

Potential symbiosis between the bathyal sea cucumber *Orphnurgus* sp. (Elasipodida, Deimatidae) and the amphipod crustacean *Adeliella* sp. (Gammaridea, Lysianassoidea) in the western tropical Pacific

Laure Corbari,^{1,*} Chantal Conand^{2,3} and Jean Claude Sorbe⁴

Sea cucumbers are known to harbour a large number of parasitic or commensal organisms, including gastropods, worms, crustaceans, echinoderms and fishes (Eeckhaut et al. 2004; Caulier 2016 (see PhD abstract in this issue); Purcell et al. 2016). More than 200 species are currently recognised as commercial sea cucumbers. Bathyal and abyssal species are also important hosts (Billet 1988; Thurston et al. 1987). Crustaceans associated with deep-sea cucumbers, ectobiontes or endobiontes, belong to different groups (Billet 1988; Thurston et al. 1987). Among the amphipods mentioned as holothurian endobionts, several associations have already been described: *Valettia hystrix* Thurston, 1989 (Valettiidae) in the posterior intestine and cloaca of two deep elasipod holothurians at Porcupine Seabight, northeast Atlantic, *Deima validum validum* and *Oneirophanta mutabilis mutabilis* Théel, 1879 (Billett 1988; Thurston 1989). *O. mutabilis* generally harbours five to seven amphipods per digestive tract.

During several expeditions conducted since 1976 by the Muséum National d'Histoire Naturelle (Paris) in the tropical west-Pacific region, numerous benthic samplings (Warén dredge, beam trawl) were

carried out on bathyal bottoms in order to inventory the biodiversity of these environments. Among these multiple operations, six trawls carried out with a beam trawl made it possible to collect 15 Lysianassoidea amphipods, probably belonging to a new species in this group. Two of these specimens were directly observed onboard, housed in the coelomic cavity of elasipod holothurians, as evidenced by the photographs of the specimen from station CP1836: one taken onboard immediately after fishing (Fig. 1A), and another after about 15 years of storage in alcohol (Fig. 1B).

The two host sea cucumbers were fished at two geographically distinct bathyal stations, but at similar depths, one in the Solomon Sea (SALOMON 1 campaign, 5 October 2001, station CP1836, 439–486 m, mud), the other north of New Hanover (KAVIENG campaign, 1 September 2014, station CP4448, 564–743 m, mud with fragments of sunken wood). These two small (5–6 cm) specimens probably belong to the same species and are characterised by a similar general morphology, relatively short and few podia, and a longitudinal median line on their ventral surface. Y. Samyn and M. Sibuet (pers. comm.)

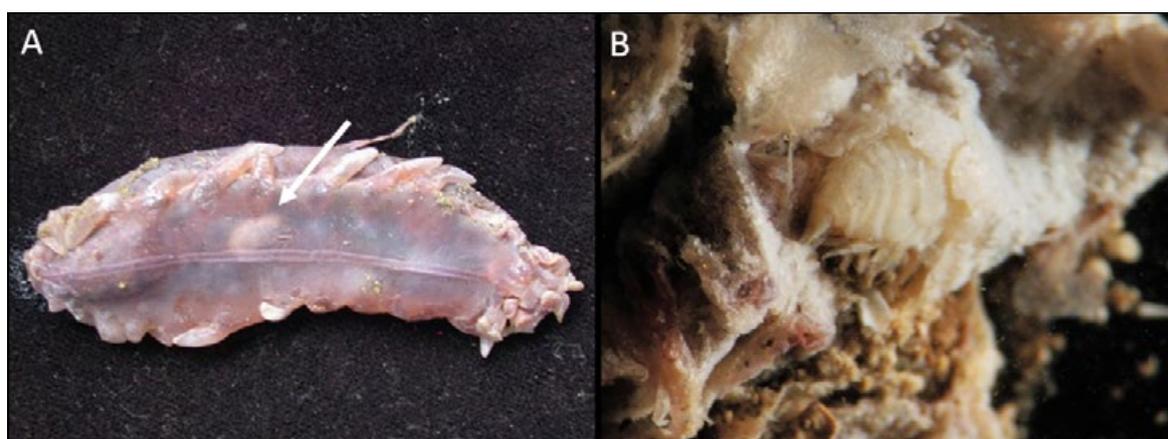


Figure 1. A: Silhouette of an amphipod (indicated by an arrow) seen through the integuments of a sea cucumber (Elasipodida) at the time of collection (station CP1836) (image: A. Warén). B: Amphipod (Lysianassoidea, genus *Adeliella*) partially cleared of the integuments of the same sea cucumber after 15 years of preservation in alcohol. (image: L. Corbari)

¹ Muséum National d'Histoire Naturelle, UMR 7205 ISyEB, 43, rue Cuvier, PO Box 26, 75005 Paris, France

* Corresponding author: laure.corbari@mnhn.fr

² Muséum National Histoire Naturelle, Milieux et Peuplements Aquatiques, Paris, France

³ UMR 9220 ENTROPIE La Réunion University, France

⁴ Station Marine, 2 rue Jolyet, 33120 Arcachon, France

suggest that they belong to the family Deimatidae, which comprises the three genera *Deima*, *Oneirophanta* and *Orphnurgus*. According to Paulay (2015), nine species are currently recognised for this deep-sea genus (174–1301 m), several species having been described from the tropical Pacific, others from the Indian Ocean (Thandar 2015). Pawson (2002) described *O. dorisae* from New Zealand and gave an identification key to all known species. The study of the spicules and anatomical characters of the specimens herein examined may help to clarify their identification.

Of the 15 amphipod specimens from various trawls carried out in the bathyal area (260–865 m) of the western tropical Pacific, only 2 were undoubtedly sea cucumber endobionts. The others were collected in the trawl cod-end, suggesting that they are occasional symbionts that can also have an independent benthic life. According to their morphology, all of these specimens belong to the same species within the Lysianassoidea superfamily. The detailed characteristics of their morphology (under study) reveal that they undoubtedly belong to the genus *Adeliella* described by Nicholls (1938). According to the World Register for Marine Species database (2016), the genus *Adeliella* currently contains four species that have been collected by trawling or in baited traps. They are generally regarded as scavengers and have so far never been mentioned in symbiosis with sea cucumbers:



Figure 2. *Adeliella* sp. (Amphipoda Lysianassoidea, specimen MNHN-IU-2015-262) collected in the Solomon Sea (station CP4338, MADEEP oceanographic campaign, 410–614 m), and photographed after storage in alcohol. (Image: I. Frutos)

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Field observations on the regeneration in *Synapta maculata* (Holothuroidea: Synaptidae)

Philippe Bourjon¹

Introduction

The order Apodida does not include fissiparous sea cucumber species but at least some species are known to exhibit autotomy and regeneration (Emson and Wilkie 1980). Such capacity has been experimentally studied in *Leptosynapta* Verrill, 1967 (Pearse 1909; Smith 1971a, b; Gibson and Burke 1983). Transversal section experiments reveal that anterior parts regenerate a smaller but functionally complete animal (Smith 1971a), whereas posterior parts never survive (Smith 1971a; Gibson and Burke 1983). Autotomy has been induced in *Synapta maculata* Chamisso and Eysenhardt, 1821 (Domanjay 1931), but field observations of the anterior part regenerating a posterior part are uncommon. This communication reports on observations made on a fringing reef at Reunion Island.

Material and methods

An anterior part of a *Synapta maculata* individual regenerating a posterior part was observed *in situ* on 10 September 2016 on the fringing reef of L'Ermitage at Reunion Island (21°07'S, 55°32'E). The specimen was found under a broken slab of concrete, 3 m from the beach and at a depth of 50 cm. The regeneration progress was monitored over seven weeks. Measurements were taken after moving the individual to a nearby sandy area without rubble. When the animal was crawling on a flat surface, its body was roughly straight, and there were very little contraction. After measurements were made, the individual *Synapta maculata* was placed back under its shelter. Photographs were taken during each monitoring session.

The specimen always stayed under the same shelter where it was first found. It was monitored until its appearance and length became similar to young individuals present at the site, and was indistinguishable from others like it.

Results

When the specimen of *Synapta maculata* was found, the loss of its posterior part seemed to have occurred rather recently because its posterior extremity showed petal-like pieces of tegument opening and closing regularly (Fig. 1 a, b, c). The body had the

same appearance as whole individuals on the reef, apart from its posterior part (Fig. 1c), which exhibited a succession of prominent bulging warts. The rest of the body remained typically wrinkled, and its colour was a semi-transparent white to pale or yellowish grey, with a low density of ochre-coloured spicules. The anterior part was yellow-brown

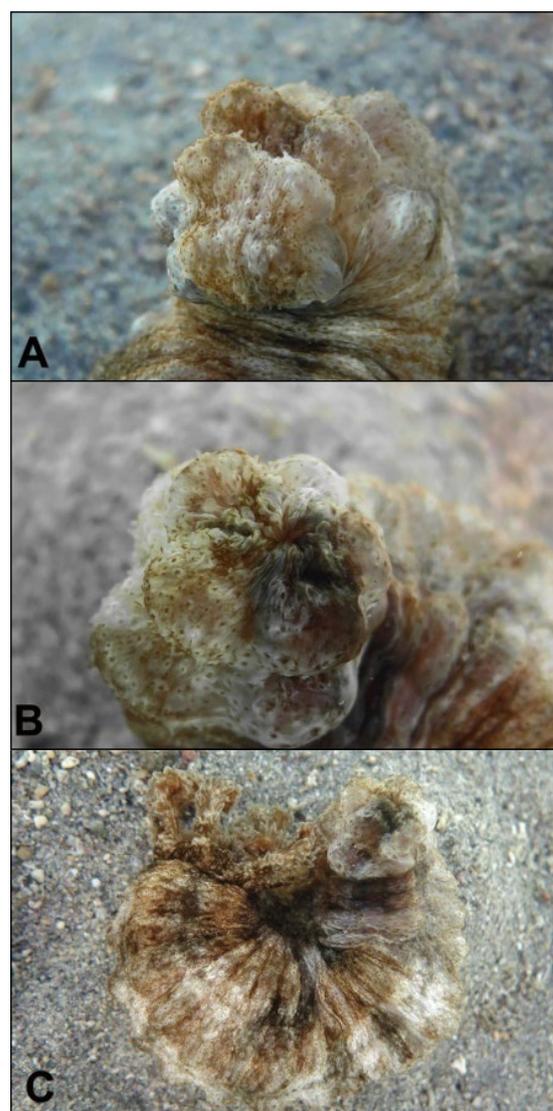


Figure 1. Anterior part of *Synapta maculata* regenerating a posterior part (observed on 10 September 2016). A: Petal-like pieces of tegument “opened” at the posterior extremity at 09.46 am. B: Posterior extremity closed at 09.47. C: Posterior extremity opened again a few seconds later.

¹ Les Sentinelles du Récif, réseau d’observateurs volontaires de la Réserve Naturelle Marine de La Réunion (GIP-RNMR). Sentinels of the Reef is a network of volunteer observers of Reunion Marine Park. Email: seizhavel@wanadoo.fr

longitudinally, with white and brown stripes and transversal dark grey blotches, and exhibited dense patches of spicules. No measurement of the non-contracted body could be done that day, as the individual kept a C-shape posture and did not attempt to crawl. Its length in this contracted posture was about 9.5 cm and its diameter was 3.5 cm; the posterior part was around a quarter of the length of the body (Fig. 1c).

During the following weeks, the specimen was identically characterised by a warty and greyish posterior part while the anterior part was wrinkled and yellowish (Figs. 2 and 3a). The posterior part remained more or less warty even when its colouration became the same as the anterior part. This feature was no longer obvious on 5 November 2016 and, therefore, monitoring ceased on that day (Fig. 3b).

On 17 September 2016, its length of the *Synapta maculata* individual when it was crawling was about 20 cm (Fig. 3a). From 17 September to 5 November, it increased in length regularly by an average of 0.42 cm by day, with the specimen reaching 41.00 cm when the observations ceased (Fig. 3b). An increase in the daily average length was noticed during this period: increasing from 0.30 cm day⁻¹ between 17 September and 12 October (26 days), to 0.54 cm day⁻¹ between 12 October and 5 November (24 days).

Discussion

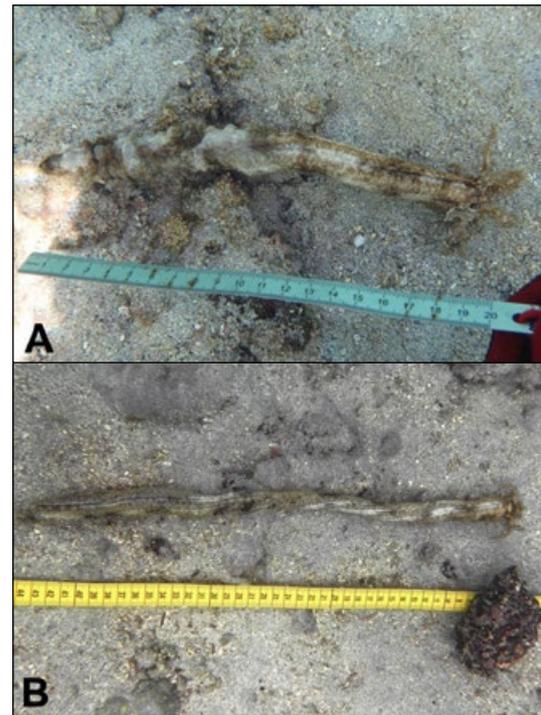
The quantitative data provided here are solely for informational purposes, as the high stretching capacity of this species prevented an accurate estimation of length in the field. Therefore, the change in the ratio of the anterior and posterior parts of the body length based on their characteristic appearances could no longer be estimated. Moreover, the cut on the body seemed to have occurred recently when the specimen was found. The posterior part of the body, close to the wound and equivalent to about 25% of the total body length, was covered with warts. This suggests that this feature could be a post-traumatic response that was rapidly exhibited by the tegument tissues of the anterior part bordering on the wound, as the warts can appear in stressful conditions in this species (Domantay 1953). Inasmuch as this response was also exhibited by the regenerating part during seven weeks, the warty appearance cannot be considered as a reliable characteristic to estimate the growth of this part because it seems impossible to perceive the precise localisation of the transection.

The almost unchanging warty morphology of the posterior part during the observation period suggests that the regenerating part exhibited a long post-traumatic stress period. This may be a way to recognise a regenerating individual in the field.

Figure 2. *Synapta maculata*: warty and greyish posterior part, and an anterior part that is wrinkled and yellowish (observed on 17 September 2016).



Figure 3. Regeneration of *Synapta maculata*. A - 24 Sept. 2016: The specimen was about 20-cm long. The posterior part was still greyish and warty. B - 5 Nov. 2016: The specimen measured about 41 cm. The posterior part was, henceforth, approximately similar to the anterior part.



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