collection No.	GenBank No.	Collection location	Date collected	Collector and No.
Fuscifolium tasa (Yendo) S. C. Lindstrom				
SCL 13670	KT936209	Amchitka Island	Jun 8, 2008	S. C. Lindstrom 13670
UBC A87472	-	Avatanak Island	Jun 12, 2008	S. C. Lindstrom 13733
UBC A87473	-	Avatanak Island	Jun 12, 2008	S. C. Lindstrom 13734
SCL 13735	-	Avatanak Island	Jun 12, 2008	S. C. Lindstrom 13735
UBC A87384	KT936210, KT936211	Avatanak Island	Jun12, 2008	S. C. Lindstrom 13747
UBC A87379	KT936212	Akun Bay, Akun I.	Jun 13, 2008	S. C. Lindstrom 13770
UBC A91798, A91799	-	Sitkin Sound, Adak I.	May 21, 1993	D. Guthrie 1247, 1248
UBC A91800, A91801, A91803	-	Loran Station Beach, Adak I.	May 21, 1993	D. Guthrie 1263, 1264, 1267
UBC A91809	-	Kuluk Bay, Adak I.	May 23, 1993	D. Guthrie 1368
UBC A91817	-	Kuluk Bay, Adak I.	May 24, 1993	D. Guthrie 1430
UBC A91820, A91821	-	Loran Station Beach, Adak I.	May 24, 1993	D. Guthrie 1432, 1433
UBC A91823	-	Andrew Bay, Adak I.	May 24, 1993	D. Guthrie 1441
UBC A91849	-	North Shore, Shemya I.	Jun 1, 1993	D. Guthrie 1737
UBC A91874, A91875, A91876, A91877, A91878, A91879, A91880, A91881, A91882	-	Antenna Beach, Attu I.	Sep 29, 1993	D. Guthrie 2111, 2112, 2114, 2115, 2116, 2124, 2125, 2126, 2128
UBC A91901, A91902	-	Antenna Beach, Attu I.	Oct 9, 1993	D. Guthrie s/n
UBC A91687	-	South Beach, Attu I.	Jun 3, 2000	D. Guthrie 15
Pyropia fallax (S. C. Lindstrom et K. M. Cole) S. C. Lindstrom				
AM512 in MICH	P742[b]	St. Makarius Bay, Amchitka I.	Aug 14, 1972	
UBC A86964	-	Akutan Harbor, Akutan I.	Jul 30, 2004	S. C. Lindstrom 11503
UBC A85657	P385[b]	Akutan Harbor, Akutan I.	Jul 30, 2004	S. C. Lindstrom 11568
UBC A86669	-	Dutch Harbor, Unalaska I.	Aug 3, 2004	S. C. Lindstrom 11615
UBC A86992	-	Dutch Harbor, Unalaska I.	Aug 3, 2004	S. C. Lindstrom 11617
UBC A86669	-	Dutch Harbor, Unalaska I.	Aug 3, 2004	S. C. Lindstrom 11618
UBC A86992	-	Dutch Harbor, Unalaska I.	Aug 3, 2004	S. C. Lindstrom 11619
UBC A87469	KT936243	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13508
UBC A87453	-	Surveyor Bay, Unalaska I.	Jun 11, 2008	S. C. Lindstrom 13706
SCL 13707	-	Surveyor Bay, Unalaska I.	Jun 11, 2008	S. C. Lindstrom 13707
SCL 13708	P545[b]	Surveyor Bay, Unalaska I.	Jun 11, 2008	S. C. Lindstrom 13708
UBC A87451	-	Surveyor Bay, Unalaska I.	Jun 11, 2008	S. C. Lindstrom 13710, 13711
SCL 13738	KT936242	Surveyor Bay, Unalaska I.	Jun 11, 2008	S. C. Lindstrom 13738
UBC A87388	KT936241	Avatanak Island	Jun 12, 2008	S. C. Lindstrom 13741
Pyropia fucicola (V. Krishnamurthy) S. C. Lindstrom				
UBC A89550	KT936221	Chichagof Harbor, Attu I.	Jun 25, 2007	M. R. Lindeberg ALEUT07_031 [005]
UBC A90693	-	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13462
UBC A87337	KT936222	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13484
UBC A87321	KT936223, KT936224	Murder Point, Attu I.	Jun 6, 2008	S. C. Lindstrom 13606
UBC A90694	KT936225	Avatanak Island	Jun 12, 2008	S. C. Lindstrom 13742

Appendix 1. Continued

Accession / Collection No.	GenBank No.	Collection location	Date collected	Collector and No.
Pyropia fucicola (V. Krishnamurthy) S. C. Lindstrom				
UBC A91765	KT936226	South Beach, Attu I.	May 28, 1992	D. Guthrie 489
UBC A91824, A91825, A91826	-	Andrew Bay, Adak I.	May 24, 1993	D. Guthrie 1443, 1444, 1446
UBC A91828	-	Kuluk Bay, Adak I.	May 25, 1993	D. Guthrie 1473
UBC A91838	-	South Shore, Shemya I.	May 28, 1993	D. Guthrie 1574
UBC A91714	KU248440	Alexi Point, Attu I.	Jun 4, 2000	D. Guthrie 56
UBC A91716	KT936227	South Beach, Attu I.	Jun 5, 2000	D. Guthrie 57
Pyropia gardneri (G. M. Smith & Hollenberg) S. C. Lindstrom				
UBC A54202	KT936249	Bird Cape, Amchitka I.	Jun 27, 1969	P. A. Lebednik AM-394
UBC A91873	-	Pratincole Beach, Attu I.	Sep 29, 1993	D. Guthrie 2087
Pyropia kurogii (S. C. Lindstrom) S. C. Lindstrom				
UBC A91894, A91895	KT936250	Shagak Bay, Adak I.	May 22, 1993	D. Guthrie H-21, H-22
Pyropia pseudolanceolata (V. Krishnamurthy) S. C. Lindstrom				
UBC A85155	-	Alimuda Bay, Unalaska I.	Jun 2, 2005	S. C. Lindstrom 12084
UBC A85159	-	Skan Bay, Unalaska I.	Jun 7, 2005	S. C. Lindstrom 12240
UBC A70820	-	Attu I.	Jun 16, 1987	K. A. Miller 4018
UBC A91904	-	Attu I.	May 1990	D. Guthrie s/n
UBC A91746, A91747	-	South Beach, Attu I.	May 22, 1992	D. Guthrie 329, 338
UBC A91795, A91796, A91797	-	Sitkin Sound, Adak I.	May 21, 1993	D. Guthrie 1244, 1245, 1246
UBC A91815, A91822	-	Andrew Bay, Adak I.	May 24, 1993	D. Guthrie 1426, 1435
UBC A91867, A91869	-	South Shore, Shemya I.	Jun 5, 1993	D. Guthrie 1900, 1903
Pyropia taeniata S. C. Lindstrom sp. nov. (this species was identified as unknown #2 in Lindstrom 2008)				
ALA 1602	KT936190	Buldir I.	May 27, 1974	M. H. Dick
UBC A90658	KU248445	Akutan Harbor, Akutan I.	Jul 30, 2004	S. C. Lindstrom 11510
UBC A90664	-	Dutch Harbor, Unalaska I.	Aug 3, 2004	S. C. Lindstrom 11614
UBC A85162	KT936166, KT936167	Volcano Bay, Unalaska I.	Jun 9, 2005	S. C. Lindstrom 12279
ALEUT06_137 [138]	KT936168, KT936169	Driftwood Bay, Unalaska I.	Jul 8, 2006	M. R. Lindeberg
UBC A85161	KT936172, KT936173	Volcano Bay, Unalaska I.	Jun 9, 2005	S. C. Lindstrom 12278
UBC A85402	KT936174	Carlisle Island	Jul 15, 2006	M. R. Lindeberg ALEUT06_263 [264]
UBC A90651	KT936175	Savage I., Temnac Bay, Attu I.	Jun 26, 2007	M. R. Lindeberg ALEUT07_044 [011]
UBC A90650	KT936176	Chichagof Harbor, Attu I.	Jun 25, 2007	M. R. Lindeberg ALEUT07_030 [003]
UBC A90649	KT936177	Kanaga Sound, Kanaga I.	Jul 8, 2007	M. R. Lindeberg ALEUT07_287 [309]
UBC A90659	KT936179	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13449
UBC A90660	KT936180	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13451
UBC A90669	KT936181	Murder Point, Attu I.	Jun 6, 2008	S. C. Lindstrom 13562
UBC A90665	KT936184	Murder Point, Attu I.	Jun 6, 2008	S. C. Lindstrom 13580

Appendix 1. Continued

Accession / Collection No.	GenBank No.	Collection location	Date collected	Collector and No.
Pyropia taeniata S. C. Lindstrom sp. nov. (this species was identified as Unknown #2 in Lindstrom 2008)				
UBC A90661	KT936183	Murder Point, Attu I.	Jun 6, 2008	S. C. Lindstrom 13581
UBC A90668	KT936182	Murder Point, Attu I.	Jun 6, 2008	S. C. Lindstrom 13582
UBC A90670	KT936185	Alaid Island	Jun 7, 2008	S. C. Lindstrom 13629
UBC A90656	KT936186	Akun Bay, Akun I.	Jun 12, 2008	S. C. Lindstrom 13763
UBC A90654	KT936188	Akun Bay, Akun I.	Jun12, 2008	S. C. Lindstrom 13783
UBC A90652	-	Sunshine Cove	Apr 13, 1995	S. C. Lindstrom 9089
S. C. Lindstrom s/n	KT936170, KT936171	Sunshine Cove	May1, 1995	S. C. Lindstrom
UBC A90667	EU223179	Pasagshak Bay, Kodiak I.	May 19, 2005	S. C. Lindstrom 11797
UBC A90653	KT936186	Sunshine Cove	Apr 27, 2009	S. C. Lindstrom 14001
UBC A90672	KT936189	Sunshine Cove	Apr 19, 2011	S. C. Lindstrom 14611
UBC A91905	-	Attu I.	May 1990	D. Guthrie s/n
UBC A91749	-	Gilbert Ridge, Attu I.	May 25, 1992	D. Guthrie 390
UBC A91755	-	Gilbert Ridge, Attu I.	May 26, 1992	D. Guthrie 409
UBC A91794	-	Sitkin Sound, Adak I.	May 21, 1993	D. Guthrie 1238
UBC A91804	-	Andrew Bay, Adak I.	May 21, 1993	D. Guthrie 1273
UBC A91810, A91811, A91813, A91814	-	Sitkin Sound, Adak I.	May 24, 1993	D. Guthrie 1414, 1415, 1417, 1418
UBC A91830	-	West End, Shemya Island	May 27, 1993	D. Guthrie 1495
UBC A91832, A91833, A91839, A91840	-	South Shore, Shemya I.	May 28, 1993	D. Guthrie 1519, 1520, 1576, 1579
UBC A91842, A91844	-	South Beach, Shemya I.	May 31, 1993	D. Guthrie 1645, 1647
UBC A91850, A91854, A91856	-	South Shore, Shemya I.	Jun 2, 1993	D. Guthrie 1747, 1780, 1792
UBC A91861, A91865	-	South Beach, Shemya I.	Jun 4, 1993	D. Guthrie 1854, 1870
UBC A91802	KT936191	Loran Station Beach, Adak I.	May 19, 1993	D. Guthrie 1265
UBC A91706, A91709, A91711	KT936192	Alexi Point, Attu I.	Jun 4, 2000	D. Guthrie 52, 53, 54
UBC A91742, A91743, A91744	KT936193, KT936196	Pratincole Beach, Attu I.	May 18, 1992	D. Guthrie 222, 224, 238
D. Guthrie 277	KT936194	South Beach, Attu I.	May 21, 1992	D. Guthrie 277
UBC A91748, A91750, A91751	KT936195	Gilbert Ridge, Attu I.	May 25, 1992	D. Guthrie 387, 391, 392
UBC A91752, A91754, A91756	-	Gilbert Ridge, Attu I.	May 26, 1992	D. Guthrie 400, 403, 411
UBC A91812	-	Sitkin Sound, Adak I.	May 24, 1993	D. Guthrie 1416
UBC A91862	-	South Beach, Shemya I.	Jun 4, 1993	D. Guthrie 1855
UBC A91816, A91819	KT936197, KU248439	Loran Station Beach, Adak I.	May 24, 1993	D. Guthrie 1429, 1431
Pyropia torta (V. Krishnamurthy) S. C. Lindstrom				
UBC A85151	-	Alimuda Bay, Unalaska I.	Jun 2, 2005	S. C. Lindstrom 12085
UBC A85180	-	Alimuda Bay, Unalaska I.	Jun 2, 2005	S. C. Lindstrom 12086
UBC A85181	-	Sedanka Point, Unalaska I.	Jun 3, 2005	S. C. Lindstrom 12138
SCL 13448	KT936236	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13448
SCL 13464	KT936237	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13464

Appendix 1. Continued

Accession / Collection No.	GenBank No.	Collection location	Date collected	Collector and No.
Pyropia torta (V. Krishnamurthy) S. C. Lindstrom				
UBC A87361	KT936238	Alaid Island	Jun 7, 2008	S. C. Lindstrom 13628
UBC A87884	KT936240	Rat Island[a]	Jun 8, 2008	S. C. Lindstrom 13649
UBC A87389	KT936239	Avatanak Island	Jun 12, 2008	S. C. Lindstrom 13731
UBC A87378	-	Akun Bay, Akun I.	Jun 13, 2008	S. C. Lindstrom 13784
UBC A91836, A91837	-	South Shore, Shemya I.	May 28, 1993	D. Guthrie 1567, 1568
Pyropia unabbottiae S. C. Lindstrom sp. nov. (this species was identified as Unknown #1 in Lindstrom 2008)				
UBC A90675	KT936198	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13455
UBC A90674	KT936201	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13463
SCL 13482	-	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13482
UBC A90676	KT936202	Chernofski Hbr, Unalaska I.	Jun 11, 2008	S. C. Lindstrom 13704
SCL 13705	-	Chernofski Hbr, Unalaska I.	Jun 11, 2008	S. C. Lindstrom 13705
UBC A90673	KT936199	Avatanak Island	Jun 12, 2008	S. C. Lindstrom 13728
UBC A90681	KT936200	Akun Bay, Akun I.	Jun 13, 2008	S. C. Lindstrom 13780
UBC A90677	KT936203	Akun Bay, Akun I.	Jun 13, 2008	S. C. Lindstrom 13781
UBC A90680	KU248446	Malcolm I., BC	May 28, 2009	S. C. Lindstrom 14136
UBC A87894	KU248447	Malcolm I., BC	May 28, 2009	S. C. Lindstrom 14139
SCL 15250	KU248448	Outside Witty's Lagoon, BC	Apr 27, 2013	S. C. Lindstrom 15250
UBC A91907	-	Attu Island	May 1990	D. Guthrie s/n
UBC A91738	-	South Beach, Attu I.	May 16, 1992	D. Guthrie 190
UBC A91753	-	Gilbert Ridge, Attu I.	May 26, 1992	D. Guthrie 402
UBC A91762, A91763	-	South Beach, Attu I.	May 28, 1992	D. Guthrie 486, 487
UBC A91707	-	Pratincole Beach, Attu I.	May 28, 1992	D. Guthrie 52
UBC A91766	-	South Beach, Attu I.	May 29, 1992	D. Guthrie 532
UBC A91720, A91722, A91781	-	Debris Beach, Attu I.	Jun 2, 1992	D. Guthrie 68, 69, 657
UBC A91782	-	South Beach, Attu I.	Jun 4, 1992	D. Guthrie 723
UBC A91817	-	Andrew Bay, Adak I.	May 24, 1993	D. Guthrie 1430
UBC A91889, A91831	-	West End, Shemya I.	May 27, 1993	D. Guthrie 25, 1496
UBC A91845, A91846	-	South Beach, Shemya I.	May 31, 1993	D. Guthrie 1706, 1707
UBC A91852	-	South Shore, Shemya I.	Jun 2, 1993	D. Guthrie 1770
UBC A91858, A91860	-	South Shore, Shemya I.	Jun 3, 1993	D. Guthrie 1827, 1843
UBC A91917	-	South Shore, Shemya I.	Jun 4, 1993	D. Guthrie S60
UBC A91691, A91699	-	South Beach, Attu I.	Jun 1, 2000	D. Guthrie 28, 37
UBC A91710	-	South Beach, Attu I.	Jun 5, 2000	D. Guthrie 53

Appendix 1. Continued

Accession / Collection No.	GenBank No.	Collection location	Date collected	Collector and No.
Wildemania amplissima Foslie				
UBC A91713	-	Casco Cove, Attu I.	May 30, 1992	D. Guthrie 55
UBC A91731	-	Antenna Beach, Attu I.	Sep 24, 1993	D. Guthrie 123
UBC A91908, A91909	-	Summer Bay, Unalaska I.	Aug 12, 1999	D. Guthrie s/n
UBC A91898	-	Andrew Bay, Adak I.	May 21, 1993	D. Guthrie H98?
Wildemania norrisii (V. Krishnamurthy) S. C. Lindstrom (this species was identified as Unknown #5 in Lindstrom 2008)				
UBC A89552	KT936228	Chichagof Harbor, Attu I.	Jun 25, 2007	M. R. Lindeberg ALEUT07_037 [004]
UBC A89551	KT936229	Cape Idalug, Amlia I.	Jul 18, 2007	M. R. Lindeberg ALEUT07_430 [403]
UBC A87882	KT936231	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13465
SCL 13585	-	Murder Point, Attu I.	Jun 6, 2008	S. C. Lindstrom 13585
UBC A87697	KT936230	Chernofski Hbr, Unalaska I.	Jun 11, 2008	S. C. Lindstrom 13701
UBC A89940	KT936232	Avatanak Island	Jun 12, 2008	S. C. Lindstrom 13730
SCL 13743	-	Avatanak Island	Jun 12, 2008	S. C. Lindstrom 13743
UBC A90099	KT936233	Eagle Rock, Sanak I.	Sep 2, 2012	S. C. Lindstrom 15201
UBC A90208	KT936234	Eagle Rock, Sanak I.	Sep 2, 2012	S. C. Lindstrom 15197
UBC A91863, A91864	P946[b]	South Beach, Shemya I.	Jun 4, 1993	D. Guthrie 1860, 1861
Wildemania variegata (Kjellman) De Toni				
UBC A85184	-	Alimuda Bay, Unalaska I.	Jun 2, 2005	A. F. Fukuyama (SCL 12120)
UBC A90049	KT936214	Kagalaska Strait, Adak I.	Jul 10, 2007	M. R. Lindeberg ALEUT07_318 [301]
UBC A87407	KT936220	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13472
UBC A87367	KT936215	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13505
UBC A87347	KT936219	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13509
UBC A87328	KT936217	Chichagof Harbor, Attu I.	Jun 4, 2008	S. C. Lindstrom 13514
UBC A87319	KT936216	Murder Point, Attu I.	Jun 6, 2008	S. C. Lindstrom 13579
UBC A87373	KT936218	Akun Bay, Akun I.	Jun 13, 2008	S. C. Lindstrom 13774
UBC A91913, A91914	-	Attu I.	May 1990	D. Guthrie s/n
UBC A91708	-	Navy town Beach, Attu I.	May 27, 1991	D. Guthrie 52
UBC A91683, A91728, A91729, A91730	-	Alexi Point, Attu I.	May 29, 1991	D. Guthrie 2, 117, 119, 122
UBC A91732	-	Pratincole Beach, Attu I.	May 30, 1991	D. Guthrie 140
UBC A91733, A91734, A91735	-	Navy Beach, Attu I.	May 14, 1992	D. Guthrie 146, 152, 159
UBC A91737	-	South Beach, Attu I.	May 16, 1992	D. Guthrie 189
UBC A91696, A91697, A91745	-	South Beach, Attu I.	May 22, 1992	D. Guthrie 34, 35, 318
UBC A91759	-	Gilbert Ridge, Attu I.	May 26, 1992	D. Guthrie 424
UBC A91704, A91705	-	Pratincole Beach, Attu I.	May 27, 1992	D. Guthrie 48, 49
UBC A91764	-	South Beach, Attu I.	May 28, 1992	D. Guthrie 488
UBC A91715, A91718, A91769, A91774, A91775, A91776, A91777	-	Casco Cove, Attu I.	May 30, 1992	D. Guthrie 56, 58, 565, 573, 574, 578, 581
UBC A91778	-	Navy town Beach, Attu I.	Jun 1, 1992	D. Guthrie 582

Appendix 1. Continued

Accession / Collection No.	GenBank No.	Collection location	Date collected	Collector and No.
Wildemania variegata (Kjellman) De Toni				
UBC A91779	-	Debris Beach, Attu I.	Jun 1, 1992	D. Guthrie 607
UBC A91719, A91780	-	Debris Beach, Attu I.	Jun 2, 1992	D. Guthrie 67, 653
UBC A91723, A91724	-	Alexi Point, Attu I.	Jun 3, 1992	D. Guthrie 73, 76
UBC A91783	-	South Beach, Attu I.	Jun 4, 1992	D. Guthrie 749
UBC A91897, A91786, A91787	-	Kuluk Bay, Adak I.	May 19, 1993	D. Guthrie H-6, 1121, 1134
UBC A91790, A91791, A91792, A91793	-	Kuluk Bay, Adak I.	May 20, 1993	D. Guthrie 1175, 1202, 1203, 1213
UBC A91807, A91808	-	Kuluk Bay, Adak I.	May 23, 1993	D. Guthrie 1358, 1360
UBC A91698, A91827, A91829	-	Kuluk Bay, Adak I.	May 25, 1993	D. Guthrie 35, 1450, 1475
UBC A91712, A91834, A91835	-	South Shore, Shemya I.	May 28, 1993	D. Guthrie 54, 1534, 1535
UBC A91885, A91841	-	South Shore, Shemya I.	May 29, 1993	D. Guthrie 5-13, 1611
UBC A91886	-	North shore, Shemya I.	May 29, 1993	D. Guthrie 5-16
UBC A91887	-	North shore, Shemya I.	May 30, 1993	D. Guthrie 5-19
UBC A91843	-	South Shore, Shemya I.	May 31, 1993	D. Guthrie 1646
UBC A91847, A91848	-	South shore, Shemya I.	Jun 1, 1993	D. Guthrie 1717, 1718
UBC A91884, A91851, A91853, A91855, A91857	-	South Shore, Shemya I.	Jun 2, 1993	D. Guthrie 5-38, 1765, 1775, 1788, 1793
UBC A91767, A91768, A91859	-	South Shore, Shemya I.	Jun 3, 1993	D. Guthrie 548, 549, 1829
UBC A91770, A91771, A91772, A91773, A91866, A91868, A91870	-	South Shore, Shemya I.	Jun 5, 1993	D. Guthrie 565, 566, 569, 570, 1897, 1901, 1941
UBC A91915	-	Summer Bay, Unalaska I.	Aug 12, 1999	D. Guthrie s/n
UBC A91892	-	Akutan I.	Aug 14, 1999	D. Guthrie A
UBC A91883	-	South Beach, Attu I.	Oct 1, 1993	D. Guthrie 2147
UBC A91684	-	South Beach, Attu I.	May 28, 2000	D. Guthrie 4
UBC A91689, A91690, A91691	-	Pratincole-Murder Point, Attu I.	May 30, 2000	D. Guthrie 20, 22, 28
UBC A91693	-	South Beach, Attu I.	Jun 1, 2000	D. Guthrie 29
UBC A91700	-	South Beach, Attu I.	Jun 3, 2000	D. Guthrie 42
UBC A91701, A91702	-	Alexi Point, Attu I.	Jun 4, 2000	D. Guthrie 45, 46
UBC A91717	-	South Beach, Attu I.	Jun 5, 2000	D. Guthrie 57
UBC A91721	-	Loran Tower Beach, Attu I.	Jun 6, 2000	D. Guthrie 68
UBC A91725	-	South Beach, Attu I.	Jun 7, 2000	D. Guthrie 84

ALEUT numbers in brackets refer to silica gel material, which was numbered separately from the herbarium vouchers. Additional collecting details can be found for each specimen in the UBC algal herbarium database (http://bridge.botany.ubc.ca/herbarium/search.php?db=ubcalgae.fmp12). Specimens identified only by the collectors´ numbers have yet to be accessioned into the UBC herbarium. Additional records of *Pyropia fallax*, *P. pseudolanceolata*, *P. nereocystis* were published in Lindstrom et al. (2015).

[a]In 2012, the name of Rat Island was changed to its native name, Hawadax Island, after rats were eradicated from the island in late 2008.

[b]Extract number. Sequence not accessioned in GenBank.