Processing and marketing of holothurians in the Toliara region, southwestern Madagascar

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Abstract

In Madagascar, sea cucumbers are processed into dried product (trepang) before being exported. Careful processing is necessary in order to yield high quality trepang (e.g. aspect, form, consistence, smell). Nowadays, processing is carried out mainly by collectors whose methods depend on the exporter's demand. Processing methods, especially for *Holothuria scabra* (sandfish), have continued to evolve over the last decade.

Investigations in several villages have been made to determine the different processing methods used in the Toliara region. For *H. scabra*, the traditional method of burying sea cucumbers in sand to remove the chalky spicules from their body wall is becoming rare. Collectors scrape the animals using stones or bivalve shells or they use ground papaya leaves. All processing steps end with cooking the sea cucumbers in brine, then rinsing them and finally sun drying. Experiments carried out on *H. scabra* by the aquaculture company, Madagascar Holothurie SA, demonstrate that, whatever the initial size of individuals, there is a 91% reduction in weight and 52 % reduction in length after processing.

In Toliara, five categories of stakeholders form the commercial chain: fishers, middlemen, collectors, operators and exporters. In general, fishers sell their fresh products directly to collectors who are the main holothurian processors, and who sell their products, most often semidried, to exporters. Exporters process sea cucumbers into trepang for Asian markets. Prices rely on species type and specimen size. Other criteria such as appearance, smell, mould, and water content are also often take into account. For *H. scabra*, properly processed trepang of the 1st category presently sells for between USD 33 kg^{-1} and 50 kg^{-1} to exporters.

Introduction

Holothurians are mostly marketed as dried product, and rarely as fresh or frozen (Conand 1990, 2004; Conand and Byrne 1993; Ferdouse 2004; Poh-Sze 2004; Aumeeruddy 2007). The trade in sea cucumbers is an important source of income for the local community of fishers (Conand 1990; Preston 1993; Conand and Muthiga 2007) and for everyone within the processing and marketing chain in producing countries who are collectors, operators and exporters (Conand 2004; Rasolofonirina 2004; Rasolofonirina 2007). The processing of sea cucumbers has a major influence on price (Conand 1990, 2004; Hamel et al. 2001), as any fault in the process may decrease the value of the product (Conand 1999).

In all Indo-Pacific countries, sea cucumber processing, which needs very simple and cheap materials, is carried out by villagers. General processing methods, used for the majority of sea cucumber species, involve three main steps: removal of viscera, cooking and drying (Conand 1990; Li 2004). Specific methods have been developed to process *H. scabra* and *H. scabra versicolor* in order to remove the chalky spicules from their body wall (Hamel et al. 2001); for example, by burying sandfish in sand for about 18 hours (Conand 1999; Anonymous 1994) or using grounded papaya leaves (Poh-Sze 2004; Rasolofonirina 2004).

Several sea cucumber processing methods are used in Madagascar. Processors employ the best method for reducing weight and length losses, but also to

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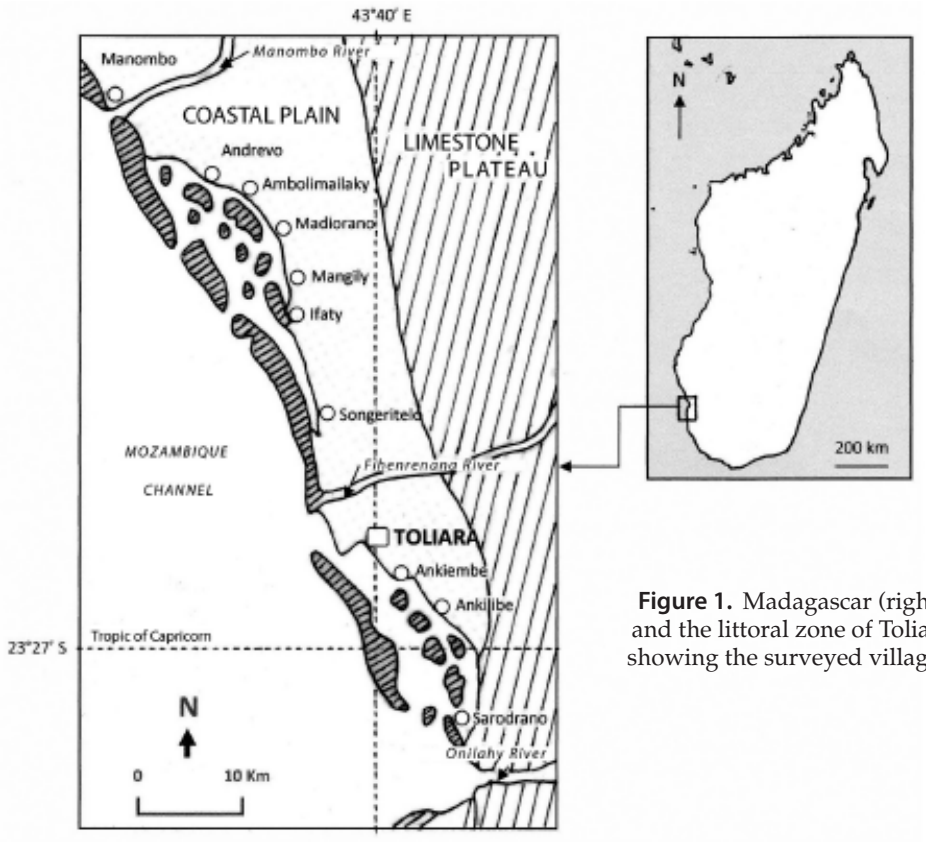

Figure 1. Madagascar (right) and the littoral zone of Toliara showing the surveyed villages.

make the task easier. Processing procedures continue to evolve. The aim of the present work is to 1) identify the different processing methods that exist in villages around Toliara, especially for *H. scabra*, 2) analyze the variations in morphometric parameters linked with processing, and 3) update the data on the holothurian trade from collectors to exporters.

Materials and methods

In order to identify the different methods used for processing sea cucumbers in the Toliara region, field observations were carried out in 2006 and 2007 in nine villages between Sarodrano in the south and Andrevo in the north (Fig. 1). These villages were chosen because they are accessible by car and because there is an active sea cucumber fishery. The first general observations consisted of noting the different processing methods used by trepang processors. Investigations were also conducted in order to determine: 1) the different contributors in the commercial chain, from the collection of sea cucumbers to their export, 2) the different processing steps along the commercial chain, and 3) the fluctuations of the prices along the chain. Interviews were carried out with fishers (10 per village), all collectors in the villages, and with some operators and exporters in Toliara. Operators and exporters were not cooperative so that it was difficult to carry out investigations and to get information on trepang prices. Questions commonly asked of fishers and collectors are summarized in Table 1. Length and weight measurements of specimens during the purchase were recorded.

Table 1. Commonly asked questions to fishers and collectors in the investigated villages

Fishers	Collectors
- material and fishing methods	- price of products
- frequency and fishing time	- different species bought
- commonly captured species and their abundance	- present methods of processing (different steps)
- processing or not of the products. If yes, processing methods	- past methods of processing
- actor and area where they sell their products	- destination of their products
- price and selling methods	- method of the purchase
	- price of the products for the resale

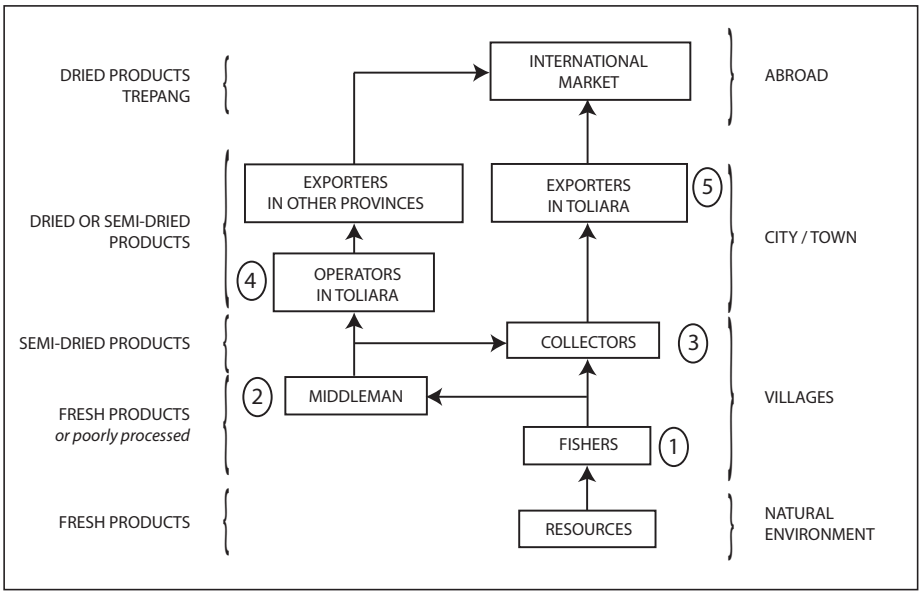

Figure 2. The sea cucumber processing and marketing chain (from natural habitat to export) in Toliara.

Most used circuit: 1–3–5 (80 %)
Often used circuit: 1–3–4–5 (15 %)
Rarely used circuit: 1–2–3–5 or 1–2–3–4–5 (5 %)

In addition, we examined fresh and dried sandfish produced and sold by the aquaculture company Madagascar Holothurie SA. An analysis was made of morphometric parameters during processing. For this study, 24-month-old sea cucumbers (larval phases included) from Madagascar Holothurie SA were used. Morphometric parameters taken during the processing of two batches of 10 individuals of two different sizes — 280 g (18 cm) and 430 g (21 cm) — were compared in order to evaluate the percentage of weight and length loss. For each experiment, weight and length of specimens were recorded at each step of processing and the mean calculated.

Results

Commercial chain

Fishers collect sea cucumbers during low tides, by walking on the reef or by free diving. From collection to export, the sea cucumber processing and marketing chain involves five different types of stakeholders (Fig. 2).

- The fisher — a villager, man or woman, anywhere from 7 to 60 years old, who collects holothurians from the natural environment.
- The middleman — a villager, man or woman, anywhere from 25 to 60 years old, who buys sea cucumbers from fishers and resells the sea cucumbers to collectors. This person does not process sea cucumbers. In all investigated villages, people do this job occasionally. Sometimes, fisher or collector may serve in this capacity.
- The collector — a villager, man or woman, between the ages of 25 and 60 years, who buys products from fishers or middlemen. This person processes holothurians and sells the processed product to operators or exporters in town. One collector may move to other villages, and stay there, depending on the resource availability. During the investigation, the number of collectors recorded per village was two in Sarodrano, four in Ankilibe, six in Ankiembe, one in Songeritelo, zero in Ifaty, one in Mangily, one in Ambolimailaky and three in Andrevo.
- The operator — a man from the city or town who buys the product from several collectors, completes the processing (if necessary), and sells it to exporters. We recorded four operators in Toliara.
- The exporter — a man from the city or town who delivers the product to the international market. There are three exporters in Toliara. They often buy semi-dried products from collectors and, in that case, must complete the processing.

In more than 80% of all cases, fishers sell their fresh products to collectors who buy them by the piece.[4] Collectors sell processed products (semi-dried) to

4. We note that it this is not the way it was done 10 years ago, when most fishers processed the sea cucumbers themselves and waited until the end of a period of good tides to sell their processed product to operators or exporters. In rare cases, where products were sold fresh, collectors bought them by the bucket.

Table 2. Price range of species of high and medium commercial value encountered in Toliara region. Prices of individual in 2007 at fresh state come from investigation into collectors; trepang price was obtained from Toliara exporters. Prices in 1996 are from Rasolofonirina 2004.

Scientific name	Price when fresh (Ar piece^{-1})[5]		Trepang price (Ar kg^{-1})[5]	
	1996	2007	1996	2007
Category I: High				
Holothuria fuscogilva	50–800	3,000–5,000	2,600–7,000	30,000–90,000
Holothuria nobilis	50–800	3,000–5,000	2,600–7,000	30,000–90,000
Holothuria scabra	400–1,500	500–4,000	5,000–15,000	25,000–90,000
H. scabra versicolor	100–1,500	500–4,000	5,000–15,000	25,000–90,000
Category II: Medium				
Thelonota ananas	20–100	3,000–5,000	600–3,000	15,000–35,000
Stichopus horrens	20–120	600–1,200	2,400–3,600	11,000–30,000
Stichopus hermanni	20–120	600–1,200	2,400–3,600	11,000–30,000
Actinopyga lecanora	30–140	200–300	600–3,000	10,000–18,000
Actinopyga mauritiana	20–100	200–300	2,000–3,000	10,000–18,000
Actinopyga echinites	20–100	200–300	2,000–3,000	10,000–18,000

exporters in the city who finalise the processing and ensure that exports reach their final destination. In 15% of observed cases, fishers sold sea cucumbers to collectors who processed them. Collectors sold their products afterward to operators in town who were in contact with exporters from other provinces, such as Antananarivo. For the few remaining cases, fishers sold to middlemen, and the products followed the chain as mentioned above.

In general, fresh products are classified according to species and size. For trepang, other factors are taken in consideration, such as appearance, smell, the presence of mould, and water content. Depending on the price, holothurian species are classified into three commercial categories (Conand 1990, 2004): high, medium and low. Species of high and medium commercial value observed in the Toliara region are presented in Table 2. This table shows current prices by species and compares them to prices 10 years ago, in 1996. Species of low commercial value, which are not presented in this table, consist of *Bohadshia*, *Pearsonothuria* and species within the genus *Holothuria*, such as *H. atra*, *H. cinerascens*, *H. edulis*, *H. excellens*, *H. fuscopunctata*, *H. impatiens*, *H. leucospilota*, *H. maculosa* and *H. rigida*. Among the species of low commercial value, we also find now *H. notabilis* and *H. arenicola*, both of which had no commercial value before. They are the most captured species in the region nowadays and are sold in small buckets, ranging in price from 1,500–3,000 ariarys, the local money.[5] One small bucket may contain 60–80 specimens, depending on size.

For the high and medium values, prices also depend on specimen size. In all investigated villages, collectors buy fresh products by the piece. The purchase is always done visually without making any measurements (either weight or length). The price varies according to buyers and the area. Collectors near the city always buy products at higher prices than those from isolated villages. This study of *H. scabra* allowed us to determine prices according to their size; fresh products are divided into four size classes: XL, L, M and S (Table 3).

Different processing methods observed in the region

Since 1997, sea cucumber processing methods have constantly evolved in the Toliara region. These methods aim at reducing both weight and length during processing, and make the task easier and so reduces the workforce. Nowadays, scraping sea cucumbers or using ground papaya leaves to remove the spicules of the integument, are common, with some variants depending on the processors and the area. However, the general principle of each step is the same as it was 10 years ago (Mara et al. 1998; Rasolofonirina 1997). In the Toliara region, processing may be carried out by fishers, collectors or exporters.

Ten years ago, most fishers processed sea cucumbers themselves. Sea cucumbers started to become scarce in 2000, and nowadays, most fishers, except those from some villages in the north of Toliara, pre-

5. Ar = Madagascar ariary. As of September 2008, the change rate was: Euro 1.00 = Ar 2,400; USD 1.00 = Ar 1,624.

fer to sell their products directly to middlemen or collectors. Processing methods employed by fishers in the north of Toliara yield products that are semi-processed, the end of the processing being done by collectors. A very simple processing method is used in Andrevo village, where holothurians are scraped with stone to remove spicules, then eviscerated, and cooked for 10 min and then sun dried for several hours.

In all villages surveyed, collectors are the main processors. They employ several processing methods that vary somewhat and that involve processing with or without grounded papaya leaves (Table 4). The processing method without papaya leaves consists of scraping the integument of the animal with a stone to remove the chalky spicules. This may be done by 1) scraping the integument after evisceration, and then salting and doing a first cooking, or 2) scraping the fresh specimens followed by evisceration. Processing with grounded papaya leaves is the most common method: collectors always use it when they have large quantities of sea cucumbers. The ground papaya leaves remove the chalky spicules through the action of papain. This method is not time consuming, makes the task easier, and reduces the necessary workload. Nevertheless, it demands delicate care because the long acting papain may destroy the integument's structure. Certain processors employ this method as the only way to remove the chalky spicules, while others use it only to clean the chalky spicules that were not removed from scraping.

Table 4 summarizes the four processing methods observed in the region. There are seven to nine steps, depending on the method, and each takes anywhere from seven to eight days. Without considering the salting and drying time, the necessary processing time for 20 specimens varies from three to six hours, depending on the method. Processors start by scraping specimens, which is then followed by evisceration (or processors may force the evisceration by making a small cut beneath the posterior part of the animal) (Figs 3A,B). All processing ends by cooking in brine, rinsing and sun drying (Figs. 3 F-H). Two methods require the use of papain (Fig. 3E). In three of the methods, sea cucumbers

Table 3. Price range of *H. scabra* in Toliara region. Price of fresh individuals in 2007 come from investigations with collectors. Trepang prices were obtained from Toliara exporters.
Exchange rate (Sep. 08): Euro 1.00 = Ar 2,400; USD 1.00 = Ar 1,624.

Size	Length (cm)	Weight (g)	Price when fresh (Ar piece^{-1})	Price of trepang (Ar kg^{-1})
XI	> 22	> 450	> 2,600	> 60,000
L	20–22	350–450	2,000–2,600	30,000–60,000
M	18–20	250–350	1,600–2,000	< 30,000
S	< 18	< 250	< 1,600	< 30,000

Table 4. Processing methods employed by collectors. (Ind: individual)

I	II	III	IV	Time
	Scraping		Scraping	10 min ind^{-1}
Evisceration	Evisceration	Evisceration	Evisceration	2 min ind^{-1}
	Salting	Salting	Salting	24 to 96 h
Cooking		Cooking	Cooking	10 to15 min
Salting				96 h
Scraping				5 min ind^{-1}
Air drying	Air drying			10 to 24 h
		Use of ground papaya leaves	Uses of grounded papaya leaves	4 to10 min
		Brushing and rinsing	Brushing and rinsing	5 min ind^{-1}
Cooking in brine (100 g of salt L^{-1})	Cooking in brine (100 g of salt L^{-1})	Cooking in brine (100 g of salt L^{-1})	Cooking in brine (100 g of salt L^{-1})	20 to 30 min
Rinsing	Rinsing	Rinsing	Rinsing	0.5 min ind^{-1}
Sun drying	Sun drying	Sun drying	Sun drying	3 h to 3 days

Figure 3. The main processing steps for *H. scabra* and *H. scabra* var. *versicolor* employed by collectors.
A: evisceration; B: scraping; C: salting; D: 1st cooking; E: using ground papaya leaves;
F: cooking in brine; G: rinsing; H: sun drying.

are boiled two times, while the last process requires only one cooking (Fig. 3D). In three of the methods, specimens are salted at the beginning of the process (Fig. 3C). In general, collectors sell semi-dried products (three hours of sun drying) in order to quickly have cash for buying new products.

For exporters, the final processing methods employed depend on the quality of the semi-dried product. If the cooking is not perfect, the semi-dried products are rehydrated, cooked for 15 minutes, and then sun-dried. If the product is not well scraped, the semi-dried product is put in water for 24–48 hours, scraped, cooked for 10 min, brushed and sun-dried. If the product still contains a considerable amount of salt, the semi-dried product is washed, cooked for two minutes, and sun-dried. Finally, if the product is not properly dried it is directly sun-dried for three days. At the end of processing, the product is dried in an oven at 60°C for six hours and then packed into plastic bags before being exported.

Evolution of morphometric parameters during processing

Before processing, the two batches (I and II) of *H. scabra* had a mean weight of 280 g (I) and 430 g (II), which corresponded to 18 cm and 21 cm in length, respectively. After processing, the average trepang weight in batch (I) was 26 g and 8.97 cm in length (the equivalent of 9.20% and 50.25% of their initial weight and length, respectively) (Figs. 4 A and B). In batch II, the trepang weighed 40.63 g and measured 10.27 cm, which corresponded to 9.40% of their weight and 47.99% of their length in a fresh state (Fig. 4 A and B). The reduction after processing were the same for the two batches ($p = 0.889$ and $p = 0.479$ for the weight and length respectively): weight and length loss was the same, whether *H. scabra* was of a medium (280 g) or large size (430 g).

The relationship between the parameters "fresh specimen weight/dried trepang weight" and "fresh specimen length/trepang length" have been analyzed (Fig. 5 A and B), and provides a rough idea of trepang weight and length after processing. The relationship between weights is significant ($r = 0.756$). Figure 5 B clearly shows that the relationship between the length parameters is not significant. The low relationship between lengths is related to the fact that this parameter is variable in the fresh state (live specimens may extend or shorten) while weight is more stable.

Discussion and conclusion

The most important sea cucumber marketed product is the dried body wall, called trepang (Conand 2004). The main processing steps are the same in all Indo-Pacific countries and always involves the removal of viscera, cooking and then drying of the body wall. Nevertheless, there are some light differences between processes (Poh-Sze 2004), and methods may vary slightly depending on areas (Chen 2004; Baine 2004; present work), species (Chen 2004; Baine 2004), or the stakeholders encountered along the processing and marketing chain (Poh-Sze 2004). Evisceration is often performed by making an incision on the ventral side of *Thelenota ananas*, on the dorsal side for the other large species (Anonymous 1994; Conand 1990; Li 2004), or by making a small cut of 2–3 cm in small species (including *H. scabra*). The cut is made either in the posterior part (Anonymous 1994) or beside the month (Alfonso et al. 2004; Li 2004). Cooking is the most important step because it may damage the product in an irreversible way (Anonymous 1995). If not cooked properly, trepang may soon rot and acquire an undesirable smell (Li 2004). Some processors employ one cooking only during the processing, such as some collectors in Madagascar, processors in Mayotte (Pouget 2004), and some fishers in Malaysia (Poh-Sze 2004). But, a second cooking is generally employed, as reported in Madagascar (present work), China (Chen 2004), Malaysia (Poh-Sze 2004), and many countries in the Pacific (Conand 1990; Anonymous 1994). Drying may be by sun or smoke, and may take several days to several weeks, depending on the species, specimen sizes, the fire pit for smoking, and the weather.

An additional step to remove the abundant chalky spicules on the integument of *H. scabra* is essential. Ten years ago, the traditional method consisted of burying cooked and chilled sandfish in sand 20–30 cm deep. This method uses bacterial action (12–18 hours) to soften the external part of the integument. *H. scabra* are washed in seawater and rubbed vigorously afterward in order to remove the remaining decomposed integument containing the chalky spicules (Anonymous 1994). Nowadays, in Madagascar, processors scrape the animal with a stone or bivalve shell, or use ground papaya leaves. This new method began in 2002 and remains the only method used in the region. The method of burying sea cucumbers in sand has been completely abandoned. The same change has occurred in Malaysia, where processors use ground papaya leaves or lime to remove chalky spicules (Poh-Sze 2004). Salting or salting in brine is also becoming very popular. This process limits desiccation and minimizes weight and length loss during processing (Rasolofonirina 2004). Processors in the Toliara region began using salt in 1999 and, at present, all processing in the southwest of Madagascar involves salting and/or salting in brine. This process is also very common in China (Chen 2004), Malaysia (Poh-Sze 2004) and Cuba (Alfonso et al. 2004). After processing, specimens lose weight and length considerably (Conand 1979, 1990; Preston 1990; Vuki 1991). In general,

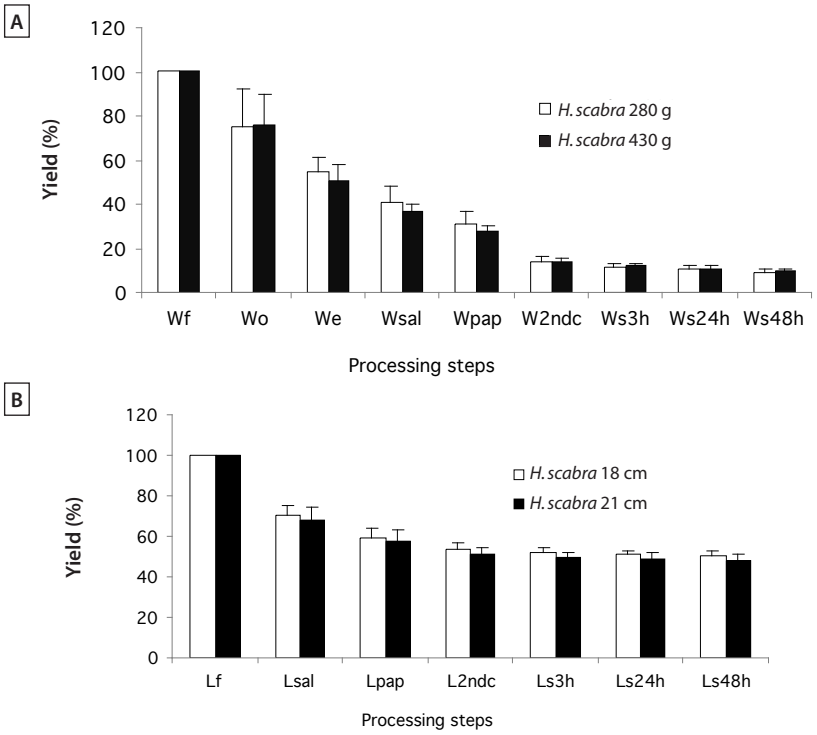

Figure 4. Variations of *H. scabra* weight (in percentage) and length according to individual sizes (n=10; vertical bars indicate the standard deviation).
A: weight (in percentage). Wf: fresh weight; Wo: opened weight; We: eviscerated weight; Wsal: weight after salting; Wpap: weight after papaya (spicules are removed); W2ndC: weight after second cooking; Ws3h: weight after three hour of sun drying; Ws24h: weight after 24 hours of sun drying; Ws48h: weight after 48 hours of sun drying;
B: length (in percentage). lf: fresh length; lsal: length after salting; lpap: length after papaya (spicules are removed); l2ndc :length after second cooking; ls3h : length after three hour sun drying; ls24h : length after 24 hours of sun drying; ls48h: length after 48 hours of sun drying.

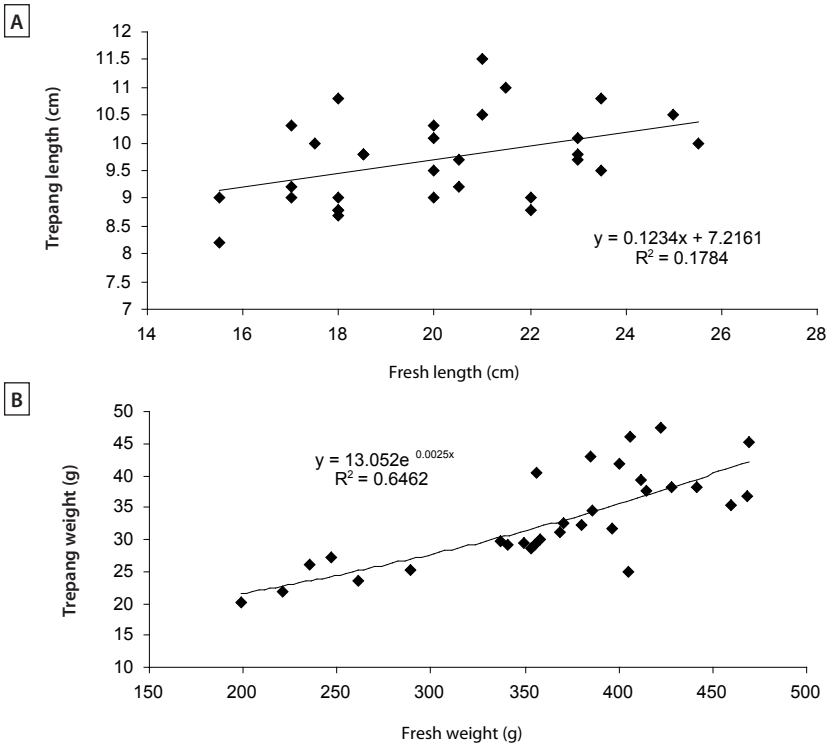

Figure 5. Relationship between fresh individuals and dried (i.e. processed) weights (A) and fresh individual and dried lengths (B) of *H. scabra*.

there is a 90–97% weight reduction recorded after processing, depending on the species (Conand 1990). For *H. scabra*, there is a 90–95% weight loss after processing (Bascar and James 1989; Anonymous 1995; Gamboa et al. 2004) and 42 to 52 % in length (Bascar and James 1989).

There are several criteria for classifying processed products. For *H. scabra,* trepang of the first category must 1) be straight or slightly curved, with numerous furrows around the body, 2) have a suitable smell, 3) have a small incision, only at the posterior part, throughout the anus, 4) have a dorsal side that is brownish to black, and a ventral side that is grey to white, and 5) be 10–15 cm in length, and about 8–12 specimens per kilogram. These trepang may be sell for between USD 33 kg^{-1} and 50 kg^{-1} to exporters of the local market, and may reach USD 80 kg^{-1} on the international market (Tuwo 2004). In fresh state, these specimens are sold between USD 2.5 and 3 $piece^{-1}$, the equivalent of USD 24–30 for 8–12 specimens. With this difference, processors may make a benefit of USD 9 to 20 kg^{-1} of trepang. Exporters may benefit about USD 30–47 kg^{-1} of trepang. It is also important to note that the price of sea cucumbers and trepang have increased significantly over the last decade (Alfonso et al. 2004). In Madagascar, the price increased three to six fold since 1996. Nevertheless, the benefit for fishermen and villages communities remains uncertain for the future because there is no scale of charges in place. This is not only because collectors buy products from fishermen without making any measurements (weight or length), but also because selling to exporters is totally blurred. Exporters fix the prices of the products themselves, and they can buy the same product at very different prices from different fishermen.

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