

Short Communication

Holothurian (Echinodermata) Diversity in the Glorieuses Archipelago (Eparses Islands, France, Mozambique Channel)

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Abstract—Due to their isolation, Eparses Islands provide a valuable opportunity to investigate biodiversity in the absence of anthropogenic influence. The Glorieuses Archipelago forms part of the Eparses Islands, or the French scattered islands in the Mozambique Channel (Western Indian Ocean). Inventories of several taxa, including the holothurians (Echinodermata), were carried out in December 2012 as part of the BIORECIE (Biodiversity, Resources and Conservation of Eparses Islands) programme. Specimens were collected and photographed on the reef slopes of the island at ten sites down to 20 m and the reef flats at twelve sites. Given the worldwide overexploitation of holothurians, it is important to know their present diversity and distribution in such remote areas. The Holothuria comprised 20 species: 10 species were collected on the slopes and 15 on the reef flats. Despite the limited number of sites surveyed, the occurrence of the different species allowed their categorisation as common, uncommon or rare. The commercial species, *Holothuria nobilis*, *Bohadschia atra* and *B. subrubra*, were common. Comparisons at local and regional scales using the same methodology showed that holothurian diversity in Glorieuses is high, but already occurring illegal fisheries are a serious concern.

INTRODUCTION

Coral reefs are among the most diverse of marine ecosystems with the highest species diversity on the globe (Paulay, 1997; Bellwood & Hughes, 2001). Numerous reports on their condition over the last decades warn of their growing degradation (e.g. Wilkinson, 2004), owing to increasing anthropogenic pressure.

Since they are remote and have no permanent human population, the Eparses Islands provide a valuable opportunity to evaluate coral reef biodiversity without anthropogenic influence. Furthermore, the Glorieuses Archipelago, part of the Eparses Islands, was declared a Marine Protected Area (MPA) in 2011 and is in need of a management plan based on scientific knowledge. To date, knowledge on the Eparses Islands remains

scarce because of their limited accessibility. The programme BIORECIE (Biodiversity, Resources and Conservation of the Eparses Islands) was devised to inventorise several taxonomic groups (scleractinians, hydroids, algae, echinoderms (including holothurians), crustaceans and fish) and, more widely, to survey the health of the coral reefs to identify priority zones for conservation. The Archipelago is composed of two principal islands, Grande Glorieuses, which is 3 km in diameter and characterized by a group of dunes attaining an altitude of 12 m, and Lys Island, or *Petite Glorieuse*, with a diameter of 0.6 km and a bog at its centre. Two rip-raps, *les Roches Vertes* and *l'Île aux Crabes*, with associated sandbars that emerge at low tide, complete the archipelago, with a land surface of 5 km² and coral reef with an area of 196 km² (Andrefouët *et al.*, 2009).

Holothurians are presently overexploited worldwide for export of the dried product *Bêche-de-mer* (or trepang) consumed by Asiatic populations (Conand 2004, 2006; Toral-Granda *et al.*, 2008; Purcell *et al.*, 2013). The holothurian fisheries in the Indian Ocean have been described (Conand, 2008) and their poor management has been pointed out (Conand & Muthiga, 2007; FAO, 2013; Muthiga & Conand, 2014). Previous observations on the holothurians on the reef

flats of the Glorieuses have been published by Vergonzannes (1977) and, more recently, on several sites located on outer reef slope and reef flat by Mulochau *et al.* (2008). The commercial value of the different species varies and the product can be classified as of high value, comprising large species such as the teatfish *Holothuria nobilis*, *H. fuscogilva* and *Thelenota ananas*; medium value - several *Actinopyga*, *Bohadschia* and *Stichopus* species; and low value - many smaller species which are harvested when the larger ones have been overfished (Conand, 2004; Purcell *et al.*, 2012; Eriksson & Byrne, 2013). The objective of this study was to provide an inventory of the holothurian diversity, compare it with earlier data and estimate the importance of the *Holothuria* in the context of poaching on the Eparses Islands.

MATERIALS and METHODS

Study areas

A multidisciplinary team explored the reef flats of the island at low tide and the reef slopes down to 20 meters using SCUBA in December 2012. Twelve reef flat sites (19, 22, 23, 27 to 33, 36, 37) and ten reef slopes (GLO 1, 2, 3, 5, 6, 7 and sites 16, 17, 18, 20) were surveyed; details of their locations and depth are presented in Figure 1.

Table 1. Holothurians recorded at ten sites on the reef slopes of the Glorieuses Islands.

Family	Species	Occurrence
Holothuriidae	<i>Bohadschia atra</i>	1
Holothuriidae	<i>Holothuria arenicola</i>	0.10
Holothuriidae	<i>Holothuria atra</i>	0.20
Holothuriidae	<i>Holothuria hilla</i>	0.10
Holothuriidae	<i>Holothuria nobilis</i>	0.30
Holothuriidae	<i>Holothuria pardalis</i>	0.20
Holothuriidae	<i>Holothuria sp. juv</i>	0.10
Holothuriidae	<i>Pearsonothuria graeffei</i>	0.20
Stichopodidae	<i>Thelenota ananas</i>	0.20
Chiridotidae	<i>Chiridota stuhlmani</i>	0.10

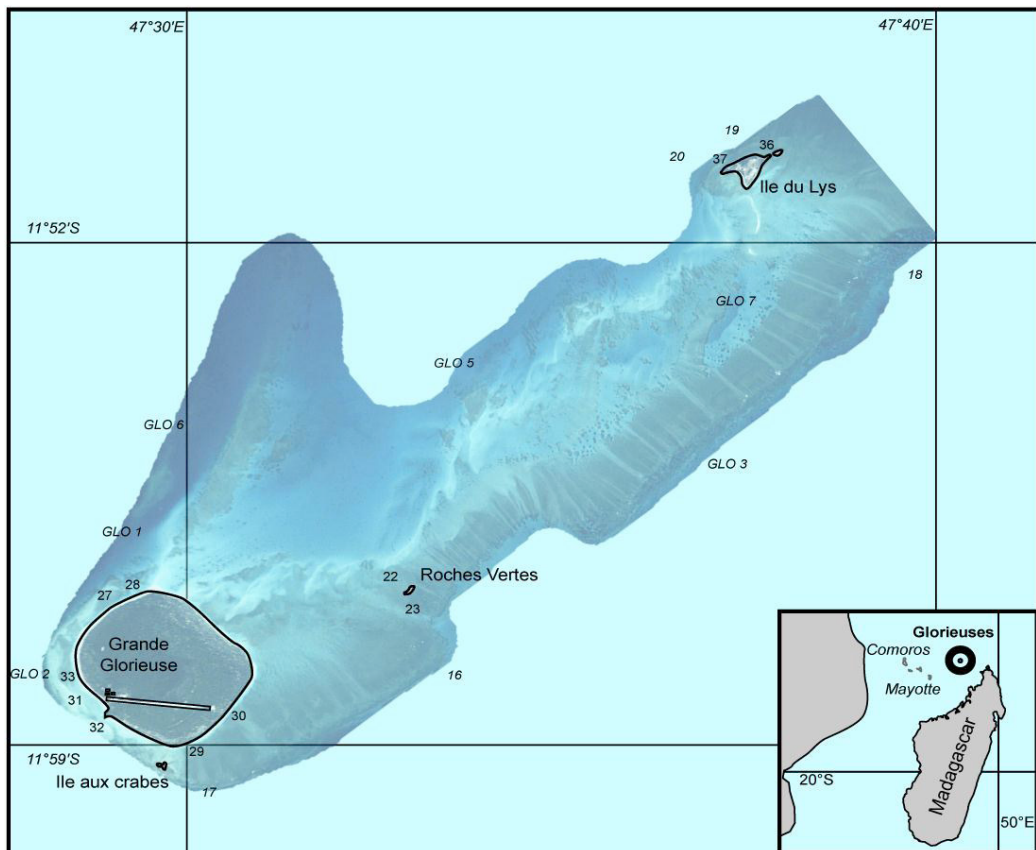


Figure 1. Map of the Glorieuses Islands in the Mozambique Channel with the sampling sites surveyed in 2012.

Holothurian specimens were collected and photographed for identification. A preliminary sort of morphs and species was done in the field and the samples were preserved in 95% ethanol. Identification to species level was undertaken at the Paris MNHN by morphological and spicule examination. The taxonomy here follows the World Register of Marine Species (Appeltans *et al.*, 2012). Holothurian occurrence was calculated separately as the number of sites where a species was present in the main habitats, divided by the total number of sites for each habitat, and categorized the field observations as common, uncommon or rare. Historical surveys (Vergonzannes, 1977; Mulochau *et al.*, 2008) were used for temporal comparison.

RESULTS

Species lists are presented for the outer reef slopes (Table 1) and reef flat habitats (Table 2). Eight species of the Holothuriidae were observed on the reef slopes (Table 1). *Bohadschia atra* occurred at all sites while the second most frequent species, the teatfish *Holothuria nobilis*, was only observed at three sites. One juvenile could not be identified to species level. *Thelenota ananas* was the only member of the Stichopodidae. *Chiridota stuhlmani*, a small species of the Chiridotidae, was only found at one site.

On the reef flats, 11 species of Holothuriidae were observed, the occurrence of *B. atra* and *H. nobilis* respectively

Table 2. Holothurians recorded at twelve sites on the reef flats of the Glorieuses Islands.

Family	Species	Occurrence
Holothuriidae	<i>Actinopyga mauritiana</i>	0.25
Holothuriidae	<i>Bohadschia atra</i>	0.42
Holothuriidae	<i>Bohadschia koellikeri</i>	0.08
Holothuriidae	<i>Bohadschia subrubra</i>	0.33
Holothuriidae	<i>Holothuria nobilis</i>	0.58
Holothuriidae	<i>Holothuria arenicola</i>	0.08
Holothuriidae	<i>Holothuria difficilis</i>	0.08
Holothuriidae	<i>Holothuria fuscocinerea</i>	0.33
Holothuriidae	<i>Holothuria hilla</i>	0.17
Holothuriidae	<i>Holothuria lineata</i>	0.08
Holothuriidae	<i>Holothuria pardalis</i>	0.25
Stichopodidae	<i>Stichopus chloronotus</i>	0.08
Sclerodactylidae	<i>Afrocucumis africana</i>	0.08
Synaptidae	<i>Euapta godeffroyi</i>	0.08
Synaptidae	<i>Synapta maculata</i>	0.17

comprising 42% and 58% (Table 2) of the population. The Stichopodidae were only represented by *S. chloronotus*, and the Sclerodactylidae by *Afrocucumis africana*, found under rubble blocks. The Synaptidae *Euapta godeffroyi* and *Synapta maculata* were also observed but not common.

DISCUSSION

We found a total of 20 holothurian species during the 2012 BIORECIE survey of the Glorieuses Islands, comprising 15 species on the reef flats and 10 species on the reef slopes. The most common species on the reef flats were *Holothuria nobilis*, *Bohadschia atra*, *B. subrubra*, *H. fuscocinerea* and *Actinopyga mauritiana*, and, on the reef slopes, *B. atra* and *H. nobilis*. These species are commercially valuable, with medium to high values (Conand, 2008; Purcell *et al.*, 2012).

Previous observations from 1977 and 2008 were used to assess temporal changes in the holothurian species diversity (Table 3). The first surveys of the reef flats were undertaken by Vergonzannes (1977). This

author recorded ten species, only *H. pardalis* being common; it was found again in 2008 and in the present study. *H. arenicola* and *L. semperianum* were less common according to Vergonzannes (1977) and were not recorded in 2008 or 2012. However, this could originate from recent taxonomic changes giving rise to species complexes (Conand *et al.*, 2010). Moreover, Vergonzannes' (1977) study was limited to reef flats which may explain why none of the large commercial species (*H. nobilis*, large *Bohadschia* and *Thelenota* spp) were recorded in 1977, since the dead coral blocks found on the reef flats are not suitable habitats for these species. More recently, Mulochau and Conand (2008) also recorded ten species on the Glorieuses reef flats, the most frequent being *H. nobilis* and *Synapta maculata*, and on the reef slopes, *B. subrubra* and *H. nobilis*. *Holothuria impatiens* and *Labidodemas rugosum* were not collected again in 2012. A few photographs of holothurians were taken during a three-day cruise of the *Marion Dufresnes* at Glorieuses (2011), showing *B. atra*, *H. fuscogilva*, *H. nobilis*, *T. ananas*, *Pearsonothuria graeffei*.

Table 3. Holothuroidea found at Glorieuses in the present and previous (Vergonzannes, 1977; Mulochau & Conand, 2008) surveys, and at Europa in 2011 (Conand *et al.*, 2013).

	Glorieuses 2012	Glorieuses 2008	Glorieuses 1977	Glorieuses 2011	Commercial value
<i>Actinopyga mauritiana</i>	x				Medium
<i>Bohadschia atra</i>	x	x		x	Medium
<i>Bohadschia koellikeri</i>	x				Low
<i>Bohadschia subrubra</i>	x	x		x	Medium
<i>Holothuria arenicola</i>	x		x		
<i>Holothuria atra</i>	x			x	Low
<i>Holothuria difficilis</i>	x				
<i>Holothuria fuscocinerea</i>	x				
<i>Holothuria hilla</i>	x	x	x		
<i>Holothuria nobilis</i>	x	x			High
<i>Holothuria lineata</i>	x	x			
<i>Holothuria pardalis</i>	x	x	x		
<i>Holothuria sp. juv.</i>	x				
<i>Pearsonothuria graeffei</i>	x				Low
<i>Stichopus chloronotus</i>	x			x	Low
<i>Thelenota ananas</i>	x			x	High
<i>Afrocucumis africana</i>	x				
<i>Euapta godeffroyi</i>	x	x			
<i>Synapta maculata</i>	x	x			
<i>Chiridota stuhlmani</i>	x				
<i>Holothuria impatiens</i>		x	x	x	
<i>Labidodemas rugosum</i>		x	x		
<i>Holothuria rigida</i>			x		
<i>Holothuria maculosa</i>			x		
<i>Bohadschia marmorata?</i>			x		Low
<i>Labidodemas semperianum</i>			x		
<i>Bohadschia vitiensis</i>				x	Low
<i>Patinapta sp.</i>				x	

The same survey methods were used during the BIORECIE cruise to Europa Island in 2011, at the southern end of the Mozambique Channel (Conand *et al.*, 2013). The holothurians at this island were less diverse than at Glorieuses, comprising only nine species, including the commonly abundant *S. chloronotus* and the common *B. atra* and *B. subrubra* (Table 3).

Comparisons with other localities in the WIO include the Comoros by Samyn *et al.* (2006) who presented a very detailed and illustrated study of 40 species, and Mayotte where Pouget (2005) and Eriksson *et al.* (2012) identified 22 species, many being of commercial value. Ecological assessments obtained during a WIOMSA/MASMA project (Conand & Muthiga, 2007; Muthiga

& Conand, 2014) have provided updates of species inventories in Kenya (44 species), Reunion (37 species; see also Conand *et al.*, 2010), Madagascar (125), Mozambique, the Tanzanian mainland and Zanzibar (26 species; see also Eriksson *et al.*, 2010), as well as abundances of the main species.

Despite the apparent present abundance of commercial species at Glorieuses, the question of the illegal fishery of holothurians must be considered. It did not seem to occur prior to 2012, given previous observations of the high value species, but concern is now raised since seizures within the Exclusive Economic Zone (EEZ) in 2013 and, very recently in March 2014, when foreign vessels were arrested by the French authorities with diving gear and one tonne of holothurians preserved in salt (*Journal de l'île de La Réunion*, 2013; TAAF 2014). In the 2012 BIORECIE survey, the white teatfish *H. fuscogilva* was not found again. This may be attributable to poaching of this valuable species.

This stresses the need for better monitoring and protection of these resources within the Glorieuses MPA in the Eparses Islands. Illegal catches (quantities and species specific records) should be documented by the authorities and compared with species abundance in the natural habitat by monitoring. Additional sampling in the Eparses Islands is needed to properly compare the coral reef fauna between the islands over time, including the commercial holothurian species, especially in the Mozambique channel, to conserve and protect the resources of these remote and relatively pristine areas.

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