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Checklist of Rhodophyta of the White Sea (the Arctic Ocean)

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Abstract: Most data on the White Sea flora are scattered in Russian publications and are largely inaccessible to researchers. The aim of the present work is to compile a checklist as well as to provide verification of the species composition of the Rhodophyta of the White Sea. This checklist is based on an exhaustive bibliographic search. As a result of a careful revision, a total of 61 species of Rhodophyta has been revealed, and 17 species and one forma were excluded on the basis of being doubtful records or misidentifications. The distribution of four species in the White Sea was clarified. Nineteen species occur throughout the White Sea, six species are widespread except for Mezen Bay, whereas seven taxa are restricted to the northern regions of the White Sea. The analysis of the species composition permits the red algal flora of the White Sea to be interpreted as representing the depleted Barents Sea flora. An extensive bibliography and data on the presence of the specimens in the Komarov Botanical Institute of the Russian Academy of Sciences are given.

Keywords: bibliography; red algae; revised checklist; Sørensen similarity index; White Sea flora.

Introduction

The White Sea (63°48′–68°40′N, 32°00′–44°40′E) is an inner basin of northwest Eurasia and forms part of the Arctic Ocean. The White Sea is connected with the Barents Sea through the Voronka and the narrow Gorlo strait (Figure 1). The sea area is 90 000 km^2 and the total length of the coastline is 5000 km. Sea-surface temperatures range from 12 to 18°C during the summer season and drop to −1(−2)°C in winter. In the winter, from November to May, the coastal areas and the inland parts of the bays are covered by ice. Salinity varies from 25–35 in the northern areas to 20–28 in central areas. The inner parts of the bays are exposed to fluctuations in salinity and high amounts of terrigenous sediments and nutrients from the Onega, Dvina and Mezen Rivers and other small rivers (White Sea Sailing Directions 1995). A variety of ecosystems, ranging from rocky shores to soft-bottom flats provide suitable habitats for seaweed growth.

Knowledge of the marine algal diversity of the White Sea is largely inaccessible to the international scientific community because most data are scattered in regional papers published mostly in Russian. The history of the study of marine algae in the White Sea dates back to 1775, when Russian naturalist, zoologist and botanist Ivan Ivanovich Lepechin reported on the occurrence of four species of red algae from the White Sea and provided the descriptions and images (Lepechin 1775). After a long interval, the famous Russian scholars Postels and Ruprecht (1840) provided further floristic information about the marine algae of the White Sea, amongst other significant findings devoted primarily to the seaweed flora of the Pacific. Their records are based on specimens collected by academician C. Baer during his expeditions to the White Sea. Later, Ch. Gobi examined the numerous collections of Baer, Schrenk, Ruprecht, Middendorff, Nylander, Goebel, Sokoloff, Grigorieff and Merezhkovskiy and published the first large review devoted to the algal flora of the White Sea (Gobi 1878). The data of Gobi were included in the book of Kjellman (1883) about the algae of the Arctic seas.

Further significant contributions to the study of the White Sea algae were made by Sinova (1921, 1922, 1929a,b, 1934). Many zoologists used the material treated by Sinova in their publications on the biology of the White Sea (Gurjanova et al. 1925, Derjugin 1928, Gurjanova 1949). Some additions to our knowledge of the White Sea marine flora were made by Meyer (1933, 1938). Zinova (1950, 1954, 1955, 1961a,b) has continued floristic and taxonomic investigations of the macroalgae of the White Sea and other seas of the USSR, being the scientific successor to her aunt E.S. Sinova. Moreover, she passed the baton of scientific discoveries to her disciples (Kalugina 1957, 1958, 1959a,b, 1962, Blinova 1962, Gemp 1967, Petrov 1967, Vozzhinskaja 1975, 1980, 1986, Perestenko 1983, Vinogradova 1996, 2002, 2005a,b, 2007, 2010, 2011). Some floristic information and data on the biology and taxonomy of certain species of the White Sea can be obtained from recent publications (Schoschina

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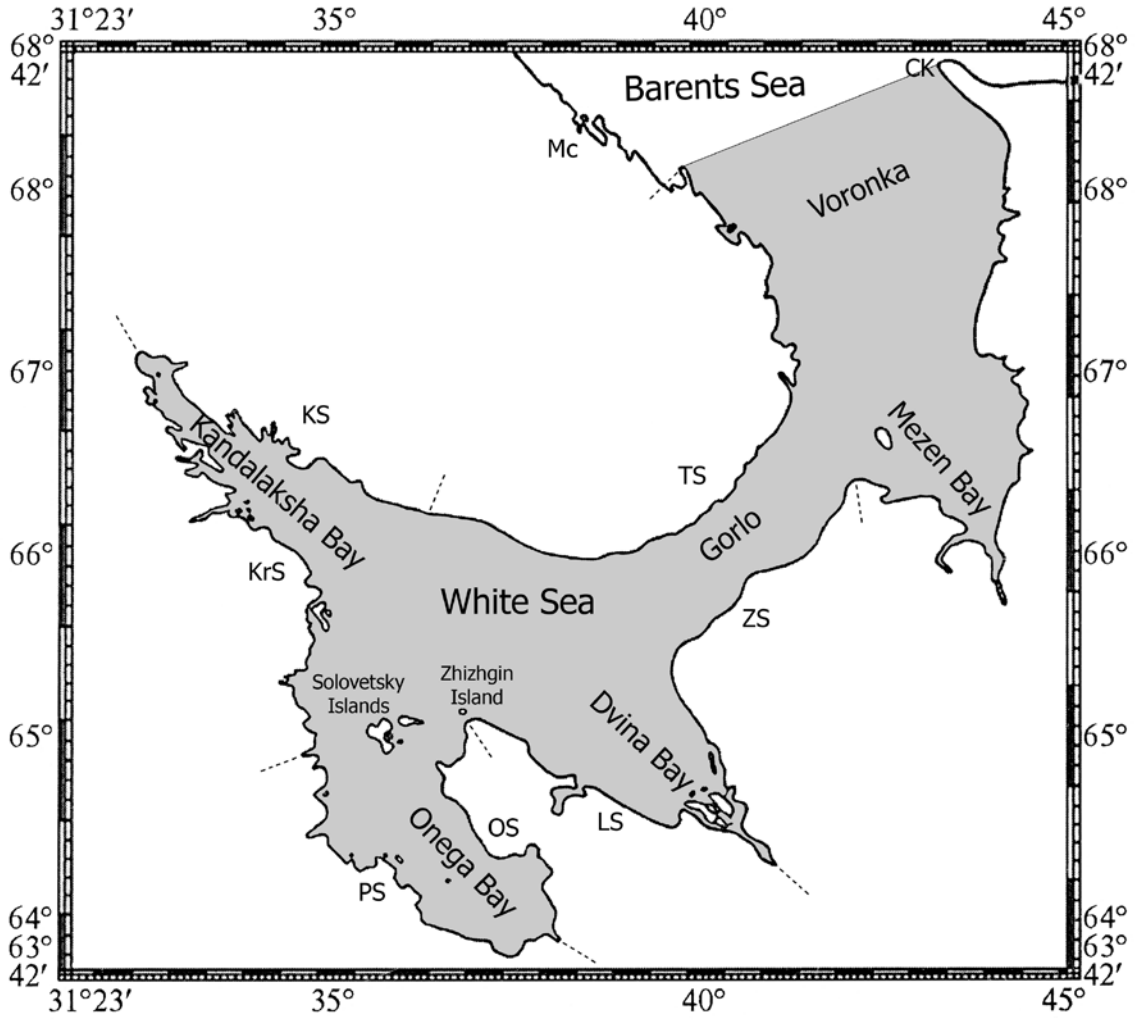

Figure 1: Schematic map of the White Sea. Symbols: CK, the Cape Kanin; KrS, the Karelsky Shore; KS, the Kandalaksha Shore; LS, the Letny Shore; Mc, the Murman coast; OS, the Onega Shore; PS, the Pomorsky Shore; TS, the Tersky Shore; ZS, the Zimny Shore; --- borders of shores.

1996, Shoshina 1981, 1990, 1991, Mikhaylova 1996, 2000, Mikhaylova and Shtrik 2007, Garbary and Tarakhovskaya 2013, Smirnova and Mikhailova 2013).

Full checklists of Rhodophyta of the White Sea can be found in the publications of Gobi (1878), Sinova (1921, 1929a,b), Zinova (1950, 1955) and Vozzhinskaja (1980). Kalugina (1962) reported the number of Rhodophyta species (67), but unfortunately she did not publish a list. The number of Rhodophyta reported for the White Sea has increased over time (Table 1). However, the most recent list (Vozzhinskaja 1980) contains numerous inaccuracies and requires clarification. Moreover, recently there have been changes in the taxonomic status and nomenclature combinations of some species. Here, we have compiled a revised checklist of the White Sea Rhodophyta and tried to reflect more completely the existing literature on the region. The goal of our work is to provide full information about when and under what name the red algal species in the White Sea have been reported, and the authors of these reports.

Table 1: The number of Rhodophyta species in the White Sea reported by different authors.

Reference	Number of species
Gobi (1878)	30
Sinova (1929b)	53
Zinova (1950)	56
Kalugina (1962)	67
Vozzhinskaja (1980)	69

Materials and methods

This checklist is based on an exhaustive bibliographic search in which both Russian and international publications were screened for species records. To compile the revised checklist of the Rhodophyta of the White Sea, the checklists for the seaweeds of the White Sea (Gobi 1878, Sinova 1921, 1929a,b, Zinova 1950, 1955, Vozzhinskaja 1980) were used as a starting point. The presence of specimens in the Komarov Botanical Institute of the Russian Academy of Sciences, St. Petersburg (the LE collection) was checked. Species records were excluded from the checklist if they were based on mis-identifications or were not supported by sufficient evidence, such as published descriptions or herbarium specimens. Marine macroalgal taxa reported in scientific books, journals and conference proceedings have been critically reviewed in the light of present-day taxonomy and nomenclature, mostly using the on-line data provided by Guiry and Guiry (2016). The taxonomy of Bangiales, Corallinales, Hapalidiales and Ceramiales follows Vinogradova (2002, 2005a,b, 2007, 2010, 2011). The checklist (Table 2) is arranged in alphabetical order. The distribution of species is listed in eight regions of the White Sea: the Voronka, the Gorlo, the Kandalaksha, the Onega, the Dvina and the Mezen Bays, the Solovetsky Islands and Zhizhgin Island (Figure 1). The White Sea Rhodophytan flora was compared with that of neighboring regions using the Sørensen similarity index (Magurran 1988). The floristic data for the neighboring regions were derived from Sinova (1925, 1956), Zinova (1955), Vinogradova (1961, 1986, 1995), Perestenko (1964), and from Internet resources (http://seaweeds.uib.no/ and www.algaebase.org).

Results and discussion

Considering the taxonomic and nomenclatural changes, as well as correcting inaccurate records, the list was reduced down to 61 species (Table 2). In this list mainly reliable records were included. The doubtful, unchecked and misidentified records are discussed below.

It is generally thought that *Bangia fuscopurpurea*, *Porphyra umbilicalis* and *Wildemania miniata* do not extend to the south of the Gorlo (Kalugina 1962: 97, Vinogradova 2007: 539, 549). These species are more common in the Barents Sea flora. However, *B. fuscopurpurea* was recorded in Onega, Dvina and Mezen Bays (Vozzhinskaja 1980: 38); *P. umbilicalis* was recorded in Kandalaksha Bay (Blinova 1962: 25, Garbary and Tarakhovskaya 2013: 272) and even on the Solovetsky Islands, and in Onega and Dvina Bays (Vozzhinskaja 1975: 104, 1980: 38); *W. miniata* (as *Porphyra helenae* A.D.Zinova) was recorded in Kandalaksha, Onega and Dvina Bays (Vozzhinskaja 1980: 38). The new data on the distribution of these species are doubtful because they are not confirmed by specimens.

Colaconema daviesii is well known for the Murman flora of the Barents Sea (Vinogradova 1961: 92, Perestenko 1964: 145, Mikhaylova 2012: 716). Comparatively recently this species was also found in Voronka (Mikhaylova and Shtrik 2007: 1820). Its record as *Chantransia daviesii* (Dillwyn) Thuret in the Solovetsky Islands region (Gobi 1878: 6, 50) is questionable. We suggest that the author meant the current *Grania efflorescens* because he provided as synonyms *Callithamnion efflorescens* J. Agardh and *Chantransia efflorescens* (J. Agardh) Kjellman. We have not included this record in our list as we are not confident about the interpretation. The record of *Colaconema daviesii* in the middle part of Karelsky Shore of the Kandalaksha Bay (Chupa Inlet) (Garbary and Tarakhovskaya 2013: 271, 275) is doubtful because the authors did not confirm it with voucher specimens.

Paralemanea catenata (Kützing) M.L. Vis *et* R.G. Sheath and *P. parvula* (Sirodot) S.L. Xie *et* Z.X. Shi in S.L. Xie, Z.X. Shi *et* R.-N. Wang were recorded by Sinova (1922: 29, 1929b: 4) as *Lemanea catenata* Kützing and *L. parvula* Sirodot and were based on specimens that Nylander collected in the rivers of Kandalaksha Bay and Tersky Shore. Since they are freshwater algae, Zinova (1950, 1955) did not include them in the flora of the White Sea.

Records of *Lithothamnion ungeri* Kjellman (Derjugin 1928: 382, Sinova 1929b: 29–30, Zinova 1950: 238, 1955: 96, 86, Vozzhinskaja 1980: 39), *Phymatolithon calcareum* (Pallas) W.H. Adey *et* D.L. McKibbin as *Lithothamnion calcareum* (Pallas) Areschoug (Sinova 1921: 42, Zinova 1950: 238, Zinova 1955: 96–97), *P. lenormandii* (Areschoug) W.H. Adey as *Lithophyllum lenormandii* (Areschoug) Rosanoff (Gobi 1878: 4, 21–22, Tsenkovskiy 1881: 144, Kjellman 1883: 35, 103–104, Vozzhinskaja 1980: 39) and as *Lithothamnion lenormandii* (Areschoug) Foslie (Sinova 1922: 29, 1929a: 18, 1929b: 30, Derjugin 1928: 382, Zinova 1950: 238, 1955: 83–84, 1961b: 89, Kalugina 1962: 97) have been challenged and excluded from the White Sea flora by K.L. Vinogradova (2010). The verification is not possible because the samples are absent or are in an unsatisfactory state (Vinogradova 2010: 669).

Very fine epiphytic specimens of *Gelidium corneum* (Hudson) J.V. Lamouroux growing as small tufts on stalks of larger algae were recorded and described by Sinova in a footnote (1929a: 18, 32). Later, she reported two findings of this species in the White Sea without providing exact

Table 2: The annotated checklist of Rhodophyta of the White Sea.

	Current name	Regions	[Reference(s)]; as *synonym* [reference(s)]	Availability in LE collection
1	*Acrochaetium collopodum* (Rosenvinge) Hamel	V K O S	as *Kylinia collopoda* [26, 53]	
2	*Acrochaetium humile* (Rosenvinge) Børgesen	G K D S	as *Kylinia humilis* [9, 11, 13, 53]	
3	*Acrochaetium microscopicum* (Nägeli *ex* Kützing) Nägeli *in* Nägeli *et* Cramer	V G K O D M S	as *Chantransia microscopica* [3, 37, 38]; as *Kylinia compacta* [26, 53]	+
4	*Acrochaetium parvulum* (Kylin) Hoyt	K O D S	as *Kylinia parvula* [10, 12, 13, 53]	
5	*Acrochaetium secundatum* (Lyngbye) Nägeli in Nägeli *et* Cramer	V G K O D M S	[20, 41]; as *A. virgatulum* [4, 41]; as *Chantransia secundata* [18, 37, 40, 56]; as *C. virgtula* [18, 56]; as *Kylinia secundata* [53]; as *K. virgatula* [13, 53]	
6	*Ahnfeltia plicata* (Hudson) Fries	V G K O D M S Z	[1, 2, 3, 4, 5, 6, 9, 10, 13, 14, 15, 17, 18, 19, 21, 23, 31, 35, 36, 37, 38, 40, 41, 52, 53, 54, 56, 58, 60]; as *Gigartina plicata* [24, 27]; as *Sterrocolax decipiens* [3, 18, 35, 37, 38]	+
7	*Antithamnionella floccosa* (O.F. Müller) Whittick	K D S Z	[4, 20, 49]	+
8	*Bangia fuscopurpurea* (Dillwyn) Lyngbye	V G	[13, 19, 52, 53]	
9	*Ceramium deslongchampsii* Chauvin *ex* Duby	G K O S	[13, 41, 45, 49, 53, 56, 57, 58]; as *C. strictum* [2, 10, 12, 13, 23, 53, 54]	+
10	*Ceramium virgatum* Roth	V G K O D M S Z	[4, 27, 41, 45, 49]; as *C. areschougii* [10, 12, 13, 53]; as *C. circinatum* [20, 21, 30, 58]; as *C. diaphanum* [5]; as *C. rubrum* [1, 2, 3, 5, 6, 10, 13, 14, 17, 18, 19, 23, 24, 30, 35, 36, 37, 38, 40, 53, 54, 56, 58]	+
11	*Chondrus crispus* Stackhouse	V G K O D S	[13, 19, 35, 37, 38, 52, 53, 56, 58]	+
12	*Choreocolax polysiphoniae* Reinsch	V K	[3, 13, 35, 38, 53]	+
13	*Chroodactylon ornatum* (C. Agardh) Basson	G K O S	as *Asterocytis ornata* [53, 57, 58]; as *A. ramosa* [7, 13, 56].	+
14	*Clathromorphum circumscriptum* (Strömfelt) Foslie	V G O D	[48, 50]	
15	*Clathromorphum compactum* (Kjellman) Foslie	V G D Z	[48, 56]; as *Lithophyllum lenormandii* [6]; as *Lithothamnion compactum* [15, 52, 53, 54, 58]; as *Phymatolithon compactum* [3, 35, 36, 37, 38, 40]	
16	*Coccotylus brodiei* (Turner) Kützing	V G K O D M S Z	as *Chondrus membranifolius* [27]; as *Phyllophora brodiei* [1, 2, 3, 5, 6, 9, 10, 13, 14, 15, 17, 18, 19, 23, 24, 35, 36, 37, 38, 39, 40, 43, 53, 54, 56, 58]; as *P. membranifolia* [7, 18, 56]	+
17	*Coccotylus hartzii* (Rosenvinge) L. Le Gall *et* G.W. Saunders	O S	as *Ceratocolax hartzii* [10, 13, 53, 56, 58]	+
18	*Coccotylus truncatus* (Pallas) M.J. Wynne *et* J.N. Heine	V G K O D M S Z	[4, 21, 41]; as *Actinococcus subcutaneus* [3, 36, 37, 38]; as *Phyllophora interrupta* [1, 2, 3, 5, 6, 10, 13, 14, 15, 18, 35, 36, 37, 38, 39, 40, 42, 54, 56, 58, 60]; as *P. truncata* [53]	+
19	*Colaconema daviesii* (Dillwyn) Stegenga	V	[22]	
20	*Corallina officinalis* Linnaeus	V G K O D M S Z	[1, 2, 3, 4, 5, 6, 8, 10, 13, 14, 15, 17, 18, 19, 23, 35, 36, 37, 38, 40, 41, 42, 43, 48, 53, 54, 56, 58, 60]; as *C. rubens* [36]	+
21	*Cruoria pellita* (Lyngbye) Fries	K O M S	[53, 58, 60]	
22	*Cystoclonium purpureum* (Hudson) Batters	V G K O D S Z	[1, 4, 5, 10, 13, 15, 41, 53, 57, 58]; as *C. purpurascens* [2, 3, 6, 14, 18, 19, 35, 36, 37, 38, 40, 56]; as *Gigartina purpurascens* [24]	+
23	*Devaleraea ramentacea* (Linnaeus) Guiry	V G K O D S Z	[21]; as *Halosaccion ramentaceum* [2, 3, 5, 6, 10, 13, 14, 15, 18, 19, 35, 36, 37, 38, 40, 43, 53, 54, 56, 58]; as *Dumontia ramentacea* [24]; as *D. tubulosa* [27]; as *Fucus graminifolius* [16]; as *F. tubulosus* [16]	+

Table 2 (continued)

	Current name	Regions	[Reference(s)]; as *synonym* [reference(s)]	Availability in LE collection
24	*Dumontia contorta* (S.G. Gmelin) Ruprecht	V G K O D S Z	[4, 41]; as *D. filiformis* [3, 6, 14, 18, 19, 24, 35, 37, 38, 40, 42]; as *D. incrassata* [1, 2, 9, 10, 13, 53, 54, 56, 58].	+
25	*Erythrocladia irregularis* Rosenvinge	S	[13, 26]	
26	*Euthora cristata* (C. Agardh) J. Agardh	V G K O D M S Z	[1, 2, 3, 4, 5, 6, 10, 13, 14, 15, 18, 19, 21, 35, 36, 37, 38, 40, 41, 43, 54, 56, 58]; as *Callophyllis cristata* [53]; as *Rhodomenia cristata* [27]; as *Rhodymenia cristata* [24].	+
27	*Fimbrifolium dichotomum* (Lepechin) G.I. Hansen	V G K O D S Z	[4, 20, 21, 41]; as *Fuci dichotomi* [16]; as *Rhodomenia ciliata* [27]; as *Rhodophyllis dichotoma* [1, 2, 3, 5, 6, 10, 13, 14, 15, 18, 19, 35, 36, 37, 38, 40, 53, 56, 58]; as *Rhodymenia jubata* [24]	+
28	*Furcellaria lumbricalis* (Hudson) J.V. Lamouroux	V G K O D M S	[4, 41]; as *F. fastigiata* [1, 2, 3, 10, 14, 15, 17, 18, 27, 29, 36, 38, 53, 54, 56, 58, 60]; as *Fastigiaria furcellata* [6]	+
29	*Grania efflorescens* (J. Agardh) Kylin	V G K O D M S Z	[4, 41]; as *Audouinella efflorescens* [1, 10, 20, 21, 53, 58, 60]; as *Chantransia efflorescens* [3, 14, 18, 38, 40, 56]	
30	*Haemescharia hennedyi* (Harvey) K.L. Vinogradova *et* T. Yacovleva	K O	[41, 51]	+
31	*Halosaccion saccatum* (Lepechin) Kützing	V	[14]; as *H. lepechini* [13, 56, 58]; as *Fucus saccatum* [16]	
32	*Harveyella mirabilis* (Reinsch) F. Schmitz *et* Reinke in Reinke	G K O M S	[4, 10, 12, 13, 53]; as *Choreocolax odonthaliae* [53]	
33	*Hildenbrandia rubra* (Sommerfelt) Meneghini	V K D S Z	[4, 21, 41]; as *H. prototypus* [10, 15, 23, 37, 38, 40, 52, 54, 56, 58]; as *H. rosea* [3, 6, 14, 35, 36, 37, 38, 56]	+
34	*Leptophytum foecundum* (Kjellman) W.H. Adey	G K O Z	[48]; as *Lithothamnion foecundum* [3, 38, 53, 56, 58]	+
35	*Leptophytum laeve* (Foslie) W.H. Adey *nom. illeg.*[a]	V G K O S	[48, 50]; as *Lithothamnion flavescens* [35, 56, 58]; as *Phymatolithon compactum* [38]	+
36	*Lithophyllum crouaniorum* Foslie	V G	as *L. crouanii* [48]	+
37	*Lithothamnion glaciale* Kjellman	V K O D S Z	[3, 14, 18, 36, 38, 41, 48, 53, 56, 58]; as *L. fasciculare* [3]; as *L. fasciculatum* [6]	+
38	*Lithothamnion tophiforme* (Esper) Unger	V G K M	[48]; as *L. alcicorne* [36, 38]; as *L. soriferum* [3, 35, 38, 53, 56, 58, 60]	
39	*Meiodiscus spetsbergensis* (Kjellman) G.W. Saunders *et* McLachlan	V K O D S Z	[1, 4, 22, 41]; as *Rhodochorton penicilliforme* [3, 10, 18, 37, 38, 40, 53, 54, 56, 58]; as *R. spetsbergense* [20, 21]	+
40	*Membranoptera fabriciana* (Lyngbye) M.J. Wynne *et* G.W. Saunders	V G K O D M S Z	as *Delesseria angustissima* [3, 18, 35, 36, 37, 38, 40]; as *D. baeri* [3, 6, 14, 18, 35, 36, 37, 38, 40, 42]; as *Pantoneura baerii* [5, 10, 13, 20, 21, 53, 54, 56, 58]; as *P. fabriciana* [49]; as *Rhodomenia baerii* [27]; as *Rhodymenia baerii* [24]	+
41	*Odonthalia dentata* (Linnaeus) Lyngbye	V G K O D M S Z	[1, 2, 3, 4, 5, 6, 9, 10, 13, 14, 15, 17, 18, 19, 20, 21, 22, 29, 32, 35, 36, 37, 38, 40, 41, 42, 43, 49, 53, 54, 56, 58, 60]	+
42	*Palmaria palmata* (Linnaeus) F. Weber *et* D. Mohr	V G K O D M S Z	[1, 4, 20, 21, 41, 54]; as *Halymenia palmata* [27]; as *Rhodymenia palmata* [3, 5, 6, 8, 9, 10, 13, 14, 15, 17, 18, 19, 24, 35, 36, 37, 38, 40, 43, 53, 56, 58]; as *R. pertusa* [18]	+
43	*Phycodrys rubens* (Linnaeus) Batters	V G K O D M S Z	[4, 19, 20, 21, 25, 28, 41, 44, 49, 56]; as *P. fimbriata* [2, 10, 13, 58]; as *P. rossica* [1, 4, 5, 10, 13, 15, 23, 43, 52, 53, 54, 58]; as *P. sinuosa* [1, 2, 5, 10, 13, 15, 35, 53, 58, 60]; as *Delesseria fimbriata* [3, 35, 38]; as *D. rossica* [3, 18, 34, 35, 36, 38, 56]; as *D. sinuosa* [3, 6, 14, 17, 18, 24, 29, 35, 36, 37, 38, 40, 42]	+
44	*Phymatolithon purpureum* (P. Crouan *et* H. Crouan) Woelkerling *et* L.M. Irvine	V G K O D M S Z	[48]; as *P. polymorphum* [3, 35, 36, 37, 38, 40, 56]; as *Lithothamnion polymorphum* [5, 23, 53, 54, 58, 60]	+

Table 2 (continued)

	Current name	Regions	[Reference(s)]; as *synonym* [reference(s)]	Availability in LE collection
45	*Plumaria plumosa* (Hudson) Kuntze	V G K O D S	[41, 49]; as *P. elegans* [5, 13, 15, 52, 53, 56, 57, 58]	+
46	*Polyides rotunda* (Hudson) Gaillon	V G K O D S Z	as *P. rotundus* [1, 2, 3, 4, 5, 6, 10, 13, 14, 15, 18, 19, 24, 35, 37, 38, 40, 41, 56, 58]; as *P. caprinus* [21, 53]	+
47	*Polysiphonia arctica* J. Agardh	V G K O D M S Z	[1, 2, 3, 4, 5, 6, 10, 13, 14, 18, 19, 21, 35, 36, 37, 38, 40, 41, 42, 49, 53, 54, 56, 58]; as *P. badia* [27]	+
48	*Polysiphonia fucoides* (Hudson) Greville	V G K O D M S Z	[4, 41]; as *P. nigrescens* [1, 2, 3, 5, 6, 9, 10, 13, 14, 17, 18, 19, 21, 23, 24, 27, 35, 36, 37, 38, 41, 42, 43, 49, 53, 56, 58]	+
49	*Polysiphonia stricta* (Dillwyn) Greville	V G K O D M S Z	[4, 41]; as *P. roseola* [24, 27]; as *P. pulvinata* [6]; as *P. urceolata* [1, 2, 3, 5, 6, 7, 10, 13, 14, 15, 17, 18, 19, 20, 22, 23, 35, 36, 38, 40, 42, 43, 49, 53, 54, 56, 58, 60]	+
50	*Porphyra purpurea* (Roth) C. Agardh	V G K O D M S Z	[47, 53]; as *P. abyssicola* [3, 5, 8, 10, 13, 21, 35, 37, 53, 56, 58]; as *P. laciniata* [3, 5, 9, 10, 14, 18, 35, 37, 38, 40, 42, 54, 56, 58]; as *P. vulgaris* [24 (unpublished comment of A.D. Zinova)]	+
51	*Porphyra umbilicalis* Kützing	V G	[2, 4, 47, 52, 53]; as *P. laciniata* [6, 38, 58]	
52	*Ptilota gunneri* P.C. Silva, Maggs *et* L.M. Irvine in Maggs *et* Hommersand	V G K O D M S Z	[4, 22, 49]; as *P. californica* f. *typica* [3, 35, 38]; as *P. plumosa* [1, 2, 3, 5, 6, 10, 13, 14, 15, 17, 18, 19, 20, 21, 23, 27, 29, 33, 35, 36, 37, 38, 40, 43, 53, 54, 56, 58, 60]	+
53	*Ptilota serrata* Kützing	V G K O D S Z	[4, 24, 41, 49]; as *P. integerrima* [35]; as *P. pectinata* [1, 2, 3, 5, 10, 13, 14, 17, 18, 19, 35, 36, 37, 38, 40, 53, 54, 56, 58]; as *P. plumosa* f. *arctica* [6]	+
54	*Rhodochorton purpureum* (Lightfoot) Rosenvinge	G K D M S	[1, 4, 13, 14, 41, 43, 58]; as *Rhodochorton intermedium* [3, 38]; as *R. rothii* [3, 36, 38, 40, 56]	
55	*Rhodomela confervoides* (Hudson) P.C. Silva	V G K O D M S Z	[4, 21, 41, 46, 49]; as *R. larix* [35]; as *R. lycopodioides* [1, 2, 3, 4, 5, 9, 10, 13, 14, 24, 35, 36, 38, 40, 53, 56, 58]; as *R. subfusca* [1, 2, 3, 5, 6, 8, 9, 10, 13, 18, 19, 27, 35, 36, 37, 38, 40, 56, 58]; as *R. virgata* [53, 56]	+
56	*Rubrointrusa membranacea* (Magnus) S.L. Clayden *et* G.W. Saunders	M S	[4]; as *Audouinella membranacea* [10, 12, 13, 53, 60]	
57	*Sahlingia subintegra* (Rosenvinge) Kornmann	V G K O D M S	as *Erythrocladia subintegra* [12, 13, 53]	
58	*Scagelia pylaisaei* (Montagne) M.J. Wynne	V G K O D M S Z	[4, 20, 21, 22, 41, 49]; as *Antithamnion americanum* [56, 57, 58, 60]; as *A. boreale* [3, 10, 13, 14, 18, 35, 37, 38, 40, 52, 53, 56, 58]; as *A. plumula* var. *boreale* [6]; as *A. pylaisaei* [5, 18, 53, 56, 58]	+
59	*Turnerella* sp.	V	[59]	+
60	*Wildemania amplissima* Foslie	K S	[4]; as *Porphyra abyssicola* [38]; as *P. amplissima* [47]	
61	*Wildemania miniata* (C. Agardh) Foslie	V G	as *Porphyra abyssicola* [14, 38, 58]; as *P. helenae* [5, 13, 53, 55, 56, 58]; as *P. miniata* [6, 24, 47]	

Regions: V, the Voronka; G, the Gorlo; K, the Kandalaksha Bay; O, the Onega Bay; D, the Dvina Bay; M, the Mezen Bay; S, the Solovetsky Islands; Z, Zhizhgin Island; +, the presence in the LE collection.

[a]The use of the name *Leptophytum* as a distinct genus is illegitimate, but no solution has been proposed to date (Guiry and Guiry 2016). The species *Leptophytum laeve* included here is illegitimate and is in need of reassignment.

localities (Sinova 1933: 67). Zinova (1950) included this species in the White Sea flora. However, the voucher specimens have not been preserved in the LE collection, and further studies have not confirmed these records. Zinova (1955) has excluded this species without any comments.

Records of *Dilsea carnosa* (Schmidel) Kuntze (=*Dilsea edulis* Stackhouse, =*Sarcophyllis edulis* (Stackhouse) J. Agardh) for the White Sea flora (Gobi 1878: 5, 39, Kjellman 1883: 36, 152, Sinova 1921: 43, 1929b: 16–17, Derjugin 1928: 382, Zinova 1950: 238, 1955: 66) are erroneous because the specimen collected by Carl v. Baer, which is reported as *Iridaea edulis* (Postels *et* Ruprecht 1840) and mentioned by other authors, belongs to the genus *Turnerella* (Zinova 1961a: 85).

Neodilsea integra (Kjellman) A.D. Zinova has been recorded as *Dilsea integra* (Kjellman) Rosenvinge, *Sarcophyllis arctica* Kjellman and *Kallymenia integra* Kjellman in the southeastern part of the Barents Sea, Novaya Zemlya, and Vaygach Island (Kjellman 1883: 36, 152–153, Flerov and Karsakoff 1925: 12, 1932: 57, Zinova 1961a: 85, Vinogradova 1996). Records based on the specimen collected by Ruprecht near Cape Kanin (Sinova 1921: 43, 1929b: 17, Derjugin 1928: 382, Meyer and Shchapova 1948: 527) are incorrect because this location is 15 km to the east and located in the Barents Sea (Zinova 1961a: 85). Records of *N. integra* by Vozzhinskaja (1980: 39, 1986: 24, 45) are very doubtful everywhere in the White Sea; they are not supported by taxonomic investigations and specimens. The finding of Korennikov and Gemp (1976: 563) seems to be more likely because their record refers to the south-west of Cape Kanin. However, we cannot include this sole record in our checklist due to the absence of voucher specimens.

Delesseria sanguinea (Hudson) J.V. Lamouroux, *Membranoptera alata* (Hudson) Stackhouse, *Turnerella pennyi* (Harvey) F. Schmitz in Rosenvinge, *Mastocarpus stellatus* (Stackhouse) Guiry and *Vertebrata lanosa* (Linnaeus) T.A. Christensen are all common in the Barents Sea flora, but they are presumed to be absent from the White Sea flora. But Vozzhinskaja (1980: 39, 40) recorded *D. sanguinea*, *M. alata*, *T. pennyi* and *M. stellatus* (as *Gigartina stellata* (Stackhouse) Batters) in southern parts of the White Sea, such as Kandalaksha, Onega, Dvina Bays and the Solovetsky Islands. *Delesseria sanguinea*, *T. pennyi* and *V. lanosa* [as *Polysiphonia fastigiata* (Roth) Greville] were also recorded earlier by Meyer and Shchapova (1948: 528, 531) without specific locations. These findings are very doubtful and are not supported by specimens. Consequently, we support the view of Zinova (1950, 1955), who did not include them in her checklist of the White Sea. Moreover, the occurrence of *M. stellatus* was commented on by Zinova (1950: 231). She named it as *Gigartina mamillosa* (Goodenough *et* Woodward) J. Agardh and referred to very old erroneous records of this species in the White Sea (as *Fucus foliaceus* nom. illeg., Koelreuter 1767: 424–428; as *F. papillosus* Gmelin 1768: 188). She also noted that this species has never been encountered in the White Sea, although it is widespread in the Atlantic Ocean.

The sole records of *Polysiphonia arenaria* (Postels *et* Ruprecht 1840: II) and *P. atrorubens* (Wahlenberg) Endlicher (Meyer 1933: 15, Meyer 1938: 12) can be ignored, because the first is "nomen nudum" (Silva 2016) and the second has uncertain taxonomic status (Guiry and Guiry 2016). The record of *P. subulifera* (C. Agardh) Harvey (Blinova 1962: 24, 25) is probably a misidentification. Zinova (1950, 1955) and Vinogradova (2011) did not include these three species in the White Sea flora. Also, the sole record of *Audouinella hermannii* (Roth) Duby (=*Chantransia violacea* Kützing) (Blinova 1962: 25) is doubtful and is not confirmed by description or specimens.

Vinogradova (1995) considered *Rhodochorton intermedium* (Kjellman) Kjellman as a synonym of *Audouinella purpurea* (Lightfoot) Woelkerling, but there is no precise indication regarding *R. intermedium* Kjellman f. *penicilliformis* Kjellman (Sinova 1922: 29). Unfortunately specimens of this form are absent from the LE collection. We can only suggest that Sinova (1922) meant the currently recognized *Meiodiscus spetsbergensis*. We have not included this taxon in our list being unsure about its interpretation.

We do not have sufficient reason to exclude *Cruoria pellita*, *Halosaccion saccatum* and *Turnerella* sp. from this checklist. However, the findings of *C. pellita* in the White and Barents Seas require verification (Vinogradova and Jacovleva 1989: 744). There are records of *H. saccatum* (Lepechin 1775, Zinova 1950, Kalugina 1962), but no voucher specimens have been preserved in the LE collection. The record of *Turnerella* sp. (Zinova 1961a: 85) is based on the sole specimen of *Iridaea edulis* collected by Carl v. Baer in 1837 (see above) and requires confirmation.

From the analysis of the species distribution, we can conclude that 19 red algal species (*Porphyra purpurea*, *Ahnfeltia plicata*, *Corallina officinalis*, *Phymatolithon purpureum*, *Grania efflorescens*, *Palmaria palmata*, *Ceramium virgatum*, *Scagelia pylaisaei*, *Membranoptera fabriciana*, *Phycodrys rubens*, *Odonthalia dentata*, *Polysiphonia arctica*, *P. fucoides*, *P. stricta*, *Rhodomela confervoides*, *Ptilota gunneri*, *Euthora cristata*, *Coccotylus brodiei*, and *C. truncatus*) occur throughout the White Sea, six species (*Devaleraea ramentacea*, *Dumontia contorta*, *Ptilota serrata*, *Cystoclonium purpureum*, *Fimbrifolium dichotomum*, and *Polyides rotunda*) are widespread, but they are absent in Mezen Bay; and seven taxa (*Bangia fuscopurpurea*, *Porphyra umbilicalis*, *Wildemania miniata*,

Lithophyllum crouaniorum, Colaconema daviesii, Halosaccion saccatum, and *Turnerella sp.*) are restricted to the northern regions of the White Sea (Voronka, or Voronka and Gorlo).

The Sørensen similarity index was calculated to examine the similarity of Rhodophyta flora in the White Sea with that in close and more distant neighboring regions. The highest similarity was observed with the Murman coast ($C_S = 0.82$; Table 3). Most White Sea species are also found on the Murman coast of the Barents Sea except for *Acrochaetium collopodum, Chroodactylon ornatum,* and *Halosaccion saccatum*. However, the first two of these species are known from the North Atlantic: *A. collopodum* is reported from Sweden, the Faroe Islands and Norway, and *C. ornatum* is reported from the Netherlands, Sweden, Britain, Ireland and Norway (Guiry and Guiry 2016). So we might expect to find them on the Murman coast. The final species (*H. saccatum*) was recorded from the west shores of the Novaya Zemlya by Postels *et* Ruprecht (1840: II) as *Dumontia lepechinii*.

Others neighboring regions (Spitsbergen, Franz Josef Land, and Novaya Zemlya) are located at higher latitudes in the Arctic and experience more severe environmental conditions, so that the species richness here is poorer than in the White Sea. But the Sørensen similarity indices of these regions with the White Sea are relatively high ($C_S > 0.5$) except for Franz Josef Land (Table 3). The poorest flora is characteristic for Franz Josef Land, and the low value of the Sørensen similarity index between this archipelago and the White Sea ($C_S = 0.34$; Table 3) reflects this fact.

The Kara Sea is the most distant Arctic region to the east and, therefore, the Sørensen similarity index with the White Sea is also not high ($C_S = 0.56$; Table 3). Norway is the more distant region to the west, but the Norwegian flora is rich because it includes both the low Arctic and the northern Atlantic floras. The Sørensen similarity index between the Norwegian flora and the White Sea is comparatively low ($C_S = 0.46$; Table 3) even though there are numerous species in common.

This analysis of the composition of the Rhodophyta flora confirms the interpretation that the White Sea flora is a low Arctic flora, and that it may represent the depleted Barents Sea flora (Zinova 1950, Kalugina 1962).

Table 3: Comparison of the Rhodophyta flora of the White Sea with those of neighboring regions.

Neighboring regions	White Sea ($N_a = 60$)		
	N_b	N_{a+b}	C_s
Murman coast	79	57	0.82
Spitsbergen	46	35	0.66
Franz Josef Land	16	13	0.34
Novaya Zemlya	47	39	0.73
Kara Sea	30	25	0.56
Norway	174	54	0.46

Na, number of species in the White Sea; N_b, number of species in the neighboring regions; N_{a+b}, number of species in common with the White Sea; Sørensen similarity index: $C_s = (2N_{a+b})/(N_a + N_b)$.

Conclusion

In this paper, we have presented the results of the revision of the Rhodophyta of the White Sea and have made the following conclusions. A total of 61 species of red algae has been revealed on the basis of the exhaustive bibliographic search, the correction of inaccurate records, and consideration of taxonomic and nomenclatural changes. The present revision has allowed the exclusion of unchecked and misidentified records for 17 species and 1 forma from the present checklist. By analyzing the distribution of the Rhodophyta in the White Sea, the widespread and restricted species were defined. The results of a comparing the species composition of the red algae of the White Sea with those of the neighboring regions are in line with an existing opinion that the White Sea Rhodophytan flora can be interpreted as representing a depleted version of the Barents Sea flora. The checklist presented here provides some valuable information about the flora and all floristic studies of this interesting inner sea of the Arctic Ocean.

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References

Balashova, N.B., A.V. Tobias and D.E. Himelbrandt. 2005. *Letnaya praktika po algologii I mikologii v Sankt-Peterburgskom universitete. Uchebnoye posobiye. [Summer practical training for mycology and phycology in St. Petersburg State University].* University of St. Petersburg Press, St. Petersburg. pp. 236 (in Russian). (1)

Blinova, E.I. 1962. Materiali po izucheniyu raspredeleniya donnoy rastitelnosti v rayone Belomorskoy biologicheskoy stantsii MGU. [Materials on the study of the bottom vegetation distribution near the White Sea Biological Station MSU.] *Trudy Belomorsk. Biol. Stantsii Moskovsk. Gosud. Univ. 1:* 22–34 (in Russian). (**2**).

Derjugin, K.M. 1928. Fauna des Weissen Meeres und ihre Existenzbedingungen. *Explorations des mers D'U.R.S.S. Institut Hydrologique. 7–8*: 1–511 (in Russian with extended Germany resume). (**3**).

Flerov, B.C. and N. Karsakoff. 1925. Algues de la règion sud-est de la mer de Barents (mer de Petchora). *Trudy Plovuch. Morsk. Nauchn. Inst. 15*: 3–17 (in Russian with extended French summary).

Garbary D.J. and E.R. Tarakhovskaya. 2013. Marine macroalgae and associated flowering plants from the Keret Archipelago, White Sea, Russia. *Algae. 28*: 267–280. (**4**).

Gemp, K.P. 1967. Epifity promislovykh vodorosley Belogo morya. [The epiphytes of the commercial algae of the White Sea.] *Materialy rybokhozaystvennykh issledovaniy Severnogo basseyna. (Tr. PINRO). [Transactions of the Fisheries Research of the North Basin (Polar Research Institute of Marine Fisheries and Oceanography).] 9*: 82–94 (in Russian). (**5**).

Gmelin, S.G. 1768. *Historia fucorum*. Petropoli. pp. 239, 35 pls.

Gobi, C. 1878. Die Algenflora des Weissen Meeres und der demselben zunächstliegenden Theile des Nördlichen Eismeeres. *Mém. Acad. Imp. Sci. Saint Pétersbourg, Sér. 7. 26*: 1–92. (**6**).

Guiry, M.D. and G.M. Guiry. 2016. *AlgaeBase* . World-wide electronic publication, National University of Ireland, Galway. Available from http://www.algaebase.org Accessed on December 2016.

Gurjanova, E. 1949. Osobennosti Belogo morya kak morskogo basseyna I perspektivi iskusstvennogo povisheniya ego produktivnosti. [The features of the White Sea as a marine basin and prospects of artificially increase of its productivity.] *Vestn. Leningradsk. Univ. 3:* 26–41 (in Russian). (**7**).

Gurjanova, E., J. Sachs and P.Uschakov. 1925. Vergleichsübersicht des litorals der Russischen Nördlichen Meere. *Raboty Murmansk. Biol. Stantsii. 1:* 110–131 (in Russian with Germany resume). (**8**).

Kalugina, A.A. 1957. Sostav i raspredeleniye vodoroslej u Zimnego berega Dvinskogo Zaliva Belogo morya. [The composition and distribution of the algae in the region of the Zimny shore of Dvina Bay, White Sea.] *Bot. Zhurn. 42*: 628–634 (in Russian). (**9**).

Kalugina, A.A. 1958. Sostav i raspredeleniye vodoroslej u beregov Solovetskogo arkhipelaga. [The composition and distribution of the algae near the shores of Solovetski archipelago.] *Bot. Zhurn. 43*: 270–277 (in Russian). (**10**).

Kalugina, A.A. 1959a. Noviye vodorosli dlya Belogo morya [New algae for the White Sea.] *Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 12*: 149–153 (in Russian). (**11**).

Kalugina, A.A. 1959b. Noviye vodorosli dlya Belogo morya II [New algae for the White Sea II.] *Trudy Bot. Inst. Akad. Nauk S.S.S.R. Ser. 2, Sporov. Rast. 12*: 176–187 (in Russian). (**12**).

Kalugina, A.A. 1962. K voprosu o nekotorykh osobennostyakh belomorskoy flory. [On the certain features of the White Sea flora.] *Trudy Vsesoyuznogo Soveshchaniya rabotnikov vodoroslevoy promychlennosti. [Proceedings of the All-Union conference of the USSR algal industrials. Archangelsk.] 1*: 94–112 (in Russian). (**13**).

Kjellman, F.R. 1883. *The algae of the Arctic sea*. Stockholm. pp. 350, 31 pls. (**14**)

Koelreuter, J.T. 1767. Descriptio Fuci foliacei, frondibus fructificantibus papillatis. *Novi Comment. Acad. Sci. Imp. Petrop. 11*: 424–428, pl. 13.

Korennikov, S.P. and K.P. Gemp. 1976. On the species composition of sublittoral marine algae of the Kanin peninsula coast locality. *Bot. Zhurn. 61*: 561–565 (in Russian). (**15**).

Lepechin, I. 1775. Quatuor fucorum species descriptae. *Novi Comment. Acad. Sci. Imp. Petrop. 19:* 476–481, 4 pls. (**16**).

Magurran, A.E. 1988. *Ecological diversity and its measurement*. Princeton University Press, Princeton, NJ. pp. 179.

Meyer, K.I. 1933. Report on the work of the expedition for determining the stock of seaweeds in the White-sea. *Trudy Gosud. Okeanogr. Inst. 3*: 7–28 (in Russian with English summary). (**17**).

Meyer, K.I. 1938. Materials on algae flora of the White Sea. *Transactions of the Institute of Marine Fisheries and Oceanography of the USSA. 7*: 5–28 (in Russian with English summary). (**18**).

Meyer, K.I. and T.F. Shchapova. 1948. Krasniye vodorosli, ili bagryanki. Tip Rhodophyta. [The red algae. Rhodophyta.] *In:* (N.S. Gaevskaya, ed.) *Opredelitel fauni I flori severnikh morey SSSR. [Determination book of the fauna and flora of the northern seas of the USSR.]* "Sovetskaya nauka", Moscow. pp. 524–531 (in Russian). (**19**)

Mikhaylova, T.A. 1996. Algal species composition in *Laminaria saccharina* plantation in the White Sea. *Bot. Zhurn. 81*: 42–47, 2 pls. (in Russian with English summary). (**20**).

Mikhaylova, T.A. 2000. Structure and interannual dynamics of *Laminaria* phytocoenosis in the White Sea. *Bot. Zhurn. 85*: 78–88 (in Russian with English summary). (**21**).

Mikhaylova, T.A. 2012. *Laminaria hyperborea* (Laminariaceae) association on the Murman coast of the Barents Sea. *Bot. Zhurn. 91*: 712–729, 2 pls. (in Russian with English summary).

Mikhaylova, T.A. and V.A. Shtrik. 2007. Macroepiphytes of *Laminaria hyperborea* (Laminariaceae) in the Barents and the White Seas. *Bot. Zhurn. 92*: 1818–1828, 1 pl. (in Russian with English summary). (**22**).

Myagkov, G.M. 1975. Sostav, raspredeleniye i sezonnaya dinamika biomassi vodoroslej biotsenoza laminariy gubi Chupa Belogo morya (po materialam vodolaznikh rabot). [The composition, distribution and seasonal dynamics of algal biomass in laminarian community of the Chupa inlet of the White Sea (according to the diving data).] *Vestn. Leningradsk. Univ. Ser. Biol. 3*: 48–53 (in Russian with English summary). (**23**).

Nylander, W. and Th. Saelan. 1859. *Herbarium Musei Fennici*. Helsingfors. pp. 118. (**24**)

Perestenko, L.P. 1964. Spisok vodorosley litorali gub Plokhiye i Bolshiye Chevry (Vostochniy Murman). [The list of algae of intertidal zone of the Plokhiye and Bolshiye Chevry Inlets (East Murman).] *Novosti Sist. Nizsh. Rast. 1:* 139–146 (in Russian).

Perestenko, L.P. 1983. Rod *Phycodrys* Kütz. I ego kharakterniye priznaki. [The genus *Phycodrys* Kütz. and its specific features.] *Novosti Sist. Nizsh. Rast. 20:* 45–51, 2 pls. (in Russian). (**25**).

Petrov, J.E. 1967. Noviye dlya Belogo morya vidi zelenikh I krasnikh vodoroslej. [New species of green and red algae for the White Sea.] *Novosti Sist. Nizsh. Rast. 4:* 106–107 (in Russian). (**26**).

Postels, A. and F. Ruprecht. 1840. *Illustrationes algarum in itinere circa orbem jussu Imperartoris Nicolai I. atque auspiciis Navarchi Friderici Lütke annis 1826, 1827, 1828 et 1829, celoce Seniavin executo in Oceano Pacifico, imprimis septemtrionalio ad littora Rossica Asiatico-Americana collectarum.* Typis E. Pratz, Petropoli [St. Petersburg], iv + 22 pp., 40 pls. (**27**).

Schoschina, E.V. 1996. Seasonal and age dynamics of growth and reproduction of *Phycodrys rubens* (Rhodophyta) in the Barents and White Seas. *Aquatic Bot. 55*: 13–30. (**28**).

Sent-Iler, K. 1908. Otchet ob exkursii na Beloye more studentov est-estvennikov Yurjevskogo Universiteta letom 1908 goda. [Report about excursion of students naturalists of Yur'evsky University to the White Sea in summer 1908.] *Uchen. Zap. Imp. Yur'evsk. Univ. 16*: 1–67 (in Russian). (**29**).

Shoshina, E.V. 1981. K sistematike belomorskikh vidov roda *Ceramium* Roth (Rhodophyta). [On systematic of genus *Ceramium* Roth (Rhodophyta) in the White Sea.] *Novosti Sist. Nizsh. Rast. 18*: 39–49 (in Russian). (**30**).

Shoshina, E.V. 1990. *Biology of Ahnfeltia plicata (Rhodophyta) in the White Sea*. Apatity. Preprint. pp. 43 (in Russian with English abstract). (**31**).

Shoshina, E.V. 1991. Growth of the red alga *Odonthalia dentata* in the Barents and White seas. *Biol. Morya (Vladivostok). 6*: 15–22 (in Russian with English abstract). (**32**).

Silva, P. 2016. Index Nominum Algarum, University Herbarium, University of California, Berkeley. Available online at http://ucjeps.berkeley.edu/CPD/ Accessed on December 2016.

Sinova, E.S. 1916. Note sur les forms de *Ptilota plumosa* (L.) Ag. et *Ptilota Californica* Rupr., recueillies aux côtes polaires de la Russie d'Europe. *Izv. Imp. Bot. Sada Petra Velikago. 16*: 416–426, 7 pls. (in Russian with French resume). (**33**).

Sinova, E.S. 1918. Note sur une nouvelle espèce des Rhodophycées (*Delesseria rossica* Sinova nov. sp.), trouvée dans la mer Blanche. *Izv. Glavn. Bot. Sada R.S.F.S.R. 18*: 40–44, 1 pl. (in Russian with French resume). (**34**).

Sinova, E.S. 1921. Note préliminaire dur les algues de la mer Blanche. *Izv. Glavn. Bot. Sada R.S.F.S.R. 16*: 34–43 (in Russian with French resume). (**35**).

Sinova, E.S. 1922. Sur la distribution des algues dans la mer Blanche et leur application technique. *Izv. Glavn. Bot. Sada R.S.F.S.R. 21*: 1–31 (in Russian with French resume). (**36**).

Sinova, E.S. 1925. Les algues de la mer Kará. *Trudy Leningradsk. Obshch. Estestvoisp. 55*: 53–116 (in Russian with French resume).

Sinova, E.S. 1929a. Les algues de la Mer Blanche et leur application pratique. *Les travaux de l'Institut de recherches Industrielles au Comité Executif d'Archangel. 6:* 3–47 (in Rissian with French resume). (**37**).

Sinova, E.S. 1929b. Les algues de la Mer Blanche. Rhodophycea. *Trudy Leningradsk. Obshch. Estestvoisp. 59*: 3–40 (in Russian with French resume). (**38**).

Sinova, E.S. 1933. Algues de Mourmane aux environs de l'île Kildine et leur utilization. *Explorations des mers D'U.R.S.S. Institut Hydrologique. 18*: 49–74 (in Russian with French summary). (**39**).

Sinova, E.S. 1934. Nouvelles recherches les algues de la Mer Blache le long de la côte Lietnaïa et leur utilization. *Explorations des mers D'U.R.S.S. Institut Hydrologique. 20*: 65–85 (in Russian with French summary). (**40**).

Sinova, E.S. 1956. Vodorosli Severnogo Ledovitogo okeana. [Algae of the Arctic Ocean.] *Trudy Bot. Inst. Akad. Nauk S.S.S.R. Ser. 2, Sporov. Rast. 11:* 39–51 (in Russian).

Smirnova, N.R. and T.A. Mikhailova. 2013. Seaweeds in the vicinity of Marine Biological Station of St-Petersburg State University. *Vestn. S.-Peterburgsk. Univ. Biol. 3*: 12–22, 4 pl. (in Russian with English abstract). (**41**).

Tsenkovskiy, L.S. 1881. Otchet o belomorskoy exkursii 1880 g. [Report about excursion to the White Sea in 1880.] *Trudy S.-Peterburgsk. Obshch. Estestvoisp. 12*: 130–171 (in Russian). (**42**).

Uspenskaya, G.D. 1963. Some data on the flora of makroepiphytes of the area of The Velikaya Salma of the Kandalaksha Bay of the White Sea. *Trudy Kandalaksk. Gosud. Zapov. 4. Trudy Belomorsk. Biol. Stantsii Moskovsk. Gosud. Univ. 2:* 274–277 (in Russian with English summary). (**43**).

Vinogradova, K.L. 1961. Noviye dlya Murmana vidy vodorosley. [New species of algae for the Murman.] *Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 14:* 91–93 (in Russian).

Vinogradova, K.L. 1986. Vidovoy sostav morskikh vodorosley arkhipelaga Zemlya Frantsa Iosifa. [Species composition of seaweeds of the Franz Josef Land.] *Novosti Sist. Nizsh. Rast. 23*: 27–37, 1 pl. (in Russian).

Vinogradova, K.L. 1995. The checklist of the marine algae from Spitsbergen. *Bot. Zhurn. 80*: 50–61.

Vinogradova, K.L. 1996. On the taxonomy of *Neodilsea integra* (Dumontiaceae, Rhodophyta). *Bot. Zhurn. 81*: 103–110, 8 pls. (in Russian with English summary).

Vinogradova, K.L. 2002. *Phycodrys rubens* (Delesseriaceae, Rhodophyta): taxonomy, relationships, distribution. *Bot. Zhurn. 87*: 139–148 (in Russian with English summary). (**44**).

Vinogradova, K.L. 2005a. *Ceramium* species (Ceramiales, Rhodophyta) in the Russian northern seas. *Bot. Zhurn. 90*: 884–890, 2 pls. (in Russian with English summary). (**45**).

Vinogradova, K.L. 2005b. The genus *Rhodomela* (Rhodomelaceae, Rhodophyta) in the flora of northern seas of Russia. *Bot. Zhurn. 90*: 1047–1057, 2 pls. (in Russian with English summary). (**46**).

Vinogradova, K.L. 2007. The genus *Porphyra* (Bangiales, Rhodophyta) in the northern seas of Russia. *Bot. Zhurn. 92*: 532–543, 3 pls. (in Russian with English summary). (**47**).

Vinogradova, K.L. 2010. Taxonomic review of the Corallinales (Rhodophyta) in the northern Russian seas. *Bot. Zhurn. 95*: 667–681, 6 pls. (in Russian with English summary). (**48**).

Vinogradova, K.L. 2011. The order Ceramiales (Rhodophyta) in the flora of the Arctic Ocean. *Bot. Zhurn. 96*: 681–695 (in Russian with English summary). (**49**).

Vinogradova, K.L. and V.A. Shtrik. 2005. Additions to the marine algae flora of the northern seas of Russia. *Bot. Zhurn. 90*: 1593–1599, 1 pl. (in Russian with English summary). (**50**).

Vinogradova, K.L. and T.A. Jacovleva. 1989. On the systematic position of the species *Petrocelis hennedyi* and *P. polygyna* (Rhodophyta, Cruoriaceae). *Bot. Zhurn. 74*: 744–753, 12 pls. (in Russian). (**51**).

Vozzhinskaja, V.B. 1975. Noniye vodorosli dlya Terskogo berega Belogo morya. [New algae for the Tersky Shore of the White Sea.] *Novosti Sist. Nizsh. Rast. 12*: 102–105 (in Russian). (**52**).

Vozzhinskaja, V.B. 1980. Vidovoy sostav, raspredeleniye I fitogeograficheskaya kharakteristika donnoy flori Belogo morya. [The species composition, distribution and biogeographical characteristics of the bottom flora of the White Sea.] *In:* (Z.A. Filatova, ed.) *Donnaya flora I produktsiya krayevikh morey SSSR. [The bottom flora and production of the marginal seas of the USSR.].* pp. 29–62 (in Russian). (**53**).

Vozzhinskaja, V.B. 1986. Donniye makrofiti Belogo morya. [Benthic macrophytes of the White Sea.] "Nauka", Moscow. pp. 191 (in Russian). (**54**).

White Sea Sailing Directions. 1995. Glavnoye upravleniye navigatsii i okeanografii. [Main Department of Navigation and Oceanography]. pp. 335 (in Russian).

Zinova, A.D. 1948. O nekotorikh vidakh roda *Porphyra* s beregov Murmana I Belogo morya i o novom vide *Porphyra helenae* Zin. [On some species of the genus *Porphyra* on the Murmansk coast and the White Sea with a new species *Porphyra helenae* Zin.] *Bot. Zhurn. 33*: 440–442 (in Russian). (**55**).

Zinova, A.D. 1950. O nekotorikh osobennostyakh flory vodoroslej Belogo morya. [On the certain features of the flora of the White Sea algae.] *Trudy Vsesoyuzn. Gidrobiol. Obshch. 2*: 231–252 (in Russian). (**56**).

Zinova A.D. 1954. Materiali k flore vodorosley Belogo morya. [The materials to the algal flora of the White Sea.] *Trudy Bot. Inst. Akad. Nauk S.S.S.R. Ser. 2, Sporov. Rast. 9:* 245–258, 9 pls. (in Russian). (**57**).

Zinova, A.D. 1955. *Opredelitel krasnykh vodoroslej severnykh morej SSSR [Determination book of the red algae of the northern seas of the USSR]*. Akad. Nauk SSSR, Moscow-Leningrad. pp. 220, 169 pls. (in Russian). (**58**).

Zinova, A.D. 1961a. O krasnoy vodorosli *Dilsea integra* (Kjellm.) Rosenv. [On the red alga *Dilsea integra* (Kjellm.) Rosenv.] *Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 14:* 82–86, 2 pls. (in Russian). (**59**).

Zinova, A.D. 1961b. Vodorosli Mezenskogo zaliva (Beloye more). [Algae of the Mezen Bay (White Sea)]. *Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 14:* 87–90 (in Russian). (**60**).

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