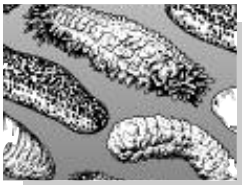

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The use of calcareous spicules for the identification of the Galápagos sea cucumber *Isostichopus fuscus* on the international market

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Introduction

About 40 species of commercial sea cucumbers are harvested throughout the world's oceans (Conand 2004). Once on the international market, the dried (processed) form of some species can be almost impossible to distinguish from others (Conand 2004). Sea cucumber taxonomy is based on anatomical features, such as the shapes and combination of microscopic spicules that are the skeletal components in the body wall of all sea cucumbers. These spicules can take widely different shapes, such as rosettes, C-shaped rods, buttons, and plates (Fig. 1) (Hickman 1998).

The sea cucumber *Isostichopus fuscus* (Ludwig, 1875) has been harvested commercially in the Galápagos Islands since 1991, where it has become the most important fishery resource (Murillo et al. 2004); it is commercially depleted in mainland Ecuador (Camhi 1995). Illegal fishing activities have been continuous in the Galápagos (Piu 1998, 2000; Martínez 1999; Sant 2004), fuelled mainly by international demand for this species and the economic needs of the local fishing sector. Although it is not among the most valuable sea cucumber species (Conand 2004), the Galápagos sea cucumber has been recognized as an important food item in the Chinese market (J. Chen, Yellow Sea Fisheries Research Institute, China, pers. comm).

In the field, this species can easily be recognized by its thick, firm brownish body wall covered with blunt yellow papillae (Fig. 2) (Hickman 1998). However, once processed, it looks similar to some other species of the family, including *S. horrens*, which is harvested illegally together with *I. fuscus* (Arellano 2004). The spicules in the body wall of *I. fuscus* take the form of tables and C-shaped rods while the tube feet produce spicules shaped like end-

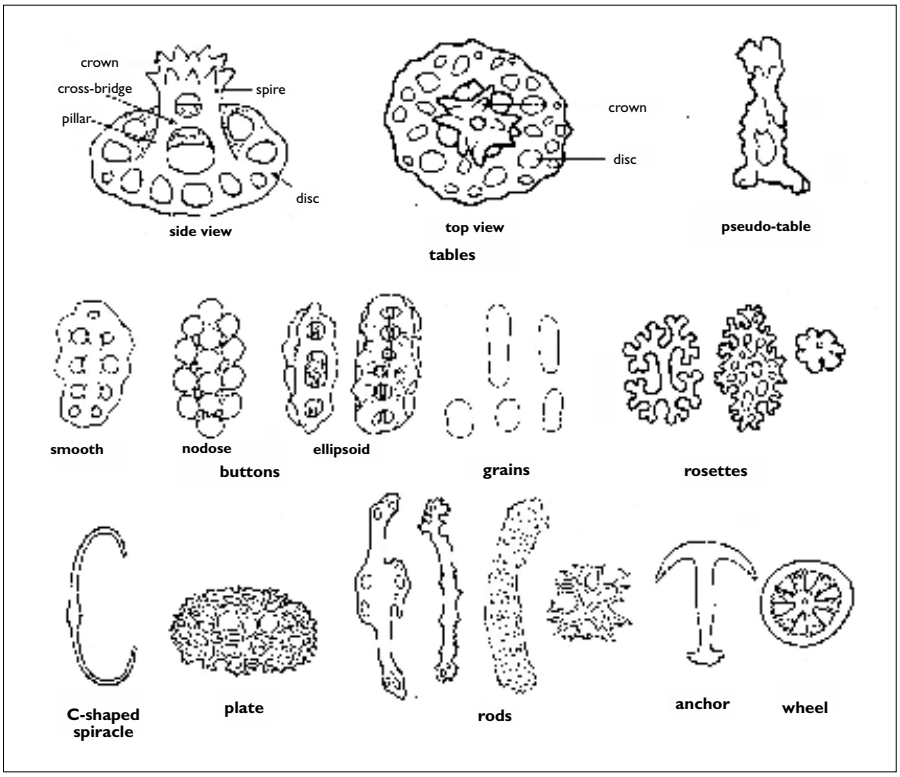

Figure 1. Different types of calcareous ossicles present in holothurians.
Source: Conand 1998

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Figure 2. The Galápagos sea cucumber *Isotichopus fuscus*. Image: Cleveland P. Hickman

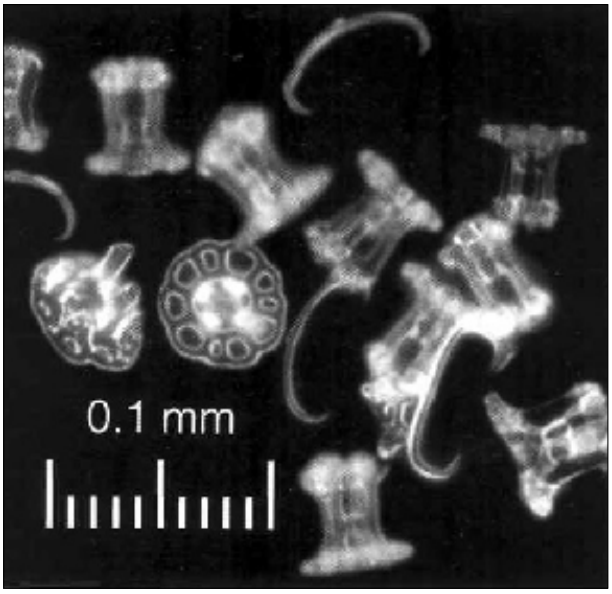

Figure 3. Tables and C-shaped rods characteristic of the body wall of *Isostichopus fuscus*. Image: Cleveland P. Hickman

plates and perforated supporting tables (Fig. 3) (Hickman 1998).

In October 2003, *I. fuscus* was included in CITES Appendix III, as a result of a valuable initiative by the Ecuadorian government to diminish the illegal trade in this species. This listing gave rise to the need to develop identification procedures that would enable positive identification of this species by officials at major trading ports and in different countries, thus deterring the illegal trade in *I. fuscus*, and supporting conservation efforts.

This paper aims to illustrate the technique used to extract the spicules as a means to aid the beche-de-mer scientific community, custom officers and the international market. It also hopes to show the advantages of this methodology for the detection of illegal shipments, hence benefiting conservation efforts of this taxon.

Methodology

Thirty *I. fuscus* specimens (10 fresh, 10 in brine and 10 dried) were obtained from the Galápagos National Park Service; all had been impounded by the Park Service. A slice 1 cm^2 x 1 mm thickness was dissected from the dorsal epidermis of each individual. Following the methodology described by Hickman (1998), each sample was placed in a small test tube with 3 ml of commercial bleach (NaOCl). Samples were left for approximately 30 min or until the body wall had dissolved and the ossicles settled to the bottom, resembling fine white sediment. By means of a pipette, the precipitated spicules were transferred to a microscope slide, covered with a cover slip and examined with a microscope at 100 x magnification (Hickman 1998).

Results and discussion

In all samples, the calcareous spicules remained intact and fully distinguishable, regardless of whether the animal was fresh, salted or dried. No changes in the proportion, size or shape of the different spicules or were observed between the different processing stages.

Commonly used taxonomic characters include the shape and composition of the spicules embedded in the body wall, as well as other morphological characters such as the presence or absence of Cuverian tubules and the shape of the calcareous ring (Uthicke et al. 2004). In the case of *I. fuscus* in the Galapagos, only the spicules were used, proving their usefulness to identify this species under different processing methods. The spicules remained intact, with little fractioning (especially of the plates), and the proportion of different types of spicules did not differ between the processing stages.

Although their harvest is illegal, large quantities of *Stichopus horrens* are caught in the Galapagos Marine Reserve (Arellano 2004); these sea cucumbers are then traded at much reduced prices, or on the black market. Using the proposed body wall methodology, we observed the existence of rosettes and large tack-like ossicles on *S. horrens* body walls that are non-existent in *I. fuscus* (Fig. 3) (Hickman 1998); this will facilitate identification of which species has been caught, which is useful both for management and enforcement.

Several methods have been used to try to identify different species of sea cucumber while live or fresh (i.e. molecular phylogeny) (Uthicke and Benzie 2003, Uthicke et al. 2004), morphology (Cherbonnier 1980), visual (Conand 1990), and skeletal features (Cherbonnier 1980, Conand 1990, Uthicke et al. 2004); these have been useful in most

cases. The methodology presented here targets dried specimens that are already on the international market, the identification of which should be done in a precise and timely manner by custom officers. In the case of *I. fuscus*, this procedure enables quick and easy identification, is cost-effective and can be performed by biologically untrained personnel. Further studies should be done to compare the spicules of *I. fuscus* among populations in different countries, so as to fully establish this method's usefulness.

Examination of calcareous spicules in other commercial sea cucumber species can benefit conservation efforts for these species worldwide. Care must be exercised when relying exclusively on this procedure to identify a species, however, as the composition of the body wall spicules has not yielded positive results in all species analysed (Uthicke et al. 2004, Uthicke et al. in press). The procedure is cost-effective and yields rapid results, and hence the feasibility of performing such examinations in time constrained situations, and by untrained personnel. A catalogue identifying the key external characteristics as well as the spicules present in each of the commercially important species could be of great help to aid conservation efforts and encourage legal trade in these species.

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