DNA barcoding and biodiversity of upper mesophotic coral community in Okinawa

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Mesophotic coral ecosystems (MCEs) are usually found at depth ranging from 30 to over 100 m depth. Mesophotic coral communities are often composed of both eurybathic tolerant species and species adapted to specific condition of the mesophotic zone. Due to its depth, the mesophotic zone is relatively protected from extreme climatic events occuring at the surface (warming, high UV radiation, storms, etc). The Deep Reef Refugia Hypothesis (DRRH) states that mesophotic coral ecosystems, due to these more stable environmental conditions, may act as refugia for shallow water species to survive extreme climatic events and re-colonise shallower reefs in the future. However, such hypothesis depends on the possibility for shallow species to live in mesophotic environments as well as the connectivity between shallow and deep communities. Currently, the taxonomic composition of such communities is still poorly known and the relations between shallow and mesophotic coral fauna are yet to be discovered.

Recent global environmental changes affected seriously shallow coral reefs around Okinawa. The combination of major bleaching events and several typhoons lead to changes in coral communities with some species apparently extinct from several locations. Around Sesoko Island in the northern part of Okinawa, several corals species disappeared since 1999 and were not recorded since then (van Woesik et al. 2011). *Seriatopora hystrix* was one of those species.

During the recent survey of a mesophotic coral ecosystem located between Sesoko Island and Motobu Peninsula, high coral diversity and dense communities were found between 35 and 55 m depth including abundant populations of *S. hystrix* between 39 and 47 m. In order to estimate the coral biodiversity as well as the relationships between shallow and mesophotic corals, several genetic markers, both nuclear and mitochondrial, were sequenced in a DNA barcoding approach for the samples collected. Symbiotic dinoflagellates were also identified.

Morphological and molecular data allowed the identification of more than 50 species, some species like *Acropora tenella* being "typical" from mesophotic environments while other species are also found in shallower reefs. One of such species is *Seriatopora hystrix* (Sinniger et al. 2013). Contrary to initial expectation of a clonal population, our results also showed intraspecific diversity within the population of *S. hystrix*. The genotypes of those deep populations correspond to genotypes previously observed from shallower reefs as well as to new genotypes. Such results suggest an absence of vertical structuring in Okinawan *S. hystrix* populations and support the DRRH. In the future, and if shallow environmental

conditions become suitable again for this species, deep populations of *S. hystrix* and other shallow species found in this environment might be of critical importance for the re-colonisation of shallow coral reefs.

(和文要旨)

DNA バーコーディングを用いた深海サンゴ礁に生息する花虫綱の分類学的研究

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近年、地球環境変動に伴いサンゴ礁の深場（中有光層、Mesophotic Coral Ecosystems、水深30-150m）が地球環境変動における浅海サンゴ類のレフュジアとして注目されている。サンゴ礁浅海の生物多様性についてはよく調べられている一方、この海域での多様性の報告はほとんどない。本研究では、琉球列島のサンゴ礁中有光層において重要な動物群である花虫綱の分布と多様性について共生藻類も含めて調べ、さらに一部のサンゴ種について浅海集団との関係を明らかにした。

調査は沖縄北部本部半島沖水深 35～55m で行った。出現した花虫綱を採集後、形態同定と分子解析により花虫綱-共生藻類の多様性について調べた。その結果、120 以上の試料より 17 科 26 属 50 種類以上を特定することに成功した。代表的な種類として深場によくみられるイシサンゴ目 *Acropora tenella* があげられ、この他浅海にもみられる種類も分布していた。

特筆すべきはトゲサンゴ *Seriatopora hystrix* の群落を発見したことである(Sinniger et al. 2013)。本種は調査域周辺の浅海では高水温による白化により死滅し、回復していないことが報告されている（van Woesik et al. 2011)。そこで本種について浅海と遺伝的に異なる集団かどうかを調べたところ、水深 40m では浅海のものと同じ遺伝型をもっており、水深による遺伝的構造に差はみられなかった。このことから、中有光層に分布する本種は浅海のものと遺伝的交流があることが示唆される。一方、水深 47m からの 1 群体はこれらとは異なり、共生している褐虫藻の遺伝的タイプもこの結果を支持した。

今回、サンゴ礁の深場にトゲサンゴ群落が見つかったことは、この海域がレフュジア（生物が絶滅を逃れて生き残った場所）として重要であることを示唆している。将来的に浅海サンゴ礁が良い環境になった場合、こうして深場に生き残った種類が再度、分布する可能性がある。

Reference

Sinniger F, Morita M, Harii S (2013) ‘‘Locally extinct’’ coral species *Seriatopora hystrix* found at upper mesophotic depths in Okinawa. Coral Reefs 32: 153

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