THE THRAUSTOCHYTRICEAE AND OTHER INTERTIDAL FUNGI OF TAIWAN

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Abstract: Eight *Thraustochytrium* species and one *Schizochytrium* were found in the intertidal waters of Taiwan. In addition to the Thraustochytriaceae, representatives of *Rhizophydium*, *Olpidium* and *Chytridium* were also isolated from the saline water samples by using the pollen baiting technique.

INTRODUCTION

The Thraustochytriaceae, belonging to the Saprolegniales, are microscopic marine fungi with a thallus similar to *Chytridium* composed of a sessile epibiotic sporangium, a endobiotic rhizoidal system, and a biflagellate zoospore (Sparrow, 1960). These fungi are world wide in distribution and they are apparently quite commonly found (Sparrow, 1969, 1968a, b; Volz & Jerger, 1972; Ulken, 1966; Höhnk, 1967), However, their occurrence could be seasonal (Gaertuer, 1967). Representative species can be monitored in their ability to break down organic matter (Gaertner, 1966). Due to their abundance, the Thraustochytriaceae have an important role in marine ecology.

No representative species of the genera described in this study were previously reported in Taiwan (Sawada, 1961). The presence and distribution of these species were examined in this study. The fungi are difficult to locate by direct examination of marine specimens. Abundant zoospore production occurs in the laboratory from newly collected marine material that in turn develop numerous sporangia on suitable substrates. Attention was directed to the saline waters of Taiwan for marine fungi after fresh water species on the island were studied (Volz, Hsu & Liu, 1974).

MATERIALS AND METHODS

A total of 190 marine collections were made from separate areas of the north, east and south shores of Taiwan. Water, algae, marine soil and floating plant debris were collected at the intertidal sampling sites. Material with water in 40-60 ml volume samples was placed in self sealing sterile plastic bags. Soon after collection the samples were taken to the laboratory and placed in sterile glass petri plates. Pine pollen was added in small quantities to each petri dish to serve as the nutrient source for developing zoosporangia. Pollen baited cultures were allowed to incubate at room temperature 2-3 days before examinations were made for marine fungi. The difficulty in locating thraustochytrid and some chytrid species on aquatic material is reduced by the pine pollen technique. Released zoospores in culture initiate mature sporangia on the pollen grains. Nonmotile spores adjacent to the pollen grain enlarge to form epibiotic sporangia and endobiotic rhizoidal systems (Sparrow, 1968b, 1960, 1936).

Sporangial morphology and zoospore release are important factors in species identification. Pollen baited cultures should remain undisturbed during incubation until pollen grains are trans-

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ferred to microscope slides for viewing. A higher incidence of zoospore release is found in slides from undisturbed water cultures. Floating pollen grains in the petri dishes were transferred to slides by touching the water surface with a glass cover slip. Direct microscopic examination followed.

RESULTS

Small isolated saline pools adjacent to the shoreline were collection sites in northern Taiwan. *Thraustochytrium globosum* Kobayashi and Ookubo, *T. aggregatum* Ulken, *T. aureum* Goldstein and *Schizochytrium aggregatum* Ulken were commonly found. From approximately 50% of the collections, *T. striatum* Schneider, *T. visergense* Ulken and *T. roseum* Goldstein were present but in less dense populations than the dominant species. *Thraustochytrium proliferum* Sparrow was found in only two collections.

Shoreline collections were also made along northern Taiwan in addition to the isolated pools. About 18% of the collections revealed no fungi. In decreasing incidence per total collection sites, the species isolated included *T. globosum* 62%, *T. aureum* 44%, *T. aggregatum* 38%, *T. visurgense* 24%, *S. aggregatum* 8%, *T. striatum* 6% and *T. proliferum* 4%. *Thraustochytrium globosum*, *T. aurem* and *T. aggregatum* were present in high populations while the other species were never found in dominating densities. Isolated collections contained populations of *Rhizophydium sphaerotheca* Zoph, *Oldidium pendulum* Braun and *Chytridium chaetophilum* Scherffel, however these chytrids were dominated by the thraustochytrid species. Unlike the thraustochytrids, zoospores of the Chytridiales are posteriorly uniflagellate (Sparrow, 1960)

Four thraustochytrids were found on the eastern shore of Taiwan. Approximately 50% of the collection sites contained *S. aggregatum* and *T. aggregatum* while over 80% had *T. aureum* and *T. globosum*. According to the collection sites, in decreasing population abundance the thraustochytrid species included *T. globosum*, *T. aureum*, *T. aggregatum* and *S. aggregatum*. No chytrid species were noted on the Taiwan eastern shore.

About 30% of the collection sites did not support chytrids or thraustochytrid species in south Taiwan. *Thraustochytrium aggregatum* was the predominant species in 50% of the collection sites. In 30% of the sites, *T. globosum*, *T. aureum* and *S. aggregatum* were found less frequently per site than *T. aggregatum*. Infrequent occurrence of less than 5% of the total collection sites included the species *T. striatum*, *T. motivum* Goldstein, *T. prolifera*, *T. visurgense* and *T. roseum*. Occasionally pollen grains supported growth of *Chytridium citriforme* Sparrow in southern Taiwan water samples. Chytrids were infrequently found in material from areas studied in Taiwan.

DISCUSSION

The predominant Thraustochytriaceae representatives isolated during these studies included 8 species of *Thraustochytrium* and one *Schizochytrium* while the occasionally found Chytridiales included 2 *Chytridium* species and one species each of *Rhizophydium* and *Olpidium*. The numbers of species and distribution varied somewhat between the three major island geographical areas, fungal density varied within one area between individual collections. In previous ecological studies on these fungi Höhnk (1955) observed that species of Olpidiaceae, Rhizidiaceae and Chytridiaceae dominated littoral areas of low salinity while Sparrow (1960) and Höhnk (1967) found that Thraustochytriaceae species were very common in saline water.

In relatively recent years the presence of thraustochytrids has been studied which lead to the isolation of additional species. Detailed species descriptions are found in the literature (Gaertner, 1967; Goldstein, 1963a, 1963b, 1963c; Goldstein & Belsky, 1964; Goldstein *et al.*, 1964; Johnson & Sparrow, 1961; Kobayashi & Ookubo, 1933; Schneider, 1968; Scholz, 1958;

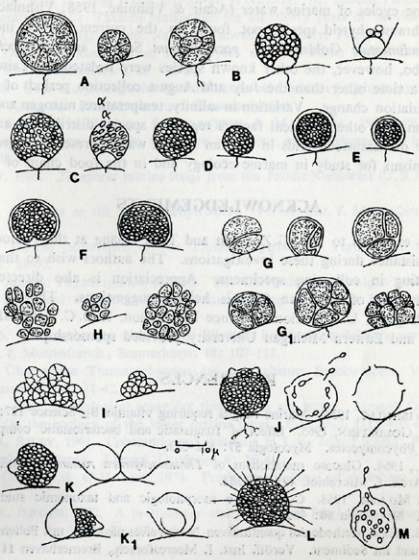

Figure legend.

Thraustochytrid sporangia: (A) *T. striatum* radial cytoplasmic cleavage and cleared central area of sporangia; (B) *T. proliferum* primary sporangia with rudiment of secondary sporangia, and nonmotile spores remaining after release; (C) *T. motivum* thin walled sporangia, prominent basal rudiments and the emergence of swimming zoospores; (D) *T. globosum* thin walled zoosporangia containing 8 to 30 spores; (E) *T. roseum* thick capsular walled orange pigmented sporangia; (F) *T. visurgense* thick encapsulated zoosporangia with apophysis like basal swelling; (G, G_1) *T. aureum* basal rudiments and irregular divisions of sporangia; (H) *S. aggregatum* bipartitioned bluster of sporangia; (I) *T. aggregatum* a group of spherical zoosporangia.

Chytrid sporangia: (J) *R. sphaerotheca* spherical sporangia with protruding papillae; (K, K_1) *C. citriforme* citriform sporangia with broad subapical papillae presenting a tilted aspect to the sporangium; (L) *C. chaetophilum* sporangium with hairs; (M) *O. pendulum* sporangium with broad discharge tube in pollen grain.

Sparrow, 1936, 1960, 1968a, 1969; Ulken, 1964, 1965). A suggestion has been made of grouping the organisms into species complexes due to similarities between species and variation within individuals (Booth & Miller, 1968).

The abundance of Thraustochytriaceae in marine habitats indicates an ecological importance and a role in the decomposition of organic materials (Gaertner, 1966, 1968; Vishniac, 1956). Some studies concluded these intertidal fungi are competitive with marine bacteria and dominate

the B_{12} and thiamine cycles of marine water (Adair & Vishniac, 1958; Vishniac, 1961; Vishniac & Riley, 1961). Thraustochytrid species not found in the current survey included *T. kinnei* Gaertner, *T. multirudimentale* Goldstein, *T. pachydermum* Scholz and *Japonochytrium marinum* Kobayashi & Ookubo, however, the other known species were isolated in Taiwan. Identifying the fungal flora at a time other than the July and August collection periods of this study would probably show population change. Variation in salinity, temperature, nitrogen and carbon sources, oxygen concentration, and other physical factors regulates species distribution and density. The common occurrence of thraustochytrids in Taiwan littoral waters presents a group of very interesting microorganisms for study in marine ecology and in the food chain of the ocean.

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