

Research Article

Marine Benthic Algae of the Commander Islands (Pacific Coast of Russia) with Checklist Revised in 2012

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Received 19 October 2012; Accepted 5 December 2012

Academic Editors: H. J. Dowsett, S. Focardi, and J. O. Herrle

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A revised checklist of marine benthic algae of the Commander Islands (Russian Pacific) is presented. It is based on the authors' field collections. The list of algae of the area totals to 187 species (36 Chlorophyta, 38 Ochrophyta, class Phaeophyceae, and 113 Rhodophyta) of these 44 species (9 Chlorophyta, 8 Ochrophyta, class Phaeophyceae, and 27 Rhodophyta) are added to the previous checklists (Selivanova and Zhigadlova, 1997). We also confirm the presence of 5 species on the Islands that were absent in our earlier material but were recorded by other authors (*Phycodrys amchitkensis*, *Mastocarpus papillatus*, *Lithothamnion sonderi*, *Odonthalia dentata*, and *Pleonosporium vancouverianum*). The species list of the newly recorded algae contains information on their ecology, fertility, and distribution. The algal taxonomy and nomenclature are updated with new world data.

1. Introduction

Information on the marine algae of the Commander Islands is more comprehensive than in other regions of the Russian Pacific. The Islands' flora has been studied more thoroughly and described in many publications by Russian and foreign authors [1–4] including our works [5–7], where we presented preliminary results of the revision of the marine algal flora. Further studies were presented in our publications [8–24], but the majority of these papers were published in Russian, some of them by local publishing houses, so they are not readily available to phycologists outside of Russia. However, the marine algal flora of the Commander Islands is of more than local interest because at this archipelago the Bering Sea meets the open Pacific Ocean between the Asian and American continents, and so the Islands act as a bridge for species intercontinental migration and exchange due to the system of ocean currents (Figure 1).

The inventory of the flora of this area is still unfinished because of the difficulty of collecting algae in this remote and sparsely inhabited region. Furthermore, there are still unsolved nomenclatural problems. Therefore, main purpose of this study was to incorporate our new collections and

update the nomenclature and taxonomy of algae to further advance knowledge of the flora of the Commander Islands.

2. Materials and Methods

The material was collected by the authors during annual expeditions of the Hydrobiology Laboratory of the Kamchatka Branch of Pacific Geographical Institute in 1986–1992 and incidental collections in 1997 and 2007–2011. Algae were collected from April through October on the littoral fringe during low tides, and with use of SCUBA at depths of 1–30 m. Algae cast ashore were also collected. Other individual collectors also took part in this work. Particularly interesting algal material used in this study was collected by our colleague zoologist Nikolai N. Pavlov on Bering Island in winter season of 2011.

Material was sectioned freehand with a razor blade, placed in a drop of fresh water on a slide, and examined with a light microscope. The sections were studied unstained, or stained with Lugol's iodine solution and aniline blue dye. The processing of collections was conducted at the Kamchatka Branch of the Pacific Geographical Institute (Petropavlovsk-Kamchatskii, Russia). Photomicrographs were made using

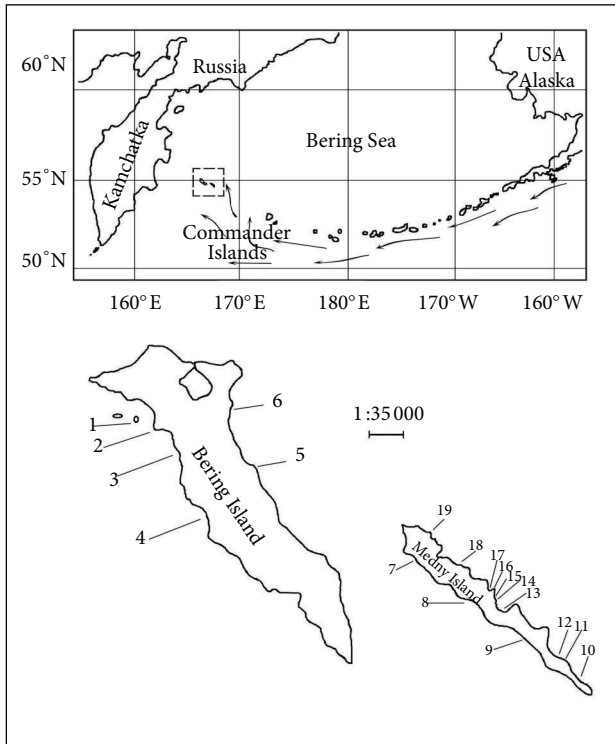


FIGURE 1: A schematic map of the Commander Islands to show collecting sites. Inset shows the position of the Islands in Bering Sea. Arrows show the direction of Alaska current. *Toporkov Islet*: (1); *Bering Island*: (2) Cape Vkhodnoi Reef; (3) Fedoskin Bay; (4) Poludennaya Bay; (5) Cape Buyan; (6) Staraya Gavan' Bay; *Medny Island*: (7) Gavrilovskaya Bay; (8) Sen'kin Bay; (9) Cape Lebyazhii; (10) Cape Drovyanie Stolby; (11) Cape Drovenskoy; (12) Glinka Bay; (13) Korabel'naya Bay; (14) Cape Popovskii; (15) Topolevskaya Bay; (16) Cape Gladkii; (17) Gladkovskaya Bay; (18) Cape Sivuchii Kamen'; (19) Cape Matveya.

a DCM-130 digital camera. Voucher material is stored in the herbarium of the Hydrobiology Laboratory of the Kamchatka Branch of Pacific Geographical Institute.

3. Results

The present paper summarizes new information on the marine macrophytic algae of the Commander Islands that has appeared since our previous revision of the flora 15 years ago [5–7].

The new general checklist of the marine benthic algae of the Commander Islands is provided in Tables 1–3 (Annex) in the Supplementary Material available online at <http://dx.doi.org/10.5402/2013/470185>. Outdated or erroneous names of the species from our previous publications are cited in the tables, and comments are provided on the current taxonomic position of algae.

At present, the marine flora of the Commander Islands is known to contain 187 species (36 Chlorophyta; 38 Ochrophyta, class Phaeophyceae and 113 Rhodophyta), 44 are new records since our previous list (see: Selivanova and Zhi-gadlova [5–7]). The former checklist contained 149 species,

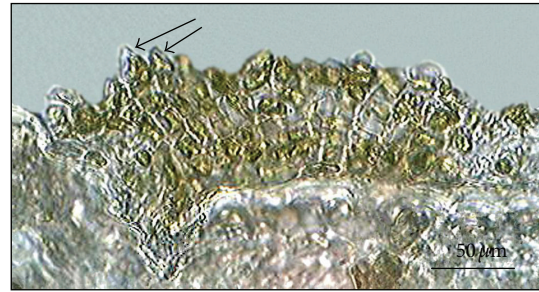


FIGURE 2: *Acrochaete apiculata* with structures presumably representing sporangia (arrows).

however later several species had been synonymized and the number of algae decreased.

Information on 44 added species is given below, including data on the ecology, fertility, and distribution of the algae on the Islands. Most recent findings are depicted on the figures.

Taxonomic notes are made where pertinent. Numbers in parentheses following the names of the islands of the archipelago in the species list correspond to collecting sites shown on the map (Figure 1).

Phylum CHLOROPHYTA

Class Chlorophyceae

Order Chaetophorales

Family Chaetophoraceae

(1) *Zygomitus reticulatus* Bornet & Flahault. Found in July and September, infrequent, endophytic in outer walls of *Hymenena ruthenica* (Postels & Ruprecht) A. D. Zinova and *Palmaria stenogona* (Perestenko) Perestenko, intertidal, subtidal (2 m) and cast ashore. Bering Island (5, 6), Medny Island (17). Vegetative.

Class Ulvophyceae

Order Ulvales

Family Ulvellaceae

(2) *Acrochaete apiculata* (Setchell & N. L. Gardner) O'Kelly (Figure 2). Found in August, very rare, epiphytic on *Palmaria stenogona*, intertidal. Bering Island (2). With structures presumably representing sporangia.

(3) *Acrochaete geniculata* (N. L. Gardner) O'Kelly (Figure 3). Found in February and from July to September, abundant, endophytic among cortical cells of *Agarum clathrus* (S. G. Gmelin) Greville and red algae (mostly on the species of the families Palmariaceae and Delesseriaceae), intertidal, and cast ashore. Toporkov Islet (1), Bering Island (2, 3, 5, 6). Vegetative.

(4) *Acrochaete ramosa* (N. L. Gardner) O'Kelly in Gabrielson et al., (Figure 4). Found in March and July, infrequent, endophytic in the internal tissues of brown algae (*Saccharina dentigera* (Kjellman) C. E. Lane, C. Mayes, Druehl &

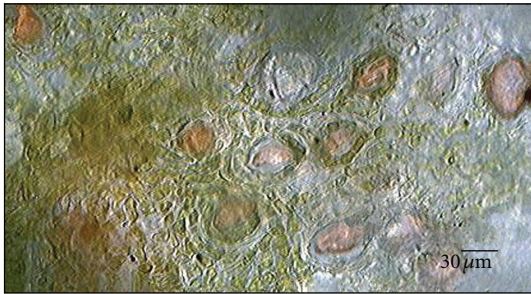


FIGURE 3: *Acrochaete geniculata*. Surface view of the filaments among cells of the host plant.

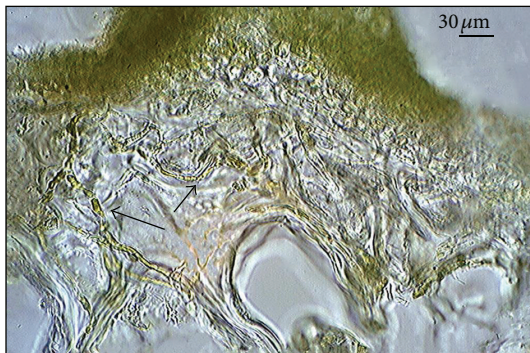


FIGURE 4: *Acrochaete ramosa*. Filaments of the endophyte (arrows) penetrating tissues of the host plant.

G. W. Saunders and *Agarum clathrus*) and red algae of the families Crossocarpaceae, Furcellariaceae, and Palmariaceae, intertidal and cast ashore. Bering Island (2, 3). Vegetative.

Note. This species has been recently recorded by us from the Commander Islands for the first time [25] and also from Karaginskii Gulf (Bering Sea) [22].

(5) *Acrochaete repens* Pringsheim (Figure 5). Found in February, infrequent, endophytic in the tissues of *Agarum turneri* Postels & Ruprecht, cast ashore. Bering Island (2). Vegetative.

(6) *Pringsheimiella scutata* (Reinke) Marchewianka (Figure 6). Found in July, rare, epiphytic on *Palmaria stenogona*, intertidal. Bering Island (5). Vegetative.

(7) *Ulvella lens* P. L. Crouan & H. M. Crouan (Figure 7). Found in July and September, rare, epiphytic on *Palmaria marginicrassa* I. K. Lee and *P. stenogona*, intertidal. Toporkov Islet (1). Vegetative.

(8) *Ulvella prostrata* N. L. Gardner (Figure 8). Found in February and July, rare, epiphytic on *Codium ritteri* Setchell & N. L. Gardner, *Agarum clathrus*, *Palmaria stenogona*, *Constantinea rosa-marina* (S. G. Gmelin) Postels & Ruprecht, intertidal and cast ashore. Bering Island (2, 5). Vegetative.

Note. This species has been recently recorded from the Commander Islands as *Pseudulvella prostrata* (N. L. Gardner) Setchell & N. L. Gardner [25].

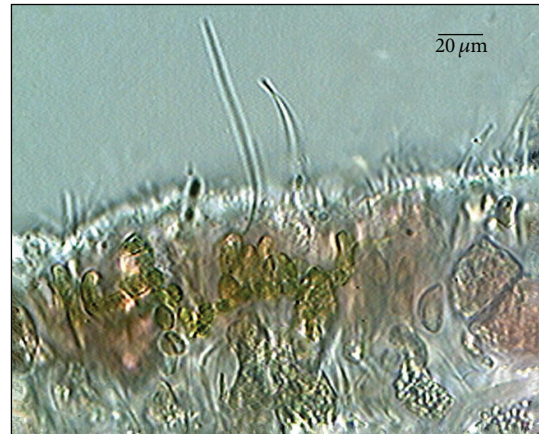


FIGURE 5: *Acrochaete repens*. Filaments with hairs in the tissues of the host plant.



FIGURE 6: *Pringsheimiella scutata*. Surface view.

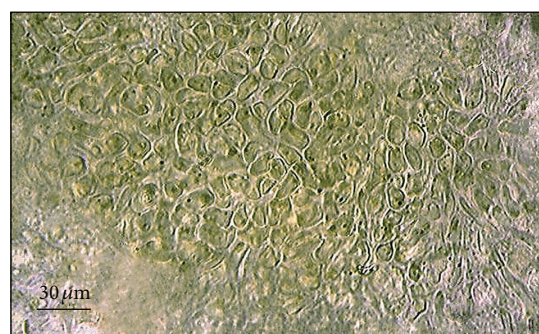


FIGURE 7: *Ulvella lens*. Surface view.

Class Trebouxiophyceae

Order Prasiolales

Family Prasiolaceae

(9) *Rosenvingiella polyrhiza* (Rosenvinge) P. C. Silva (Figure 9). Found in February-March, rare, epiphytic on

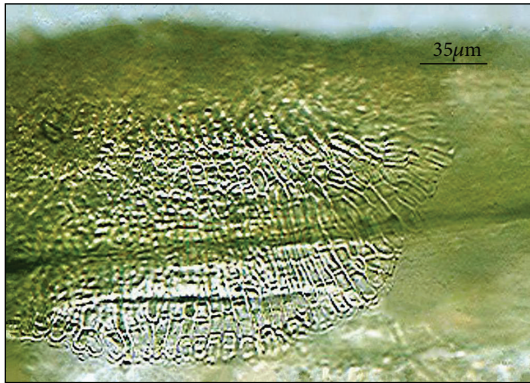


FIGURE 8: *Ulvella prostrata*. Surface view.



FIGURE 9: *Rosenvingiella polyrhiza*. Cylindrical stage.

Saccharina bongardiana, cast ashore, Bering Island (2).
Vegetative.

Phylum OCHROPHYTA

Class Phaeophyceae

Order Ectocarpales

Family Chordariaceae

(10) *Hecatonema primarium* (Setchell & N. L. Gardner) Loiseaux (Figure 10). Found in July, rare, epiphytic on *Palmaria stenogona*, intertidal. Bering Island (5). With plurilocular sporangia.

Note. This entity was erroneously recorded earlier for the first time for the Commander Islands as *Myrionema strangulans* Greville [21]. Under the name *Hecatonema primarium* it is recorded in the present paper for the first time for the Islands.

(11) *Myrionema balticum* (Reinke) Foslie (Figure 11). Found in February and in August, rare, epiphytic on *Saccharina bongardiana*, *Palmaria stenogona*, and *Constantinea rosa-marina*, intertidal, and cast ashore. Bering Island (2). With plurilocular sporangia.

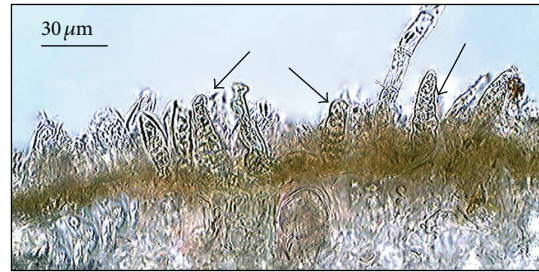


FIGURE 10: *Hecatonema primarium* with multiseriate plurilocular sporangia (arrows).

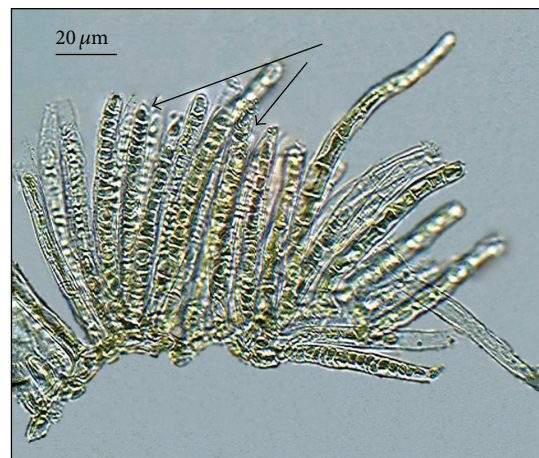


FIGURE 11: *Myrionema balticum* with uniseriate plurilocular sporangia (arrows).

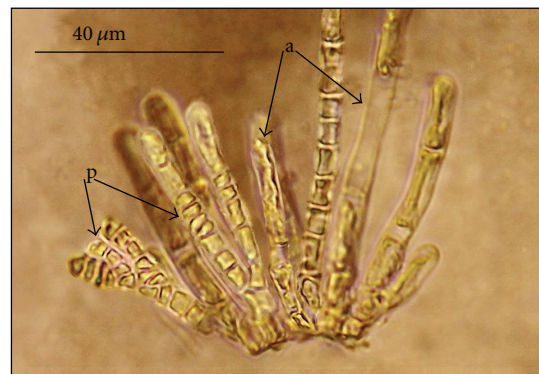


FIGURE 12: *Myrionema magnusii* with ascocysts (a-arrows) and uniseriate plurilocular sporangia (p-arrows).

(12) *Myrionema magnusii* (Sauvageau) Loiseaux (Figure 12). Found in March, very rare, epiphytic on *Agarum clathrus*, cast ashore. Bering Island (2). With plurilocular sporangia.

(13) *Streblonema evagatum* Setchell & N. L. Gardner (Figure 13). Found in February-March, rare, endophytic in the tissues of *Saccharina dentigera*, cast ashore. Bering Island (2). With plurilocular sporangia.



FIGURE 13: *Streblonema evagatum* with uniseriate plurilocular sporangia (arrows).



FIGURE 14: *Streblonema scabiosum* with uniseriate plurilocular sporangia (arrows).

(14) *Streblonema myrionematoides* Setchell & N. L. Gardner. Found in February and September, infrequent, endophytic in the tissues of *Agarum clathrus* and *Palmaria stenogona*, cast ashore. Bering Island (2, 6). With plurilocular sporangia.

(15) *Streblonema scabiosum* Setchell & N. L. Gardner (Figure 14). Found in July, very rare, endophytic in *Palmaria stenogona*, intertidal. Bering Island (5). With plurilocular sporangia.

Order Scytosiphonales,
Family Scytosiphonaceae.

(16) *Compsinema serpens* Setchell & N. L. Gardner (Figure 15). Found in July, very rare, epiphytic on *Palmaria stenogona*, intertidal. Bering Island (5). With plurilocular sporangia.

(17) *Scytosiphon dotyi* M. J. Wynne. Found in September, rare, epilithic, intertidal. Bering Island (2). With gametangia.

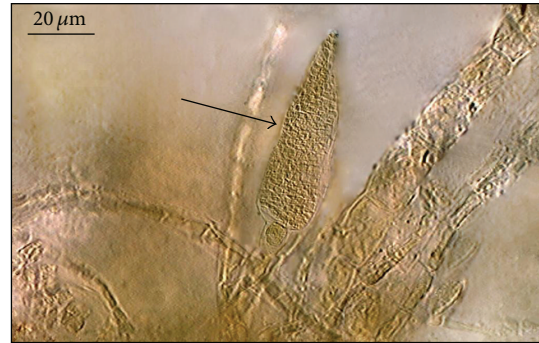


FIGURE 15: *Compsinema serpens* with multiseriate plurilocular sporangia (arrow).

Phylum RHODOPHYTA,
Class Compsopogonophyceae,
Order Erythropeltidales,
Family Erythrotrichiaceae.

(18) *Erythrotrichia carnea* (Dillwyn) J. Agardh. Found in July, infrequent, epiphytic on algae of the family Palmariaceae, intertidal. Bering Island (5). Vegetative.

Class Bangiophyceae,
Order Bangiales,
Family Bangiaceae.

(19) *Pyropia nereocystis* (C. L. Anderson) S. L. Lindstrom. Found in July, rare, epiphytic on *Nereocystis luetkeana* (Mertens) Postels & Ruprecht, cast ashore. Medny Island (15). Fertile (with carpospores and spermatia).

Note. The species known as *Porphyra nereocystis* C. L. Anderson was transferred to the genus *Pyropia* J. Agardh in the light of the recent revision of the genus *Porphyra* C. Agardh (*sensu lato*) and its subdivision into 5 new and 2 resurrected genera on the basis of molecular-genetic studies [26].

(20) *Porphyra purpurea* (Roth) C. Agardh. Found in June and September, infrequent, epilithic, intertidal. Bering Island (2, 6). Fertile.

Note. Geographic range of this species remains controversial. *P. purpurea* was considered to have both Pacific and Atlantic distribution [27–32]. Later it was revised by Lindstrom and Cole [33, 34], who showed by biochemical and genetic analyses that true *P. purpurea* was distributed only in the Atlantic Ocean, while its Pacific vicariant was described by these authors as a new species, *Porphyra kurogii* S. C. Lindstrom [34]. The morphological description of *P. kurogii*, however, was considerably different from that of *P. purpurea* given by Perestenko [29, 30, 35], who insisted on wide Atlantic-Pacific distribution of *P. purpurea*. According to Silva et al. [36] *P. purpurea* is also met in Indian Ocean. Later on morphological and molecular studies on Atlantic *P. purpurea* complex were

carried out by western phycologists [26, 37, 38]. As a result of these studies a considerable part of the species of the former genus *Porphyra* were transferred to the genus *Pyropia* [26] but *P. purpurea* was retained within the genus *Porphyra* as a type species [26]. There were specimens of *Porphyra* in our material that morphologically represented *Porphyra purpurea* in Perestenko's [35] interpretation. There were also specimens that fit into former *Porphyra kurogii* that is now transferred to the genus *Pyropia* as *Pyropia kurogii* (S. C. Lindstrom) S. C. Lindstrom [26]. Both *Porphyra purpurea* and *Pyropia kurogii* are presented in Supplementary Table 3.

Class Florideophyceae,
Order Ahnfeltiales,
Family Ahnfeltiaceae.

(21) *Ahnfeltia plicata* (Hudson) E. M. Fries. Found only once, in August, epilithic, intertidal. Medny Island (13). Vegetative.

Order Corallinales,
Family Hapalidiaceae.

(22) *Lithothamnion sonderi* Hauck. Found from August through October, epilithic, subtidal (1.5–25 m depth). Bering Island (6). Fertile.

Order Acrochaetiales,
Family Acrochaetiaceae.

(23) *Acrochaetium arcuatum* (K. M. Drew) C. K. Tseng. Found in February, rare, epiphytic on *Ptilota serrata* Kützing and *Constantinea rosa-marina*, cast ashore Bering Island (2). With monosporangia.

(24) *Acrochaetium densum* (K. M. Drew) Papenfuss (Figure 16). Found in February, rare, epiphytic on *Agarum clathrus*, cast ashore. Bering Island (2). Vegetative.

(25) *Acrochaetium microscopicum* (Nägeli ex Kützing) Nägeli (Figure 17). Found in July, rare, epiphytic on *Palmaria stenogona*, intertidal. Bering Island (5). With monosporangia.

(26) *Acrochaetium parvulum* (Kylin) Hoyt. Found in July, rare, epiphytic on *Palmaria stenogona*, intertidal. Bering Island (5). With monosporangia.

(27) *Acrochaetium porphyrae* (K. M. Drew) G. M. Smith (Figure 18). Found in August, rare, endophytic in *Pterosiphonia bipinnata* (Postels & Ruprecht) Falkenberg, intertidal. Bering Island (2). With monosporangia.

Order Colaconematales,
Family Colaconemataceae,

(28) *Colaconema desmarestiae* (Kylin) P. W. Gabrielson in Gabrielson et al. (Figure 19). Found in February, rare,

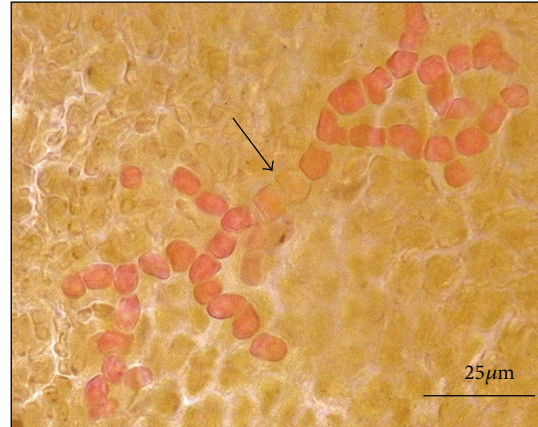


FIGURE 16: *Acrochaetium densum* basal portion of the plant showing original two cells (arrow).

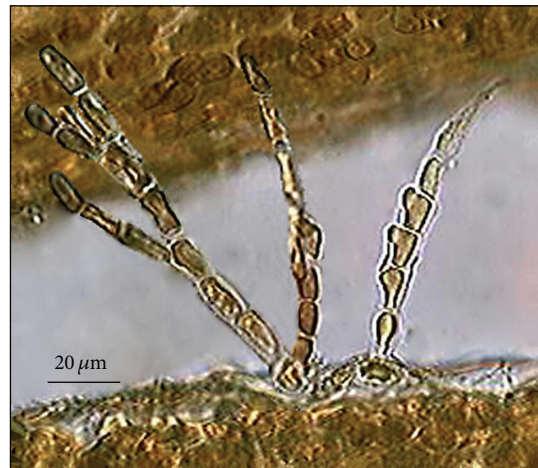


FIGURE 17: *Acrochaetium microscopicum*. Filaments on the surface of the host plant.

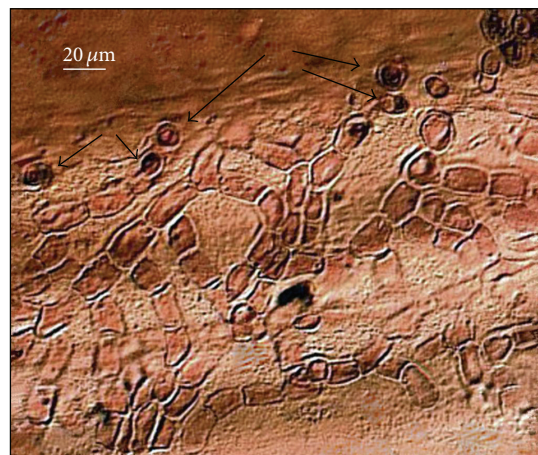


FIGURE 18: *Acrochaetium porphyrae* with monosporangia (arrows).



FIGURE 19: *Colaconema desmarestiae* with monosporangium (arrow).

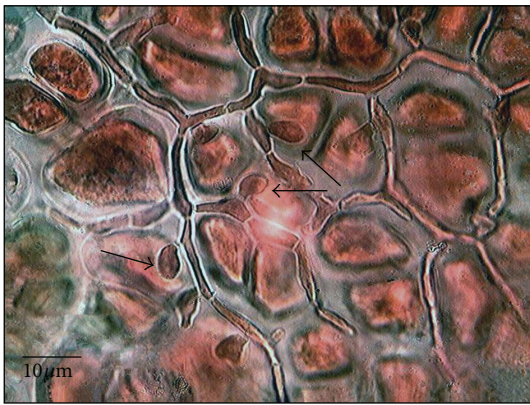


FIGURE 20: *Colaconema endophyticum*. Filaments of the epiphyte among the cells of the host plant with monosporangia (arrows).

epiphytic on *Desmarestia aculeata* (Linnaeus) J. V. Lamouroux, cast ashore. Bering Island (2). With monosporangia.

(29) *Colaconema endophyticum* (Batters) J. T. Harper & G. W. Saunders (Figure 20). Found in March and August, rare, endophytic in the tissues of *Membranoptera dimorpha* N. L. Gardner and in outer walls of other red algae of the family Delesseriaceae. Bering Island (2); Medny Island (12). With monosporangia.

(30) *Colaconema pacificum* (Kylin) Woelkerling. Found in September, very rare, epiphytic on *Palmaria stenogona*, intertidal. Toporkov Islet (1). With monosporangia.

Order Bonnemaisoniales,

Family Bonnemaisoniaceae.

(31) *Pleuroblepharidella japonica* (Okamura) M. J. Wynne. Found in February-March and in July-August, infrequent, epiphytic on *Ptilota serrata* and *Neoptilota asplenioides* (Esper) Kylin, cast ashore, Bering Island (2). Vegetative and with tetrasporangia. Also epilithic, subtidal (5–10 m), Medny Island (11, 12). With tetrasporangia.

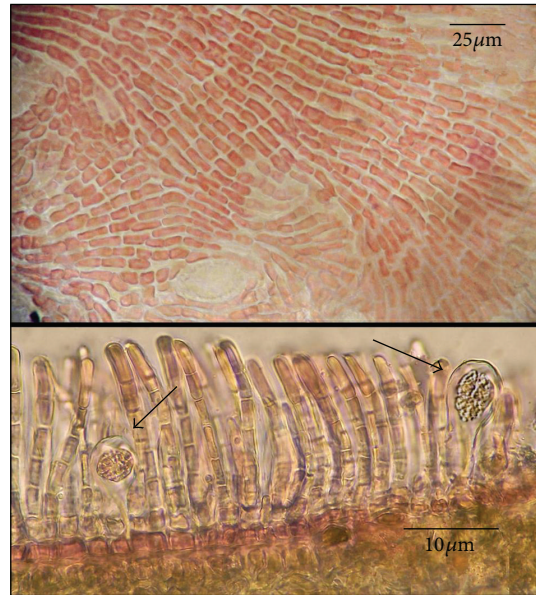


FIGURE 21: *Meiodiscus concrescens*. Surface view of the epiphyte on the upper part of the figure. Cross-section showing tetraspores (arrows) on the lower part of the figure.

Order Rhodymeniales,

Family Faucheaceae.

(32) *Gloiocladia guiryi* (Selivanova) Selivanova. Found in April and July, infrequent, epilithic, subtidal (10–30 m). Bering Island (4), Medny Island (7, 9, 10, 11, 13, 14, 16, 18). With tetraspores and cystocarps.

Note. *Gloiocladia guiryi* appears to be the first and up to now the only representative of the genus and the family Faucheaceae to be reported from the Far-Eastern Seas of Russia. Originally it was described as *Faucheia guiryi* Selivanova [14]. However, a taxonomic revision of the genus *Faucheia* Bory and Montagne in Montagne based on morphological and molecular-genetic data resulted in the transfer of the majority of the species of the genus, including the generitype *F. repens* (C. Agardh) Montagne and Bory de Saint-Vincent, to the genus *Gloiocladia* J. Agardh [39]. This necessitated the transfer of *F. guiryi* to *Gloiocladia* [15] with a new nomenclatural combination, *Gloiocladia guiryi* (Selivanova) Selivanova [16].

Order Palmariales,

Family Meiodiscaceae.

(33) *Meiodiscus concrescens* (K. M. Drew) P. W. Gabrielson in Gabrielsen et al. (Figure 21). Found in February-March, rare, epiphytic on *Palmaria stenogona*, *Constantinea rosamarina*, *Agarum clathrus*, and *Desmarestia aculeata*, cast ashore. Bering Island (2). With tetrasporangia.

(34) *Rubrointrusa membranacea* (Magnus) S. L. Clayden & G. W. Saunders. Found only once, in June, on the shell

of *Colisella* (Gastropoda), with mono- and tetrasporangia. Bering Island (2).

Family Palmariaceae.

(35) *Palmaria hecatensis* M. W. Hawkes. Found from July to September, common, epilithic, intertidal, cast ashore. Bering Island (2, 3, 5). With spermatangia.

Note. Some specimens of this species were erroneously identified previously as *Palmaria marginicrassa*.

(36) *Palmaria mollis* (Setchell & N. L. Gardner) van der Meer & C. Bird. Found in June, rare, epilithic, intertidal. Bering Island (3). Vegetative.

Note. Some samples of this species were erroneously identified previously as *Palmaria stenogona*.

Family Rhodophysemataceae.

(37) *Rhodophysema elegans* (P. L. Crouan & H. M. Crouan ex J. Agardh) P. S. Dixon. Found in February, rare, epiphytic on *Laminaria longipes* Bory de Saint-Vincent growing in the intertidal zone. Bering Island (2). With tetrasporangia.

Order Gigartinales,

Family Phylloporaceae.

(38) *Lukinia dissecta* Perestenko. Found in July, rare, epilithic, subtidal (20 m). Medny Island (19). With cystocarps.

Note. A red alga recorded from the Commander Islands by Sinova [3] as *Sarcophyllis edulis* (Stackhouse) J. Agardh was reexamined by Perestenko and shown to represent a new species, described by the latter as *Lukinia dissecta* [35]. However, she had doubts concerning the exact family affiliation of the taxon. Later, Schneider and Wynne (2007) [40] placed this genus in the Phylloporaceae.

(39) *Mastocarpus papillatus* (C. Agardh) Kützing. Found from July to September, infrequent, epilithic, intertidal, cast ashore. Medny Island (8, 11, 12). With cystocarps.

Note. This species was previously attributed to the family Petrocelidaceae on the basis of the presence in its life history a stage of development known as *Petrocelis* Kützing. Later it was shown to belong to the Phylloporaceae on the basis of molecular-genetic studies by Fredericq and Ramirez [41].

Order Ceramiales,

Family Delesseriaceae.

(40) *Pantoneura juergensii* (J. Agardh) Kylin. Found in June, very rare, epilithic, subtidal (5 m). Medny Island (14). Vegetative.

(41) *Phycodrys amchitkensis* M. J. Wynne. Found in July, very rare, epilithic, subtidal (30 m). Medny Island (9). Vegetative.

Family Rhodomelaceae

(42) *Neorhodomela aculeata* (Perestenko) Masuda. Found in February and from June to September, frequent, epilithic, intertidal, and epiphytic on the disk of *Fucus evanescens*, cast ashore. Bering Island (2, 3, 6). With cystocarps and tetrasporangia.

Note. This species was for a long time treated in Russian taxonomic literature as *Neorhodomela larix* (Turner) Masuda subsp. *aculeata* Perestenko. As *N. aculeata* it was recorded by Klochkova et al., [42] from the near-Kamchatka water areas, however the Commander Islands were not mentioned by these authors. So this is a new record of *N. aculeata* precisely from the Commander Islands.

(43) *Odonthalia dentata* (Linnaeus) Lyngbye. Found in June, rare, epilithic, subtidal (8 m). Bering Island (2). Vegetative.

Family Wrangeliaceae.

(44) *Pleonosporium vancouverianum* (J. Agardh) Setchell & N. L. Gardner. Found in February, epiphytic on *Neoptilota asplenioides*, cast ashore. Bering Island (2). Vegetative.

4. Discussion

Although the present paper increases the checklist of the marine algae of the Commander Islands from 149 to 187 species, the list is still incomplete and will continue to grow as more collections are processed. In this paper, we recorded 44 species found after 1997. The examined specimens of the new additions are in good agreement with previous descriptions of the taxa [28–30, 35, 43–57].

The most recent findings, recorded for the first time for the flora of the Commander Islands are: *Acrochaete apiculata*, *Acrochaete geniculata*, *Acrochaete ramosa*, *Acrochaete repens*, *Ulvella lens*, *Ulvella prostrata*, *Rosenvingiella polyrhiza* (Chlorophyta); *Hecatonema primarium*, *Myrionema balticum*, *Myrionema magnusii*, *Streblonema evagatum*, *Streblonema myrionematoides*, *Streblonema scabiosum*, *Componema serpens* (Ochrophyta, class Phaeophyceae); *Erythrotrichia carnea*, *Acrochaetium densum*, *Acrochaetium microscopicum*, *Acrochaetium parvulum*, *Acrochaetium porphyrae*, *Colaconema desmarestiae*, *Colaconema endophyticum*, *Colaconema pacificum*, *Meiodiscus conrescens* (Rhodophyta). All of the mentioned species represent microscopic epi- and endophytes that were extremely poorly studied in this area. These algae are difficult to detect and identify and therefore were overlooked in earlier studies. The present study helps to fill in the gaps in the knowledge on this group of algae.

In addition, we found 3 macrophytes: brown alga *Scytosiphon dotyi* and 2 red algae: *Neorhodomela aculeata* and *Pyropia nereocystis* that are newly recorded from the Commander Islands. The latter also appears to be new to the Russian Pacific region.

Eight species were found and published by us previously: *Ahnfeltia plicata*, *Porphyra purpurea*, *Palmaria hecatensis*, *Pleuroblepharidella japonica* [17], *Rubrointrusa membranacea*

([18] as *Audouinella membranacea* and [19] as *Colaconema membranaceum*), *Pantoneura juergensii* [11], *Palmaria mollis* [19, 20]. *Lukinia dissecta*, described by Perestenko [35] from the Commander Islands, was found in our material from Medny Island after 2000 [17], and was recorded in our later paper on the macrophytic algae of Bering Island [18].

We included *Gloiocladia guiryi* described from the Commander Islands [14–16] as a new record in our list for the reason that our revised checklist summarizes all available information appeared after the first revision of the Islands' flora [5–7].

We also confirm the presence of 5 species that were recorded by other authors but were absent in our earlier collections. *Phycodryas amchitkensis* was recorded as presumably inhabiting Commander Islands by Gusarova and Semkin [58], and our collections of this alga on Medny Island confirm their supposition; *Mastocarpus papillatus* was recorded by Perestenko [59]; *Lithothamnion sonderi*, *Odonthalia dentata*; and *Pleonosporium vancouverianum* were recorded by Klochkova and Berezovskaya [60].

On the whole the marine algal flora of the Commander Islands can be characterized as diverse in its species composition and allochthonous in origin. No endemic species were found. The diverse species composition shows that the floristic complex of the Commander Islands is under the strong influence of adjacent areas.

The main ecological factor shaping the contemporary flora of algae macrophytes in the region is the system of marine currents. The Commander Islands are greatly influenced by the American continent due to a branch of the Alaska current (Figure 1) providing penetration of American elements into the Islands' flora. We believe this process is the main influence on the development of the flora of the Commander Islands, providing greater richness and diversity compared to other areas of the Bering Sea. Many species found by us for the first time on the Islands from 1986 to 1997 were earlier described from the American coast (e.g., *Palmaria callophyloides* M. W. Hawkes & Scagel, *P. hecatensis*, *Laingia aleutica* M. J. Wynne, *Beringiella labiosa* M. J. Wynne, and *Tayloriella abyssalis* M. J. Wynne). Our present study confirms this tendency, as the species we found there in the last decade were previously described from the American coast as well (*Ulvella prostrata*, *Acrochaete apiculata*, *A. geniculata*, *A. ramosa*, *Hecatonema primarium*, *Streblonema evagatum*, *S. myrionematoides*, *S. scabiosum*, *Compsonea serpens*, *Scytosiphon dotyi*, *Acrochaetium arcuatum*, *A. densum*, *A. porphyrae*, *Colaconema desmarestiae*, *C. pacificum*, *Pyropia nereocystis*, etc.). Most of them are not known up to now from the other Russian Pacific regions. Of course, the absence of records of some species from the Russian sector of the North Pacific does not in all cases mean that these algae do not grow there. Probably it is caused by less careful studies in this area in contrast to the Commander Islands. Moreover, it should be noted that in spite of the fact that all above-mentioned species were described from the American continent, they are not necessarily American in their origin. It is quite possible that marine algal flora of the American continent is more comprehensively studied and new species

are found and described there more often in comparison with the Russian Pacific sector.

In any case, according to our data (Supplementary Tables 1–3), the presence of 23 species (about 12% of the total number in our checklist) on the Commander Islands that are not met in other areas of the Russian Pacific but are common with the American coast proves our supposition that the marine flora of the Commanders is appreciably influenced by the American floristic elements. In addition, it is possible to indicate some algal species occurring on the Commander Islands that were originally described from the American sector but now found also on the Pacific coasts of Russia: *Scytosiphon dotyi*, *Palmaria callophyloides*, *P. hecatensis*, *P. mollis*, *Constantinea subulifera* Setchell, *Neodilsea natashae* S. C. Lindstrom, *Phycodryas amchitkensis*, and *Tokidadendron bullatum* (N. L. Gardner) M. J. Wynne. Presumably these species migrated from American to Asian continent via the Commander Islands. So the Islands serve as a peculiar bridge uniting American and Asian algal floras. Certainly the Aleutian Islands form the major part of this bridge. Considerable similarity of the floristic and faunistic complexes of the Commander and Aleutian Islands was noted by Kussakin and Ivanova [4]. Obviously it is due to similarity in geographic position, geological structure of both archipelagoes, and hydrological conditions providing continuous species exchange between the continents. According to our calculations there are 165 species of algae growing on the Commander Islands that also occur in the American sector of the North Pacific. At the same time there are 165 species of the Commander Islands' flora common with the other areas of the Russian Pacific sector. So the Commander Islands' marine flora has equal similarity with Asian and American floristic complexes. There are 140 species included in our list that are common for all discussed areas.

5. Conclusion

The Commander Islands marine algal flora is species rich. Marine macrophytes are among the most dominant components of benthic communities on the shelf, so an inventory of the algae is very important. The new checklist will provide important background material for studies on biodiversity, ecology and phytogeography. Knowledge of the contemporary algal flora will also be helpful for interpreting of historical phytogeography, and the processes of species formation and migration. Increased knowledge of the marine flora of the Commander Islands and of other areas of the Russian Pacific coasts assures a better understanding of the occurrence and functioning of benthic communities as a whole. Inventory of the marine flora is necessary not only for clarification of scientific questions but also for solving of some important practical problems. In particular, there is a threat of biodiversity decrease in the region and the loss of still unknown species. Already known rare species included in the Red Data Book of Kamchatka are also under the threat of loss. It is essential to continue studies on biodiversity of marine coastal ecosystems paying special attention to their plant components that provide habitat

and/or food for valuable commercial species (herring, rock trout, sea urchins, etc.). These studies help to fulfill the task of biodiversity conservation and sustainable nature use in Kamchatka region.

Acknowledgments

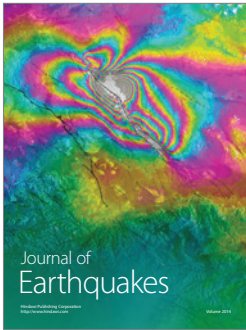
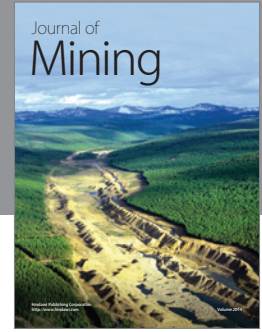
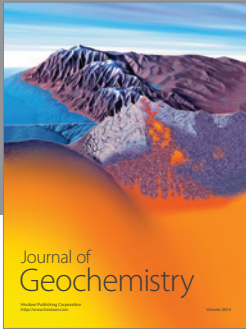
The authors would like to thank the researcher of the Commander State Biosphere Reserve Nikolai N. Pavlov for algal collection carried out by him on the shelf of Bering Island during winter period of 2011 and the students of Kamchatka State University who took part in algal collections in summer seasons.

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