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講演要旨



PLENARY LECTURES

LIFE HISTORY OF CERAMIALES SPECIALLY REFERRING TO THE MIXED-PHASE REPRODUCTION. In Kyu Lee and Gwang Hoon Kim. Department of Biology Seoul National University, Seoul, Korea

Most studies on life history of Ceramiales carried out in culture have not incorporated either cytological observations or genetic investigations of key features, and the unusual phenomena seen in Ceramiales, such as bisexuality and mixed-phase reproduction have been largely unexplained. This study, based on laboratory culture of about sixty Korean species of Ceramiales under the controlled environment, was aimed to elucidate the essential life history of ceramialecean species as well as the cause and meaning of the mixed phases by chromosome analysis and crossing experiment among isolates of each species.

The members of four families of the Ceramiales investigated characteristically showed a *Polysiphonia*-type life history with isomorphic gametophytic and tetrasporophytic generations. Most of the variations in the life history that have been encountered both in nature and under laboratory conditions involve only secondary modifications of the *Polysiphonia*-type life history. Among them, *Antithamnion nipponicum* Yamada et Inagaki, *Antithamnion sparsum* Tokida, *Antithamnion secundum* Itono, *Platythamnion yezoense* Inagaki, *Aglaothamnion oosumiense* Itono (Ceramiaceae), *Dasysiphonia chejuensis* Lee et West (Dasysiphonia), *Polysiphonia morrowii* Harvey and *Symphycladia pennata* Okamura (Rhodomelaceae) showed mixed phases and/or bisexuality in laboratory culture. Mixed-phase plants of *Antithamnion sparsum*, *A. nipponicum*, *A. secundum* and *Platythamnion yezoense* were collected also from the

field. In *Antithamnion sparsum*, *Platythamnion yezoense*, *Dasysiphonia chejuensis* and *Polysiphonia morrowii*, mixed phases and bisexuality often occurred on the same plants. Most species were regularly dioecious. However, dioecious species sometimes producing both sexes on the same plant as an aberrant behaviour. Most common is the occurrence of mixed phases with both sexual stages and tetrasporangia occurring on the same plant. The occurring percentage of mixed-phase plants varied greatly according to the species and populations, and it also varied according to environmental conditions of each isolates in *Antithamnion nipponicum*, *A. sparsum*, *A. secundum*, *Platythamnion yezoense*, *Aglaothamnion oosumiense* and *Dasysiphonia chejuensis*. All of the examined populations of above species showed a same pattern of life history. Therefore, mixed-phase reproduction was found to be one of the natural property and could be used as good character of each species.

The cause of mixed phases and/or bisexuality must be closely related to the sex determining mechanism of each species. The male and female sex ratio examined most of the species was always 1:1 regardless of environmental condition, so that the sex of these species was thought to be determined by sex chromosome. Some of the species which have only asexual life history were also observed: *Monosporus indicus* Boergesen and *Monosporus keomundoensis* Kim et Lee (nom. inval.) have monosporangium and *Callithamnion chejuense* Kim et Lee (nom. inval.) have only parasporangium for the reproductive structure, respectively. Sexual reproduction seems to be degenerated in these species.

A PERSPECTIVE ON THE PHYLOGENY OF THE PHAEOPHYCEAE. Hiroshi Kawai, Department of Botany, Faculty of Science, Hokkaido University, Sapporo, 060 Japan

The class Phaeophyceae is a member of the so-called Chromophyta containing chlorophyll *a* and *c* as photosynthetic pigments, distinguished from other classes in having multicellular thalli with plasmodesmata, differentiation between vegetative and reproductive cells and abundant alginates and florotannins. The Phaeophyceae is generally believed to be derived from the Chrysophyceae, as supported by some fine structural and molecular data (Lim et al. 1985, O'Kelly & Floyd 1985, Bhattacharya et Druehl 1988).

Concerning the phylogeny in the Phaeophyceae, Kylin (1933) proposed a phylogenetic tree, in which he regarded the life history pattern and basic construction of the thallus as the most important characteristics in discussing the phylogeny. Since then his basic concept has been generally accepted, although some modified phylogenetic trees have been proposed (Scagel 1966, Wynne & Loiseaux 1976). However, several basic contradictions have become apparent as further knowledge accumulated especially from recent culture studies. For example, the orders Laminariales and Desmarestiales which were considered to belong to different phylogenetic lines, now appear to have much closer systematic relations. Therefore, a revision of our concept of the fundamental characteristics and phylogeny of the Phaeophyceae is needed. In the present paper, I will review some taxonomic characteristics and recent biological findings, paying special attention to their systematic implications.

The number and shape of the chloroplasts and presence and absence of the pyrenoids are the most prominent and important cytological features. They are generally constant among various species in an order irrespective of the life-stage or part of the thallus, and are regarded as good systematic characteristics. A single chloroplast with a pyrenoid in a cell is considered to be the most primitive condition in the Phaeophyceae, and many chloroplasts without pyrenoids in a cell to be the most derived.

Life history patterns are still one of the most important systematic characteristics. In *Syringoderma*, obvious variations in the morphology of the gametophytes (from branched filaments to only 2 gametophytic cells) are found, despite the rather uniform morphology of the sporophyte (Henry 1984). Monoecism and dioecism seem to occur widely in some orders such as Laminariales, Desmarestiales and Fucales.

Sexual pheromones are shown to have essential roles in the sexual reproduction of the Phaeophyceae (Maier & Müller 1986). About 10 sexual pheromones (often occurring as mixtures) have been identified to date and their distribution among phaeophycean taxa apparently has systematic implications. For example, lamoxirene is confirmed to be the functional pheromone in more than 30 species of the derived Laminariales, however, it is not found in the primitive laminarialean families nor in any other orders. Desmarestene, viridiene, fucoserratene and cystophorene are also known only in one order as actual pheromones, although others (e.g. ectocarpene and hormosirene) are found in several orders. In *Analipus*, a quantitatively minor substance (hormosirene) is suggested to act as the actual pheromone (Müller et al. 1990).

The structure of swimmers (i.e. the condition of the chloroplasts and flagella) is considered to have important systematic implications. Most phaeophycean zoospores have a chloroplast with a stigma and flagellar swelling on the basal part of posterior flagellum. Flagellar basal bodies are connected with the nucleus and are spatially associated with the chloroplasts. However, those of derived Laminariales lack a stigma and flagellar swelling. Green flagellar autofluorescence associated with the stigma and flagellar swelling, which is suggested to be involved in the photoreception of phototaxis, is noted to occur in phototactic swimmers (Müller et al. 1987, Kawai 1988). The stigma is shown to have a reflective function and focuses the reflected light on the flagellar swelling (Kawai et al. 1990, Kreimer et al. 1991). Some sperm (e.g. Laminariales) have longer posterior flagella and several fragmented chloroplasts which are not associated with the flagellar base, while others (e.g. Fucales) share the longer posterior flagellum but have a chloroplast with or without a stigma. Remnant flagella were found in some immotile cells such as laminarialean egg and dictyotaean spores (Motomura 1989, Phillips 1991), which suggest that the eggs and tetraspores in these orders originate from flagellate cells. The flagellar rootlet system is in principle similar among most phaeophycean swimmers, composed of bypassing rootlets which pass through the flagellar bases longitudinally, and four kinds of rootlets (MAR, mar, MPR, mpr) which issue from the flagellar bases (O'Kelly 1989). Laminarialean sperm lack MPR. In fucal sperm a bundle of the MAR forms a proboscis. There are variations in the number of tubules in those rootlets, however, the basic number in phaeophycean swimmers is reported to be $MAR/mar/MPR/mpr/BR = 7/1/3/1/7$.

INVITED PAPERS

TAXONOMIC FEATURES OF *POLYSIPHONIA MORROWII* HARVEY (CERAMIALES, RHODOPHYTA). Toshihiko Kudo¹, Michio Masuda². ¹Biol. Lab., Sapporo Univ., Toyohira-ku, Sapporo, Japan. ²Dept. of Botany, Fac. of Science, Hokkaido Univ., Kita-ku, Sapporo, Japan

Taxonomic features of *Polysiphonia morrowii* were investigated through its life history stages by laboratory culture experiments and periodic field observations. The taxonomic criteria which had been used for this species were evaluated by comparing ontogenetic data of field-collected and cultured plants. Some of taxonomic features adopted previously show phenotypic variation according to environmental conditions or growth stages: the length/diameter ratio of segments, the external appearance of branches, number of axillary tetrasporangial branches. The significant specific features of *P. morrowii* were confirmed in this investigation.

This species is characterized by the following features: (1) ecorticated thalli with 4 pericentral cells, (2) thick and setaceous thalli in fully matured stage, (3) adventitious rhizoids without septations, (4) tightly intricate prostrating branches, (5) sharply pointed ultimate branchlets, (6) endogenous axillary branchlets formed from the central axial cells, (7) a few trichoblasts in matured stage, (8) tetrasporangia formed both on the ultimate and axillary branchlets, (9) axillary tetrasporangial branchlets tuftly (7-8 in number) formed on the axils of fully matured plants, (10) spermatangial branches replacing the whole trichoblasts, (11) urceolate cystocarps.

The occurrence of endogenous axillary branches is a peculiar feature characterizing some species in the genus *Polysiphonia*. The taxonomic relationship between *P. morrowii* and closely related species sharing the above-mentioned feature is discussed.

LIFE HISTORY, PHENOLOGY AND TAXONOMY OF *CAMPYLAEPHORA CRASSA* (CERAMIALES, RHODOPHYTA). Boo, Sung-Min. Dept. of Biology, Chungnam National Univ., Daejeon, 305-764, Korea.

The life history of an epiphytic species, *Campylaephora crassa* (Okamura) Nakamura, was investigated in the wild on the central eastern coast of Korea and under various laboratory conditions. Korean *C. crassa* plants showed no obvious seasonal differences in the occurrence of reproductive organs, whereas their overall habit was variable. In culture the species completed a *Polysiphonia* type of life history without the basiphyte, but parasporangia occurred at a frequency of about 1 % on young tetrasporophytes. Paraspores grew into tetrasporophytes, which later cycled a *Polysiphonia* type of life history. Crossability tests also documented that paraspores had the same nuclear phase as normal tetrasporophytes. This fact indicates that paraspores of *C. crassa* may be mitotic diploids which show a temporary modification in the life history strategy. Maximal growth in the field occurred in May when the seawater temperature ranged from 14.9 to 18.2 °C, while in culture the optimum temperature for growth was between 16 and 20 °C under each photon flux density. Plants in the field had tetrasporangia and cystocarps throughout year and the tetrasporophytes in culture formed tetrasporangia at most combinations of photon flux densities and temperatures.

CULTIVATION AND UTILIZATION OF SEaweEDS IN KOREA. Chul Hyun Sohn¹ and Nam Pyo Koh². ¹Dept. of Aquaculture, Nat'l Fish. Univ. of Pusan, Pusan, Korea. ²Dept. of Aquaculture, Yeosu Fish. College, Yeosu, Korea

Seaweed flora of the Korean coast is quite diverse, and more than 600 species has been reported. In Korea utilization of the seaweeds dates back to the early Korean history, and they have been cultivated since 17 C. The total annual production of the seaweed from the natural algal beds and by cultivation was recently estimated to be 483,000 M/T. The production by cultivation occupies more than 90% of the total algal production. In 1988, 34,619 M/T of seaweeds were exported, while 3,090 M/T were imported, and most of them were dried and salted. The major algae of economic importance include *Porphyra*, *Gelidium*, *Gracilaria*, *Pachymeniopsis*, *Undaria*, *Laminaria*, *Sargassum*, *Hizikia*, *Enteromorpha* and *Codium* etc. Of these *Porphyra*, *Undaria*, *Laminaria*, *Hizikia*, *Enteromorpha* have been cultivated. *Porphyra* is very popular, and its annual production is amounting to US \$ 300 million which is more than half of the total aquaculture fisheries production in Korea. Traditionally the seaweeds have been consumed by various ways such as fresh salads, dried snacks, roasting lavers and seaweed soup. However industrial processing has been undeveloped. In Korea the agar production is made mainly by agar extraction from *Gelidium amansii*, while production of carrageenan/alginate acid is very few.

UTILIZATION OF MICROALGAE AND IAM CULTURE COLLECTION. Mikio Tsuzuki and Naomi Shimoyama. Institute of Applied Microbiology, Univ. of Tokyo, Yayoi, Bunkyo-ku, Tokyo 113 Japan

Microalgae has often been used as materials for research of plant science. It is because they can grow very fast under a certain condition and be taken out quantitatively with pipettes. Axenic culture and mutants have also been useful. However, the species usually used have been rather restricted so far, and the strain number of the species are sometimes important for physiological and biochemical researches, for each strain shows different characteristics at times. The same is the case in biotechnology. Though some chemicals such as β -carotene and polysaccharides are extracted from some strains, microalgae are still relatively untapped resources.

It is important for a researcher to obtain and then to keep strains of algae when he wants to use them. Since most of the algal species must be maintained by serial transfer at regular intervals, there is a great risk of disappearance. There needs the special center where algal strains are maintained and supplied by demand.

Algal Culture Collection in the Institute of Applied Microbiology (IAM), University of Tokyo was commenced in 1957. Many strains of microalgae were collected and identified there and were maintained to be distributed for scientific and technological studies and education. These works, however, were carried out in a research laboratory. In 1989 Microbial and Microalgal Research Center was established in the same institute and it took over the collection for the purpose of substantial culture center of microorganisms including microalgae. As the first step of the center, we have been checking the strains we have and collecting information about them for a catalogue. Other activities of our collection will be also reported in this symposium.

MORPHOLOGY AND LIFE CYCLE OF *EUNOTIA MULTIPLASTIDICA* SP. NOV. (BACILLARIOPHYCEAE) WITH SPECIAL REFERENCE TO SYSTEMATICS OF RAPHI-DIROID DIATOMS. Shigeki Mayama. Department of Biology, Tokyo Gakugei Univ., Koganei-shi, Tokyo, Japan.

Valve shapes of *Eunotia* species are usually simple and the taxonomic characteristics are scarce under light microscopy. In addition, the valve shape varies during the life cycle. However, there has been no observation throughout the life cycle using SEM in any species.

E. multiplastidica was originally found on wet moss in Sainokawa, Ehime Pref., Japan. Unialgal cultures were established from the original material. One to two months later, sexual reproduction was observed in these cultures. In this process, one auxospore was formed from two gametangia. An initial cell developed within each auxospore was followed by a formation of post-initial cells. The initial valves were 45-47 μm long and about three times longer than those of gametangial cells.

Observations of the valves and plastids were carried out throughout the life cycle using these cultured cells. Though the shape and length of the valves varied extremely, certain characteristics were stable throughout the life cycle, i.e., the numerousness of chloroplasts, the location of pattern center and raphe, areola morphology, striation density, the number of labiate process and epitheca depth. These characteristics were used as taxonomic criteria of this species.

In the pennate diatoms, there have been few reports on the fine structure of the perizonium. In this study, the structure of the perizonium was examined in detail using SEM. The traditional systematics of the raphidiod diatoms was constructed based on only the presence of the labiate process and the raphe. However, the particular structure in the perizonium, namely, the areolated primary transverse band with both a circular and linear pattern center, suggests a probable phylogenetic affinity with the centric diatoms and the araphid diatoms.

MORPHOLOGIC AND TAXONOMIC INVESTIGATIONS ON THE DIATOM GENUS *DIPLONEIS* EHR. Choi, Joong Ki and Jae Hoon Noh. Department of Oceanography, Inha University, Incheon 402-751, KOREA

A large number of *Diploneis* species collected from the Korean coastal waters have been investigated by light and scanning electron microscope. 27 species, 8 varieties and 1 forma are identified, however, 7 species are unidentified and photographed in this study. Among these species, 16 species, 5 varieties and 1 forma are newly recorded in Korea. These species are *D. bomboides*, *D. adonis* var. *oamaruensis*, *D. diplosticta*, *D. novaesleendae*, *D. bombus* var. *bombiformis*, *D. hospes*, *D. dalmatica*, *D. campylodiscus*, *D. nitescense*, *D. gemmata* var. *pristophora*, *D. vespa*, *D. notabilis*, *D. suborbicularis*, *D. crabro* var. *dirhombus*, *D. schmidtii*, *D. contigua*, *D. graefii*, *D. vacillans*, *D. parca*, *D. vacillans* var. *renitens*, *D. smithii* forma *rhombica* and *D. lacrimans*.

EFFECT OF UV RADIATION ON THE VERTICAL DISTRIBUTION OF RED ALGAE AND CONTENTS OF UV ABSORBING SUBSTANCE. Miyuki Maegawa, Masayo Kunieda and Washirou Kida. Faculty of Bioresources, Mie Univ., Tsu, Mie, Japan.

UV band occupies 9 % of solar radiation in the outer space and 1-4 % on the sea surface depending on weather conditions. UV radiation, dose not penetrate so much as PAR in the sea, decreased to 10 % at a depth of 5 m, and below 1 % at a depth of 10 m. We tested the influence of UV radiation, full solar radiation and PAR for several red algae collected from shallow water, intertidal zone to upper subtidal zone, and from deep water, 25-30 m depth. UV radiation, which occupied only a few ratios of solar radiation, depressed photosynthetic activity of deep water species significantly as well as full solar radiation and PAR did. Shallow water species were not affected so much by UV radiation, full solar radiation and PAR.

We have a hypothesis that UV absorbing substance containing much in red and blu-green algae protect the thallus from strong UV radiation. Shallow water species may have an ability to resist injurious UV radiation, and deep water species may have no such an ability. However, there have been a little information for ecological role of UV absorbing substance. Then, we measured the contents of UV absorbing substance for 33 species collected from shallow and deep waters. Shallow water species contained much UV absorbing substance, and deep water species contained little or no UV absorbing substance. Particularly, intertidal species had more UV absorbing substance than other species.

In our previous paper, deep water species had more phycoerythrin, which absorbed green to blue light, than shallow water species. So, deep water species adapted to deep water light condition. In this study, shallow water species have more UV absorbing substance than deep water species. So, shallow water species are protected from injurious UV radiation by high contents of UV absorbing substance. UV radiation in the sea is one of the most important factors to control the vertical distribution of red algae, with reference to the content levels of UV absorbing substance between shallow and deep water species.

ECOLOGICAL STUDIES ON SUCCESSION OF MARINE ALGAE. Young Hwan Kim, Jong Su Yoo and Jee Hwan Kim. Dept. of Biology, Chungbuk Nat. Univ., Chongju 360-763, Korea.

As the process of ecological succession occurs more rapidly in benthic marine habitats than in terrestrial communities, benthic marine communities provide a particularly convenient testing-ground for theories about ecosystem development and ecological succession. Since 1985 we have examined the variations of colonization, growth pattern and succession of benthic marine algae on various artificial substrata and also on cleared natural surfaces.

Firstly, seven kinds of artificial substrata, i.e., concrete, slate, glass, wood, rubber, aluminium and PVC plates, were placed at upper, middle and lower intertidal zones of Poryong and Sochon, western coast of Korea, during the period of January - November 1985. As a whole, coccoid blue-green algae and diatoms were observed as pioneer algae settled over newly placed substrata, and then filamentous green and crustose coralline algae were gradually luxuriant, whereas diatoms decreased in abundance. Colonization and growth of marine algae were significantly influenced by differences between tidal levels or the kind of artificial substrata.

Studies have also been made of the recolonization of cleared natural surfaces over a 21-mo period (July 1986 to April 1988) at intertidal zones of Muchangpo and Maryangri, western coast of Korea. Surfaces were sterilized by burning after clearing. In general, the successive stages found in the permanent quadrats were blue-greens or filamentous algae - membranous algae - perennial algae. However, the nature and position of the surface and length of time of exposure have been shown to influence the population which develops. It was concluded that a climax community can be attained after 18 months since the substrata were cleared.

DISTRIBUTION PATTERN OF MACRO-ALGAE IN THE WEST SEA (EASTERN YELLOW SEA), KOREA. Chul-Hwan Koh, Sang-Hee Oh, Dept. of Oceanography, Seoul Nat. Univ. Seoul, Korea

Koh and Lee (1982) tried to differentiate the floral composition of benthic algae between coastal and open waters in the Kyunggi Bay, West Sea of Korea. The total number of species tends to increase from the coastal waters to the open sea. Brown algae are more sensitive in terms of species number. Song (1984), Sohn (1987) and Park & Kim (1990) reported also the same tendency in the distribution pattern of macroalgae in the whole area of West Sea.

Koh and Lee (1982) insisted that the floristic differences that are observed between the coastal waters and open sea area appears to be related to water turbidity rather than to temperature as reported by Kang (1966). Several authors have agreed with the importance of turbidity since 1982. The relationship between the distribution and environments are reviewed in this presentation.

REPRODUCTIVE STRUCTURE AND TAXONOMY OF *SPATOGLOSSUM* (DICTYOTALES, PHAEOPHYCEAE). Jiro Tanaka. Dept. of Botany, National Science Museum, Shinjuku-ku, Tokyo, Japan

Three species of *Spatoglossum*, *S. pacificum* YENDO, *S. crassum* sp. nov. and *S. latum* sp. nov. occur along the Pacific coasts of the central Japan. They form three kinds of reproductive organs, i.e. sporangia, oogonia and antheridia on separate plants. Sporangia can be distinguished from oogonia by bigger size and sometimes by possession of four spores. As the result of the morphological comparison among the Japanese species and the other established species of the world, the genus *Spatoglossum* can be separated into two groups based on the position of reproductive organs.

In the first group including *S. pacificum*: sporangia and oogonia aggregated in sori and project above the thallus surface; antheridial sori stand up above the general thallus surface. These characters are well known in the other genera of the Dictyotales, i.e. *Dictyota*, *Dilophus*, *Pachydictyon* and *Dictyopteris*. This group comprises *S. areschougii* J. AG. from Barbados in the Caribbean Sea and *S. chapmanii* LINDAUER from New Zealand.

In the second group including *S. crassum* and *S. latum*: sporangia scatter throughout the thallus and not in a sorus; sporangia and antheridial sori are lying completely within the cortex; oogonia scatter throughout the thallus and project both above and below the cortex. These features, particularly the buried sporangia into the cortex, have never been known in the other genera of the Dictyotales. This group comprises *S. crispata* HOWE from Peru and *S. macrodontum* J. AG. from Australia.

It can be concluded that these two groups are separated into two genera based on the above-mentioned remarkable differences on reproductive structures.

A CHEMOTAXONOMIC STUDY ON GEOGRAPHICAL VARIATIONS OF KOREAN FUCALES PLANTS. 4. THE ISOENZYMES. Soon-Ae Yoo and Ki-Sung Lee. Department of Biology, Pai-Chai University, Daejon 302-735, Korea.

To obtain chemotaxonomic characteristics of Korean Fucales plants, we had already compared the composition of pigments, phospholipids, neutral fats, inorganic polyphosphate, and haemagglutinin^{1,2,3}). In this paper, we compare the patterns of 13 kinds of isoenzymes extracted from 10 species of Korean Fucales plants.

The electrophoretic zymograms showed that most of the carbohydrate-metabolizing enzymes (G-6-P DH, MDH, ADH, IDH, PGM, AMY) and catalase had mono- and/or di-morphic patterns. It seems that the genetic variations are small in those enzyme systems. Those enzyme systems seem to be genetically stable. They have the main enzyme activities in isoenzymatic zymograms mobilized to the cathode.

On the other hand, in the case of haydolase (AKP, ACP, EST), isomerase (GPI), oxidoreductase, they all showed polymorphic isoenzymatic zymograms. We believe that these enzymatic systems are genetically rather unstable. Most of these enzymes are involved in phosphate metabolism, and the activity of these enzymes varies according to the phosphate concentration of the environment. So these enzymes seem to be important in studying genetic variations in Fucales plants growing in different geographical habitat.

1) Yoo, S. A. and K. S. Lee. 1988. A chemotaxonomic study on geographical variations of Korean Fucales plants. 1. The comparison on pigments, phospholipids, neutral fats and inorganic phosphates. *Korean J. Phycol.* 3(1):1-8.

2) Yoo, S. A., K. S. Lee, and K. S. Park. 1988. A chemotaxonomic study on geographical variations of Korean Fucales plants. 2. Lectin. *Korean J. Phycol.* 3(1):9-12.

3). Yoo, S. A. and K. S. Lee. 1988. A chemotaxonomic study on geographical variations of Korean Fucales plants. 3. The 3-dimensional analysis of total lipids. *Kor. Jour. Bot.* 31(2):83-89.

MOLECULAR TAXONOMY OF MICROCYSTIS (CYANOPHYCEAE) BASED ON ALLOZYME DIVERGENCE. KATO Tatsumi and WATANABE Masayuki. National Science Museum, Tsukuba 305, JAPAN.

Microcystis is a limnoplanktic, bloom-forming blue-green alga. As a part of molecular taxonomic revision, allozyme divergence of Japanese Microcystis was studied electrophoretically.

We investigated allozyme genotypes at four enzyme loci (IDH, 6PGD, PGI and PGM) on a total of 168 strains collected at forty-three waters. The obtained data were statistically analyzed according to KATO & DOI's Minimum Replacement Method. As a result, the strains studied were classified into four genetic types: Microcystis aeruginosa S-type, M. aeruginosa L-type, M. viridis and M. wesenbergii. Each of the four types was found to exhibit characteristic morphology. M. aeruginosa S-type was characterized by its small size cells (3.0-4.2 μm). The other three types that have larger cells (4.5-6.5 μm) were discriminated by the colony formation: M. aeruginosa L-type, M. viridis and M. wesenbergii formed clathrate, cubic and pouched colonies, respectively. Accordingly, the four genetic types could be viewed as separate taxonomic entities.

The above achievements will provide a new and reliable taxonomic system of Microcystis. As clearly illustrated here, the allozyme study (i.e. molecular taxonomic approach based on allozyme divergence) is considered as one of the most effective approaches that would lead to the solution of many taxonomic problems on cyanophytes, especially at the species and/or genus level.

BIOCHEMICAL AND PHYSIOLOGICAL PROPERTIES OF A GAMETIC PROTOPLAST-RELEASE-INDUCING PROTEIN IN *CLOSTERIUM*.

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Heterothallic strains of *Closterium* proliferate asexually in nitrogen-sufficient medium while conjugation is induced in nitrogen-deficient mating medium (MI medium). The conjugation process consists of cell division, pairing, formation of conjugation papillas, release and fusion of gametic protoplasts, and formation of zygotes. Some cells formed a papilla and released their protoplasts without pairing. This indicated that the process of protoplast-releasing was independent upon pairing and there might be a substance, which was responsible for protoplast release, in the medium.

1). *Detection of a substance that induces the gametic protoplasts.* When mt^+ and mt^- cells were separately incubated in the MI medium obtained from 55h-old-mixed cultures of mt^+ and mt^- cells, release of protoplasts was observed only in mt^- cells. These data indicated that a substance responsible for protoplast release was released into the medium.

2). *Purification of a protoplast-release-inducing protein (PR-IP).* The substance with the ability to induce the release of protoplasts was purified from the medium by sequential column-chromatographic steps, and named PR-IP. The PR-IP had an apparent molecular mass of 95k on gel filtration and could be separated into several isoforms by anion-exchange chromatography. Each isoform consisted of two glycopolypeptides of M_r s of 42k and 19k, while the deglycosylated polypeptides had M_r s of 34k and 18k, respectively.

3). *Physiological properties of PR-IP.* Light was indispensable for the protoplast-release. From an analysis of dose-response curves, the concentration required for 50% of the maximum response (ED_{50}) was calculated as $4.1 \cdot 10^{-9}$ M. Moreover, the reduced protoplast-releasing reaction was observed by the treatment of high concentration of PR-IP (5.2 μ g/2ml). These data indicated that PR-IP dose not act as cell wall lytic enzyme, which is well-known in conjugation of *Chlamydomonas*. We propose the PR-IP is a biologically active glycopolypeptide that induces the release of protoplasts by binding to receptors on the cell surface, as do animal peptide hormones.

CHARACTERIZATION OF A Na^+ -ACTIVATED ATPASE OF A MARINE RAPHI-DOPHYTE, *HETEROSIGMA AKASHIWO*. Masato Wada. Institute of Biol. Sci., Univ. of Tsukuba, Tsukuba-shi, Ibaraki, Japan.

A marine raphidophycean unicellular biflagellate, *H. akashiwo*, is a naturally occurring, wall-less organism which is useful for both the preparation of plasma membrane and the investigations of its physiological functions. One of the major functions of plasma membranes is the regulation of ion transport at the cell surface. High purified plasma membranes were isolated from *H. akashiwo* with silica microbead method and the novel membrane associated Na^+ -activated ATPase activity were characterized. The ionic requirements and spectra of effective inhibitors on the ATPase activity showed a close similarity to the animal Na^+, K^+ -ATPase. This kind of ATPases which are sensitive to vanadate forms phosphorylated intermediate in their enzyme cycle. The phosphorylated intermediate of this ATPase were detected as 140 kDa polypeptide with acid SDS-polyacrylamide gel electrophoresis; this molecular weight was considerably bigger than the α subunit of animal Na^+, K^+ -ATPase. However, the antiserum to animal Na^+, K^+ -ATPase reacted to *H. akashiwo* 140 kDa ATPase. It was suggested that both Na^+ -activated ATPases have a common epitope. The cDNA sequences of animal Ca^{2+} -ATPase and fungal H^+ -ATPase has been already analyzed with biotechnological methods. The obtained informations on their functions have facilitated to understand the ion transport, ion selectivity and ATP hydrolysis mechanisms of these ATPases. The primary structure of the ATPase of *H. akashiwo* contribute the understanding of Na ion transport or Na ion selectivity mechanism. A cDNA cloning of the ATPase from *H. akashiwo* was achieved with PCR method and succeeded, the homology between those ATPases was discussed.

TAXONOMY AND PHYLOGENETIC ANALYSIS OF THE NEMALIALES (RHODOPHYTA) ON THE BASIS OF THE THALLUS STRUCTURE, INITIATION OF CARPOGONIAL BRANCH AND CARPOSPOROPHYTE FORMATION. Makoto Yoshizaki, Dept. of Biology, Toho University, Funabashi-shi, Chiba, Japan

The order Nemaliales was established by Schmitz (1892), on the basis of the lack of auxiliary cell in the formation of carposporophyte, and the following 3 families as taxa composing the order Nemaliales are proposed by Pueschal and Cole (1982): The Acrochaetiaceae, Helminthocladaceae and Galaxauraceae.

The data available at present, the following keys can be made in connection with the taxonomy and phylogenetic relationships of the Nemaliales on the basis of the thallus structure, carpogonial branch and carposporophyte formation:

1. Carpogonial branch is directly formed on the filamentous thallus ----- 2
1. Carpogonial branch is formed on the assimilatory filament ----- 3
2. Compact carposporophyte is formed ----- Acrochaetiaceae
2. Diffused carposporophyte is formed ----- Woelkerlingiaceae
fam. nov.
3. Carpogonial branch is formed terminally on a cell of assimilatory filament ----- 4
3. Carpogonial branch is formed laterally on a cell of assimilatory filament ----- 6
4. Hypogynous cell gives rise lateral cells with dense contents ----- Galaxauraceae
4. Hypogynous cell not produce lateral cells ----- 5
5. Compact carposporophyte is formed ----- Nemaliaceae
5. Diffused carposporophyte is formed ----- Dotyophyceae
fam. nov.
6. Compact carposporophyte is formed -- Helminthocladaceae
6. Diffused carposporophyte is formed ----- Dermonamataceae

TAXONOMY OF THE GENUS *GRATELOUPIA* (HALYMENIACEAE, RHODOPHYTA) IN KOREA

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The external morphology, internal structure and reproductive organ of nine species of *Grateloupia* (Halymeniaceae, Rhodophyta) analyzed and re-evaluated taxonomically. The species of *Grateloupia* reported until now in Korea is *Grateloupia divaricata*, *G. filicina*, *G. filicina* var. *porracea*, *G. imbricata*, *G. livida*, *G. okamurae*, *G. prolongata*, *G. sparsa* and *G. turuturu*. As a result of comparison of the taxonomic characters between *G. filicina* and *G. filicina* var. *porracea*, the latter is regarded as a independent species from the former. And the morphological characters of *G. okamurae* is compared to other species and re-evaluated taxonomically. The taxonomic characters of the plants belong to the genus *Grateloupia* are (1) lubricous texture, (2) 5-10 cell layers of cortex, (3) lobed inner cortical cell, (4) longitudinal arrangement of medullary filaments, (5) reproductive organs on frond surfaces, and (6) conical auxiliary cell ampulla with one primary and on to four secondary ampullar filaments.

TAXONOMY AND PHYLOGENY OF A GREEN DINOFLAGELLATE, *LEPIDODINIUM VIRIDE* (DINOPHYTA).

Makoto M. Watanabe¹ Shoichiro Suda¹, Isao Inouye² and Tsutomu Sasa¹. ¹National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan. ²Institute of Biol.Sci., Univ. Tsukuba, Tsukuba, Ibaraki, Japan.

A green-colored marine dinoflagellate, *Lepidodinium viride* with a chlorophyll *a*- and *b*-containing vestigial endosymbiont is given with special emphasis on the morphology and the pigment composition.

The host dinoflagellate cell is unarmored and has a gymnodinoid overall appearance. The theca or amphiesma basically consists of the outer membrane and flattened thecal vesicles in which no thecal plates are developed. Unusual hand basket-shaped scales cover the entire cell surface together with a layer of mucilaginous material. These findings led us to conclude that the organism was a new member of the Gymnodiniaceae and to propose the above new genus and species name. The ultrastructure of the host cells is typical of the dinoflagellates; however, the organism has 1) an unusual cytoplasmic projection that may be a homologue of the peduncle, 2) a single membrane-bounded body containing membranous sheets, closely situated next to the endosymbiont, and 3) an electron opaque network-forming appendage surrounding the transverse flagellum. None of these features have been found in other dinoflagellates.

The vestigial endosymbiont is unlike anything that has been found in the dinoflagellates before. The cytoplasm of the endosymbiont is separated from the host cytoplasm by a double membrane and neither a nucleus or mitochondria occur within it. The endosymbiont contains chlorophylls *a* and *b* and the usual chlorophyte carotenoids, that are neoxanthin, violaxanthin, antheraxanthin, zeaxanthin and beta-carotene. In addition to these carotenoids, some unknown peaks were detected. One peak is situated at the identical retention time to that of lutein, but the absorption spectrum is slightly different from that of lutein. The other peaks are undecided, although there is a small peak which seems to show the identical retention time and absorption spectrum to those of siphonaxanthin. Based on these results, it is speculated that a prasinophyte would seem to be the likeliest candidate for a progenitor of the endosymbiont.

ALGAL CALCIFICATION. ITS CONTRIBUTION TO THE "CO₂ PROBLEM". Megumi Okazaki. Department of Biology, Tokyo Gakugei University, Nukuikita-machi, Koganei-shi, Tokyo 184, Japan.

The recent increase in atmospheric CO₂ (350ppm at present) is a matter of anxiety because of rapid climatic changes from its greenhouse effect. However, the primitive atmosphere contained much more CO₂ (about 97%) and it has been suggested that photosynthesis and biological CaCO₃ deposition in ocean played an important role to obtain the present low level of CO₂ on the earth. In fact, nearly 10,000 times as much carbon of atmosphere is in undecayed organic matter in sediments and indeed 100,000 times as much in limestone (CaCO₃).

The certain corallinean algae form algal limestone and *Halimeda* is important as a CaCO₃-sand former and as a sediment-consolidator in coral reefs.

Coccolithophorid such as *Emiliania huxleyi* is regarded as the chief producer of CaCO₃ in ocean.

CaCO₃ deposition in ocean takes place by a following reaction:
 $2 \text{HCO}_3^- + \text{Ca}^{2+} \rightarrow \text{CO}_2 + \text{CaCO}_3 + \text{H}_2\text{O}$.
 Therefore, it should be noticed that CaCO₃ formation accompanies CO₂ evolution from dissolved HCO₃⁻ in seawater. Algal calcification, however, is coupled with their photosynthesis and the rate of photosynthesis is several times higher than calcification rate. Thus, CO₂ release from seawater never takes place during their calcification process. However, their photosynthetic products in ocean might be completely oxidized sooner or later. Therefore, contribution of calcification to fixing atmospheric CO₂ is dependent on what proportion of organic matter produced in ocean is not oxidized back to CO₂.

CONTRIBUTED PAPERS

AGLAOTHAMNION CHEJUENSE SP. NOV.
RHODOPHYTA, CERAMIAEAE) FROM KOREA.

Gwang Hoon Kim and In Kyu Lee. Department of Biology, Seoul National University, Seoul 151-742, Korea

Aglaothamnion chejuense, a new red alga bearing parasporangia, is described from Cheju island of Korea. Although, the plants showed alternate branching pattern and had only one nucleus in each vegetative cell, it was clearly distinguished from other members of the genus *Aglaothamnion* as well as *A. hookeri*, the only other species bearing parasporangia, by the characters of branching pattern, apical parasporangia and lack of sexual stages. Asexual life history which comprised of parasporophyte and tetrasporophyte was repeated six times without any sexual reproductive structure. The parasporangia developed from an apical cell of branch, whereas the tetrasporangia developed serially on the adaxial side of lateral branches.

CULTURE OF LAMINARIA JAPONICA USING DEEP-OCEAN-WATER PUMPED UP IN TOYAMA BAY.
Daisuke Fujita. Toyama Pref. Fish. Exp. Stn., Nameri-kawa-shi, Toyama, Japan.

Using flowing deep-ocean-water(DOW, 6°C) pumped up from the depth <200m of Toyama Bay, one year old plants of Laminaria japonica were cultured in a tank set on the artificial upwelling experimental facility for about one month in summer. They grew well at the rate of 9.6mm/day, while those cultured in the sea (25°C, 5m depth) deteriorated. Iron level was high at the old part of DOW-cultured kelp. In the laboratory culture(10°C, 3,000 lux) for one month, sporelings of the kelp grew the best in PEDOWI, and in PESI, in DOW and in SW in turn. Undaria pinnatifida sporelings also grew well in the order above.

A RE-EXAMINATION OF SOME EUROPEAN AND CALIFORNIAN LAURENCIA SPECIES (CERAMIALES, RHODOPHYTA). Ki Wan Nam and Yuzuru Saito*. Dept. of Mar. Biol., National Fish. Univ. of Pusan. *Lab. Mar. Bot., Fac. Fish., Hokkaido Univ.

Morphology of some European and Californian species, *L. pinnatifida*, *L. spectabilis*, *L. crista*, *L. platycephala* and *L. hybrida*, was re-examined. Spermatangia and tetrasporangia essentially differ from those of *L. obtusa*, the type of the genus, as produced at alternately branched filaments derived from epidermal cells rather than at dichotomously branched trichoblasts done from axial cells and at epidermal cells rather than at pericentral cells, respectively. Those species probably occupy a different position in evolutionary line from the genus. Of those species, *L. hybrida* is distinctive in with six pericentral cells instead of five at fertile segment of female trichoblast.

GAMETOGENESIS AND EARLY SPOROPHYTE DEVELOPMENT OF LAMINARIA RELIGIOSA MIYABE IN THE EAST COAST OF KOREA. Jin Ae Lee, Dept. Environ. Sci., Inje Univ., Kimhae 621-749, Korea.

Ecotypic populations of *Laminaria religiosa* in the east coast of Korea were monitored from October 1989 to October 1990 to investigate growth and reproductive phenology at near southern limit of its distribution in East Sea of Korea. Plants exhibited an annual growth pattern with maximum in June. Most of the morphological parameters measured showed the similar pattern and reached maximum values in June. Blade disintegration occurred during the summer months. Reproductive sporophytes occurred from October to December 1989. Young sporophyte population was observed in March, which was assumed to be the result of the late fall sporogenesis activity. Reproduction and growth in gametophytes and growth in juvenile sporophytes were studied in relation to temperature and irradiance. Although no seasonal variation was found, higher irradiance ($80 \mu\text{E}\cdot\text{m}^{-2}\cdot\text{sec}^{-1}$), and temperature of 4 - 12 °C resulted in greater activities.

A STUDY OF DIATOM SPECIES
 GOMPHONEMA VIBRIO EHR. VAR.
 SUBCAPITATUM (MAYER) LEE, COMB. NOV.
 Jung Ho Lee¹, Toshikazu Gotoh² and Jun
 Chung¹. ¹Dept. Biol., Kyungpook
 Univ., Taegu, Korea. Dept. Biol.,
²Kinki Univ., Osaka, Japan.

This taxon was described as
Gomphonema intricatum var. vibrio f.
subcapitata by Mayer (1928).
 Micromorphology of this taxon and G.
vibrio were studied with ornamentation
 of girdle can be devided this taxon
 from G. angustum (Syn. G. intricatum).

There is no basal difference
 between G. vibrio and V. intricatum
 var. vibrio f. subcapitata except for
 size and outline of valve and striae
 density. It therefore is proposed
 that the new combination, G. vibrio
 var. subcapitatum. And also, it is
 elucidate that G. nipponica Skv. is a
 synonym of this taxon.

THE EFFECT OF SEAWATER DILUTION
 ON THE PHOTOSYNTHETIC ACTIVITY OF SEA-
 WEEDS GROWING IN TIDE POOLS. Nobuyasu
 Katayama¹, Kumi Takakura¹ and Yasutsugu
 Yokohama². ¹Dept. of Biology, Tokyo
 Gakugei Univ., Koganei, Tokyo, Japan.
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 of Tsukuba, Shimoda, Shizuoka, Japan.

The effect of a stepwise seawater
 concentration fall, diluted with dis-
 tilled water or buffered isotonic NaCl
 solution (pH 8.2), on the photosynthetic
 rate of Ulva pertusa, Enteromorpha cri-
nita and Grateloupia filicina, growing
 in tide pools, was examined. E. crinita
 was most tolerant of the seawater dilu-
 tion among them. The photosynthetic
 activity of G. filicina was affected
 mainly by the change in CO₂ concentra-
 tion, while of U. pertusa the activity
 was affected by the changes in both pH
 and salinity. These seaweeds retained
 their photosynthetic activities even in
 freshwater in several hours. The result
 obtained indicates that the tolerance
 for the seawater dilution by a rainfall
 must be one of the important properties
 of seaweeds growing in tide pools.

A STUDY ON THE TAXONOMY OF THE
 MARINE DIATOM GENUS COSCINODISCUS AND
 THEIR GEOGRAPHICAL VARIATIONS IN THE
 KOREAN COASTAL WATERS. Jin Hwan Lee
 and Yoon Hee Jung. Sangmyung Women's
 University, Seoul 110-743, Korea

In order to identify the RADIATI
 group of the diatom genus Coscino-
discus from the eastern, western, and
 southern Korean coastal waters, it has
 been studied both light microscope
 (LM) and scanning electron microscope
 (SEM) observations of a fine structure
 and morphological patterns.

As a result, the genus Coscino-
discus was recorded six species and
 one unidentified species : C. gigas,
C. granii, C. asteromphalus and C.
sp.1.

Most of Coscinodiscus taxa have
 showed the insignificant morphological
 (the valve diameter, number of
 areolae, the number of marginal
 processes, etc.) variations in three
 coastal waters of Korea. As compared
 between Korean specimens and other
 waters, it showed geographical
 differences ; valve diameters, areolae
 number, feature of labiate processes,
 perforations of the cribra, etc.

INFLUENCE OF LIGHT INTENSITY AND
 TEMPERATURE ON CALLUS DEVELOPMENT IN YOUNG
 SPOROPHYTES OF SOME SPECIES OF LAMINARIALES
 (PHAEOPHYTA). Masahiro Notoya. Mikako
 Nagashima and Yusho Aruga. Lab. of Phycol.,
 Tokyo Univ. of Fish., Konan-4, Minato-ku,
 Tokyo, 108 Japan

Excised rectangular blade pieces (0.5-1
 mm) in young sporophytes (3-5 mm blade
 length) of four Laminariales species
 (Costaria costata, Eisenia bicyclis
Laminaria japonica, Undaria pinnatifida)
 were cultured under various light
 intensities (1-8 klux) and temperatures
 (10-25°C). and callus development and
 differentiation were observed. Callus
 development from pieces of sporophyte
 explant was almost the same in each
 species. After 2-4 days in culture, callus
 cells were produced from the cut edge. In
 about 3-4 weeks, blade-like plantlets were
 differentiated from growing callus cells.
 Favorable conditions for callus development
 from explants were different with species:
 15°C and 2-4 klux in C. costata, 20 °C and
 1 klux in E. bicyclis, 10-15°C and 1 klux
 in L. japonica and 15-20°C and 2 klux in U.
pinnatifida.

TAXONOMY ON THE GENUS *CLADOPHORA* (CLADOPHORACEAE, CHLOROPHYTA) FROM KOREA
Yoon Sik Oh and In Kyu Lee, Department of Biology, Seoul National University, Seoul 151-742, Korea

A taxonomic study on the members of *Cladophora* commonly collected from the coasts of Korea was carried out to re-appraise the morphological characters and elucidate the interspecific delimitations among species. For the distinction of *Cladophora* species, the following taxonomic criteria along with traditional ones were used: architecture, color, texture, rhizoidal morphology of plants, density, basal fusion, and ramification with phyllotaxis of branches, and cell shape and dimension. On the basis of these criteria, seventeen species including a new one were described in this study. They also showed distributional pattern closely related to environmental factors and were divided into several groups with ecological characteristics in relation to the morphological variations.

GENETIC IMPROVEMENT OF EATING QUALITY OF DRIED SHEETS OF *PORPHYRA* BY USING WILD-TYPE RECOMBINANT IN *P. YEZOENSIS*. Jong-Ahm Shin and Akio Miura, Lab. Algae Cultivation, Tokyo Univ. Fish., Minato-ku, Tokyo, Japan.

Growing test of the gametophytes of ZGRW was performed for determining of characteristics pertaining to ZGRW. Crispness and free amino acids contents of dried sheets of *Porphyra* are related in eating quality. They were determined to compare ZGRW with growers' one. ZGRW showed better quality in crispness than growers' one. Concerning free amino acids contents, alanine, glutamic acid, aspartic acid and taurine in ZGRW were more abundant than those of growers' one. Alanine and glutamic acid are concerned in taste substances in dried sheets of *Porphyra*. Alanine was 522.86-2625.57mg/100g and glutamic acid was 592.87-1574.02mg/100g in ZGRW to that alanine 485.69-2525.89mg/100g and glutamic acid 476.70-1472.59mg/100g in growers' one. ZGRW presented more sweet flavor than growers' one.

PURIFICATION AND CHARACTERIZATION OF NITRATE REDUCTASE FROM *PORPHYRA YEZOENSIS* (RHODOPHYTA). Yoshiko Nakamura and Tomoyoshi Ikawa.

Institute of Biol. Sci., Univ. of Tsukuba, Tsukuba-shi, Ibaraki, Japan. Assimilatory nitrate reductase (NR) catalyzes the first step in the reduction of nitrate to ammonia. We developed an effective method to isolate the homogenous NR from *Porphyra yezoensis* using PEG treatment, ammonium sulfate fractionation, chromatography on butyl Toyopearl 650-M, blue Sepharose CL-6B, DEAE Cellulose, hydroxyapatite columns and Sephacryl S-400 gel filtration. The best enzyme preparation was purified to 5,700-fold and had a specific activity of $12.5 \mu\text{mol NO}_2^- \cdot \text{min}^{-1} \cdot \text{mg}^{-1}$ protein. A molecular weight for the native enzyme was estimated to be 380,000 and for the subunit to be 100,000. Deduced from the native and subunit molecular weights, NR from *P. yezoensis* is a tetramer. The UV/visible absorption spectra of the oxidized and reduced NR indicated typical features of b-type cytochromes. The enzyme was NADH specific and had an optimal pH at pH 8.5.

EFFECTS OF HEAVY METALS ON *ULVA PERTUSA* KJELLMAN. Ik Kyo Chung & Mi Kyung Kim, Dept. of Marine Science, Pusan National Univ., Pusan 609-735, KOREA.

The effects of several metals (Cd, Cu, Zn, Hg) on *Ulva pertusa* were examined. Acclimated disc samples were continuously exposed for a maximum period of 2 weeks to a series of concentration of metals supplemented to enriched seawater.

Toxicity of metals assessed in terms of growth rate, photosynthetic pigment contents and chlorophyll fluorescence, were highest in Hg treated samples, severe in Cu, moderate in Zn and low in Cd in *U. pertusa*. Values of F_{max}/F_0 ratio in photochemical quenching were remarkably decreased and growth rates were significantly reduced at higher concentrations of metals. These indicate that those are effective and reliable means of assessing toxicity of contaminants in relatively short term studies with this green alga.

PHENOLOGY AND MORPHOLOGICAL VARIABILITY IN A KOREAN POPULATION OF *GRACILARIA VERRUCOSA* (HUDSON) PAPANFUSS, RHODOPHYTA. Kim, Myung-Sook, In Kyu Lee and Sung-Min Boo*. Dept. of Biology, Seoul Natl. Univ., Seoul 151-742 and *Dept. of Biology, Chungnam Natl. Univ., Daejeon 305-764, Korea

The phenology and morphological variability of *Gracilaria verrucosa* (Huds) Papanfuss were analysed at the littoral habitat of Daechon, west coast of Korea from July 1988 to June 1989. Fifty or more plants were sampled haphazardly in field for phenology. Twenty-five plants were randomly selected and measured for the length, axis diameter, medullary cell diameter and constriction in basal portion of branches. Cystocarpic plants occurred at maximum from June to July, while tetrasporic ones dominated from August to September. This implied that ecological conditions related with summer were important for reproduction of our plants. Plant length, axis diameter, medullary cell diameter and constriction in basal portion of branches varied significantly throughout the year. The correlation coefficient between axis diameter and medullary cell diameter was positively correlated, whereas between plant length and constriction of basal portion of branches it was negatively correlated. In standardization of four investigated characters, the monthly variability of basal constriction of branches contrasted with those of other three features.

SEXUAL REPRODUCTION IN THE MARINE DINOFLAGELLATE *PYROPHACUS STEINII*.

Pornsilp Pholpunthin, Yasuwo Fukuyo, Hiroaki Inoue and Yoshihachiro Nimura. Department of Fisheries, Faculty of Agriculture, University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo, Japan

The sexual reproduction in *Pyrophacus steinii* is anisogamous and heterothallic. Male gametes differ from female gametes and vegetative cells. The female gametes can not be differentiated from the vegetative cells. Cell fusion between the male and female gametes occurs in a few hours to several days after inoculation of the male gametes into a culture of non-male clone. Zygotes are similar to the vegetative cells in shape except possessing two longitudinal flagella. The transformation from the planozygote to the hypnozygote (resting cyst) requires five to eight days for completion.