



2017.5.20. Sendai

# 漂着物に何が付いていたか - 海藻 -

川井浩史・羽生田岳昭(神戸大学)

ゲイル ハンセン (オレゴン州立大)



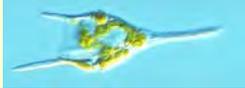
- 海藻類はどのような生き物？
- どのような海藻類が付いていたのか？
- 漂流物に付いていた海藻が外来種になるのを防ぐために



## 陸域



## 沿岸 (浅い海)



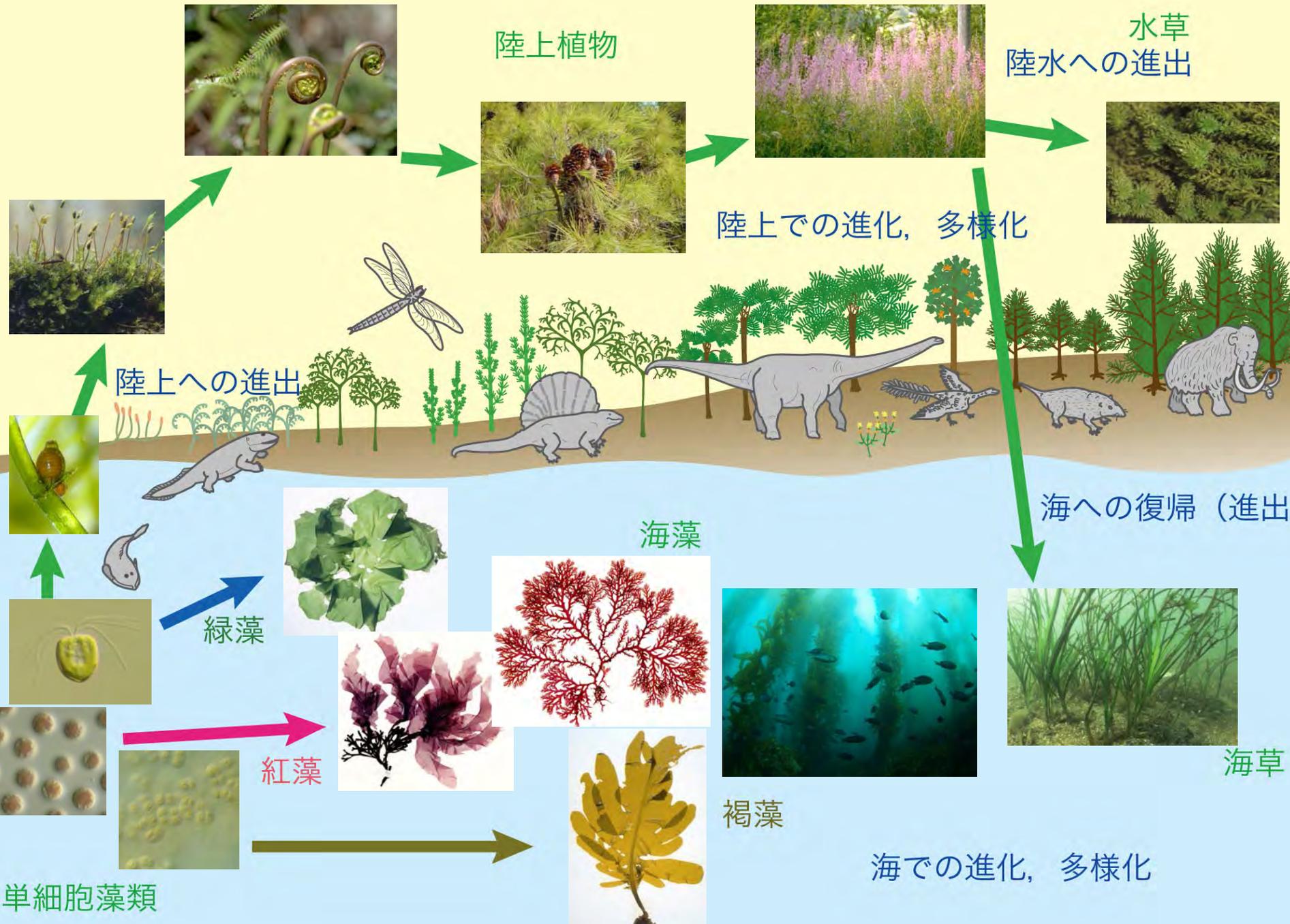
植物プランクトン・付着性微細藻  
海藻・海草

## 陸上植物

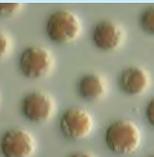
## 外洋 (深い海)



植物プランクトン



単細胞藻類



陸上への進出



陸上植物



陸上での進化, 多様化



水草

陸水への進出



海藻



紅藻



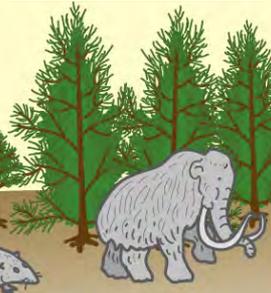
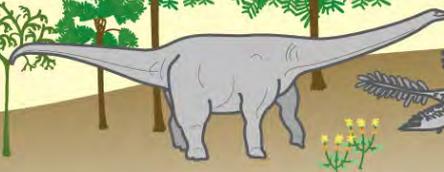
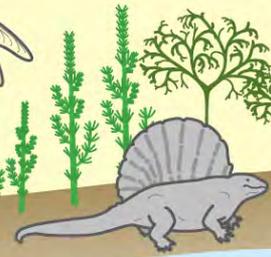
褐藻



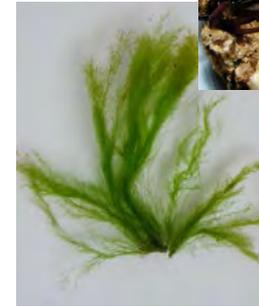
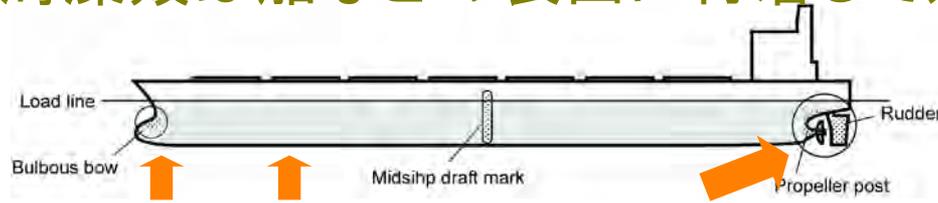
海草

海への復帰 (進出)

海での進化, 多様化



# 海藻類は船などの表面に付着して運ばれることがある



船に付着する海藻類は多くは小形で、生育期間が短いものが多い

## 浮き桟橋などに付着する海藻類



うきさんばし

浮き桟橋は海藻にとって良い環境で、多くの種類が付着している

# 津波漂流物付着生物（三沢漁港浮き桟橋，2012年6月オレゴン州）



- ◆ 海藻類だけではなく，共存する多様な動物も一緒に移動した
- ◆ 沿岸生物相（動物・植物）がそのまま移動するような移入は例がない

Marine Organisms Found Living on a Floating Dock from  
Misawa, Aomori Prefecture, Japan dislodged by the 2011 Tōhoku Earthquake and Tsunami

1 species of urchin

Northern Pacific seastar  
*Asterias amurensis*

Japanese shore crab  
*Hemigrapsus sanguineus*

Granular claw crab  
*Oedignathus inermis*

Solitary tunicate

Oyster

*Mytilus galloprovincialis*

4+ species of barnacle

Bryozoans

3+ species of amphipod

17+ species of worm

Sponge on mussel

11 species of mollusk

Anemone

*Halosydna brevisetosa*

*Trypanosyllis zebra*

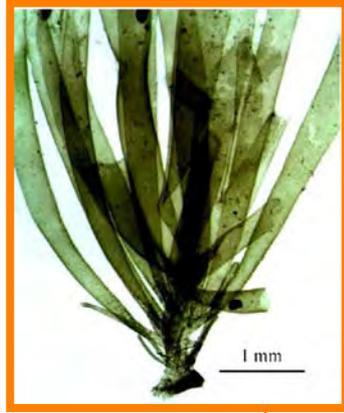
Oregon State University's Hatfield Marine Science Center & Coastal Oregon Marine Experiment Station

# 津波漂流物に付着していた海藻の多様性

## 緑藻



アナアオサ



アオサ属の一種



オオバアオサ

ウスバアオノリ

北米西岸に本来分布しない種



ヒメアオノリ



ワタシオグサ



ミル



ハネモ

# 褐藻



マコンブ



ワカメ



マツモ



カヤモノリ



ウスカヤモ



ケウルシグサ



ウルシグサ



ムチモ



3 cm  
セイヨウハバノリ

# 紅藻



スサビノリ



ダルス



ベニスナゴ



アカバ



ヒラムカデ



オオバツノマタ



クロバギンナンソウ



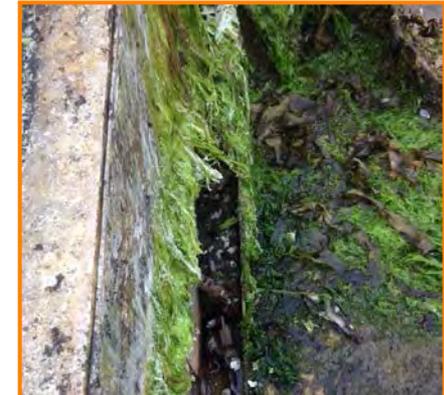
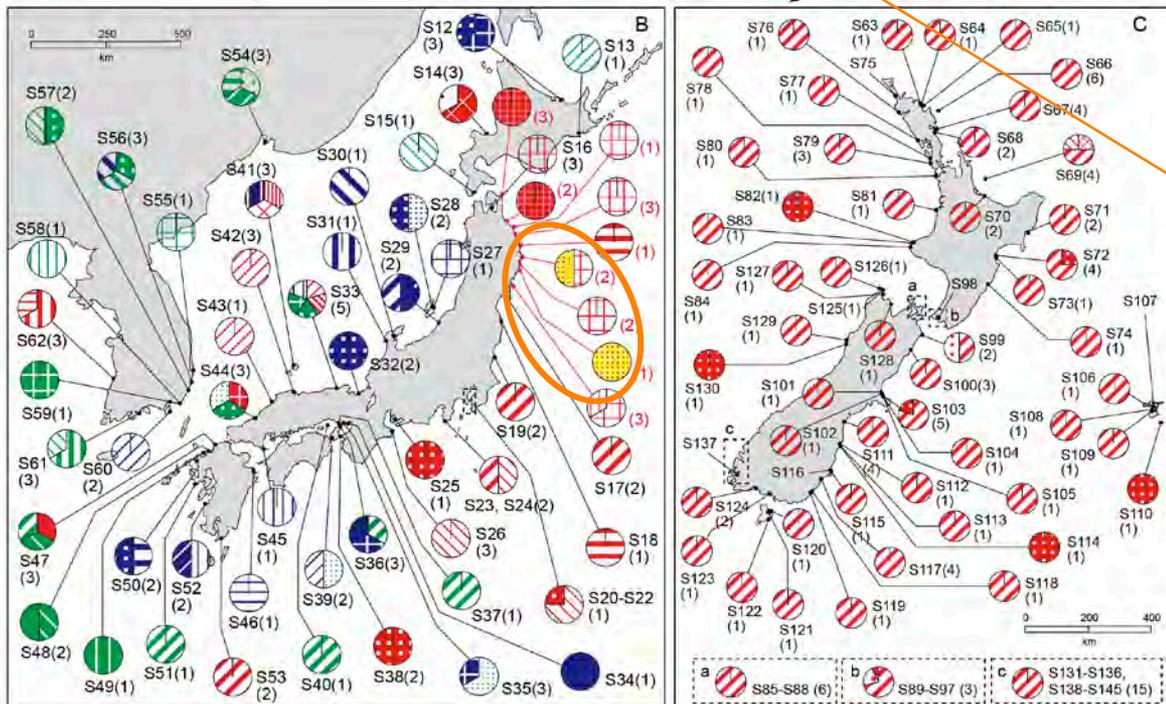
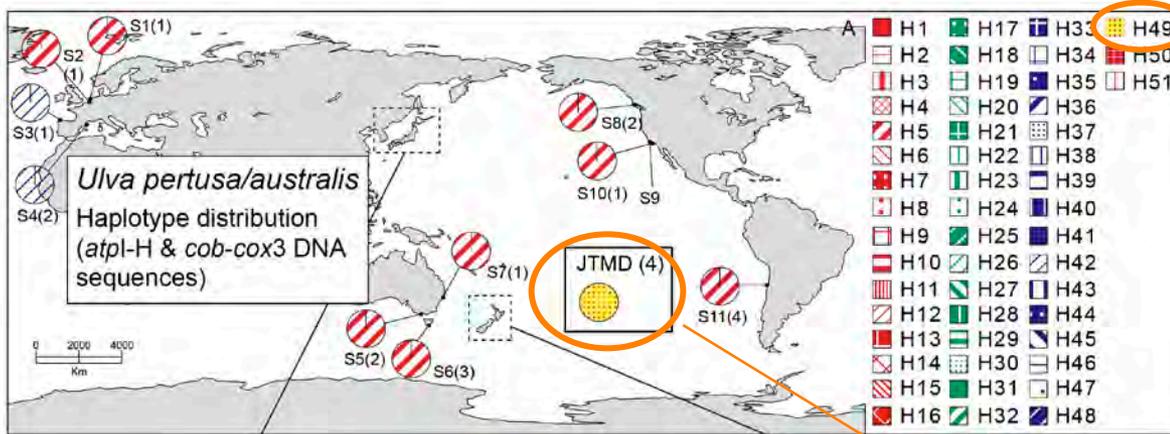
ツルツル

# 東北沿岸，津波漂流物付着，北米西岸の海藻類集団の遺伝子比較



# 緑藻アナオサの各地域集団の遺伝的多様性の解析

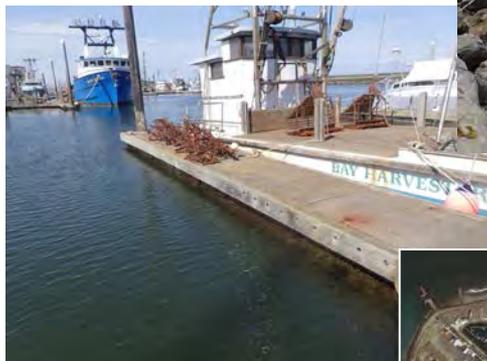
漂着した船名不詳の破損した漁船は東北沿岸に由来することが確かめられた



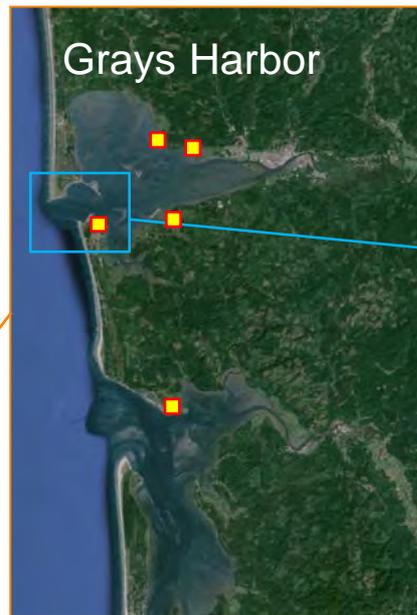
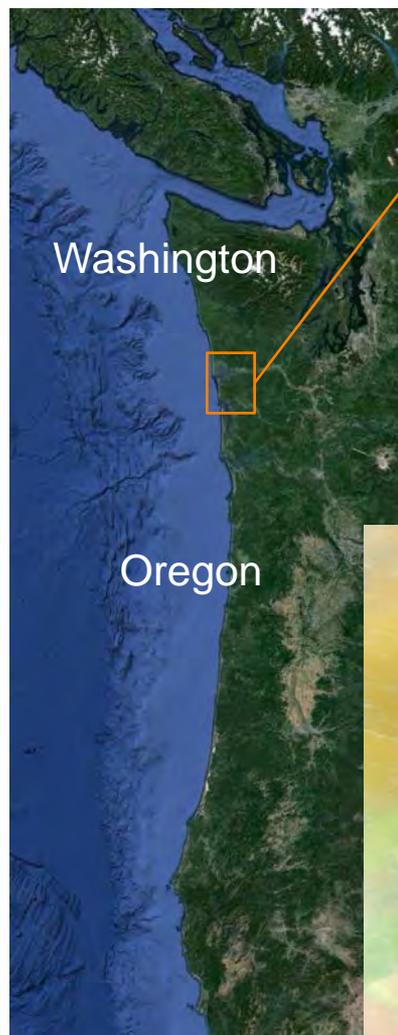
# 移入海藻類の早期検出に向けて

さまざまな地点での野外調査

Field survey for detecting new recruitment



# 津波漂流物付着海藻の移入の早期検出に適した場所の選定



# 代表的な津波漂流物付着海藻の同定のためのパンフレットの作成・配付

## Identification guide of seaweeds on Japanese tsunami debris



Floating dock originated from Misawa Port and stranded to Oregon coast in 2012. Its surface was covered with abundant healthy seaweeds and benthic animals. Photographs by Oregon State University.

Since 2012 marine debris caused by the 2011 Great East Japan Earthquake and Tsunami has been arriving on Northwestern Pacific shores. Often healthy seaweeds (marine macroalgae) were attached to them, which may become introduced to the Northwestern Pacific coasts. To date, about 80 species have been identified on debris based on morphological characters, and about 30 of the larger forms have been genetic analyzed for confirmation. Since many of these species do not yet occur in the NE Pacific, their introduction and dispersal could cause considerable impacts to the ecosystem. To help prevent the introduction and possible invasion of these species, it is important that any new recruitment of these species is discovered so that measures can be taken to minimize their spread.

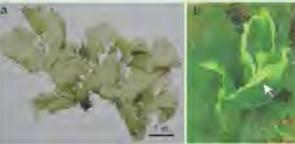
This identification guide provides information for morphologically identifying some of the most prominent species of seaweeds found on the marine debris.

Representative seaweed species found on the Japanese tsunami debris along the Washington and Oregon coasts and identified by morphology and genetic analyses. The species shown in bold are described in this brochure.

**Green algae:** *Blidingia minima*, *Bryopsis plumosa*, *Chaetomorpha linum*, *Cladophora albida*, *Cladophora vogeliana*, *Codium fragile*, *Ulva compressa*, *Ulva lactuca*, *Ulva lutea*, *Ulva pertusa* (= *U. australis*), *Ulva prolifera*, *Ulva simplex*.  
**Brown algae:** *Astartia crassifolia*, *Astartia japonica*, *Costaria costata*, *Dennisia japonica*, *Ectocarpus commutatus*, *Ectocarpus crumetorum*, *Feldmannia irregularis*, *Feldmannia michelii*, *Kuecknickia spinosa*, *Mutinus cylindricus*, *Petalonia fasciata*, *Petalonia zosterifolia*, *Petrodroma maculiformis*, *Poncharia lanifolia*, *Saccharina japonica*, *Scytosiphon gracilis*, *Scytosiphon lomentaria*, *Sphaerocladia rigida*, *Undaria pinnatifida*.

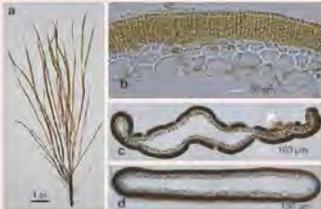
**Red algae:** *Bangia fuscopurpurea* complex, *Ceramium imbricatum*, *Chondrus giganteus*, *Chondrus yendoii*, *Coloclamena* sp., *Cryptopleura rufocinctata*, *Grateloupia livida*, *Grateloupia nurutara*, *Neodilsea yendoana*, *Palmaria palmata* auct. japon., *Polysiphonia korana*, *Polysiphonia morrowii*, *Pyropia yezoensis*, *Schizymenia dubyi*, *Tosamania trispicifera*.

### *Ulva pertusa* (= *U. australis*)



*Ulva pertusa* (= *U. australis*) forms distromatic membranous thallus. The species resembles *U. lactuca*, but tends to have more perforation of thallus. Original distributional range of the species is Northwestern Pacific but the species has been introduced to wide ranges in the Pacific and Atlantic coasts. Recently the species was suggested to be synonymous to *U. australis* by genetic analysis.

### *Scytosiphon gracilis*



*Scytosiphon gracilis* forms gregarious, linear saccate thalli. The species resembles *Scytosiphon lomentaria*, but differs in having more flattened thalli without constrictions and forming plurilocular gametangia lacking paraphyses (ascocysts). The thalli are basically hollow, but may become partly solid. The original distributional range of the species is Northwestern Pacific Ocean, but the species has been introduced to Baja California and Chile.

a, Habit of fresh gregarious thallus. b, Cross section of fertile thallus forming plurilocular gametangia lacking paraphyses. c, Cross section of middle portion of thallus with lady fertile and smoothened (arrow) oostereangia. d, Cross section of lower part of thallus.



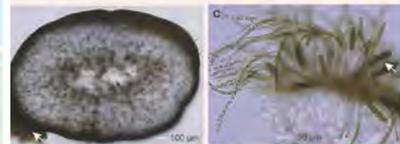
a, Habit of fresh thallus. b, Underwater photograph of the thallus. c, Cross section of thallus.

*Saccharina japonica* (makombu) is a basically biennial kelp that may exceed several meters in length. The blades have undulations when young, but later becomes smooth. This is an economically important species in NE Asia and widely cultivated in Japan, Korea and China. Externally, the young thallus resemble *S. latissima*, but when mature, the stipes are shorter and the blade base is narrower (more acute) than in most other *Saccharina* species occurring in the NE Pacific. The species has not been reported from eastern Pacific coasts.

### *Pyropia yezoensis*



a, Habit of fresh thallus. Male reproductive regions (antheridia) appear as white stripe. b, Surface view of fertile thallus showing female (top) and male reproductive cells (bottom). c, Cross section of thallus forming female reproductive cells.



*no cylindricus* has branched terete thalli. They form male and female tangia in sori as patches on separate thalli. Gametangia are plurilocular tures accompanied with assimilatory filaments. The species has been introduced to California, but has not been reported from north of Oregon.

### *Undaria pinnatifida*



a, Habit of young thallus. b, Habit of fertile thallus forming sori along the stipe (arrow). c, Cross section of blade forming gland cell (arrow) in the cortical layer. d, Cross section of blade forming hair conceptacle (arrow).

*Undaria pinnatifida* (wakame) is an annual kelp having a distinct midrib and lobed membranous blade. When mature, sori are formed along the side of stipe and the portion becomes ruffled. The blade has gland cell and hair conceptacles on the surface. This is an economically important species in Northeastern Asia and widely cultivated in Japan, Korea and China. The species has been introduced worldwide including California, but has not been reported from north of Oregon.

a, Habit of young thallus. b, Habit of fertile thallus forming sori along the stipe (arrow). c, Cross section of blade forming gland cell (arrow) in the cortical layer. d, Cross section of blade forming hair conceptacle (arrow).

### *Neodilsea yendoana*



a, Habit of fresh thallus. b, Habit of the thallus in the field. c, Cross section of thallus.

*Neodilsea yendoana* is a large annual red alga that is ovate to obovate in shape with a wedge-shaped basal portion. The thalli are yellowish to dark red in color, undulated and easily disintegrate. The species has not been reported from eastern Pacific coasts. Externally the species resembles some forms of Northeastern Pacific *Grateloupia doryphora* but the thalli of *Neodilsea* are somewhat bulbate and not smooth as in *Grateloupia*.

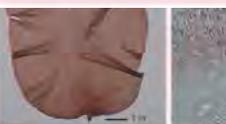
a, Habit of fresh thallus. b, Habit of the thallus in the field. c, Cross section of thallus.

### *Chondrus yendoii*



a, Habit of fresh thallus. b, Cross section of thallus.

*Chondrus yendoii* has gregarious tough, simple or irregularly branched thalli. The upright thalli are annual, but the basal system is perennial. The species that occurs in the high intertidal of OR and WA, but it is about twice the size. In Alaska, it resembles several species, including *Mazzaella phylicarpa*. The species has not yet been reported from Northeastern Pacific.



*Schizymenia dubyi* bears a short stipe and an ovate to broadly lanceolate foliose thallus that can be deeply split. The thallus is soft and slippery when young, but later becomes somewhat leathery. The inner medullary layer is filled with loosely interwoven filaments. Characteristic gland cells are formed in the cortical layer. The species has a heteromorphic life history alternating between an upright gametophyte and a crustose sporophyte. In fern thalli, carpogonophores are thickly dispersed in the subcortical giving the thallus mottled appearance. The species has a relatively broad distributional range. However, in the Northeastern Pacific, it has only been found in California.

This project was supported by the research grant of the Japanese Ministry of the Environment through the North Pacific Marine Science Organization (PICES) to Hiroshi Kawai, Takeaki Hanaya (Kobe University) and Gayle Hansen (Oregon State University), and Oregon Sea Grant to G.H. We thank Masahiro Suzuki for collection of a part of the specimens. Copyright of photographs (excl. those of Misawa floating dock) belongs to Hiroshi Kawai (kawai@kobe-u.ac.jp).

Published by the Kobe University Research Center for Inland Seas, Rokkoda, Kobe, 657-8501, Japan

### *Grateloupia livida*



a, Habit of fresh thallus. b, Cross section of thallus.

*Grateloupia livida* is a red alga having branched strap-shaped thalli with acute apices. The thalli are simple to one to two times branched, but highly variable in the external morphology. The thallus frequently forms adventitious branched on the edges. The inner medullary layer is filled with relatively densely interwoven filaments. The species is distributed in Northeastern Asia, and has not been reported from Northeastern Pacific.

a, Habit of fresh thallus. b, Cross section of thallus. c, Fertile gametophyte forming cystocarp (arrow). d, Gland cell (arrow).

*nurutara* is a red alga ical to lanceolate (us that is attached to the y a short stipe and dist. The thallus has a slippery mucilagenous he medullary layer are osely interwined orphologically, the ribles some Northeastern nenia species. The een introduced to many oth Pacific and Atlantic NE Pacific, it has been fornia, but it is not areas further north.