SYNOPSIS OF BIOLOGICAL DATA ON

MONOSTROMA LATISSIMUM Wittrock

in Japanese cultivation

Prepared by

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A revised version of this synopsis will be issued in the same series.

Readers are requested to suggest corrections and additions to this provisional version to make it comprehensive. Comments and requests for information should be addressed to the editor

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Synopsis of biological data on
Monostroma latissimum Wittrock
in Japanese cultivation

Taxonomy. Distribution. Bionomics and life history. Population studies. Harvesting. Chemical composition. Utilization.

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C O N T E N T S

*As no information was available to the authors, these items are not listed in the text.

1 IDENTITY

1.1 Taxonomy

1.1.1 Definition

Phylum Euthallophyta
Class Chlorophyaceae
Order Ulotrichales
Suborder Ulotrichineae
Family Ulvaceae
Genus Monostroma

Green Ulotrichalean alga of the thalloid type, consisting of an expanded membrane of a single layer of cells, thereby differing from Ulva which has two layers.

1.1.2 Description

Frond membranaceous, greenish in colour, thin, flat, variable in shape but usually elliptical in outline, 10-20 cm long, 20-61μ in thickness, undulate in marginal portion, composed of a single layer of cells almost from the beginning of development; cells almost square or hexagonal, arranged irregularly; reproductive cells grouped in the marginal portion, dioecious. Sexual reproduction by 2-ciliated gametes all originating in unchanged cells. The zygote usually germinates immediately. Non-sexual reproduction by 4-ciliated spores or vegetatively.

1.2 Nomenclature

1.2.1 Correct scientific name

Monostroma latissimum Wittrock 1866

1.2.2 Synonyms

Ulva latissima Kützing 1843 (not of Linnaeus)

1.2.3 Standard common names, vernacular names

Hirohano-hitoeguso; Aonori (Japanese)

1.3 General variability

1.3.1 Subspecific fragmentation (races, varieties, hybrids)

Systematic subspecies have not yet been established, but the following three ecological types are distinguishable morphologically:

(a) Inner bay type (Naiwan type)
Frond less undulated, grows to a large size. Whole frond with many small perforations at adult stage. Artificially cultivated.

(b) Estuary type (Kakō type)
Adult frond usually with radial folds running from the base to the periphery, and without perforations.

(c) Open sea type (Gaikai type)
Frond small, irregularly undulated, without perforations.

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2 DISTRIBUTION AND ECOLOGY

2.1 Delimitation of the total area of distribution and ecological characterization of this area

This species is distributed along the middle and southern Pacific coasts of Japan, Pacific coast of North America, Atlantic coast of America, west coast of Europe, Baltic sea, Mediterranean sea, Africa and New Zealand; it grows in a broad zone from inner bays to open sea, with wide temperature and salinity range.

2.2 Ecological requirements

Level: Middle or upper part of littoral zone.

Substratum: Rock or stone, wood, net (palm-yarn, hemp palm-yarn or chemical fibre-yarn).

Temperature: At about 15-20°C it grows thickly and propagates.

Illumination: In general, it grows better with increasing light.

Turbulence: Prefers quiet inner bays, where it is abundant and grows thickly.

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.1.1 Sexuality

The gametophyte (leaf-like membrane) is dioecious.

3.1.2 Maturity

This species is an annual plant. The leafy frond matures in March-May, without relation to the size of the frond.

3.1.3 Fecundity

The gametes are isogametes. The average size just after liberation is 7.5 x 2.0μ. The zygote, which is at rest and becomes spherical, is 4.2μ diameter on average. The resting spherical zoospore is 5.4μ diameter on average. There are considerable individual variations in the size of these spores. The size and number of spores have no special relation to the size and degree of maturity of the frond. The number liberated is rather affected by environment (water temperature, exposure to air, light intensity, streaming of the water) and variations in the specific situation.

3.1.4 Liberation of spores or gametes

Along the middle part of the Japanese Pacific coast the zoospores are produced from the beginning of September; reproduction is at peak in the middle of the month and finishes at the end of September. The gametophytes usually appear from the beginning of March to the end of May; the peak period is from the middle of April to the beginning of May.

Spore emission is related to the light condition. In early morning they are liberated in larger numbers than at any other time of day. The periodicity of liberation appears to be related to tidal conditions. The liberation of spores is promoted by exposure to the sun for a short while and exposure to air. The artificial fertilization of gametes is experimentally easy and large numbers of zygotes can be obtained.

3.1.5 Spores and zygotes development

Upon attaching to the substratum, the zoospore begins to germinate and directly develops to the polycellular leafy plant. On the other hand the zygote becomes a minute, globular unicellular frond and, gradually increasing in size, rests through the summer period.

Rate of growth: The leafy frond attains to macroscopic size in 20-30 days and after 2 or 3 months develops to the adult frond of 10-15 cm in length. The zygote reaches 60-90 diameter in 3-4 months after attaching to the substratum, becoming encysted.

Development period: The leafy frond appears macroscopically in the beginning of October and then grows thick between November and March. The zygote increases its size conspicuously in May-June and at the end of August.

Ecological requirements: The leafy fronds are most abundant along the coast in shallow, calm, inner bay districts. They grow best in fully lighted places. The zygote passes the summer period on the bottom in shallow sea water; the adequate conditions for this are: water temperature of 22-25°C in water of 1.020-1.025, specific gravity, with rather feeble light.

The leafy frond is attacked by Achnanthes, Licmophora, Melosira etc. in unhealthy conditions and damaged by them, but there is no other destructive factor.

3.2 Life cycle

3.2.1 Alternation of generations

When the zoospore germinates and grows up, it becomes a gametophyte, while the zygote becomes a sporophyte when it develops. In other words, the sexual and asexual generations appear alternately and regularly.

3.2.2 Nuclear phases

Though not precisely distinguished yet, generally the gametophyte is haploid (n) and the sporophyte is diploid (2n). A reducing division of the nucleus appears to occur when the zoospore is formed.

3.3 Life history

3.3.1 Sporophyte

The zygote is a microscopic, spherical, unicellular frond with a usual life of 4 to 8 months. Competitors, grazers, parasites and diseases are not known, but it is weak to drying. Its greatest size is about 100μ in diameter.

3.3.2 Gametophyte

The membranaceous, polycellular frond, usually elliptical, normally lives for some 5 to 8 months.

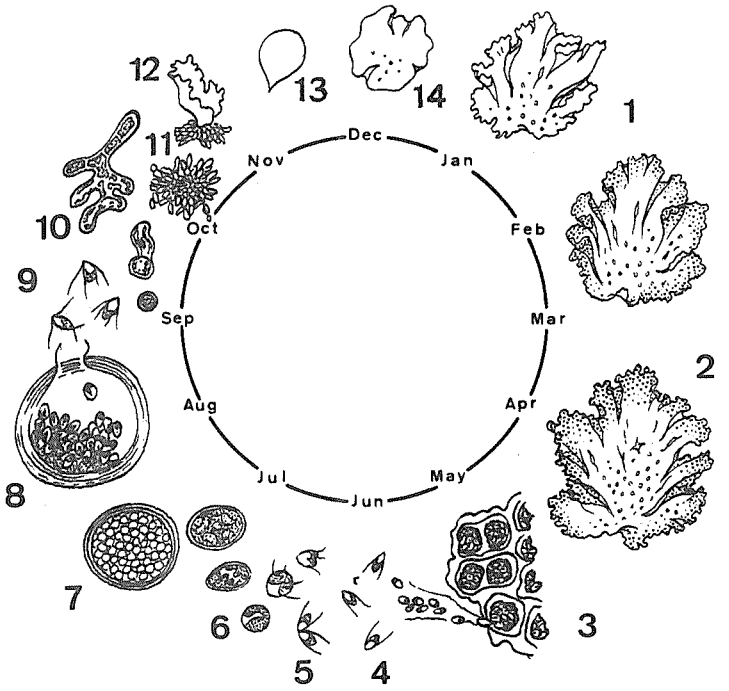
It has a comparatively high resistance to changes in outer conditions such as temperature, salinity, exposure and drying but is feeble under freezing.

It may be occupied by Enteromorpha, Balanus, diatoms etc., but no special grazers are known. The diatoms mentioned above may cause diseases. The so-called "freezing damage", due to exposure to cold in frigid winter, is its worst enemy. The length of the frond in the largest specimens of Naiwan type is about 30 cm.

3.4 Nutrition and growth

3.4.5 Relation of growth to environmental factors such as temperature and light

The places most suitable for growth are quiet, inner bays where temperature and salinity are high. The effect of other factors such as nutrient salts, organic nutrition or those concerned with photosynthesis have not yet been studied.



The life cycle of Monostroma latissimum Witt.

1: adult frond
2: matured frond (gametophyte)
3: liberation of gamete
4: gamete
5: conjugation of gametes
6: zygote
7: cyst
8: liberation of zoospore
9: zoospore
10: early development of zoospore
11: disc shaped development
12: erect development
13,14: young frond (gametophyte)

4 POPULATION (STOCK)

4.1 Structure

4.1.1 Sex ratio and sporophyte-gametophyte ratio

The male and female gametophytes are so alike that the sex ratio is obscure. The leafy frond is always a gametophyte.

The sporophyte-gametophyte ratio is unknown.

4.1.2 Age composition

As this plant is not a perennial, age composition does not apply.

4.1.3 Size composition

The stable appearance of the adult plant beds during their growing period is maintained by the fact that numerous young germlings developed in autumn grow rapidly by small groups

4.3 Mortality, morbidity

4.3.2 Effect of harvesting

Overcrowding results in low harvesting. In such cases, thinning is effective; but precise study has not been carried out.

5 EXPLOITATION

5.1 Harvesting equipment

5.1.1 Harvesting gear

In a shallow water district a palm yarn net is set horizontally, attached to poles. This is known as a "Hibi". The net is arranged as a layer above the growing zone and the spores released into the water become attached to it.

5.1.2 Harvesting boats

In order to set the "Hibi" and to pick up Monostroma, an ordinary small wooden boat is used.

5.2 Harvesting areas

5.2.1 General geographic distribution (in Japan)

This plant is cultivated along the coasts of Ise Bay, Mikawa Bay, small bays around them and a certain part of Seto Inland Sea.

5.2.2 Geographical ranges (latitudes, distances from coast etc.)

Approximately 30-40 N. latitude, in shallow inland waters.

5.2.3 Depth ranges

From exposed line to 5 m depth of sea.

5.3 Harvesting seasons

5.3.1 General pattern of harvesting season

The plant is harvested from the same "Ami-hibi"[1] at the rate of once a month.

5.3.2 Duration of harvesting season

Six months, from December to May.

5.3.3 Dates of beginning, peak and end of season

The harvesting begins during the first half of December. It is at its peak in March-April and ends in late May.

5.3.4 Variation in time or duration of harvesting season

The harvesting period may sometimes be delayed about one month. The end of harvesting tends to be earlier in inner bay districts and later in open sea areas.

5.3.5 Factors affecting harvesting season

Those taken into consideration are: temperature and intensity of light as factors of climate, water temperature and the effect of river water as factors of sea environment, and others such as density of plants attached to "Hibi" and speed of growth.

5.4 Harvesting operations and results

5.4.1 Effort and intensity

One "Ami-hibi" (1.2 x 18.0 m) is harvested six times in an ordinary year. The average amount each time is 3-4 kg (dried weight).

5.4.2 Selectivity

The method of harvesting is to pick by hand. After harvesting the fronds remaining on the "Hibi" are regenerated and effective.

5.4.3 Harvest

The total annual amount in Japan is around 1,500 tons in dried weight, but varies somewhat from year to year.

5.4.4 Past and present factors of effect on operations and results

Climatic factors such as temperature, intensity of light, seasonal wind, amount of rain, and environmental factors such as water temperature, salinity, flow of seawater, supply of nourishment, with other factors like the density of plants on the "Hibi", are taken into consideration.

5.5 Harvesting management and regulations

The height of the "Ami-hibi" is so adjusted as to coincide with the growing layer, affected by seasonal variations in tide and intensity of light, and managed and operated so as to increase and promote the growth of the plants.

5.6 Culturing, transplanting and other intervention

The germlings are collected from "Ami-hibi" arranged in "Taneba" (germination areas) where the spores are abundant. When the germ attains to macroscopical size in the middle or end of October, the "Hibi" is transferred to the culture ground and there nutured.

[1] coarse, meshed webbing suspended between poles.

6 CHEMICAL COMPOSITION

6.1 Water content

9.2 to 11.8 percent in dried Aonori.

6.2 Mineral constituents

Ca about 1.0 percent, Fe 35 to 54 percent, others in small percentage.

6.3 Organic constituents

6.3.1 Cell wall constituents (agar, alginic acid etc.)

Indistinctive

6.3.2 Pigments

Chlorophyll (a, b), Carotin, Xanthophyll.

6.3.3 Vitamins

Vitamin C very high (around 38 mg percent)

6.3.4 Other cell constituents

Various kinds of aminoacid such as methionin, glutamin acid, and protein, fibre, fat.

7 UTILIZATION

7.1 Food

Aonori is boiled with seasoning, soy and caramel and used as food.