

Form 3

論 文 要 旨

Abstract

論 文 題 目

Title

The biology of the common reef zoanthid species – *Palythoa tuberculosa*

Coral reefs around the world are now facing rapid degradation due to anthropogenic destruction and climate change, and it is urgent to build up baseline knowledge of various benthic organisms under different environmental conditions for future coral reef projections, conservation and management. Zoanthids (Cnidaria: Hexacorallia) are an order of morphologically plastic hexacorals, and due to their plasticity and various coloration, their taxonomy has been chaotic in the past. Recently a combination of morphology and molecular analyses has been able to solve the taxonomy dilemma for many zoanthid groups. In such recent analyses the diversity of zoanthids has been shown to be high in the western Pacific region. Along with the high diversity of zoanthids, their endosymbiotic zooxanthellae (*Symbiodinium* spp.) might also have high diversity. Many zoanthids are considered generalists, and although their *Symbiodinium* may be generalist clades the zoanthids have potential to host various of *Symbiodinium* clades in different environments. Many zoanthids are common at similar spatial and temporal regions as hard corals (Scleractinia) but their ecological aspects have been rarely studied and most research has been done in the western Atlantic and the Caribbean, and not in the Pacific. One species of zoanthid, *Palythoa tuberculosa*, is a colonial zoanthid that embeds sand within its tissue, and it has been shown to commonly occur on reef flats and reef crests in Okinawa and the Indo-Pacific region. *Palythoa* spp. have also been shown to grow very quickly, be aggressive during composition, and have a tendency to dominate in polluted waters. However, how *Palythoa tuberculosa* populations react under different benthic compositions and environmental conditions remain unclear. The purpose of this dissertation therefore is to: 1. clarify the identity of *Palythoa tuberculosa* and *Palythoa caesia* in the Pacific; 2. reveal *Symbiodinium* diversity in *P. tuberculosa* in Taiwan and compare to previous results from Japan; and 3. clarify ecological aspects of *Palythoa tuberculosa* and its relationship with environmental factors in Okinawa.

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(様式第5-2号) 課程博士

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学位（博士）論文審査及び最終試験の終了報告書

学位（博士）の申請に対し、学位論文の審査及び最終試験を終了したので、下記のとおり報告します。

記

申請者	専攻名 海洋環境学 氏名 Sung-Yin YANG 学籍番号	
指導教員名	James Davis REIMER	
成績評価	学位論文 ☒ 合格 ☐ 不合格	最終試験 ☒ 合格 ☐ 不合格
論文題目	The biology of the common reef zoanthid species – <i>Palythoa tuberculosa</i> サンゴ礁域におけるスナギンチャク類の普通種 <i>Palythoa tuberculosa</i> の生物学	
審査要旨（2000字以内） In her thesis, the candidate investigated some basic biological aspects of the common reef zoanthid <i>Palythoa tuberculosa</i> (Cnidaria: Anthozoa: Hexacorallia: Sphenopidae). This species is widely distributed in the Indo-Pacific Ocean, and is found in a wide variety of habitats, as it is a 'generalist'. Previous research has shown this species is most common in the shallow intertidal reef crest and the outer reef slope. In some areas, this species is the dominant benthos on coral reefs. Due to its commonness and wide range, as well as ease of identification, this species has been relatively well investigated (for a zoanthid). Despite this, some basic aspects of its biology remain unexamined, and this study attempts to address these gaps in our knowledge in order to provide a more complete understanding of this species.		

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審查要旨

In the first section of her research, the candidate investigated the diversity of endosymbiotic *Symbiodinium* dinoflagellates in *P. tuberculosa* in Taiwan for the first time ever. Previous research had examined the diversity of these symbionts across the Indian Ocean to Singapore and Indonesia, and in Japan from Okinawa to the Izu Islands. From Taiwan, the candidate found two types of symbiont, a previously reported type, as well as a new novel type never seen before. This novel type was found only from 50% of specimens from the Penghu Islands. It is suggested that this unique type of *Symbiodinium* is due to the unique environment of Penghu, which has very low temperatures in winter (approx. 11°C) and a monsoon season. These results show that *P. tuberculosa* has flexibility and can harbor different symbiont types in different environments, perhaps due to horizontal transmission.

In the second portion of her research, the candidate investigated the relationship between *P. tuberculosa* abundance and water quality parameters on Okinawa. Recently, there have been unpublished suggestions and some scientific evidence that *Palythoa* spp. can undergo outbreaks, resulting in a stable phase shift. This is the first study of its kind in the Indo-Pacific. In this study, 6 locations on the west coast of Okinawa from the heavily anthropogenically impacted south to the relatively pristine north were investigated. Various water quality parameters and benthic composition data were acquired and analysed. Results showed that *P. tuberculosa* abundance could be related with the presence of coralline algae, some hard coral taxa, and was positively correlated only with lower than normal salinity levels. These results show that *P. tuberculosa* has its own unique environmental parameter niche, and that the species may be more common in areas with fresh water input (and subsequent levels of nitrification). These data will help researchers understand the ecological role of *P. tuberculosa* in the future.

This thesis represents the first effort to understand *P. tuberculosa* from an ecological point of view. Thus, from a scientific standpoint, the candidate's work is important for coral reef biology. The discovery of a unique and novel symbiont type adds to the known knowledge of *Symbiodinium* diversity, and demonstrates the uniqueness of Penghu Islands. Thus, further research into symbiont diversity in Penghu is needed. Her ecological data on *P. tuberculosa* in Okinawa represents a critical first step towards a more complete understanding of coral reef ecosystems and nature of outbreaks of various benthic taxa. Thus, based on the above reasons, the downstream results of this research will be applied in the future research of not only *P. tuberculosa* but also other understudied benthos worldwide.

The candidate's publication history related to this thesis more than meets graduation requirements, with 1 first author paper and 2 more papers as co-author, all in respected international journals. The candidate gave a final thesis presentation (=final examination) on February 13, 2014, in the Science Collaborative Building Room 102, from 13:00 to 14:00 in front of all three members of the Committee. This presentation was open to the public, and attended by many people from both inside and outside the university. In her presentation she discussed symbiont identification in *P. tuberculosa* in Taiwan, and then the relationship between environmental parameters and *P. tuberculosa* distribution in Okinawa. Overall, the candidate talked for 40 minutes, and then appropriately answered numerous questions related to her thesis and research field for 20 minutes. The Committee then met on February 13, 2014, at 15:45, and discussed and judged the candidate's presentation, as well as answers to questions, as demonstrating her hard work, results, and knowledge. Thus, based on the above results, for these reasons, the Committee unanimously recommended "Pass" for the candidate.