Changes in weight and length of sea cucumbers during conversion to processed beche-de-mer: Filling gaps for some exploited tropical species

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Abstract

Converting the weights or lengths of sea cucumbers in processed forms (e.g., salted or dried) to their original (live) measurement is essential for standardising data from fishery-dependent surveys and exports. We estimated the proportionate change in length and weight, during processing stages, of several species for which published data were lacking. The wide variation among species in the percentage of weight lost during processing emphasises that conversions should be made on a species-by-species basis. *Stichopus herrmanni* shrunk more in length and weight than any other species we studied. We present new estimates for *Actinopyga spinea*, *A. palauensis*, *A. echinites*, *Holothuria lessoni*, and *H. whitmaei*. These findings complement previous studies by filling some gaps in conversion factors for tropical species, and will allow for realistic conversions of data from fishery assessments and national exports.

Introduction

Reporting the weights of sea cucumbers for exports or studies using fishery-dependent surveys is fraught with difficulty and errors because they can be in various states of commercial processing at the time they are measured. Some studies have been conducted on various holothurian species to determine the average change in weight from whole, unprocessed animals to dried beche-de-mer. Conand (1989, 1990) presented a comprehensive table of percentage changes in seven species of commercially exploited sea cucumbers. Skewes et al. (2004) reviewed some additional literature on weight change in processing sea cucumbers, and conducted a further study of six species.

We recently conducted a multi-disciplinary programme in New Caledonia to evaluate wild stocks and current patterns of exploitation of sea cucumbers (Purcell et al. 2009). Animals sold or presented by fishers were in various forms of processing into beche-de-mer. On some occasions, the catch was just gutted; other times, the animals were gutted and salted; other times they were dried already. We needed to be able to convert the individual weights back to whole body weight in order to have a common unit for analyses and to allow comparisons with data from our field population surveys. The conversion factors given by Skewes et al. (2004) allowed us to convert weights of many species, but no published data existed for some of the conversion ratios we needed for other species. This article reports a short study from the programme, in which we estimated the average weight loss at each principal stage of processing for six species for which published data were lacking. It therefore complements the results and reviews by Conand (1989, 1990) and Skewes et al. (2004) by filling in some missing gaps for tropical commercial species.

Methods

The 70 samples for this study were obtained either by accompanying a fisher and using animals he collected, or by using animals we collected during a population survey near Île Ouen, New Caledonia. Once collected, the animals were drained on the deck of the boat for approximately 1 minute, and then the whole body was weighed to nearest 5 g using an electronic balance. The viscera were then removed, by cutting the animals as practised by the fishers. Tags were placed through the body wall of the animals; a plastic label was threaded through the anus with fishing line, and (for *A. palauensis* and *H. whitmaei*) a T-bar tag was also inserted through the body wall. The bodies were then weighed (i.e. gutted weight). Next, salt was added to the sea cucumbers (Fig. 1a) and they were left for 10 days (with two salt changes during that time), which is standard for the processor we worked with. Then each individual was weighed again. For *Stichopus herrmanni*, animals were not salted by the fisher, since his practise was to place them immediately on ice (Fig. 1b) and boil them after returning to land. The sea cucumbers were boiled and dried to a hard product (beche-de-mer) and weighed again (Fig. 1c).

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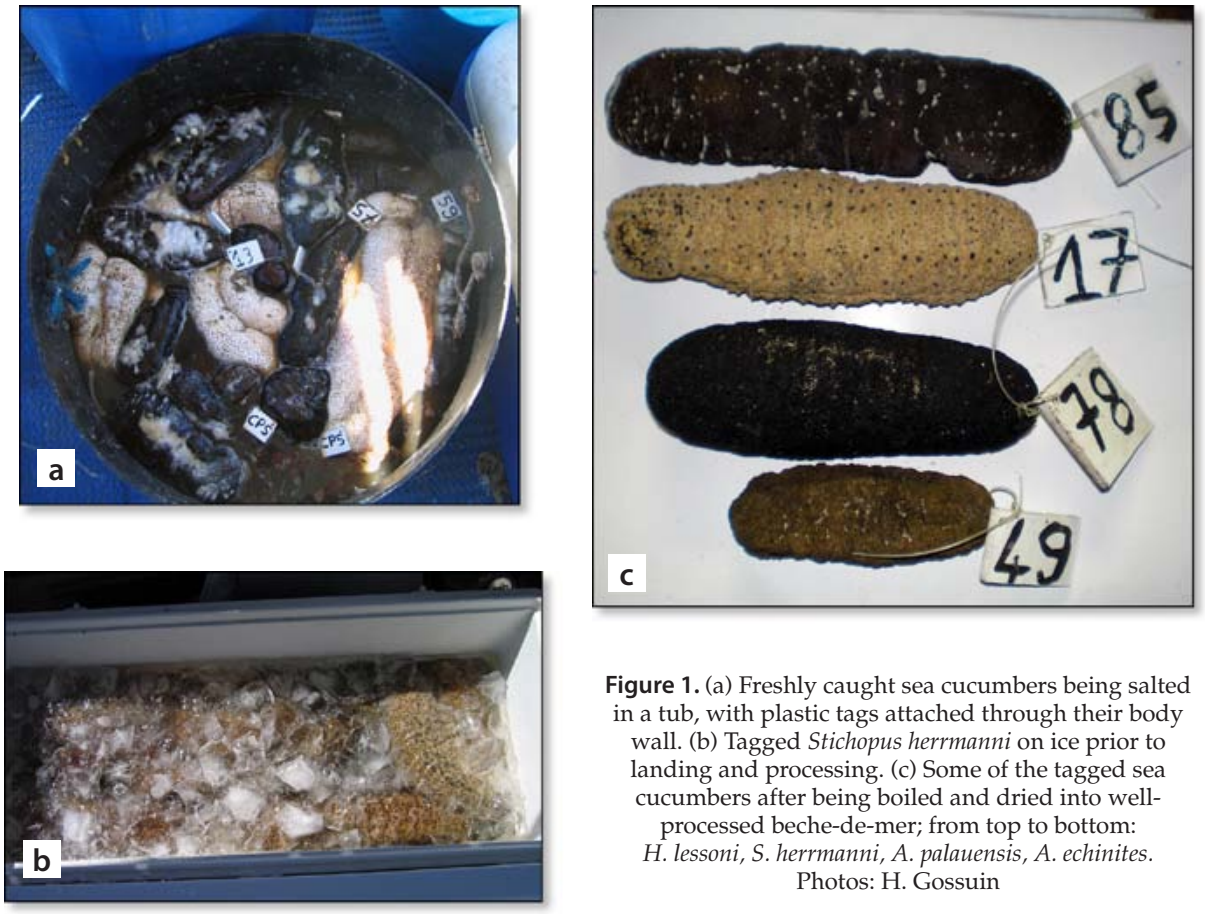

Figure 1. (a) Freshly caught sea cucumbers being salted in a tub, with plastic tags attached through their body wall. (b) Tagged *Stichopus herrmanni* on ice prior to landing and processing. (c) Some of the tagged sea cucumbers after being boiled and dried into well-processed beche-de-mer; from top to bottom: *H. lessoni*, *S. herrmanni*, *A. palauensis*, *A. echinites*. Photos: H. Gossuin

The species and number of individuals for which we calculated weight loss at each successive stage of processing are given in Table 1. Note that some tags were lost during the salting and boiling stages. The loss of tags resulted in fewer replicates for conversion factors of the later stages. Averages of proportionate changes in length and weight that we present are based on values of proportionate loss calculated for each individual separately.

Results

This study provided some reliable estimates of conversion ratios for the six species (Table 2). About 30–45 per cent of the body weight is lost in the initial stage of gutting animals. For species that were salted by the processor we worked with, the salting stage decreases the body weight by a further 12–17 per cent of the initial body weight. At that stage,

Table 1. Number of individuals of the six species measured at different stages of transformation into beche-de-mer.

Species	Number of individuals weighed (n)			
	Whole (fresh)	Gutted	Salted	Dried
Actinopyga echinites	15	15		14
Actinopyga spinea	15	15	13	9
Actinopyga palauensis	7	7	7	7
Holothuria lessoni	11	11	9	8
Holothuria whitmaei	10	10	10	10
Stichopus herrmanni	11			9

Holothuria lessoni, *H. whitmaei* and *Actinopyga palauensis* weighed about one-half of their initial weight. In contrast, *A. spinea* specimens experienced greater weight loss, weighing 38 per cent of their initial weight after salting.

The final boiling and drying stages greatly decrease body weight and length (Table 2). There is a large variation in the percentage reduction in weight of animals to the dried beche-de-mer stage, presumably due to differences in initial content of water in the body tissue of the animals. Dried *Holothuria whitmaei*, *Actinopyga echinites*, and *A. palauensis* averaged about 11–12 per cent of their initial whole body weights. Dried *Holothuria lessoni* averaged about 10 per cent of their initial body weights, while *Actinopyga spinea* averaged 7 per cent of their initial body weights. Of the species we studied here, *Stichopus herrmanni* decreased the most in length and lost the most weight during processing into beche-de-mer; it lost 96.7 per cent of its initial weight through processing to a dried form.

Discussion

As shown in similar studies, the proportion of weight lost through processing varied markedly among species. If export data of dried, or salted, weights of sea cucumbers are to be converted to fresh (landing) weight, it is far more accurate to convert data on a species-by-species basis than to use one approximate factor to convert weights of all species combined. Even within genera, we found large variations in conversion factors for weights. With the exception of *S. herrmanni*, a generality was that dried sea cucumbers were roughly one half the length of their original fresh bodies.

Our finding that dried *Stichopus herrmanni* represented just 3.3 per cent of their initial body weight concurs closely with 3.9 per cent stated by Preston (1990). While Conand (1989, 1990) reported that dried golden sandfish *Holothuria lessoni* (then known as *H. scabra* var. v*ersicolor*) averaged 6 per cent of their fresh weight, our result of 9.8 per cent is much higher. These findings stress that this species does not lose nearly as much weight during processing as sandfish *H. scabra* (dried weight just 5 per cent of fresh weight — Skewes et al. 2004), even though these species are closely related (Uthicke et al. 2005, Massin et al. 2009). Our results of percentage weight loss for *A. echinites* correspond closely with those of Conand (1989, 1990), but we estimated less weight loss of *H. whitmaei* to the dried form than studies reviewed by Skewes et al. (2004).

Our measurements on *A. spinea* and *A. palauensis* are the first reported for these species, to our

Table 2. Changes in mean body length and weight (± standard error [SE]), and their percentage of initial (whole, fresh) measurements, across the different stages of processing selected species of sea cucumbers into beche-de-mer. Stages: 1 = whole, fresh body; 2 = gutted, fresh; 3 = gutted and salted (after 10 days); 4 = boiled and dried.

		Body length (cm)			Body weight (g)			
Processing stage:		1	3	4	1	2	3	4
Actinopyga echinites	Mean	19		8	334	231		35
	SE	±0.3		±0.2	±20	±14		±2
	%	100		42.1	100	69.2		10.5
Actinopyga spinea	Mean	27	21	13	1352	735	507	99
	SE	±1	±1	±1	±72	±39	±26	±11
	%	100	77.8	48.1	100	54.4	37.5	7.3
Holothuria lessoni	Mean	31	28	16	2256	1456	1187	221
	SE	±1	±1	±0.2	±80	±50	±32	±7
	%	100	90.3	51.6	100	64.5	52.6	9.8
Stichopus herrmanni	Mean	37		14	2658			88
	SE	±2		±0.3	±154			±5
	%	100		37.8	100			3.3
Holothuria whitmaei	Mean	25	27	15	1829	1174	968	213
	SE	±0.8	±0.9	±0.4	±104	±45	±35	±14
	%	100	108.3	59.9	100	64.2	52.9	11.6
Actinopyga palauensis	Mean	27	23	15	1416	985	740	165
	SE	±0.7	±2	±0.5	±86	±61	±44	±11
	%	100	85.9	53.8	100	69.6	52.3	11.7

knowledge. This study is the only one to date to provide estimates for converting gutted or salted *A. echinites* to the fresh (whole) or dried form. Likewise, we present the first estimates for obtaining fresh or dried weights or lengths from measurements of gutted or salted *H. lessoni* and salted *H. whitmaei*. These results were particularly important for standardising data from catch surveys in our overarching programme because the sea cucumbers were often salted, or sometimes just gutted, at the time of sale when we measured them.

We encourage readers to consult the comprehensive review by Skewes et al. (2004) and use 'recovery rates' of species from studies matching their localities closest. While Skewes et al. (2004) present regression relationships between weight measurements (e.g. live weight vs. dried weight, for each species), we chose not to do this in the current study. Our view was that as any of the measurements theoretically approach zero, so too will the (paired) measurement of the other processed form, so regression relationships should be forced through the origin (i.e. zero). This means that linear regressions we would perform would not have a constant, and the result is, effectively, just a single conversion factor that is multiplied by one measurement to achieve the other.

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