



2014 年 公開臨海実習

発展的海洋生物学・生態学コース

Advanced Course for Marine Biology and Ecology 2014



From August 7<sup>th</sup> to 12<sup>th</sup>, 2014

At Akkeshi Marine Station, Hokkaido University

**Advanced Course for Marine Biology and Ecology** is an open marine course co-organized by Akkeshi Marine Station and Muroran Marine Station of Field Science Center for Northern Biosphere, Hokkaido University. It is aimed to provide the synthetic knowledge on marine biology and ecology, including cell biology, developmental biology, physiological ecology, and ecosystem ecology. We specially targeted macrophyte (seagrass and seaweed) community in cold current region, which is the prominent character of the coastal seas of Hokkaido.

### Venue

Akkeshi Marine Station, Hokkaido University

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<http://www.fsc.hokudai.ac.jp/akkeshi/AMS/en/index.html>

### Schedule

Aug. 7<sup>th</sup> (Thu) Guidance starts in the dining room at 18:00

Aug. 8<sup>th</sup> (Fri) 1<sup>st</sup> Day: Field collection and Thin-layer chromatography with algal pigments

Aug. 9<sup>th</sup> (Sat) 2<sup>nd</sup> Day: Cell biology of marine algae

Aug. 10<sup>th</sup> (Sun) 3<sup>rd</sup> Day: Field collection and seagrass productivity measurement

Aug. 11<sup>th</sup> (Mon) 4<sup>th</sup> Day: Food web structure in seagrass beds, Room cleaning, and Banquet

Aug. 12<sup>th</sup> (Tue) The course ends after breakfast.

>> The schedule can be change depending on weather conditions.

### 【Tidal chart in Akkeshi Bay】

Date	Lowest tide time	Lowest tide (cm)
Aug. 8 <sup>th</sup>	7:30	23.5
Aug. 9 <sup>th</sup>	8:15	18.3
Aug. 10 <sup>th</sup>	8:55	15.6
Aug. 11 <sup>th</sup>	9:31	15.7

**【Staff】**

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**【Students】**

Name	Sex	University	Course
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Wan-Ting Su	F	National Taiwan University	M.S
Kullawit Limchularat	M	Kasetsart University	P.D
Muhamad Kemal Idris	M	Bogor Agricultural University	M.S
Allyn Duvin Pantallano	F	Mindanao State University	M.S
Tom Gerald Taer Genovia	M	Mindanao State University	M.S
Mikko Lacandazo Garcia	M	University of the Philippines	M.S

**【Assignments】**

Each student has to submit a short report for each subject of the course. The deadline is **August 29<sup>th</sup>**.

Submission by email is recommended.

Subjects on 1st and 2nd day: to Prof. Motomura (motomura@fsc.hokudai.ac.jp)

Subjects on 3rd and 4th day: to Prof. Nakaoka (nakaoka@fsc.hokudai.ac.jp)

1<sup>st</sup> Day (Aug. 8<sup>th</sup>)

## **Biodiversity of algal community**

### **Outline**

Many species of seaweeds (macroalgae; green, red and brown algae) are found in the seashore of Hokkaido, especially facing the Pacific. We can easily observe various colors, forms and sizes of macroalgae around Akkeshi Marine Station. On the first day, we will go to Daikoku-jima island for collecting the seaweeds. After coming back to the lab, we'll make the dry specimens and sketching the algal tissues (\* Refer to the list of seaweeds in Akkeshi at the end of this textbook).

Additionally, we will start preparing the samples for tomorrow's experiment (observation of microtubules in brown algal cells).

**Keywords:** Brown algae, Field collection, Green algae, Macroalgae, Sketch, Specimens, Red algae

### **Schedule**

07:00 – 07:30 Breakfast

08:30 –12:00 Field session #1: Trip to Daikoku-jima Island by RV "Misago-maru". Observation of algal bed and collection of algae

12:30 – 13:30 Lunch

13:30 –17:30 Lab session #1 Identification of collected macroalgae and making specimens and sketches. Afterwards, preparation of tomorrow's experiment will start.

18:00 – Dinner

2<sup>nd</sup> Day (Aug. 9<sup>th</sup>)

[Experiment 1]

## Cell biology of marine algae

### Outline

Brown algae are prominent in cold region, and large kelps make the marine forest in the seashore. They are included in heterokont algae with diatoms and several other phytoplankton. Heterokont algae, of which phylogenetic position is far different from red and green algae (land plants), have characteristically evolved and adapted in sea. As the results, cellular features are unique, for example, mitosis, cytokinesis, chloroplast and cytoskeleton. In this experiments, we will observe the cytoskeleton (microtubules and actin filaments) in the brown alga *Dictyota dichotoma* cells by immunofluorescence microscopy and compare to those of animal and land plant cells.

Depending on the mature condition of the filed kelp *Saccharina japonica var. diabolica*, it may be possible to try detecting the flagella of zoospores in the unilocular sporangium with special antibodies.

**Keywords:** Antibodies, Actin, Brown algae, Chloroplasts, DAPI, Flagella, Immunofluorescence microscopy, Microtubules, Mitochondria, Nucleus, Nucleoid

### Schedule

07:00 – 07:30 Breakfast

08:30 – 12:00 Start Experiment 1: Cell biology of marine algae

12:30 – 13:30 Lunch

13:30 – 17:00 Continuation of the Experiment 1 and initiation of Experiment 2: Algal pigments for aquatic photosynthesis.

18:00 – Dinner

### Observation of microtubules (MT) of brown algae by indirect immunofluorescence microscopy

Materials: Cultural material, *Dictyota dichotoma* (AMIJIGUSA)

Natural sample, *Saccharina japonica var. diabolica* (ONIKONBU)

<Equipment>

Fluorescence microscope (Olympus epifluorescence microscope BX50WI-FLA) with a CCD camera (AxioCam from Zeiss)

<Chemicals>

- Poly-L-Lysine coated cover glass
- Fixative (paraformaldehyde, glutaraldehyde)
- PHEM buffer

- PBS
- blocking solution
- DAPI (4', 6-diamidino-2-phenylindole)
- mounting medium
- Primary antibodies

*Dictyota dichotoma*: Monoclonal anti-actin antibody

Monoclonal anti- $\beta$  tubulin antibody

*Saccharina japonica*: Monoclonal anti- $\beta$  tubulin antibody

Polyclonal anti-helmchrome antibody

Polyclonal anti-mastigoneme antibody

- Secondary antibodies Polyclonal anti-mouse IgG antibody  
Polyclonal anti-rabbit IgG antibody

PHEM buffer		PBS (1L)		Blocking solution	
PIPES	60mM	NaCl	8g	Skim Milk	2.5%
HEPES	25mM	KCl	0.2g	Normal goat	
EGTA	10mM	Na <sub>2</sub> HPO <sub>4</sub>	0.7g	serum	5%
MgCl <sub>2</sub>	2mM	KH <sub>2</sub> PO <sub>4</sub>	0.2g	NaN <sub>3</sub>	0.1%
pH7.4		pH7.4		in PBS	

#### <Procedure>

##### I) Fixation

###### <Chemical fixation>

- Fix samples for 30 min in 3% paraformaldehyde, 0.1% glutaraldehyde, 2% NaCl in PHEM buffer, and wash with PBS three times.

###### <Freeze-substitution fixation>

- Rapid fixation of samples in liquid propane (-180°)
- Keep samples in methanol for two days or more in a deep freezer (-80°)
- After keeping samples for 2 hr at -20° and 2hr at 4°, finally wash them with PBS three times at room temperature.

II) Softly squash samples between poly-L-lysine coated cover slip and slide glass. Cell are attached on the former.

III) 5% Triton X-100 in PBS for 30 min at room temperature and washing with PBS three times.

Purpose of this step is that;

- elution of chlorophylls in chloroplasts, which possess strong red fluorescence under

fluorescence microscope.

- easy penetration of antibodies (mw over 150K) into cells

IV) 0.1% NaBH<sub>4</sub> (sodium borohydrate) in PBS for 20 min and washing with PBS three times.

- for omitting autofluorescence of glutaraldehyde, therefore it is not necessary in the case of cryofixation.

V) Blocking solution for 30 min at room temperature.

- for preventing unspecific binding of antibodies.

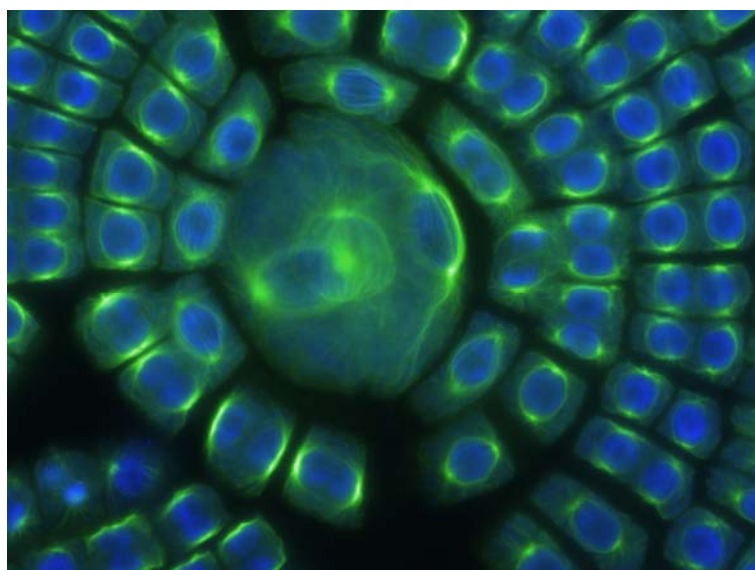
VI) Primary antibody, (monoclonal anti-actin and anti- $\alpha$ -tubulin antibody Goat) 90 min at room temperature (or overnight) and washing with PBS three times.

VII) Secondary antibody, (polyclonal FITC (green fluorescence) or Rhodamine (red fluorescence) labeled anti-mouse IgG (or anti-rabbit IgG) antibody Goat) 60min at room temperature, and washing with PBS three times.

VIII) DAPI (0.5 mg/mL) in PBS 10 min at room temp.

- DAPI (4', 6-diamidino-2-phenylindole) binds to A-T bond in DNA double helix, and possesses strong blue fluorescence.
- Nucleus and nucluids in mitochondria and chloroplasts can be observed.

IX) Mount samples with mounting medium containing glycerin and 0.2% *p*-phenylenediamin for preventing fading of fluorescence.



Microtubules (green) and nucleus (blue) in apical part of *Dictyota dichotoma*

[Experiment 2]

## Algal pigments for aquatic photosynthesis

### Outline

Macro algae can be classified to three major groups; Green, Red and Brown algae. Here, we are going to learn about basic classification of macro algae. Then, we will address to the primary taxonomic character, "colors of algae". The reason of these colorful variations is because of various photosynthetic pigments and combinations. Seawater is much more efficient absorber of 'Light' than air, and water depth is one of the biggest factors to change the light conditions in the aquatic environment. For adaptation to such variable light condition, algae create many kinds of pigments and combinations of pigments. In this session, we are going to understand how much various on algal photosynthetic pigments and trying to think why they are needed.

**Keywords:** Taxonomy, Green algae, Red algae, Brown algae, Photosynthesis, Pigments, Light condition, Water depth, Chlorophyll, Thin-layer chromatography

### *Thin-layer chromatography of algal photosynthetic pigments*

<Materials> Green, Red and Brown algae obtained in the Daikoku-jima island

<Chemicals>

- Diethylether
- Silica gel (powder)
- TLC plate

<Equipment>

- Mortar and pestle
- Test tubes with caps
- Pasteur glass pipette

<Procedure>

I) Preparation

0. Make a line on TLC plate with pencil carefully
  - \*Don't touch and scratch the surface of TLC plate

II) Extraction of Pigments

1. Cut the specimens to section 2-3cm<sup>2</sup>
2. Add a small spoon of silica gel powder and algal sections to Mortar
3. Homogenize algal section to be powder
4. Transfer algal powder to eppendorf tube
5. Add 0.5mL of diethylether to the tube and mix (named pigment solution)



III) Loading materials

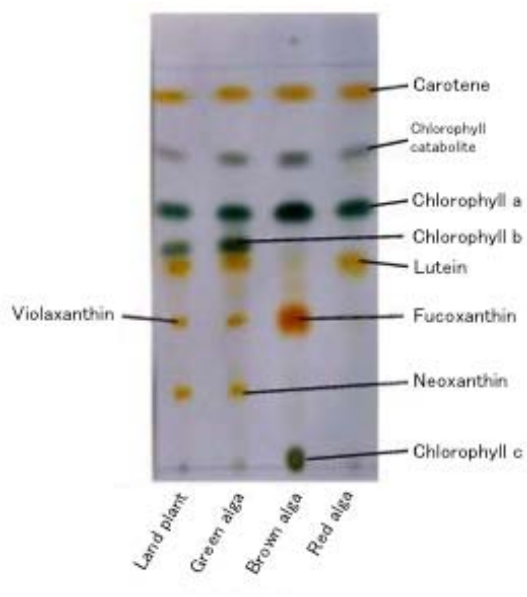
6. Add 1-1.5 mL of ethyl acetate, diethylether and xylene to the test tubes individually and seal with caps
7. Take pigment solution with Pasteur pipette and make a spot on TLC plate
8. Dry the pigment spots for several minutes
9. Put the TLC plates into the test tubes including each organic solvent
10. Watch out for over-loading
11. Make a mark for final loading tip immediately

IV) Calculation of R<sub>f</sub> values

12. Take photos just after finishing loading to keep data
13. Measure the distance from starting point
14. Calculate 'retardation factor (R<sub>f</sub>)' values for each material and solvent

$$R_f = \frac{\text{migration distance of substance}}{\text{migration distance of solvent front}}$$

Figure. Example for various pigments with thin-layer chromatography



3<sup>rd</sup> Day (Sunday, August 10)  
Seagrass productivity measurement

**Outline:** Environmental conditions, such as light intensity, nutrient, temperature, current velocity, desiccation and grazing pressure, determine the species composition, morphology, biomass and productivities of macrophytes. We can observe at least four seagrass species around the Akkeshi Marine Station. Consider the relationship between seagrass species distribution and environmental factors through field trip on 3<sup>rd</sup> and 4<sup>th</sup> days. To measure the seagrass growth, hole-punch is one of the major method. However, it is destructive and usually takes more than 1 week and considerable effort. In this session, we will learn how to measure seagrass productivity using PAM fluorometer in non-destructive manner, and discuss how environmental conditions affect the seagrass productivity and distribution.

**Keywords:** Species composition, morphology, growth, fluorescence, Pulse Amplitude Modulation, Rapid Light Curve, desiccation, emergence, light adaptation.

**Schedule**

7:00 – 7:30 Breakfast

8:30 – 12:00 Field session #2: Trip to a seagrass bed in Akkeshi Bay. Instruction of field measurement of photosynthetic activity of seagrass by Diving-PAM. Collection of seagrasses for lab analyses”.

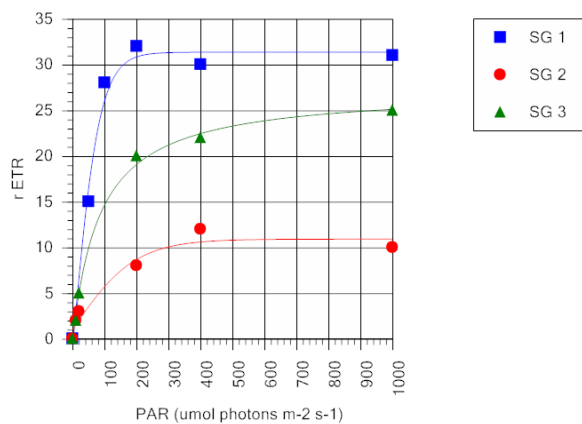
12:30 – 13:30 Lunch

13:30 – 17:30 Lab session #2: Observation of morphological characters of seagrasses. Measurement of photosynthetic activity of seagrasses under different stresses.

18:00 – Dinner



**PAM fluorometer**



**Example of the RLC**

4<sup>th</sup> Day (Monday, August 11)

### Food web structure in seagrass beds

**Outline:** Submerged aquatic vegetation, such as salt marsh, seagrass bed and kelp forest, plays important roles in coastal ecosystems because of their high productivity and biodiversity. However, they are susceptible to human-induced stresses such as eutrophication and disturbance affected by terrestrial and oceanic environmental changes. In this session, we will investigate the biodiversity and food web structure of seagrass bed in Akkeshi by semi-quantitative measurements of species diversity and abundance, and by gut-content analyses of major consumers. We will also learn about stable isotope technique for food web analyses. Based on these subjects, we will discuss what factors affect biodiversity and ecosystem functions of coastal ecosystems.

**Keywords:** Field monitoring of biodiversity and biomass, Analyses of food web structure, Measurements of coastal environments, Gut content analyses, Stable isotope analyses

#### Schedule

7:00 – 7:30 Breakfast

8:30 – 12:00 Field session #3: Trip to a Akkeshi-ko and Akkeshi Bay. Collection of seagrasses, seagrass-associated organisms for community structure analyses and food web studies.

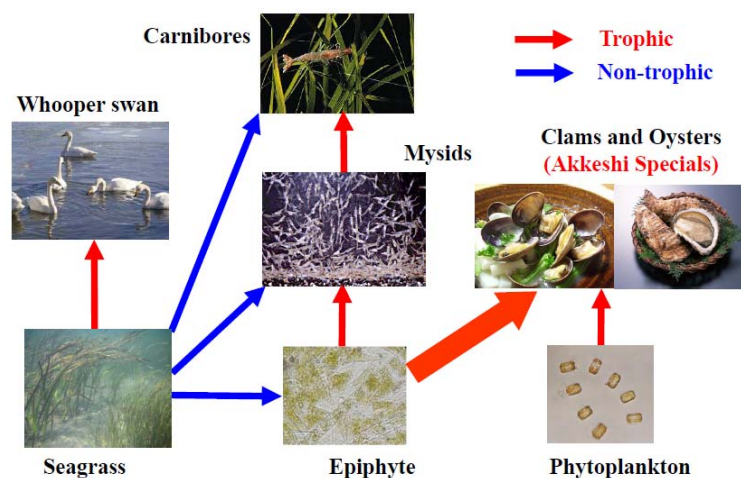
12:30 – 13:30 Lunch

13:30 – 16:30 Lab Session #3: Community ecology and stable isotope analyses of seagrass bed assemblage.

16:30 – 17:30 Cleaning of laboratory and bedrooms

18:00 – Dinner (Banquet)

### Key species interactions in Akkeshi-ko estuary



**List of seaweeds in Akkeshi and Muroran**  
室蘭・厚岸付近の海藻 (2012年版)

**Chlorophyta (Green Algae) 緑色植物門**

(A:Akkeshi, M:Muroran)

**Ulotrichales ひびみどろ目**

Collinsiellaceae らんそうもどき科

*Collinsiella tuberculata* Setchell et Gardner らんそうもどき M

Ulotrichaceae ひびみどろ科

*Ulothrix flacca* (Dillwyn) Thuret ひびみどろ A M

**Ulvales あおさ目**

Capsosiphonaceae かぶさあおのり科

*Capsosiphon groenlandicus* (J. Agardh) Vinogradova ひもひとえぐさ A

Kornmanniaceae もつきひとえぐさ科

*Kornmannia leptoderma* (Kjellman) Bliding もつきひとえ A M

Monostromataceae ひとえぐさ科

*Monostroma angicava* Kjellman えぞひとえぐさ A M

*Monostroma crassidermum* Tokida あつかわひとえ A

*Protomonostroma undulatum* (Wittrock) Vinogradova しわひとえぐさ A M

Prasiolaceae かわのり科

*Prasiola delicata* Setchell et Gardner ひめいそかわのり A

Ulveaceae あおさ科

*Blidingia minima* (Kützing) Kylin ひめあおのり A M

*Ulva arasaki* Chihara ながあおさ M

*Ulva compressa* Linnaeus ひらあおのり M

*Ulva intestinalis* Linnaeus ぼうあおのり M

*Ulva lactuca* Linnaeus おおばあおさ M

*Ulva linza* Linnaeus うすばあおのり A M

*Ulva pertusa* Kjellman あなあおさ A M

*Ulva prolifera* O.F. Müller すじあおのり A

*Ulvaria fusca* Ruprecht くろひとえぐさ A M

**Acrosiphoniales もつれぐさ目**

Acrosiphoniaceae もつれぐさ科

*Spongomorpha duriuscula* (Ruprecht) Collins もつれぐさ A

*Spongomorpha heterocladia* Sakai いぶりもつれぐさ A M

*Spongomorpha mertensii* Setchell et Gardner かぎもつれぐさ A

*Spongomorpha saxatilis* (Ruprecht) Collins とげなしもつれぐさ A M

*Spongomorpha spiralis* Sakai うずもつれぐさ A M

*Urospora penicilliformis* (Roth) Areschoug しりおみどろ A M

**Cladophorales しおぐさ目**

Cladophoraceae しおぐさ科

*Chaetomorpha aerea* (Dillwyn) Kützing たるがたじゅずも A

*Chaetomorpha moniligera* Kjellman たまじゅずも A M

*Cladophora glemerata* (Linnaeus) Kützing かもしおぐさ A

*Cladophora opaca* Sakai つやなししおぐさ A M

*Cladophora rudolphiana* (C. Agardh) Kützing たまりしおぐさ M

*Cladophora sakaii* Abbott あさみどりしおぐさ M

*Cladophora speciosa* Sakai みやびしおぐさ M

*Cladophora stimpsonii* Harvey きぬしおぐさ A M

*Rhizoclonium tortuosum* (Dillwyn) Kuetzing ながもつれ A M

**Codiales みる目**

Codiaceae みる科

	<i>Codium yezoense</i> (Tokida) Vinogradova	えぞみる (いもせみる)	A
	<i>Codium fragile</i> (Suringar) Hariot	みる	M
<b>Bryopsidales</b>	<b>はねも目</b>		
Bryopsidaceae	はねも科		
	<i>Bryopsis plumosa</i> (Hudson) C. Agardh	はねも	M
Derbesiaceae	つゆのいと科		
	<i>Derbesia marina</i> (Lyngbye) Solier	ほそつゆのいと	A
<b>Phaeophyceae (Brown Algae)</b>	<b>褐藻綱</b>		
<b>Ectocarpales</b>	<b>しおみどろ目</b>		
Ectocarpaceae	しおみどろ科		
	<i>Acinetospora crinita</i> (Charmichael ex Harvey) Kornmann		M
	<i>Ectocarpus arctus</i> Kützing	けなししおみどろ	M
	<i>Ectocarpus fusiformis</i> Nagai		A
	<i>Ectocarpus siliculosus</i> (Dillwyn) Lyngbye	しおみどろ	A
	<i>Ectocarpus yezoensis</i> Yamada et Tanaka	えぞしおみどろ	A
	<i>Laminarionema elsbetiae</i> Kawai et Tokuyama	らみなりおねま	M
	<i>Spongonema tomentosum</i> (Hudson) Kützing	かぎしおみどろ	A M
	<i>Streblonema evagatum</i> Setchell et Gardner	こぶやどりみどろ	A
Pylaiellaceae	ピラエラ科		
	<i>Pylaiella littoralis</i> (Linnaeus) Kjellman	ぴらえら	A M
Sorocarpaceae	ソロカルパ科		
	<i>Botrytella micromora</i> Bory	いそぶどう	A M
	<i>Botrytella reinboldii</i> (Reinke) Kornmann & Sahling	きたしおみどろ	M
<b>Ralfsiales</b>	<b>いそがわら目</b>		
Ralfsiaceae	いそがわら科		
	<i>Analipus filiformis</i> (Ruprecht) Papenfuss	いとまつも	M
	<i>Analipus gungii</i> (Yendo) Kogame et Yoshida	ぐんじまつも	M
	<i>Analipus japonicus</i> (Harvey) Wynne	まつも	A M
	<i>Ralfsia fungiformis</i> (Gunnerus) Setchell et Gardner	いそがわら	A
	<i>Ralfsia verrucosa</i> (Areschoug) Areschoug	いそいわたけ	A M
<b>Chordariales</b>	<b>ながまつも目</b>		
Acrotrichaceae	にせもずく科		
	<i>Acrothrix gracilis</i> Kylin	きたにせもずく	A
	<i>Acrothrix pacifica</i> Okamura et Yamada	にせもずく	M
Chordariaceae	ながまつも科		
	<i>Chordaria chordaeformis</i> (Kjellman) Kawai et S. H. Kim	ひもながまつも	A
	<i>Chordaria flagelliformis</i> (O.F. Müller) C. Agardh	ながまつも	A M
	<i>Eudesme virescens</i> (Carmichael) J. Agardh	にせふともずく	A M
	<i>Heterosaundersella hattoriana</i> Tokida	からふともずく	A
	<i>Papenfussiella kuromo</i> (Yendo) Inagaki	くろも	A
	<i>Saundersella simplex</i> (Saunders) Kylin	もつきちやそうめん	A
	<i>Sphaerotrichia divaricata</i> (C. Agardh) Kylin	いしもずく	A M
Elachistaceae	なみまくら科		
	<i>Elachista fusicola</i> (Vellay) Areschoug		A
	<i>Elachista tenuis</i> Yamada	ほそなみまくら	M
	<i>Halothrix ambigua</i> Yamada	そめわけぐさ	A M
Leathesiaceae	ねばりも科		
	<i>Leathesia difformis</i> (Linnaeus) Areschoug	ねばりも	A M
	<i>Leathesia difformoides</i> Takamatsu		M
	<i>Leathesia monilicellulata</i> Takamatsu	なんきんねばりも	M
	<i>Phaeophysema sphaerocephala</i> (Yamada) Tanaka, Uwai et Kawai		
	ひめねばりも		A M
Myrionemataceae	みりおねま科		
	<i>Compronema secundum</i> Setchell et Gardner		A

	<i>Hecatonema terminale</i> (Kützinger) Kylin	M
	<i>Myrionema corunnae</i> Sauvageau	M
<b>Scytosiphonales</b>	かやものり目	
Scytosiphonaceae	かやものり科	
	<i>Colpomenia bullosa</i> (Saunders) Yamada わたも	A M
	<i>Colpomenia peregrina</i> (Sauvageau) Hamel うすかわふくろのり	A M
	<i>Melanosiphon intestinalis</i> (Saunders) Wynne きたいわひげ	A M
	<i>Petalonia fascia</i> (O. F. Müller) Kuntze せいはばのり	A M
	<i>Petalonia zosterifolia</i> (Reinke) Kuntze ほそばせいはばのり	A M
	<i>Scytosiphon lomentaria</i> (Lyngbye) Link かやものり	A M
	<i>Scytosiphon canaliculatus</i> (Setchell et Gardner) Kogame かやもどき	M
	<i>Scytosiphon tenellus</i> Kogame ひらかやも	M
<b>Dictyosiphonales</b>	ういきょうも目	
Coilodesmaceae	えぞぶくろ科	
	<i>Coilodesme cystoseirae</i> (Ruprecht) Setchell et Gardner ほそえぞぶくろ A	
	<i>Coilodesme japonica</i> Yamada えぞぶくろ	A M
Delamareaceae	にせかやも科	
	<i>Delamarea attenuata</i> (Kjellman) Rosenvinge にせかやも	A
Dictyosiphonaceae	ういきょうも科	
	<i>Dictyosiphon foeniculaceus</i> (Hudson) Greville ういきょうも	A M
Punctariaceae	はばもどき科	
	<i>Litosiphon groenlandicus</i> var. <i>japonicus</i> Kawai et Kurogi いそひげも M	
	<i>Pogotrichum yezoense</i> (Yamada et Nakamura) Sakai et Saga こぶのひげ A M	
	<i>Punctaria flaccida</i> Nagai ちしまはばもどき	A M
	<i>Punctaria latifolia</i> Greville はばもどき	M
	<i>Punctaria plantaginea</i> (Roth) Greville はばだまし	A M
<b>Sphacelariales</b>	くろがしら目	
Sphacelariaceae	くろがしら科	
	<i>Sphacelaria plumigera</i> Holmes はねくろがしら	A
	<i>Sphacelaria rigidula</i> Kützinger みつでくろがしら	A M
<b>Desmarestiales</b>	うるしぐさ目	
Desmarestiaceae	うるしぐさ科	
	<i>Desmarestia ligulata</i> (Stackhouse) Lamouroux うるしぐさ	A M
	<i>Desmarestia viridis</i> (Müller) Lamouroux けうるしぐさ	A M
<b>Laminariales</b>	こんぶ目	
Akkesiphycaceae	こんぶもどき科	
	<i>Akkesiphycus lubricum</i> Yamada et Tanaka こんぶもどき	A
Alariaceae	ちがいそ科	
	<i>Alaria angusta</i> Kjellman ほそばわかめ	A
	<i>Alaria crassifolia</i> Kjellman ちがいそ	M
	<i>Alaria praelonga</i> Kjellman あいぬわかめ	A
	<i>Undaria pinnatifida</i> (Harvey) Suringar わかめ	M
Chordaceae	つるも科	
	<i>Chorda asiatica</i> Sasaki et Kawai つるも	A M
Costariaceae	すじめ科	
	<i>Agarum clathratum</i> Dumortier あなめ	A M
	<i>Costaria costata</i> (C. Agardh) Saunders すじめ	A M
Laminariaceae	こんぶ科	
	<i>Arthrothamnus bifidus</i> (Gmelin) Ruprecht ねこあしこんぶ	A
	<i>Saccharina sculpera</i> Lane, Mayes, Druehl et Saunders がごめこんぶ	M
	<i>Saccharina gyrata</i> (Kjellman) Lane, Mayes, Druehl et Saunders とろろこんぶ	A
	<i>Saccharina angustata</i> (Kjellman) Lane, Mayes, Druehl et Saunders みついしこんぶ	M
	<i>Saccharina coriacea</i> (Miyabe) Lane, Mayes, Druehl et Saunders がっがらこんぶ、あつぽこんぶ	A

	<i>Saccharina diabolica</i> (Miyabe) Lane, Mayes, Druehl et Saunders	おにこんぶ	A
	<i>Saccharina japonica</i> (Areschoug) Lane, Mayes, Druehl et Saunders	まこんぶ	M
	<i>Saccharina longissima</i> (Miyabe) Lane, Mayes, Druehl et Saunders	ながこんぶ	A
	<i>Saccharina longipedalis</i> (Okamura) Lane, Mayes, Druehl et Saunders	えながこんぶ、かきじまこんぶ	A
	<i>Saccharina yendoana</i> (Miyabe) Lane, Mayes, Druehl et Saunders	えんどうこんぶ	M
	<i>Laminaria yezoensis</i> Miyabe	ごへいこんぶ	A
Pseudochordaceae	にせつるも科		
	<i>Pseudochorda nagaii</i> (Tokida) Inagaki	にせつるも	A
<b>Dictyotales</b>	<b>あみじぐさ目</b>		
Dictyotaceae	あみじぐさ科		
	<i>Dictyopteris divaricata</i> (Okamura) Okamura	えぞやはす	M
	<i>Dictyota dichotoma</i> (Hudson) Lamouroux	あみじぐさ	M
<b>Fucales</b>	<b>ひばまた目</b>		
Fucaceae	ひばまた科		
	<i>Fucus distichus</i> Linnaeus ssp. <i>evanescens</i> (C. Agardh) Powell	ひばまた	A M
	<i>Silvetia babingtonii</i> (Harvey) E. Serrão, T.O. Cho, S.M. Boo et Brawley	えぞいしげ	A M
Cystoseiraceae	うがものく科		
	<i>Cocophora langsdoerffii</i> (Turner) Greville	すぎもく	M
	<i>Cystoseira crassipes</i> (Turner) C. Agardh	ねぶともく	A
	<i>Cystoseira hakodatensis</i> (Yendo) Fensholt	うがのもく	A M
Sargassaceae	ほんだわら科		
	<i>Sargassum boreale</i> Yoshida et Horiguchi	ほっかいもく	A
	<i>Sargassum confusum</i> C. Agardh	ふしすじもく	A M
	<i>Sargassum miyabei</i> Yendo	みやべもく	A M
	<i>Sargassum muticum</i> (Yendo) Fensholt	たまははきもく	A M
	<i>Sargassum thunbergii</i> (Roth) Kuntze	うみとらのお	M
<b>Rhodophyta (Red Algae)</b>	<b>紅色植物門</b>		
<b>Porphyridiales</b>	<b>ちのりも目</b>		
Goniotrichaceae	べにみどろ科		
	<i>Stylonema alsidii</i> (Zanardini) Drew	べにみどろ	A M
<b>Erythropeltidales</b>	<b>エリスロペルティス目</b>		
Erythropeltidaceae	エリスロペルティス科		
	<i>Erythrotrichia carnea</i> (Dillwyn) J. Agardh	ほしのいと	A M
<b>Bangiales</b>	<b>うしけのり目</b>		
Bangiaceae	うしけのり科		
	<i>Bangia atropurpurea</i> (Roth) C. Agardh	うしけのり	A M
	<i>Porphyra amplissima</i> (Kjellman) Setchell et Hus	べにたさ	A
	<i>Porphyra takadae</i> Miura	そめわけあまのり	A
	<i>Porphyra kuniedae</i> Kurogi	まるばあさくさのり	M
	<i>Porphyra kurogii</i> Lindstrom	ちしまくろのり	A M
	<i>Porphyra moriensis</i> Ohmi	かやべのり	M
	<i>Porphyra occidentalis</i> Setchell et Hus	きいろたさ	A
	<i>Porphyra onoi</i> Ueda	おおのり	M
	<i>Porphyra pseudocrassa</i> Yamada et Mikami	まくれあまのり	A
	<i>Porphyra pseudolinearis</i> Ueda	うっふるいのり	A M
	<i>Porphyra seriata</i> Kjellman	いちまつのり	M
	<i>Porphyra suborbiculara</i> Kjellman	まるばあまのり	M
	<i>Porphyra variegata</i> (Kjellman) Kjellman	ふいりたさ	A M
	<i>Porphyra yezoensis</i> Ueda	すさびのり	A M
<b>Acrochaetiales</b>	<b>アクロカエティウム目</b>		

Acrochaetiaceae	アクロケチウム科	
	<i>Acrochaetium alariae</i> (Jonsson) Bornet	M
	<i>Audouinella codii</i> (Crouan) Garbary	A
	<i>Audouinella daviesii</i> (Dillwyn) Woelkerling	M
	<i>Audouinella rhizoidea</i> (Drew) Garbary	A M
	<i>Rhodochorton purpureum</i> (Lightfoot) Rosenvinge	M
	<i>Rhodochorton subimmersum</i> Setchell et Gardner	M
<b>Nemalionales</b>	<b>うみぞうめん目</b>	
Liagoraceae	こなはだ科	
	<i>Helminthocladia australis</i> Harvey	べにもずく M
	<i>Helminthocladia yendoana</i> Narita	ほそべにもずく M
Nemaliaceae	うみぞうめん科	
	<i>Nemalion vermiculare</i> Suringar	うみぞうめん A M
<b>Bonnemaisoniales</b>	<b>かぎけのり目</b>	
Bonnemaisoniaceae	かぎけのり科	
	<i>Bonnemaisonia hamifera</i> Hariot	かぎのり M
<b>Gelidiales</b>	<b>てんぐさ目</b>	
Gelidiaceae	てんぐさ科	
	<i>Gelidium subfastigiatum</i> Okamura	なんぶぐさ M
	<i>Gelidium vagum</i> Okamura	よれくさ M
	<i>Pterocladia capillacea</i> (Gmelin) Santelices et Hommersand	おぼくさ M
<b>Corallinales</b>	<b>さんごも目</b>	
Corallinaceae	さんごも科	
	<i>Bossiella cretacea</i> (Postels et Ruprecht) Johansen	いそきり A M
	<i>Clathromorphum compactum</i> (Kjellman) Foslie	あなあききたいしも A
	<i>Corallina pilulifera</i> Postels et Ruprecht	ぴりひば A M
	<i>Pneophyllum zostericola</i> (Foslie) Fujita	もかさ A M
Hapalidiaceae	ハパリデウム科	
	<i>Lithothamnion japonicum</i> Foslie	みやべおこし M
	<i>Lithothamnion obtectulum</i> (Foslie) Foslie	あつけしおこし A
	<i>Lithothamnion pacificum</i> (Foslie) Foslie	あつけしいぼいし A
	<i>Melobesia pacifica</i> Masaki	あばたもかさ M
	<i>Clathromorphum reclinatum</i> (Foslie) Adey	かさきのこいしも A M
	<i>Phymatolithon lenormandii</i> (Areschoug) Adey	あつけしいしも A
<b>Hildenbrandiales</b>	<b>べにまだら目</b>	
Hildenbrandiaceae	べにまだら科	
	<i>Hildenbrandia rubra</i> (Sommerfelt) Meneghini	べにまだら M
<b>Gigartinales</b>	<b>すぎのり目</b>	
Caulacanthaceae	いそもっか科	
	<i>Caulacanthus usutulatus</i> (Turner) Kuetzing	いそだんつう M
Dumontiaceae	りゅうもんそう科	
	<i>Constantinea rosa-marina</i> (Gmelin) Postels et Ruprecht	おきつばら A
	<i>Constantinea subulifera</i> Setchell	おおばおきつばら A
	<i>Dumontia alaskana</i> Tai, Lindstrom et Saunders	りゅうもんそう A
	<i>Dumontia simplex</i> Cotton	へらりゅうもん M
	<i>Masudaphycus irregularis</i> (Yamada) Lindstrom	にせかれきぐさ A
	<i>Hyalosiphonia caespitosa</i> Okamura	いそうめもどき M
	<i>Neodilsea longissima</i> (Masuda) Lindstrom	ながあかば M
	<i>Neodilsea tenuipes</i> Yamada et Mikami	まるばあかば A M
	<i>Neodilsea yendoana</i> Tokida	あかば A M
Endocliadiaceae	ふのり科	
	<i>Gloiopeltis furcata</i> (Postels et Ruprecht) J. Agardh	ふくろふのり A M
Gigartinaceae	すぎのり科	
	<i>Chondrus armatus</i> (Harvey) Okamura	とげつのまた A M
	<i>Chondrus pinnulatus</i> (Harvey) Okamura	ひらことじ A M



	<i>Chondrus yendoi</i> Yamada et Mikami	くろはぎんなんそう	A M
	<i>Mazzaella japonica</i> (Mikami) Hommersand	あかばぎんなんそう	A M
Gloiosiphoniaceae	いとふのり科		
	<i>Gloiosiphonia capillaris</i> (Hudson) Carmichael	いとふのり	M
Halymeniaceae	むかでのり科		
	<i>Grateloupia asiatica</i> Kawaguchi et Wang	むかでのり	M
	<i>Grateloupia divaricata</i> Okamura	かたのり	A M
	<i>Grateloupia livida</i> (Harvey) Yamada	ひらむかで	M
	<i>Grateloupia turuturu</i> Yamada	つるつる	M
	<i>Grateloupia elliptica</i> Holmes	たんばのり	M
	<i>Polyopes affinis</i> (Harvey) Kawaguchi et Wang	まつのり	M
Kallymeniaceae	つかさのり科		
	<i>Callophyllis rhynchocarpa</i> Ruprecht	ひめとさかもどき	A M
	<i>Cirrulicarpus gmelinii</i> (Grunow) Tokida et Masaki	えぞとさか	A
	<i>Euthora cristata</i> (Turner) J. Agardh	ゆうそら	A
	<i>Kallymenia ornata</i> (Postels et Ruprecht) J. Agardh	きたつかさのり	A
	<i>Kallymenia reniformis</i> var. <i>cuneata</i> J. Agardh	えぞつかさのり	M
Petrocelidaceae	いぼのり科		
	<i>Mastocarpus pacificus</i> (Kjellman) Perestenko	いぼのり	A M
Phylloporaceae	おきつのり科		
	<i>Ahnfeltiopsis flabelliformis</i> (Harvey) Masuda	おきつのり	A M
Rhodophyllidaceae	あみはだ科		
	<i>Rhodophyllis capillaris</i> Tokida	いとあみはだ	A M
Schizymeniaceae	べにすなご科		
	<i>Schizymenia dubyi</i> (Chauvin) J. Agardh	べにすなご	M
Solieriaceae	みりん科		
	<i>Turnerella mertensiana</i> (Postels et Ruprecht) Schmitz	えぞなめし	A
Tichocarpaceae	かれきぐさ科		
	<i>Tichocarpus crinitus</i> (Gmelin) Ruprecht	かれきぐさ	A M
<b>Gracilariales</b>	<b>おごのり目</b>		
Gracilariaceae	おごのり科		
	<i>Gracilaria chorda</i> Holmes	つるしらも	A
	<i>Gracilaria vermiculophylla</i> (Ohmi) Papenfuss	おごもどき	A
	<i>Gracilaria asiatica</i> Zhang et Xia	おごのり	A M
<b>Ahnfeltiales</b>	<b>いたにぐさ目</b>		
Ahnfeltiaceae	いたにぐさ科		
	<i>Ahnfeltia fastigiata</i> (Endlicher) Makijenko	ねつきいたにぐさ	M
<b>Rhodymeniales</b>	<b>まさごしばり目</b>		
Champiaceae	わつなぎそう科		
	<i>Champia parvula</i> (C. Agardh) Harvey	わつなぎそう	M
Lomentariaceae	ふしつなぎ科		
	<i>Lomentaria hakodatensis</i> Yendo	こすじふしつなぎ	A M
Rhodymeniaceae	まさごしばり科		
	<i>Chrysymenia wrightii</i> (Harvey) Yamada	たおやぎそう	M
	<i>Sparlingia pertusa</i> (Postels et Ruprecht) Saunders et al.	あなだるす	A M
<b>Palmariales</b>	<b>だるす目</b>		
Palmariaceae	だるす科		
	<i>Halosaccion firmum</i> (Postels et Ruprecht) Kuetzing	かたべにふくろのり	A
	<i>Halosaccion yendoi</i> Lee	べにふくろのり	A M
	<i>Palmaria marginicrassa</i> Lee	あつばだるす	A
	<i>Palmaria palmata</i> (Linnaeus) Kuntze	だるす	A M
Rhodophysemataceae	ふちとりべに科		
	<i>Pseudorhododiscus nipponicus</i> Masuda	べにごろも	A M
	<i>Rhodophysema elegans</i> (Crouan) Dixon	うすふちとりべに	M
	<i>Rhodophysema georgii</i> Batters	ふちとりべに	A M

	<i>Rhodophysema odonthaliae</i> Masuda et Ohta	ひめふちとりべに	M
<b>Ceramiales</b>	<b>いぎす目</b>		
<b>Ceramiaceae</b>	<b>いぎす科</b>		
	<i>Antithamnion densum</i> (Suhr) Howe	きぬいとふたつがさね	A M
	<i>Antithamnion nipponicum</i> Yamada et Inagaki	ふたつがさね	M
	<i>Antithamnionella spirographidis</i> (Schiffner) Wollaston	ほそがさね	A
	<i>Aglaothamnion callophyllidicola</i> (Yamada) Boo, Lee, Rueness et Yoshida	きぬいとぐさ	M
	<i>Campylaephora crassa</i> (Okamura) Nakamura	ふといぎす	M
	<i>Campylaephora hypnaeoides</i> J. Agardh	えごのり	A M
	<i>Ceramium cimbricum</i> Petersen	まつばらいぎす	A M
	<i>Ceramium fastigiramosum</i> Boo et Lee	ひめいぎす	M
	<i>Ceramium japonicum</i> Okamura	はねいぎす	A M
	<i>Ceramium kondoi</i> Yendo	いぎす	A M
	<i>Herpochondria elegans</i> (Okamura) Itono	さえだ	M
	<i>Neoptilota asplenioides</i> (Esper) Kylin	かたわべにひば	A
	<i>Pterothamnion yezoense</i> (Inagaki) Athanasiadis et Kraft	よつがさね	M
	<i>Ptilota filicina</i> J. Agardh	くしべにひば	A M
	<i>Ptilota phacelocarpoides</i> Zinova	こばのくしべにひば	A M
	<i>Scagelia pylaiesii</i> (Montagne) Wynne	からふとよつがさね	A
	<i>Tokidaea corticata</i> (Tokida) Yoshida	べにはねも	A M
<b>Delesseriaceae</b>	<b>このはのり科</b>		
	<i>Acrosorium yendoi</i> Yamada	はいうすばのり	M
	<i>Acrosorium polyneurum</i> Okamura	すじうすばのり	M
	<i>Branchioglossum nanum</i> Inagaki	ひめむらさき	M
	<i>Congregatocarpus pacificus</i> (Yamada) Mikami	このはのり	A M
	<i>Delesseria serrulata</i> Harvey	ぬめはのり	M
	<i>Erythroglossum pinnatum</i> Okamura	ひめうすべに	M
	<i>Neoholmesia japonica</i> (Okamura) Mikami	すずしろのり	A M
	<i>Neohypophyllum middendorffii</i> (Ruprecht) Wynne	ながこのはのり	A
	<i>Hideophyllum yezoense</i> (Yamada et Tokida) Zinova	あつばすじぎぬ	A M
	<i>Phycodryx riggii</i> Gardner	かしわばこのはのり	A
	<i>Phycodryx radicata</i> (Okamura) Yamada et Inagaki	ひめこのはのり	A M
	<i>Tokidadendron kurilensis</i> (Ruprecht) Perestenko	らいのすけこのは	A
<b>Dasyaceae</b>	<b>だじあ科</b>		
	<i>Dasya sessilis</i> Yamada	えなしだじあ	M
	<i>Heterosiphonia japonica</i> Yendo	いそはぎ	M
	<i>Heterosiphonia pulchra</i> (Okamura) Falkenberg	しまだじあ	M
<b>Rhodomelaceae</b>	<b>ふじまつも科</b>		
	<i>Benzaitenia yenoshimensis</i> Yendo	べんてんも	M
	<i>Chondria crassicaulis</i> Harvey	ゆな	M
	<i>Chondria dasyphylla</i> (Woodward) C. Agardh	やなぎのり	A M
	<i>Chondria tenuissima</i> (Withering) C. Agardh	ほそやなぎのり	M
	<i>Enelittosiphonia stimpsonii</i> (Harvey) Kudo et Masuda	まきいとぐさ	A M
	<i>Janczewskia morimotoi</i> Tokida	もりもとそぞまくら	A M
	<i>Laurencia nipponica</i> Yamada	うらそぞ	A M
	<i>Neorhodomela aculeata</i> (Perestenko) Masuda	ふじまつも	A M
	<i>Neorhodomela munita</i> (Perestenko) Masuda	いとふじまつ	A M
	<i>Neorhodomela oregona</i> (Doty) Masuda	あつけしふじまつも	A
	<i>Neosiphonia harveyi</i> (Bailey) Kim et al.	きぶりいとぐさ	A M
	<i>Neosiphonia yendoi</i> (Segi) Kim et Lee	えんどういとぐさ	M
	<i>Odonthalia annae</i> Perestenko	ありゅうしゃんのこぎりひば	A
	<i>Odonthalia corymbifera</i> (Gmelin) Greville	はけさきのこぎりひば	A M
	<i>Odonthalia macrocarpa</i> Masuda	おおのこぎりひば	A M
	<i>Odonthalia yamadae</i> Masuda	あつけしのこぎりひば	A

<i>Polysiphonia fragilis</i> Suringar	くろいとぐさ	A
<i>Polysiphonia morrowii</i> Harvey	もろいとぐさ	A M
<i>Pterosiphonia arctica</i> (J. Agardh) Setchell et Gardner	いなぼぐさ	A
<i>Pterosiphonia bipinnata</i> (Postels et Ruprecht) Falkenberg	いとやなぎ	A
<i>Rhodomela lycopodioides</i> f. <i>tenuissima</i> (Ruprecht) Kjellman	みやびふじまつも	A
<i>Rhodomela sachalinensis</i> Masuda	からふとふじまつも	A
<i>Rhodomela teres</i> (Perestenko) Masuda	ほそばふじまつも	M
<i>Symphyocladia latiuscula</i> (Harvey) Yamada	いそむらさき	A M
<i>Symphyocladia marchantioides</i> (Harvey) Falkenberg	こざねも	M