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金門烈嶼底棲性海藻之研究

Benthic Marine Algae of Lieyu, Kinmen

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摘要：

本文為 2009 年間在金門烈嶼進行海藻的採集及調查研究。共有 25 科 38 屬 64 種海藻被發現，包括綠藻 16 種，褐藻 16 種，紅藻 32 種，其中有 18 種海藻為烈嶼的首次記錄。在海藻組成上，烈嶼具有許多典型溫帶性海藻，如帶狀蜈蚣藻(*Greteloupia turuturu*)、鼠尾菜 (*Sargassum thunbergii*)、繩龍鬚菜(*Gracilaria chorda*) 及巴氏松藻(*Codium bartlettii*)等，只產於金門烈嶼等地，但並不產於台灣。並討論有關洋流對本區海藻相之影響。

關鍵詞：海藻，新記錄種，植物地理，烈嶼，金門。

Abstract

The marine algae collected from Lieyu, Kinmen were identified and listed. A total of 64 species of seaweed, belonging to 38 genera and 25 families, and including 16 of Chlorophyta, 16 of Heterokontophyta, and 32 of Rhodophyta. Among them, 18 species are firstly recorded in Lieyu. Most of algae in Lieyu are of temperate elements. Some of algae, such as *Grateloupia turuturu*, *Sargassum thunbergii* and *Gracilaria chorda*, *Codium bartlettii* appeared in Lieyu, but not appeared in Taiwan. The effects of current on the distribution of algae and the floristic affinity of this island are discussed.

Key words: Marine algae, New record, Phytogeography, Lieyu, Kinmen

Introduction

Liyu (118°14'E, 24°26'N), known as the “Little Kinmen”, is a small island located about 2 km off southwestern Kinmen and only 5 km away from Mainland China, making Lieyu the most important frontline of Taiwan. Having no mountains on all sides, Lieyu island has a coastline of about 13.5 km with granite rocky coast and white quartz sandy beach, and an area of about 14.85 km² (Fig. 1). Lieyu has a subtropical climate and is affected by the monsoon and current, the annual air temperature is 20.9 °C (Yang and Lu, 1997, Wang, 2008). The highest average temperature in summer is 28.2 °C recorded in August. While the lowest average temperature in winter is 12.8 °C in January (Yang and Lu, 1997).

The coast of Lieyu has been restrained; there are only a few records on seaweeds in Lieyu (Literature Committee of Kinmen, 1968; Lu et al, 2005, Wang, 2008, Lieyu Township Office, 2010). The field floristic survey is obviously insufficient. This study provides information about the composition, distribution and habitat of the benthic marine algae in this region.

Material and Methods

Algal specimens were collected from five sampling sites of Lieyu (Fig. 1) during 20-28 April, 2009 and 7-12, July, 2009. Specimens were either dried and mounted, or preserved in 10% formalin seawater. Both the liquid-preserved and

dried herbarium specimens were used for this study. Sections were made by hand or with a freezing microtome. All voucher specimens are deposited in the Herbarium of National Taiwan Museum (TAIM).

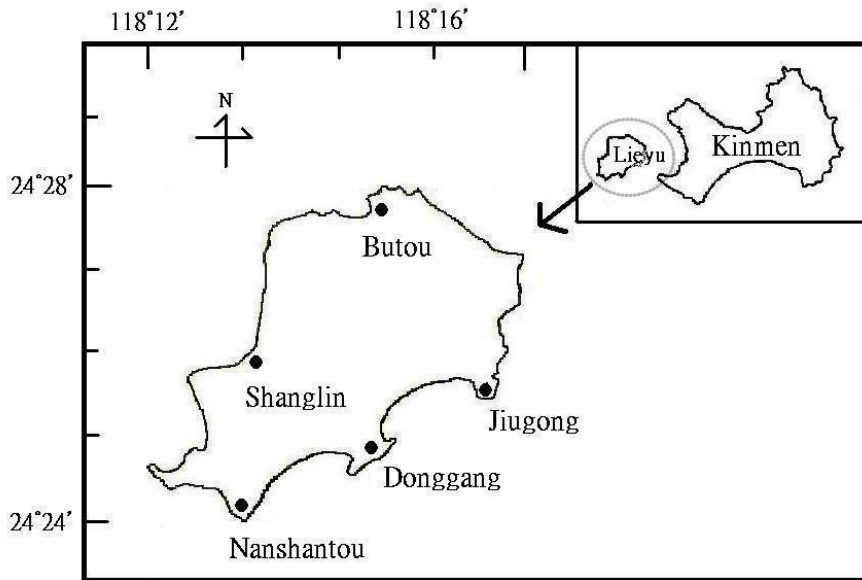


Fig. 1. Map of Lieyu, showing the sampling sites. Butou (埔頭), Shanglin (上林), Nanshantou (南山頭), Donggang (東崗), Jiugong (九宮).

Results

There is a total of 64 species of marine algae identified in this study. They belong to 38 genera and 25 families, and include 16 species of Chlorophyta, 16 of Heterokontophyta, and 32 of Rhodophyta (Table 1). Among them, 19 species are firstly recorded in Lieyu.

Table 1. Numbers of algal taxa during studying period in Lieyu.

Phylum	No. of families	No. of genera	No. of species	No. of new records for Lieyu
Chlorophyta	4	4	16	4
Heterokontophyta	5	11	16	3

Rhodophyta	16	23	32	12
Total	25	38	64	19

Table 2. Numbers of algal taxa at sampling sites.

Sampling stations	Chlorophyta	Heterokontophyta	Rhodophyta	Total
Butou	1	6	5	12
Shanglin	3	9	11	23
Nanshantou	11	11	16	38
Jiugong	12	10	21	43
Donggang	10	6	16	32

As shown in Table 2, the station Jiugong dock has the richest flora with 43 species of algae. Station Nanshantou has the second richest with 38 species. Station Donggang has 32 species and Station Shanglin has 23 species. The station Butou has the least number of species, only 12 species.

The structure of algal communities was also analyzed. In general, the flora of the upper wave-washed regions (upper littoral regions) was dominated by *Ishige okamurae*, *Gloiopeltis furcata* and *Gloiopeltis tenax*. In the middle littoral region, there was a mixture of *Ulva intestinalis*, *Ulva linza*, *Ulva pertusa*, *Ulva prolifera*, and *Colpomenia sinuosa*. On the exposed rock of the lower littoral region or subtidal fringe, the scattered patches of *Codium cylindricum*, *Gracilaria chorda*, *Grateloupia filicina*, *Endarachne binghamiae*, *Hinckesia mitchelliae* and *Sargassum thunbergii*. The orders of the floristic list of algae are arranged according to Algaebase (Guiry, 2010), while families, genera and species are arranged alphabetically.

CHECKLIST OF SPECIES

*: New record for Leiyu

CHLOROPHYTA

BRYOPSIDALES
BRYOPSIDACEAE

****Bryopsis plumosa* (Hudson) C. Agardh**

Distribution: Nanshantou.

Habitat: Growing on lower intertidal rocks or in rock pools in sheltered places.
though often exposed to moderate surf.

CODIACEAE

***Codium bartlettii* Tseng & Gilbert**

Distribution: Donggang.

Habitat: Growing on lower intertidal rocks.

***Codium contractum* Kjellman**

Distribution: Shanglin, Nanshantou, Jiugong, Donggang.

Habitat: Growing on lower intertidal rocks.

***Codium cylindricum* Holmes**

Distribution: Donggang, Jiugong, Nanshantou.

Habitat: Growing on lower intertidal rocks.

***Codium fragile* (Suringar) Hariot**

Distribution: Jiugong, Nanshantou.

Habitat: Growing on lower intertidal rocks.

***Codium geppiorum* Schmidt**

Synonym: *Codium geppii*; *Codium divaricatum*

Distribution: Jiugong.

Habitat: Growing on lower intertidal rocks covered with sand.

****Codium latum* Suringar**

Distribution: Donggang.

Habitat: Growing on lower intertidal rocks covered with sand.

SIPHONOCLADALES

VALONIACEAE

****Valoniopsis pachynema* (Martens) Børgesen**

Distribution: Jiugong, Nanshantou.

Habitat: Growing on lower intertidal and subtidal rocks.

ULVALES
ULVACEAE

***Ulva clathrata* (Roth) C. Agardh**

Synonym: *Enteromorpha clathrata*; *Enteromorpha crinita*; *Enteromorpha clathrata* var. *crinita*

Distribution: Jiugong, Nanshantou.

Habitat: Growing on middle to lower intertidal rocks.

***Ulva conglobata* Kjellman**

Distribution: Jiugong, Donggang, Nanshantou.

Habitat: Growing on upper and middle intertidal rocks covered with sand.

****Ulva fasciata* Delile**

Distribution: Jiugong, Donggang, Nanshantou.

Habitat: Growing on middle intertidal rocks and in rock pools.

***Ulva intestinalis* Linnaeus**

Synonym: *Enteromorpha intestinalis*

Distribution: Jiugong, Donggang, Nanshantou.

Habitat: Growing on middle to lower intertidal rocks and in rock pools..

***Ulva lactuca* Linnaeus**

Distribution: Around all coasts of Leiyu island.

Habitat: Growing on middle intertidal rocks and in rock pools.

***Ulva linza* Linnaeus**

Synonym: *Enteromorpha linza*

Distribution: Donggang, Jiugong.

Habitat: Growing on lower intertidal rocks or in rock pools.

***Ulva pertusa* Kjellman**

Distribution: Donggang, Nanshantou.

Habitat: Growing on lower intertidal rocks.

***Ulva prolifera* O.F. Müller**

Synonym: *Enteromorpha prolifera*

Distribution: Shanglin, Jiugong.

Habitat: Growing on lower intertidal rocks or in rock pools.

HETEROKONTOPHYTA

DICTYOTALES

DICTYOTACEAE

***Dictyopteris pacifica* (Yendo) Hwang, Kim & Lee**

Distribution: Shanglin, Butou.

Habitat: Growing on the lower intertidal rocks.

****Dictyopteris prolifera* (Okamura) Okamura**

Distribution: Donggang, Jiugong.

Habitat: Growing on the lower intertidal rocks.

****Dictyota dichotoma* (Hudson) Lamouroux**

Distribution: Shanglin, Butou, Jiugong.

Habitat: Growing on lower intertidal area.

***Dilophus okamurae* (E.Y. Dawson) Hörnig et al**

Distribution: Shanglin, Butou, Nanshantou, Jiugong, Donggang .

Habitat: Growing on lower intertidal area.

****Pachydictyon coriaceum* (Holmes) Okamura**

Distribution: Shanglin, Nanshantou.

Habitat: Growing on lower intertidal area.

***Padina australis* Hauck**

Distribution: Jiugong, Nanshantou, Donggang.

Habitat: Growing on lower intertidal area.

***Spatoglossum pacificum* Yendo**

Distribution: Shanglin, Nanshantou, Jiugong

Habitat: Growing on lower intertidal area.

ECTOCARPALES

ACINETOSPORACEAE

***Hincksia mitchelliae* (Harvey) P.C. Silva in P.C. Silva et al.**

Synonym: *Giffordia mitchelliae*; *Ectocarpus mitchelliae*.

Distribution: Jiugong, Nanshantou, Donggang.

Habitat: Thalli attached on the lower intertidal rocks with sand.

FUCALES

SARGASSACEAE

Sargassum angustifolium C. Agardh

Distribution: Shanglin.

Habitat: Growing on lower intertidal to subtidal rocks.

Sargassum fusiforme (Harvey) Setchell

Distribution: Jiugong, Nanshantou, Butou, Donggang.

Habitat: Growing on lower intertidal to subtidal rocks.

Sargassum hemiphyllum (Turner) C. Agardh

Distribution: Jiugong.

Habitat: Growing on lower intertidal to subtidal rocks.

Sargassum thunbergii (Mertens ex Roth) Kuntze

Distribution: Shanglin, Nanshantou, Butou, Jiugong, Donggang.

Habitat: Growing on lower intertidal to subtidal rocks.

Sargassum vachellianum Greville

Distribution: Shanglin, Nanshantou.

Habitat: Growing on subtidal rocks (1-10 m deep).

ISHIGEALES

ISHIGEACEAE

Ishige okamurae Yendo

Distribution: Donggang, Butou, Nanshantou, Jiugong.

Habitat: Growing on upper wave-washed regions (upper littoral regions).

SCYTOSIPHONALES

SCYTOSIPHONACEAE

***Colpomenia sinuosa* (Mertens ex Roth) Derbès & Solier in Castagne**

Distribution: Jiugong, Donggang, Nanshantou.

Habitat: Thalli growing on lower intertidal rocks.

***Endarachne binghamiae* J. Agardh**

Distribution: Butou, Shanglin, Nanshantou, Jiugong, Donggang

Habitat: Growing on lower intertidal to subtidal rocks (1-10 m deep).

RHODOPHYTA

BANGIALES

BANGIACEAE

***Porphyra dentata* Kjellman**

Distribution: Shanglin, Butou, Jiugong, Nanshantou.

Habitat: Growing on upper intertidal rocks.

CERAMIALES

RHODOMELACEAE

****Chondrophyucus intermedius* (Yamada) Garbary & Harper**

Distribution: Jiugong, Nanshantou.

Habitat: Growing on lower intertidal rocks.

****Laurencia glandulifera* Kützing**

Distribution: Shanglin.

Habitat: Growing on lower intertidal rocks.

***Laurencia okamurae* Yamada**

Distribution: Donggang, Jiugong.

Habitat: Growing on lower intertidal to subtidal rocks.

CORALLINALES

CORALLINACEAE

****Amphiroa ephedraea* (Lamarck) Decaisne**

Distribution: Nanshantou, Donggang, Jiugong.

Habitat: Growing on lower intertidal to subtidal rocks (1-5 m deep)

***Amphiroa zonata* Yendo**

Distribution: Nanshantou, Donggang, Jiugong.

Habitat: Growing on lower intertidal to subtidal rocks.

***Corallina confusa* Yendo**

Distribution: Donggang.

Habitat: Growing on lower intertidal to subtidal rocks.

***Corallina pilulifera* Postels & Ruprecht**

Distribution: Nanshantou, Donggang, Jiugong.

Habitat: Growing on lower intertidal to subtidal rocks.

****Jania decussato-dichotoma* (Yendo) Yendo**

Distribution: Nanshantou, Donggang, Jiugong.

Habitat: Growing on lower intertidal to subtidal rocks.

****Marginisporum crassissima* (Yendo) Ganesan**

Distribution: Jiugong, Nanshantou.

Habitat: Growing on lower intertidal to subtidal rocks.

HAPALIDIACEAE

****Mesophyllum simulans* (Foslie) M. Lemoine**

Distribution: Nanshantou.

Habitat: Growing on lower intertidal to subtidal rocks (1-5 m deep)

GELIDIALES

GELIDIACEAE

****Gelidium divaricatum* Martens**

Distribution: Shanglin, Jiugong.

Habitat: Growing on lower intertidal to subtidal rocks.

***Pterocladia capillacea* (S.G. Gmelin) Santelices & Hommersand**

Distribution: Jiugong, Nanshantou.

Habitat: Growing on lower intertidal to subtidal rocks.

GELIDIELLACEAE

****Gelidiella acerosa* (Forsskål) Feldmann et Hamel**

Synonym: *Gelidiopsis rigida*

Distribution: Jiugong, Nanshantou.

Habitat: Growing on lower intertidal rocks or in rock pools.

GIGARTINALES

ENDOCLADIACEAE

***Gloiopeltis furcata* (Postels et Ruprecht) J. Agardh**

Distribution: Donggang, Jiugong

Habitat: Growing on upper intertidal rocks.

***Gloiopeltis tenax* (Turner) Decaisne**

Distribution: Donggang, Jiugong

Habitat: Growing on upper intertidal rocks.

GIGARTINACEAE

****Chondracanthus intermedius* (Suringar) Hommersand in Hommersand**

Distribution: Donggang, Jiugong, Nanshantou

Habitat: Growing on lower intertidal to subtidal rocks.

***Chondracanthus tenellus* (Harvey) Hommersand**

Distribution: Donggang, Shanglin.

Habitat: Growing on lower intertidal to subtidal rocks.

HYPNEACEAE

***Hypnea charoides* Lamouroux**

Distribution: Shanglin, Nanshantou.

Habitat: Growing on middle to lower intertidal l rocks.

***Hypnea spinella* (C. Agardh) Kützing**

Distribution: Donggang

Habitat: Growing on lower intertidal to subtidal rocks.

PHYLLOPHORACEAE

***Ahnfeltiopsis flabelliformis* (Harvey) Masuda**

Distribution: Jiugong, Donggang, Nanshantou, Butou, Shanglin.

Habitat: Growing on lower intertidal to subtidal rocks.

RHIZOPHYLLIDACEAE

***Portieria hornemannii* (Lyngbye) P.C. Silva in Silva et al**

Distribution: Jiugong, Donggang

Habitat: Growing on lower intertidal to subtidal rocks.

SARCODIACEAE

***Sarcodia montagneana* (J.D. Hooker & Harvey) J. Agardh**

Distribution: Jiugong, Donggang, Nanshantou.

Habitat: Growing on lower intertidal to subtidal rocks.

GRACILARIALES

GRACILARIACEAE

***Gracilariopsis chorda* (Holmes) Ohmi**

Distribution: Shanglin, Butou.

Habitat: Growing on lower intertidal to subtidal rocks.

HALYMENIALES

HALYMENIACEAE

***Grateloupia chiangii* S. Kawaguchi & H.W. Wang**

Distribution: Shanglin, Butou

Habitat: Growing on lower intertidal to subtidal rocks.

***Grateloupia filicina* (J.V. Lamouroux) C. Agardh**

Distribution: Jiugong, Nanshantou.

Habitat: Growing on lower intertidal to subtidal rocks.

***Grateloupia turuturu* Yamada**

Distribution: Shanglin, Donggang, Jiugong.

Habitat: Growing on lower intertidal to subtidal rocks.

***Polyopes polyideoides* Okamura**

Distribution: Jiugong, Nanshantou.

Habitat: Growing on lower intertidal to subtidal rocks.

****Prionitis crispata* (Okamura) Kawaguchi**

Distribution: Shanglin.

Habitat: Growing on lower intertidal to subtidal rocks.

***Prionitis ramossissima* (Okamura) Kawaguchi**

Distribution: Shanglin, Butou, Jiugong.

Habitat: Growing on lower intertidal to subtidal rocks.

NEMALIALES

GALAXAURACEAE

****Dichotomaria marginata* (J.Ellis & Solander) Lamarck**

Distribution: Jiugong

Habitat: Growing on lower intertidal to subtidal rocks (3-8 m deep)

RHODYMENIALES

LOMENTARIACEAE

****Ceratodictyon spongiosum* Zanardini**

Synonym: *Ceratodictyon spongioides*

Distribution: Donggang.

Habitat: Growing on lower intertidal rocks or in rock pools.

DISCUSSION

In the records of seaweeds of Taiwan (Chang, 1995; Chang *et al.*, 2002, 2003; Chen, 1977, 1980, 1991; Chen and Chiang, 1981a, 1981b; Chiang, 1960, 1962a, 1962b, 1972, 1973a, 1973b; Chiang and Chen, 1982, 1983; Chiang and Chou, 1980; Chiang and Wang, 1987; Chiang *et al.*, 1985, 1990; Chou and Chiang, 1981; Fan, 1951, 1974; Huang, 1990, 1991, 1997, 1998, 1999a, 1999b, 1999c, 2000, 2002, 2003, 2006; Huang and Lu, 2006; Huang and Yang, 1999; Lewis, 2000; Lewis and Norris, 1987; Lin, 2002, 2004; Lin and Fredericq, 2003; Lin *et al.*, 2004; Okamura, 1931, 1936; Shen and Fan, 1950; Wang, 2008; Wang and Chen, 1980; Wang and Chiang, 1977, 1993, 1994, 2001; Wang *et al.*, 1993, 2005; Yang, 1981, 1995; Yang and Chiang, 1982, 1995; Yang and Lu, 1977; Yang *et al.*, 1994), there are about 597 species of marine algae listed. There are 64 species of marine algae registered in this study, taking about 12.3% of Taiwan's species. Though Lieyu has an area of only 14.85km², its marine algal flora is rather complicated.

The difference in topographic feature affects the composition and distribution of seaweeds. In general, more complicated topography has higher diversity of species. In this study, it was found that the station Jiugong has a lot of different topographic features, such as rock reef, ditches, drains, tide pools and sandy beach. It is suitable for the diversity of algae and therefore has the highest abundance in the species. On the contrary, the station Butou has a simple topography with sandy bottom which is not suitable for the growth of algae.

The most of marine algae in Lieyu are red algae (50%), then green algae (25%), and brown algae (25%). According to the (R+C)/P hypothesis of Cheney (Cheney, 1977), the ratio of red and green to brown algae in Lieyu is 3.0, indicating a characteristic temperate nature. This agrees with the fact that most of algae in Lieyu are of temperate species.

According to the phytogeographical study, it is found that the algal flora in this region shows strong affinities with temperate west Pacific Ocean. For example,

Porphyra dentata, *Ulva linza*, *Ishige okamurae*, *Endarachne binghamiae*, *Sargassum fusiforme*, *Sargassum thunbergii*, *Hypnea charoides*, *Chondracanthus intermedium*, *Greteloupia turuturu*, *Grateloupia filicina*, *Gloiopeltis tenax*, *Gloiopeltis furcata* and *Gracilaria chorda* are all widely distributed in temperate seas, such as in Japan, Korea, and China (Tseng, 1983; Xia and Yamamoto, 1985; Yoshida, 1998; Guiry, 2010). Especially, some of algae occurred only in temperate seas, such as *Greteloupia turuturu*, *Sargassum thunbergii*, *Codium bartlettii* and *Gracilaria chorda*, which appeared in Lieyu, China and Japan (Okamura, 1936; Tseng, 1983; Tseng and Chang, 1961, 1962; Tseng *et al.*, 1985; Chang, 1995; Yoshida, 1998, Yoshida *et al.*, 1985; Guiry, 2010.), but not in Taiwan and other tropical countries (Lewis and Norris, 1987; Børjesen 1934; Thoi, 1969; Nguyen and Huynh, 1993; Cordero, 1977a, 1977b; Silva, *et al.*, 1987; Silva *et al.*, 1996; Trono, 1997, 1998; Callumpong and Menez, 1997). This suggests that Lieyu is more affinity with temperate areas than Taiwan.

The reason for such affinities with temperate areas is possibly related to the China Coastal Current. The China Coastal Current with low temperature and low salinity flows southward along the Chinese coast from the northern parts of the yellow Sea into the East China Sea where part of it continues along the coast and another part joins and turns eastward with the northward flowing Taiwan Current (Chu 1963, 1971; Guan, 1983; Li, 1991). Recently, there are several studies about the variation of ocean temperature from the NOAA-HRPT satellite (National Oceanic and Atmospheric Administration High Resolution Picture Transmission satellite remote sensing system), and found that the cold phenomena of China Coastal Current in China (Antonov *et al.*, 1998; Levitus *et al.*, 2000). The Lieyu is just located on the way of China Coastal Current. It is not surprising that the China Coastal Current has exerted strong effect on the algal flora in this area.

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