

Studies on the marine flora of southern Taiwan*

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In the recent years the author has made several collections of marine algae along the coast of southern Taiwan and has found that the marine flora of this area markedly differs from that of northern Taiwan. Although many specimens of marine algae collected have yet to be thoroughly identified, the author has found that some northern species do not occur in the southern waters. On the contrary, there are quite many species which occur in southern Taiwan but not in the northern regions.

The author has also found that there are interesting relationships among the marine flora of southern Taiwan, northern Taiwan and Okinawa.

The purpose of this paper is to present some data on the distribution of marine algae in southern Taiwan and to discuss its possible relationship with that of northern Taiwan and Okinawa.

Descriptions of Collecting Localities

The present study was done based on the collections and observations of marine algae in the following four localities: Maopit'ou (November 19, 1972, April 3, 1973), Nanwan (October 18, 1971, April 7, 1972, September 9, 1972, April 4, 1973), Chuanfanshih (March 28, 1971, October 18, 1971, April 7, 1972), and Oluanpi (March 28, 1971, April 8, 1972).

These localities are all situated on the southern tip of Taiwan (Fig. 1). Taiwan lies partly in the tropics, with the Tropic of Cancer passing through the middle of the island, and therefore the most of the island belongs to the subtropics with some near tropical conditions in the extreme south. The annual average temperature for Keelung (in the north) is 71.2°F and for Hengchun in the south 75.9°F. Winter temperature at Keelung averages 59.3°F while at Hengchun is 68.9°F. The annual range of variation at Keelung is 23.4°F and only 12.6°F at Hengchun¹⁾.

According to NITANI²⁾, during the summer, one branch of the

* This study was supported by National Science Council of the Republic of China.

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The Bulletin of Japanese Society of Phycology, Vol. XXI, No. 3, 97-102, Sep. 1973.

Kuroshio Current goes westward the Luzon Straits and enters the South China Sea. The Kuroshio in the Luzon Straits flows back into the Pacific and goes northward along the eastern coast of Taiwan (Fig. 2). This area is, therefore, considered to be the site being influenced by the Kuroshio during the summer.

A common feature of the coasts of these localities is quite similar with one another and it consists of an emergent limestone platform. There are many linear indentations cut into the limestone and oriented shorewards. Various sizes of tidal pools exist at the head or in the middle part of these indentations.

Observations on Four Localities

Maopit'ou

The littoral zone consists of a very irregularly pitted limestone platform which in turn is backed by a high rocky cliff. Indentations that have been cut into the limestone are usually wide, especially in its upper end. The bottom of the indentations are usually sandy.

Compared with Nanwan, Chuanfanshih and Olaunpi (which will be mentioned later), Maopit'ou is richer in marine vegetation.

During November, in the tidal pools and the wider parts of indentations in the upper-littoral region, there were to be found *Boergesenia forbesii*, *Caulerpa racemosa* var. *laete-virens* and *Chlorodesmis caepitosa* growing with *Ulva lactuca*, *U. pertusa*, *Enteromorpha* sp., *Cladophoropsis* spp. and *Hypnea charoides*, but these were not in large quantities. In the middle littoral region, *Gelidiella acerosa*, *Amphiroa* spp., *Jania* spp. and *Padina minor* were the dominant algae in some of the larger tidal pools.

On the exposed rocks in the middle littoral region the algal community was a mixture of *Valoniopsis pachynema*, *Boodlea composita*, *Cladophoropsis* sp., *Ulva lactuca*, *U. pertusa*, *Enteromorpha intestinalis*, *Centroceras clavulatum* and *Laurencia* spp. with *Chaetomorpha crassa*, *C. spiralis* and *Mastophora rosea* growing as epiphytes on the other algae.

At the edge of the indentations *Laurencia* spp. grew abundantly with *Amansia glomerata*, *Hypnea saidana* and *Gelidiopsis repens*. In the lower littoral zone belts of *Laurencia* and *Sargassum* were usually found.

During April, the number of plants of *Gelidiella acerosa*, *Valoniopsis pachynema*, *Chaetomorpha*, *Boergesenia forbesii*, *Cladophoropsis*, *Chondria* and *Gelidiopsis* decreased but *Dityosphaeria cavernosa* and *Valonia aegagropila* increased greatly on the surface of the exposed rocks in

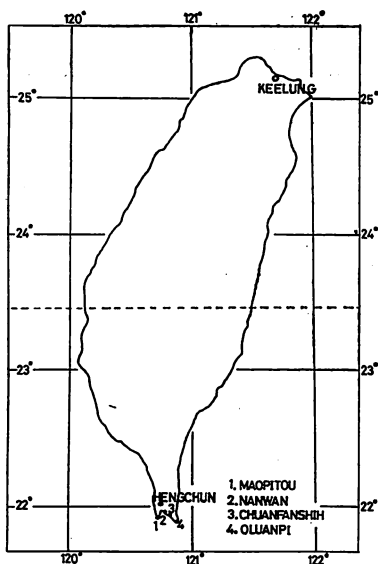


Fig. 1. A map showing collection localities.

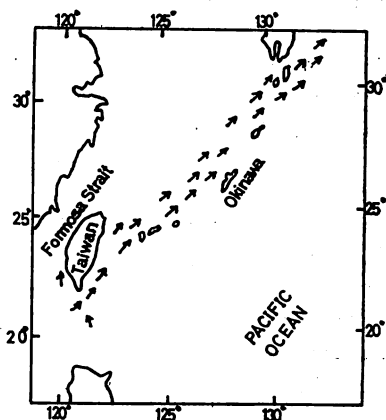


Fig. 2. A map showing the path of the Kuroshio, around Taiwan and Okinawa.

the upper and middle littoral regions. The edge of the indentations of the middle and lower littoral regions were occupied by a large number of *Eucheuma serra* growing with *Laurencia* and other algae. It is interesting to note that plants of *Gelidiella acerosa* and *Centroceras clavulatum* at Maopit'ou are markedly larger than those growing in northern Taiwan, while the thalli of *Ulva lactuca*, *U. pertusa*, *Enteromorpha intestinalis* and *E. linza* are generally smaller and thinner than those in the north.

Nanwan

This area consists of a short stretch of sandy beach which is bordered on its southeast side by a narrow belt covered with medium-sized rocks. Further to the southeast is a wide limestone platform and shows less variation than that at Maopit'ou, Chuanfanshih and Oluanpi. There are various sizes of tidal pools in the upper portion of this limestone platform.

During September on the rocky belt *Monostroma latissimum*, *Ulva lactuca* and *Enteromorpha linza* were found growing here and there on the rocks of upper littoral zone. Next, to these were *Ulva reticulata*, *Chaetomorpha crassa*, *Hypnea charoides* and *Laurencia* spp. and at its

lower littoral region was a belt of *Sargassum*.

On the limestone platform, in the tidal pools of both the upper and middle littoral regions, *Boergesenia forbesii*, *Anadyomene wrightii*, *Halimeda macroloba*, *H. opuntia*, *Ulva lactuca*, *Padina minor*, *Gracilaria arcuata* and *Hypnea charoides* were found growing in scattered patches.

The exposed portion of the middle littoral zone was covered with *Dictyospheria cavernosa*, *Valoniopsis pachynema*, *Gelidiella acerosa*, *Amphiroa* spp. and *Laurencia* spp. and among them were *Acrocystis nana*, *Desmia hornemanni* and *Yamadaella cenomyce*.

During April the algal community of this area did not change very much from that of September and October, the only marked change was that *Monostroma latissimum* was replaced by another species of *Monostroma*. Furthermore the number of plants of *Ulva reticulata* and *Chaetomorpha crassa* greatly decreased. In the tidal pools plants of *Neomeris annulata*, *Bornetella sphaerica*, *Galaxaura oblongata* and *G. tenera* were found in addition to the algae previously mentioned. In April, a great quantity of *Codium intricatum* and *Sargassum* spp. was found cast ashore.

Chuananshih and Oluanpi

The littoral zone of these two areas is occupied by emergent limestone platform which slopes gradually seaward. The limestone is usually cut into irregular bands by deep furrows.

The marine flora of these two areas are almost the same, and thus they will be described together.

The upper littoral regions of these areas were generally poor in vegetation, except some places where *Ulva fasciata*, *U. lactuca* and *Enteromorpha* sp. were abundant. In some of the tidal pools a great number of small or prostrate species of *Laurencia* grew together with *Enteromorpha intestinalis*, *E. linza*, *Cladophoropsis* sp. and *Turbinaria conoides*.

The algal communities on the edges of furrows of the middle littoral region were quite complex, with the following species being commonly seen; *Halimeda macroloba*, *H. opuntia*, *Chlorodesmis caepitosa*, *Laurencia* spp., *Chondria armata*, *Hypnea saidana*, *Neurymenia fraxinifolia*, *Acanthophora orientalis*, *Mastophora rosea*, *Gracilaria* spp., *Amphiroa* spp., *Corallina* spp., *Eucheuma serra*, *Acrocystis nana*, *Galaxaura tenera* and *G. oblongata*.

On the exposed rocks of the lower littoral region scattered patches of *Yamadaella cenomyce* could be found; growing with small numbers of *Desmia hornemanni*, *Hydroclathrus clathratus* and *Gigartina* sp. At some places where the waves were heavy a belt of *Sargassum* was found.

Conclusion

Based on the present study and the author's previous papers^{3,4)} on the algae of northern Taiwan, together with more recent explorations along the northern coast, it has been found that the marine flora of southern Taiwan is quite different from that of the north. This result agrees with the report of TANIGUTI⁶⁾ regarding the marine flora of this area. The distinguishing feature of the marine flora of southern Taiwan is that many of the algae which often become dominant in the intertidal zone at some localities in northern Taiwan are not found at all in the south. These include *Endarachne binghamiae*, *Ishige okamurai*, *Bangia fusco-purpurea*, *Porphyra* spp., *Dermonema frappieri*, *Scinaia pseudo-japonica*, *Pterocladia tenuis*, *P. nana*, *Grateloupia ramosissima*, *G. filicina*, *Polyopes polyideoides*, *Gloiopeltis furcata*, *Caulacanthus spinellus* and *Chondrus ocellatus*.

In northern Taiwan, during the spring time, great quantities of *Enteromorpha linza*, *E. intestinalis*, *Ulva lactuca*, *U. fasciata*, *Gigartina intermedia* and *Centroceras clavulatum* are found growing on rocks of the upper or middle littoral regions, but these algae have never been found on extensive scale on the coasts of southern Taiwan. Moreover, the morphology of these same species of algae is quite different when growing in the north and south.

Another interesting feature is that some southern species, such as *Boergesenia forbesii*, *Neomeris annulata*, *Bornetella spherica*, *Halimeda* spp., *Chondria armata*, *Amansia glomerata* and *Neurymenia fraxinifolia* have not been found in northern Taiwan.

These differences between the distribution of marine algae in the north and that of the south are probably caused mainly by temperature and to some extent by light intensity. This may be proved by the short growing periods of *Endarachne binghamiae*, *Ishige okamurai*, *Bangia* sp., *Porphyra* spp. and *Dermonema frappieri* in northern Taiwan i. e., during the spring.

It is well known that the distribution of marine algae is greatly influenced by the current. Geographically Okinawa (Fig. 2) is situated far to the north of Taiwan. Despite their geographical situation, there are quite many tropical species which occur both in southern Taiwan and Okinawa, but not in northern Taiwan. Among these are *Boergesenia forbesii*, *Valonia aegagropila*, *Anadyomene wrightii*, *Nomeris annulata*, *Bornetella sphaerica*, *Halimeda opuntia* and *H. macroloba*^{5,7)} The presence of these tropical algae seems to be explained by the fact that the current is a factor playing most important role in the distribution

of marine algae. These tropical algae were probably brought by the Kuroshio Current from southern Taiwan to Okinawa and have become naturalized there. This also means that the Kuroshio passes far from the coasts of northern Taiwan, otherwise, there should be some of these typically tropical algae growing in northern Taiwan, as they do in Okinawa.

I wish to express my gratitude to Professor M. Chihara for kindly reading the manuscript.

Summary

The intertidal zonation of marine algae were studied in Maopit'ou, Nanwan, Chuanfanshih and Oluanpi of southern Taiwan.

The result of this study shows that the marine flora of southern Taiwan differs from that of northern Taiwan, and the vegetation of the area studied is generally poorer than that of northern Taiwan. The difference between the marine flora of northern and southern Taiwan may be caused by temperature.

Some typically tropical algae, such as *Neomeris annulata* and *Bornetella sphaerica* etc. have been found both in southern Taiwan and Okinawa, but not in northern Taiwan. This means most probably that the Kuroshio current plays a primarily important role in the distribution of these plants in the waters around Taiwan and Okinawa.

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