

## First observation of a large group of *Holothuria leucospilota* sea cucumber juveniles at a nursery in Manado (north Sulawesi, Indonesia)

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### Introduction

The white thread-fish sea cucumber, *Holothuria (Mertensiothuria) leucospilota*, is a tropical holothurian species that is widely distributed in shallow reef areas (e.g. reef flats, shallow costal lagoons, seagrass beds) of the tropical and sub-tropical Indo-Pacific region, including the Red Sea (Conand 1998; Samyn et al. 2006; Conand 2008). Like abalone shells or shark fins, holothurian species constitute both a traditional commodity and a potentially significant commercial resource for coastal populations. In addition to their commercial value as food, holothurian species may also be significant because of their biotechnological properties (Xing and Chia 2000; Tamori et al. 2006; Han et al. 2007; Lawrence et al. 2010).

There is global concern regarding overfishing of *H. leucospilota*. *H. leucospilota* is one of about 60 species of sea cucumber (both temperate and tropical species) that constitute a major part of worldwide holothurian fisheries (Lovatelli et al. 2004; Purcell et al. 2010; Uthicke et al. 2010). In this regard, sea cucumber conservation is a primary concern. As with some other aspidochirots, *H. leucospilota* shows two distinct reproduction modes: 1) sexual reproduction, characterized by dioecism, external fertilization, and a planktonic larval stage (Purwati and Luong-van 2003; Drumm and Loneragan 2005; Gaudron et al. 2008; Kohler et al. 2009); and 2) asexual reproduction by transverse fission (Conand et al. 1997; Purwati 2004; Purwati and Dwiono 2005), which has generated studies on its use in aquaculture and for re-stocking purposes (Purwati and Dwiono 2005).

The diversity of coral reef ecosystems in Southeast Asia and the western Pacific (SEA-WP) presents a strong interest for both global biodiversity conservation and local (human) community development. However, coral reef ecosystems in this region are

deeply threatened due to various factors, including human impacts on the environment and global climate change. Coral reefs of distinct islands are sometimes considered to be independent entities, especially due to the limited movement of adult marine organisms. However, the life history of many marine species, such as holothurians, includes a pelagic larval phase, and so there is an exchange of organisms and species between island ecosystems. Therefore, even within an island-studded region, a global management plan is necessary. Such a global regional management plan within the SEA-WP region, however, requires international coordination.

The SEA-WP Connectivity Project, led by Kazuo Nadaoka (Taquet et al. 2009) aims to provide useful information concerning larval dispersal patterns and reef connectivity, thereby contributing to the identification of important candidate areas for marine protected areas (MPAs). In this study, we used two different approaches: numerical simulation of larval dispersal and a population genetics study. The second approach required extensive tissue sample collection in order to properly infer genetic connectivity in the SEA-WP region. We conducted a sampling campaign in several sites of Indonesia, which allowed us to make other observations. In this paper, we describe a large aggregation of *H. leucospilota* juveniles and some potential implications.

### Results and discussion

We explored the general area around Manado (north Sulawesi) in May 2010, and visited Pantai Kalinaun (Fig. 1) on the eastern side of Manado peninsula, north of Bitung. At this site, we observed a large number of very small black sea cucumbers in a seagrass bed (main species *Thalassia* sp.) on a sandy substrate with coral rubble (Fig. 2B and D). Except for their body size, the morphology corresponded

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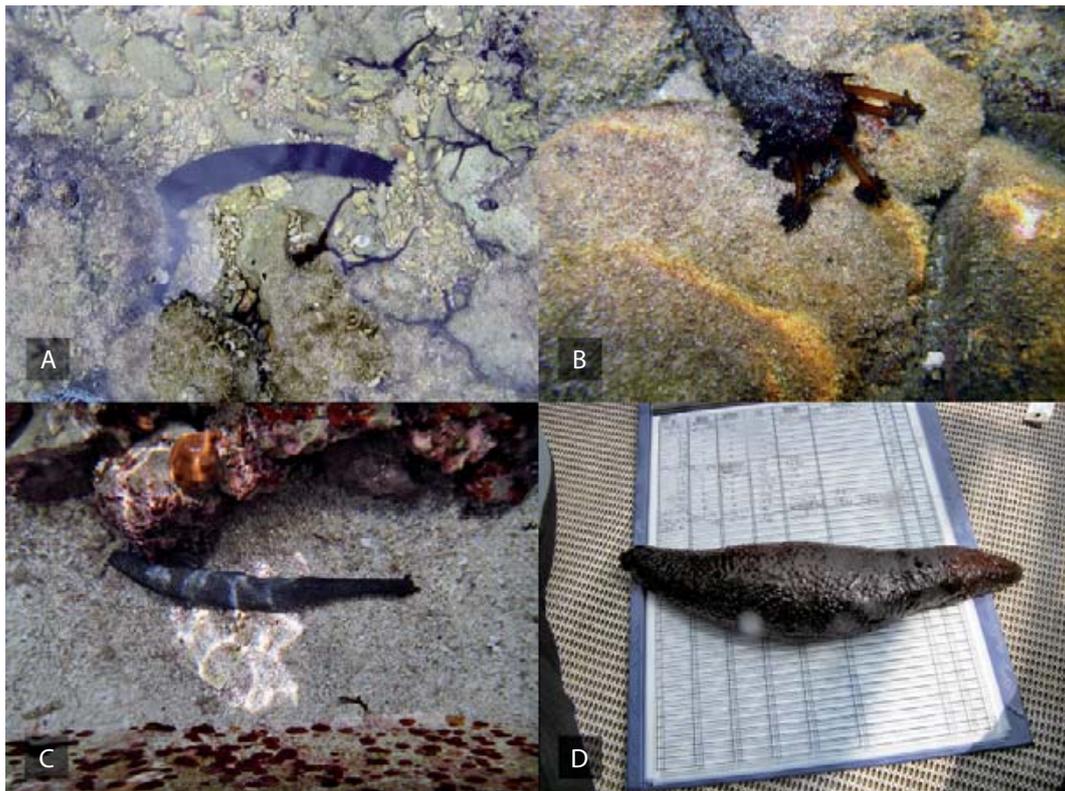
**Figure 1.** Pantai Kalinaun (1°38'0.04"N, 125° 9'2.62"E), Manado area, north Sulawesi, Indonesia (source: ©Google Earth).

exactly with *Holothuria leucospilota* (Conand 1998; Samyn et al. 2006; Conand 2008): long black body, lightly pear shape when contracted, very fine and smooth tegument, Cuvierian tubules. They also presented some characteristics (e.g. reaction and texture to the touch) that are typically found in adult *H. leucospilota* at other sites (Fig. 3). This lead us to consider that those individuals were juvenile *H. leucospilota* (Fig. 2A and C). Indeed, while the mean

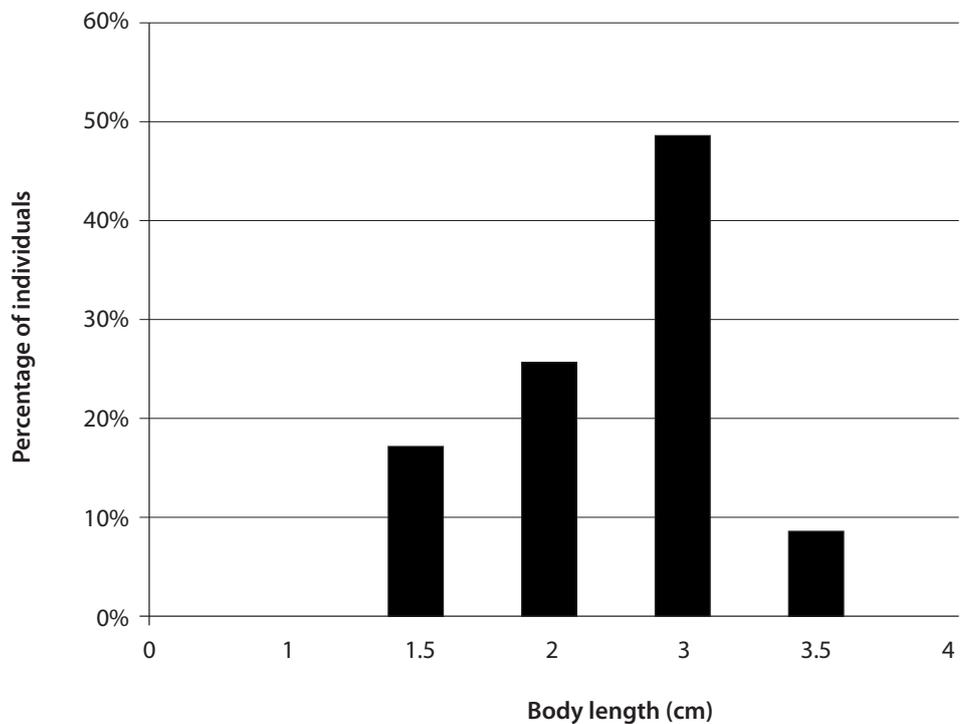
body length of adults is about 35 cm (Conand 1998; Kohler et al. 2009), all of the individuals observed in Pantai Kalinaun had a curved body length between 1.5 cm and 3.5 cm, with an average length of 2.37 cm (based on a sample of 35 individuals captured from seagrass bed, Fig. 4). Such length values are consistent with previous observations of *H. leucospilota* juveniles (Shiell 2004). In addition, the length-to-width ratio was similar to that of adults, and the



**Figure 2.** *Holothuria leucospilota* juveniles observed in Pantai Kalinaun, Manado area, north Sulawesi, Indonesia (Photos: Coralie Taquet).



**Figure 3.** Adult *Holothuria leucospilota* (Photos: Coralie TAQUET): Photos A, B and D are from Kenting Marine Park (Taiwan); and photo B is from Vairao, Tahiti (French Polynesia).



**Figure 4.** Body length distribution of 35 juvenile *H. leucospilota* in the nursery at Pantai Kalinaun (Manado, north Sulawesi, Indonesia).

absence of a fission “scar” at either end of the body indicates that they were sexually reproduced rather than asexually produced individuals.

Contrary to most of the previous observations of holothurian juveniles (Shiell 2004), we did not observe any adults nearby in Pantai Kalinaun. The holothurian fauna in that small area (approximately 50 m x 40 m) was comprised almost entirely of *H. leucospilota* juveniles. We estimated the mean density of juveniles inside this area to be about 100 ind m<sup>-2</sup>. Accordingly, a rough estimate of the total number of juveniles would be 200,000 individuals. This constitutes a huge number given the scarcity of juveniles that have been observed (Purwati and Luong-van 2003) for this species (reputed to reproduce asexually), but shows evidence of spawning in various sites (Purwati and Luong-van 2003; Purwati 2004; Drumm and Loneragan 2005; Gaudron et al. 2008; Kohler et al. 2009). Considering the relatively low number of juveniles observed in some other sites (Shiell 2004) in contrast to the high concentration of juveniles in Pantai Kalinaun, we consider this aggregation to be a real “nursery”.

This observation occurred on 15 May 2010 during a spring flood tide, between 15:00 and 17:00. Depth was about 50 cm. Even with the scant information on larval duration and growth in the wild, we hypothesize that these juveniles could have been produced from the last spawning period in January–April (Purwati and Luong-van 2003; Drumm and Loneragan 2005; Gaudron et al. 2008). Concerning the geographical origin of these new recruits, several hypotheses could be considered due to the complex oceanic currents around Indonesia (Sprintall et al. 2004). On one hand, it is possible that these recruits simply come from nearby sites because we observed adult *H. leucospilota* throughout the Manado area. On the other hand, recruits could come from Mindanao Island (Philippines), north of Kalimantan (Indonesia), or north of Sulawesi (Indonesia) from Indonesian Through Flow and Celebes Sea eddy system (Aditya R. Kartadikaria, PhD student, Tokyo Institute of Technology, pers. comm.). This matter may be addressed by genetic analyses of recruits, and more particularly a comparison between individuals from other spots in the Manado area, but also from elsewhere in Indonesia (e.g. Derawan, Bontang) and the Philippines (Taquet et al. in prep.).

## Conclusion

The study of a large nursery of *H. leucospilota* could provide useful information concerning the sexual reproduction of this species, which plays an essential part in maintaining genetic diversity. Such a study could also allow an assessment of factors

that influence settlement and survivorship of holothurian juveniles. This last point is also significant in the context of global holothurian overfishing, because it could facilitate re-stocking through the release of hatchery-produced juveniles in the wild and/or MPA networks.

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