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Distribution of economic returns in small-scale fisheries for international markets: A value-chain analysis

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ABSTRACT

Small-scale fishers are often believed to receive marginal earnings for seafood relative to other value- chain actors but proportionate incomes across different traded species are rarely compared. This study compares value chains for 15 species of sea cucumbers between Fiji and Kiribati using data collected on sale prices of dried products (bêche-de-mer) from fishers to middlemen and exporters, export prices and market retail prices in China. Pacific islanders comprised almost all fishers, but represented only some middlemen and few exporters. Proportional increases in prices along the value chains differed greatly among sea cucumber species and between countries. Fishers' earnings varied greatly among species. The relative share of the end market value they received was negatively related to product end-market value; on average 50% of the end retail value for the lowest-value species but < 10% for the highest-value species. Most fishers lacked information about market prices. The gross markup of exporters differed greatly between the two countries. Downstream actors reaped increasingly higher proportions of the product value for higher value species. Variation in sale prices between countries and fishers for the same product indicates a potential for higher earnings to fishers. Improved transparency of prices to fishers could empower them to negotiate higher prices, especially for more valuable species. Upgrading of value-chain governance, e.g. through fisher cooperatives or auction systems, could improve efficiency and fisher incomes, potentially reducing the need for high fishing rates. Such interventions will benefit from understanding the value-chain patterns among different species harvested in multispecies fisheries.

1. Introduction

The role that small-scale fisheries (SSF) should play in supporting human development is gaining increasing attention, not least through the recently adopted sustainable development goals (https://sustainabledevelopment.un.org/sdgs). Great progress has been made in improving the management of SSFs through better understanding of the socioeconomic issues facing fishers, especially in low-income countries [1–4]. There are now global calls for greater consideration of the entire value chain of the seafood industry into management [5], and for incorporation of social indicators of wellbeing in fisheries supply chains [6]. But are value chains in small-scale fisheries equitable for fishers, and what interventions appear most important for upgrading value chains to benefit a larger proportion of small-scale operators?

A common belief is that small-scale fishers reap a small share of the economic benefits from traded seafood [7–9]. Yet basic data are lacking to assess the distribution of benefits from seafood trade for many types of fisheries [10,11] and how the benefits might differ among traded species. This is in part because value-chain analyses of multispecies fisheries have tended to aggregate species when examining changes in prices of seafood products along the value chain (e.g. [10,12–14]). This lack of resolution in species, trade and derived income is unfortunate as small-scale fisheries are often multispecies in nature [15,16] and there is an assumption that fishing effort could be reduced, in certain cases, if incomes were improved [17].

A minimum criterion for fisheries management must be that the fisheries and associated supply chains are structured in such a way that they do not incentivize overexploitation, and that they allow those

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participating in the value chain to derive a sustainable livelihood [18]. However, many fisheries around the world today suffer from a lack of transparency, in terms of actor participation, prices, income and other benefit flows. Transparency in value chains broadly concerns the disclosure of information among actors in various segments (e.g. production practices, sourcing materials, and prices). Traders and processors often possess market information exclusively [8] and sometimes create exploitative social relations with fishers [9,19–21]. Improved transparency is not without potential pitfalls, but could be one mechanism to improve the sustainability in global supply chains generally [22]. For example, producers empowered with market information can make better decisions for production and trade (e.g. timing of harvests, negotiating prices). High-profile examples of such initiatives include mobile phone applications that provide East African farmers with up-to-date market prices (http://www.agromarketday.com), or the suite of apps under Abalobi (http://abalobi.info) developed for small-scale fisheries in South Africa.

In addition to improving transparency, different forms of certification of internationally traded seafood are playing an increasing role in improving fisheries sustainability and governance [23]. However, some types of certification might not be useful or pertinent for certain fisheries or seafoods. For example, current eco-label standards such as the Marine Stewardship Council (MSC) have been critiqued for being expensive for small-scale producers [24] and failing to address the least sustainable fisheries [25]. Moreover, certain markets are less concerned with ecological sustainability of seafood and value other seafood attributes more [26,27]. In contrast, Fair Trade certification is a strategy of upgrading that aims to reposition and empower producers by mandating fair pricing standards for products [9], but one which has not had a strong focus on ecological sustainability and which remains to be fully developed in a fisheries context.

However, information on prices of traded seafood along value chains is a fundamental prerequisite for Fair Trade, MSC and other certification schemes and regulated pricing standards. Understanding inequities in fisheries value-chains can also form the rationale for supporting fisher cooperatives or auctioning schemes to promote better financial returns for fishers and market participants. Such interventions are germane where internationally traded seafood is initially harvested and traded by rural artisanal fishers and traders who are both financially challenged and lack the skills or information to negotiate prices with buyers.

For high-value products, there are clear disincentives for transparency by foreign traders. One such example is sea cucumbers [28], which are collected by small-scale fishers worldwide to supply demand by Asian consumers, notably Chinese [29]. Although they are sold as a luxury seafood in Asia [29], the prices offered to fishers in low-income countries often do not reflect the high retail prices in the marketplace [see Supporting Information in 30]. For certain species, trade is restricted under national or international regulations [31,32], so traders can offer low prices in black-market transactions. These inequitable value chain dynamics have both social and ecological sustainability repercussions. Generally, poor financial returns to fishers can keep them in poverty traps in which unscrupulous fishing rates are the only means to secure a basic livelihood. Understanding the economics of fisheries through the value-chain lens is therefore useful to reforming fisheries to alter the benefit distribution so as to promote improved fisher (and small-scale trader) livelihoods and resource sustainability.

This study contributes to these efforts by examining the prices across the various nodes of sea cucumber value chains stemming from artisanal fisheries in two Pacific Island countries, Fiji and Kiribati. These value chains are notoriously complex and fragmented, and have been studied largely through qualitative approaches [11] or the use of surrogate data from other fisheries [32]. Indeed, value chain analysis can be done using various approaches according to research questions and context [8,33]. Here, we use quantitative data on sales prices to examine price markup (gross profit margin) of dried sea cucumbers along value-chains for fifteen different species from fisher to retail stores in China. Our study provides novel data on the huge variability in share of end-market prices that fishers receive depending on the types of species traded, and the relative financial returns to exporters in both countries. The implications for improving transparency and trade arrangements for Pacific Island sea cucumber fishers should be relevant also for other small-scale fisheries connected to international markets.

2. Materials and methods

2.1. Study locations and period

The sea cucumber fisheries in Fiji and Kiribati were operated by small-scale artisanal fishers harvesting a similar suite of species and used broadly comparable methods for processing the sea cucumbers into dried beche-de-mer [34], although shipping routes were apparently longer (i.e. sometimes via Fiji) for products exported from Kiribati. The study locations and data collection methods are described by Purcell and co-authors [35] and briefly reiterated here. Based on advice from national or provincial fishery authorities, 8 and 5 locations (provinces or island groups) were selected within Fiji and Kiribati, respectively, where fishers were collecting and selling sea cucumbers. Within locations, we generally visited 3–6 villages that were known to have fishers who collected sea cucumbers.

We interviewed sea cucumber fishers, middlemen and exporters in Kiribati during 2011, and in Fiji in 2014, on account of research funding and approval in Fiji. The fisheries and exports in these countries operate independently and there was no evidence to suspect significant variations in value chains in Fiji between 2011 and 2014. The two countries had different national fishery management regulations [see 35], and community-based management was a minor part of the fisheries or non-existent.

Market prices of dried sea cucumbers in China were recorded in November 2011. Prices for a range of species were recorded from 11 shops in the Yide-Lu markets in Guangzhou, and the shop owners told us retail prices (stating that prices would be somewhat lower for sales in large [wholesale] volumes). A smaller range of species were sold in Hong Kong, where we recorded prices from 5 retail shops in the Sheung Wan district. More recent data (S. Purcell et al., unpubl. data) suggest that prices for some species would have increased slightly from 2011 to 2014, so our reported ratios between the selling prices of fishers in Fiji and retail prices might be slightly biased (high) for some species.

2.2. Survey methodology and data collection

Although sea cucumbers can be sold fresh or dried, our study examines only data on sale prices of dried sea cucumbers (beche-de-mer). After several processing steps of cooking, salting, smoke-curing and drying, well-processed beche-de-mer do not need further processing or storage costs along the supply chain. Hence, once the beche-de-mer enters the value chain no further processing costs are necessary, although sometimes exporters might briefly re-cook and re-dry the product. By only comparing data on dried products, we also avoided assumptions about weight loss of the products along the supply chain, and vagaries in weight loss due to differences in processing methods (e.g. extent of salt curing or cooking) used by different supply-chain actors. Surveyed fishers used locally-available wood and coconut husks as fuel to cook sea cucumbers and their cost in processing is almost exclusively labour [34]. The economic cost of their labour is not examined in the present study — rather, we examine how the price of their processed products increase along the value chain to consumers in China. Costs to exporters of shipping from Kiribati and Fiji to China vary depending on the shipping route and whether freight is by air or by sea, and we lacked estimates from enough buyers to confidently incorporate those costs. Accounts from a Fijian exporter suggest that shipping by air freight costed US$3 kg^{-1}, whereas shipping by sea costed around US

$0.20 kg^{-1} (includes transport costs to wharf, government export and wharf charges, and container shipping charge).

Four variables were examined:

1) The sale value of the dried products along the value chain, expressed in US dollars after exchange rate conversions.
2) The proportional value of different species at first sale by fishers relative to their average market retail price — this is the proportion of the end retail price captured by fishers.
3) The markup (i.e. gross profit margin from buying and exporting) by exporters — this is the profit of exporters not counting transaction and shipping costs.
4) The ratio between export price and retail price for each species (here referred to as the 'transaction differential').

We interviewed sea cucumber fishers, middlemen and exporters using ethics-approved questionnaire-based interviews [see 35]. Importers and distributors in China are not covered in this study. Surveys were standardized across all fishers in both countries. Less than one-third (74) of the 235 sea cucumber fishers interviewed in Fiji sold dried sea cucumbers, whereas more than three quarters (65) of the 84 sea cucumber fishers interviewed in Kiribati sold dried sea cucumbers (Table 1). The interviews also allowed time for additional qualitative information from respondents. Fishers were located using the 'snowball' technique and through key informants in villages, and we interviewed fishers who could be found at the time of interviews. Within each village, generally five fishers were interviewed, but the range was 1–16 fishers owing to the small villages in Kiribati. Middlemen and exporters were located by asking fishers and fishery officers. Some exporters and middlemen declined to be interviewed, although there was no apparent pattern to those who declined, whereas nearly all fishers accepted.

As part of a more extensive survey [see 35] we asked fishers the price they receive when selling different sized sea cucumbers, the form in which they were sold, whether they sold to a middleman or exporter, and whether they had any problems selling their products. Sea cucumbers were mostly sold either by the piece fresh, or by the kilogram as fully processed dried product (beche-de-mer). Dried product is obtained through a series of post-harvest processing stages [36]. In line with the common size-dependent grading system we recorded prices for large- and small-sized products for each species wherever possible, and used only the prices for large-sized products in figures and analyses to standardise comparisons across supply chains. Questionnaires for middlemen and exporters were different from those asked to fishers. Some middlemen were unable to provide data on prices of each species sold to the exporter because they were paid a salary, so they could not be included in our analyses. Among other questions, we asked exporters about their export prices for each species, what two species they most prefer to buy from fishers, and which two species they presently export most by volume. We collected information from fishery management authorities on the number of fishers and exporters, and recorded comments from exporters about the number of importers in China.

Sampling of products in markets in China is described by Purcell (2014); briefly, 3 or 4 random specimens (whole dried sea cucumbers) were measured and weighed from 2 or 3 lots (open bags or bins) of beche-de-mer, in each store where possible. Prices were converted using international exchange rates: 1 CNY = 0.159 US$; 1 HKD = 0.129 US$. Meetings were also held with several importers to find out about the structure of supply chains in Hong Kong and mainland China.

Table 1
Sample sizes of interviewed actors in producing countries who provided data on selling prices of dried sea cucumbers.

Location	Fishers (*n*)	Middlemen (*n*)	Exporters (*n*)
Fiji	74	10	7
Kiribati	65	17	4

2.3. Value-chain analysis

For each sea cucumber species, we calculated the average market retail prices of the largest-third (by length) of lots from Hong Kong and Guangzhou. This allowed us to match the market prices with prices for 'large' sea cucumbers sold in Pacific Islands. We used this average market price of large specimens as a reference by which to calculate the proportional share of value of each species sold by fishers to middlemen or exporters, and the proportional markup by exporters for each species in relation to their final retail market value. We converted sale prices to US$ rather than using purchase price parity conversions because currencies of sale changed at different nodes in the value chains, even within countries (e.g. export sales in the Pacific Island countries were in US$), which would render the ratios of sale prices between actors misleading with respect to actual gross money earned by the actors. Furthermore, purchasing price parity conversions would have resulted in spurious ratios contrary to the purposes of our study, which was to examine relative changes in markup rather than comparing incomes of actors in different countries.

Value chains for Fiji and Kiribati were constructed from data for which we had market prices of at least two lots from Guangzhou or Hong Kong and for which we had data on sale prices from fishers. Of the 23 species studied, 15 species meeting these two criteria were selected based on number of replicates of sale prices from fishers for both countries combined. To assess (in)equality of gross marginal profit of fishers and exporters we examined the relationships between average market price and (1) the proportional value at first sale of different species relative to their average market price, and (2) the markup by exporters relative to export price for different species. While prices in China can vary seasonally, especially owing to Chinese New Year, fishers did not note great seasonal variation in prices in Pacific Islands.

3. Results

3.1. Value chain actors and relations

The supply chains structure has a distinct hourglass shape (Fig. 1). In both Pacific Island countries, more than one thousand fishers contrasted with less than one hundred middlemen and around 10–20 exporters. Exporters claimed that there are in the order of 100 importers in China but that a majority of beche-de-mer imports are channelled through less than 10 main importing companies. We posit that there are in the order of hundreds of wholesalers, and probably thousands of retailers and hundreds of millions of consumers. Low-value sea cucumbers, such as *Holothuria atra*, are sold in vast quantities from the Pacific Islands (as elsewhere in many Indo-Pacific fisheries) yet few lots were seen in Guangzhou or Hong Kong markets (Purcell 2014), and importers explained that these form ingredients in widely consumed food stuffs.

Practically all fishers were Pacific Islanders. Downstream in the supply chains, the proportion of Asian actors progressively increases (Fig. 1). A key feature was that exporters in the producing countries were almost all Asian; mostly Chinese but also Taiwanese and Korean. Even when indigenous nationals were partners in the export company, they were nearly always partners to an Asian merchant who controlled the exporting arrangements.

3.2. Value distribution along the supply chain

The top two species most preferred by exporters in Fiji were white teatfish (*Holothuria fuscogilva*) and black teatfish (*H. whitmaei*), whereas exporters in Kiribati preferred white teatfish and prickly redfish (*Thelenota ananas*). The top two most exported species by volume were leopardfish (*Bohadschia argus*) and amberfish (*T. anax*) in Fiji, and

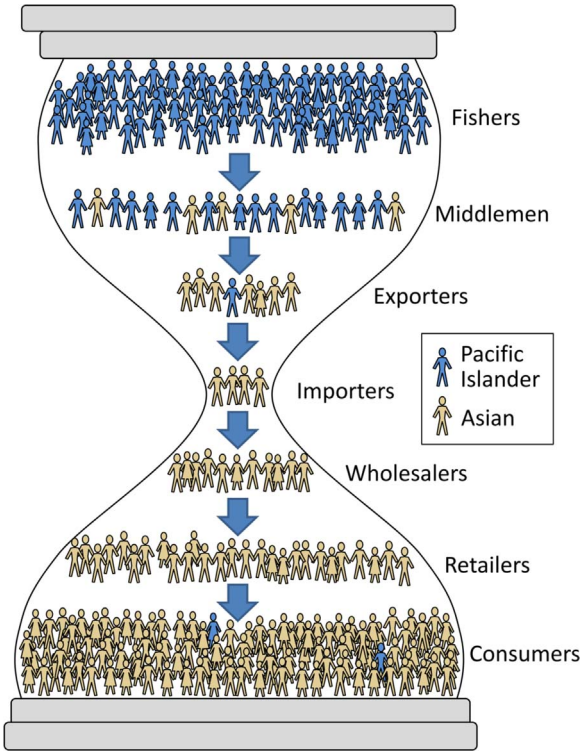

Fig. 1. Schematic of supply chain structure associated with sea cucumber fisheries in Fiji and Kiribati. Proportions of actor numbers and types across value chain segments are approximative for illustration purposes, based on random sampling of actors in interviews, information from key respondents, and observations at outlets in Guangzhou and Hong Kong, China.

lollyfish (*H. atra*) and greenfish (*Stichopus cholonotus*) in Kiribati.

The pattern of value increase of beche-de-mer along the value chain nodes differed greatly among species (Fig. 2). Two species (*Holothuria scabra* and *H. lessoni*) were harvested in Fiji but do not occur in Kiribati. For some species, such as *Actinopyga miliaris*, *A. palauensis*, and *Holothuria fuscogilva*, selling prices (converted to US dollars) reported by fishers, middlemen and exporters were generally higher in Fiji than Kiribati. Dragonfish (*Stichopus horrens* group) were sold by fishers for higher prices in Fiji than in Kiribati but middlemen and exporters did not furnish data on their sale prices. For the remaining species (more than half of all species), value chains were comparable or partially overlapping across the two countries. For species for which we have data on prices offered by both middlemen and exporters, fishers in Kiribati more often received higher prices from exporters whereas fishers in Fiji more often received higher prices from middlemen.

Comparing across species, higher-value species (Fig. 2, upper panels) have distinctly larger proportional increase in overall price development than lower-value species (Fig. 2, lower panels). This means that for higher-value species, fishers receive a proportionally lower share of the end-market price. Fig. 3 summarizes this pattern by plotting the relationship between the average market retail price of a species and the average proportional value at first sale (from fishers to middlemen or exporters). One exporter said that one reason he offered relatively low prices to fishers for their sea cucumbers was so that they would continue to harvest at a high rate and sell greater volumes to him, rather than fishing at a slower rate had they been content with weekly income received from higher prices. For the three most valuable species, fishers receive less than 10% of the end market value when selling to middlemen or exporters. In contrast, the average proportionate return to fishers for mid-value species ranged 15–34% of the end market value, and averaged 50% of the end market value for the three lowest-value species.

Also noteworthy is the large variation in prices for certain species among actors within nodes. Within both countries, fishers in some locations received much less than fishers in other locations for the same species of dried sea cucumbers. In several cases (see Fig. 2), the prices middlemen received from exporters for the same species was highly variable. Some middlemen had additional patron-client arrangements with exporters such as partial salaries or provision of equipment, which were not captured in the structured questions of our surveys.

Exporters' gross profit margin from buying and exporting dried sea cucumbers was generally 2.6 times (median) higher in Fiji than Kiribati for most species (Fig. 4a). In Fiji, exporters reported gross profit margins of around US$40–65 per kilogram bought from fishers, except for the three lowest-value species which returned US$8–20 per kilogram traded. The gross markup, in price per kg, by Fijian exporters averaged 2.9 times more than the actual sale prices of the species sold by fishers to them (i.e. 290% markup). In contrast, the gross markup by Kiribati exporters averaged 0.7 times more than the actual sale prices by fishers (i.e. a 70% gross markup).

The proportional returns for exporting beche-de-mer (average export value relative to average retail value) varied greatly among different species, and ranged from 10 to 60% of the market value (Fig. 4b). This 'transaction differential' declined with increasing market price of the species for exporters in Fiji but there was no trend evident for data from exporters in Kiribati.

4. Discussion

4.1. Value chain structures

The hourglass-shaped value chain structure of fishery supply chains from Fiji and Kiribati (Fig. 1) is similar to those found in several other small-scale developing country fisheries linked to international markets (e.g. [10,19,37]). This structure is a result of millions of producers [38] supplying to end markets with hundreds of millions of consumers, channelled via a much smaller number of intermediaries. Variations of such hourglass structures are found in many food and agricultural supply chains where intermediary or dominant actors coordinate sourcing or consolidate products [39–41].

While the coordinating and exporting function is important for achieving access to international markets and logistical efficiency, the reduced number of actors in the intermediary (exporter and importer) nodes of the value chain also leaves this structure vulnerable to disproportionate capture of wealth by these actors [11]. Despite significant research effort, generalizable trends are somewhat difficult to draw for sea cucumber value-chains because fresh, semi-processed and fully processed products can be traded and actors have variable patron-client relationships [42]. Power asymmetries appear more prevalent where competition among middlemen and exporters is weak, or where there are no regulations to control power or increase information transparency in the value chain. Efforts to address such issues of power asymmetries could include policy to foster increased competition among buyers (e.g. issue a high number of export licences), in tandem with measures to limit expansion of numbers of fishers. Competition among exporters is speculated to have been a key determinate of prices offered to sea cucumber fishers in Papua New Guinea [11] and is generally assumed to have a significant effect on price transmission in small-holder value chains [43]. Exporters could also be encouraged to contribute to institutions for transparency and social responsibility (c.f. http://keystonedialogues.earth).

4.2. Distribution of revenue from sea cucumber trade

Our findings show that the proportion of the end market value captured by fishers depends greatly on the end market value of the species sold. Fishers usually reaped a small proportion of the end market value when selling high-value species, but usually a substantial proportion of the end market value when selling low-value species. The

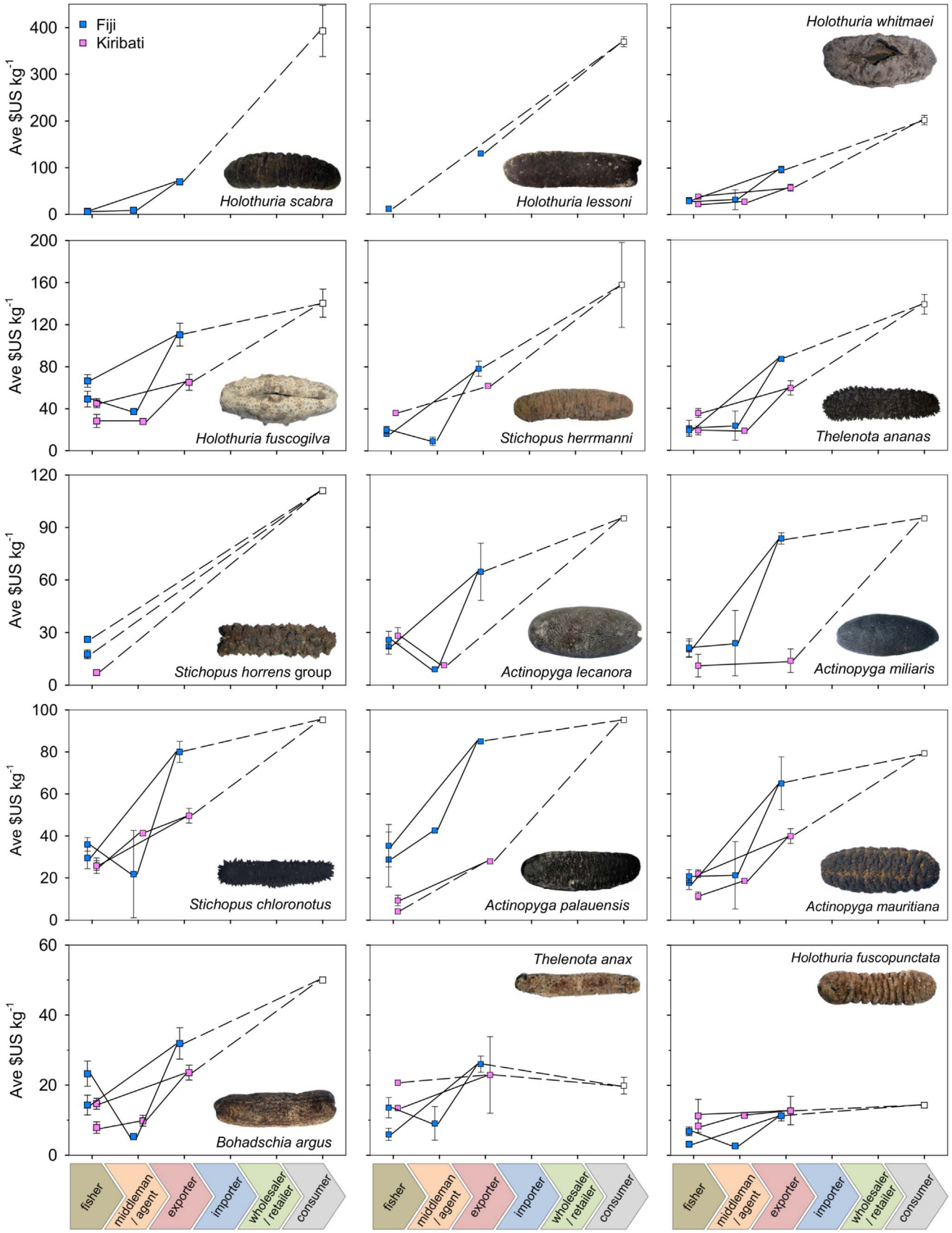

Fig. 2. Value chains for 15 species of sea cucumbers from Fiji and Kiribati. Note that y-axes cover different ranges in prices in order to illustrate variations along value chains of high-value species (upper panels) to low-value species (lower panels). Market prices in China are averages from the largest (by length) third of 'lots' of products in shops in Guangzhou and Hong Kong. Prices for fishers, middlemen and exporters are for 'large' specimens, to preserve a standard size for comparison across actors. Solid lines denote changes in prices from one actor to another where data were available on the direct transactions; dashed line denote changes in prices where sale prices from actors along the value chain were missing. Error bars are standard errors of the mean, based on replicate actors interviewed, or 'lots' sampled for consumer prices in China.

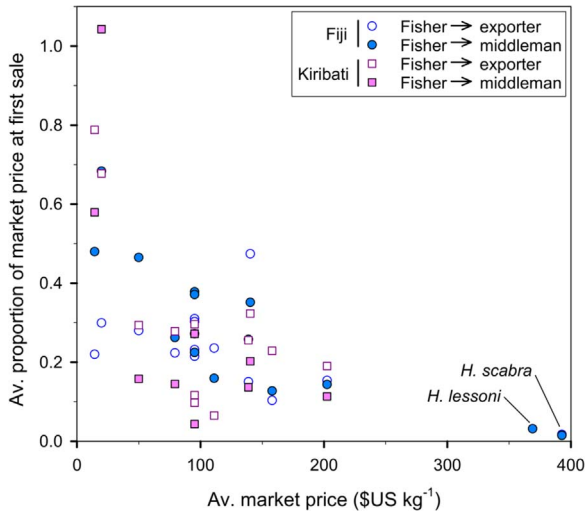

Fig. 3. Relative revenue to fishers. Scatter plots for Fiji (blue) and Kiribati (pink) of proportionate financial returns to fishers versus the average market prices, across the range of sea cucumber species. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

markup (in dollars) by exporters was indeed higher for high-value species (Fig. 4a) but the proportion of the end market value they received from exports was actually greater for low-value species. This seeming paradox is simply owing to the massive difference in prices between low- and high-value species in stores in China.

Even though the share captured by fishers for the six highest-value species was less than 20% of the end market value, this represents between US$30–40 kg^{-1}. The small proportion (< 10%) of the end market value to fishers when selling the highest-value species to either middlemen or exporters contrasted starkly with high proportionate returns for low-value species (average 50% of market retail price). Fishers often stated that it was not worth their effort to harvest certain species if the price was too low (e.g. < USD 5–10 kg^{-1}) [30] — thus the prices offered by traders for low-value species represented a greater share of the end retail value. This also means that actors further along the supply chain received a relatively lower proportion of the overall value of the product when trading those low-value species. This is one key reason why exporters preferred buying and exporting high-value species. Sea cucumber fishers in Pacific Islands are often not empowered with market information to equip them to bargain for higher prices [32,34,42]. Indeed, a companion study found that around half of sea cucumber fishers were dissatisfied with the income they earn from fishing and selling sea cucumbers [30].

Certainly in Fiji, exporters are, on average, earning several times more gross income (per kg) from exporting sea cucumbers than fishers earn from selling dried sea cucumbers to them. There was less disparity in Kiribati, where fishers earned slightly more gross income per kg of dried sea cucumbers than exporters. One decade ago, sea cucumber fishers in Papua New Guinea also generally received one-half to two thirds of the export price for dried sea cucumbers [44]. Caution is needed when interpreting price markups when costs and other activities along the value chain are unaccounted [45]. For example, Fijian exporters have customs and transport costs of $0.20–3.00 kg^{-1}, plus additional labour costs for sorting and packing the dried products, and potential risks in transactions with importers. We speculate that these costs combined were probably less than $5 kg^{-1} of beche-de-mer. Importers, wholesalers and retailers would also have some transport costs (although minor compared to international shipping from Pacific Islands), labour for product sorting, and overhead costs. On balance, our data on export prices relative to retail prices leads us to surmise that down-stream actors (importers, wholesalers or retailers) together reaped a majority of the value for high-value species (Fig. 4b), which

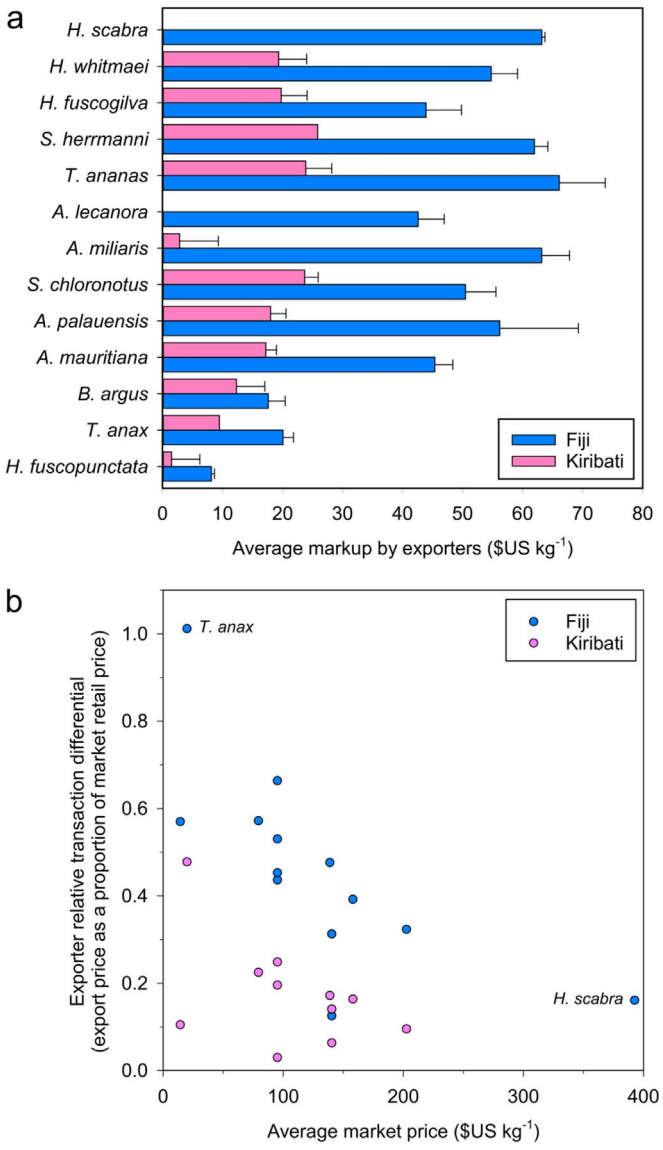

Fig. 4. Absolute and relative financial returns to exporters. a) Bar chart of the average markup in absolute terms (US dollars) by exporters in Fiji (blue) and Kiribati (pink). Error bars are standard errors of the mean, based on replicate exporters interviewed. Species are ordered along the same scale of increasing retail prices (high at the top, lower at the bottom) as in Fig. 2 for ease of comparison; b) Scatter plots for Fiji (blue) and Kiribati (pink) of relative export value as a proportion of the average final market retail versus the average market prices, across the range of sea cucumber species. Each data point is an average for one species in either country. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

tended to yield proportionally low returns to fishers (Fig. 3). Comparable, and sometimes much lower, selling prices by fishers for beche-de-mer in other countries (Suppl. Inf. S2 in [30]) indicates that this is a pervasive trend for these fisheries for international markets. The relatively low financial returns to fishers is concerning, considering the great investment in time taken by fishers to harvest and process the animals [34,35]. However, traders on occasion bear substantial risks [8], which we did not evaluate, yet would impact on prices because mitigating financial risk is a key factor of consideration for these types of traders [46].

In terms of overall economic benefits reaped by actors in the different nodes of the chain, one must also consider that quantities sold by fishers are of the scale of kilograms whereas quantities exported by exporters are of the scale of tonnes. Shipping containers hold roughly

15 t of dried sea cucumbers, and some exporters were trading many shipping containers every year. This indicates that annual revenue to exporters is likely to be two or three orders of magnitude greater than that of fishers.

4.3. Opportunities for value increases by chain actors

Large variation in selling prices for the same traded species among fishers indicates opportunities for interventions to improve the earnings of fishers receiving low prices compared to other fishers. Previously, we found large variation in prices of dried sea cucumber among locations within countries [30]. This trend has also been reported in Palau [32]. In Kiribati, it appears that fishers more often received higher prices from exporters than middlemen, but this was not usually the case among all of the traded species in Fiji.

Higher prices from exporters is probably because profits by middlemen are circumvented and exporters can pay fishers similar prices as they would a middleman. Other factors can affect prices offered to fishers by middlemen and exporters, including: (i) differing postharvest processing quality or level of dryness of beche-de-mer sold by fishers, which would in turn affect market prices [44,47], (ii) unscrupulous pricing behaviour, and (iii) credit or other contractual arrangements between fishers and traders that stipulate lower prices to fishers for their products as part of their repayment scheme [11,48,49]. Credit and labour-tying arrangements of this nature are commonplace in many other small-scale fisheries [19,37,50]. As such, while there is potential value increases for those earning less of same products, this potential might be inhibited by power relationships in value-chains which would need to be overcome.

4.4. Policy implications

The Chinese market presents challenges for producing countries that are unique from those of other major markets. Compared to the EU, for example, China tends to favour unrefined agricultural products, limiting the value-adding potential in producing countries [51]. Low-income developing countries are also in a less advantageous position to upgrade their value adding capacity compared to high-income developed countries [52]. The prospects of significant value-adding and profit generation by small-scale agricultural and fisheries producers are therefore weaker for products destined for Chinese markets.

The relatively meagre returns to small-scale fishers for some processed beche-de-mer species compared to down-stream actors could be attributed to poor knowledge of the market value of these products [34,47]. Increasing the information transparency in the value chain, for example by having easily accessible information on market prices, could partially address the lack of evidence on which fishers can bargain higher prices from middlemen or exporters [8,32]. But greater transparency might not result in better prices to fishers unless they can also organise to gain greater market power as a collective. Transparency in value chains also will only work when the information is reliable [22].

Poor knowledge of market prices also limits the ability of fishery management institutions to evaluate the veracity of export values reported by exporters. This type of transparency around market prices has benefited tuna fishers in the Pacific Islands through the Partners to the Nauru Agreement (PNA), which supplies monthly “market intelligence” to members (http://www.pnatuna.com/Tuna-Market-Intelligence).

In certain circumstances, middlemen can be important links in supply chains in which to communicate and support management measures for fishery sustainability [19,20]. However, with unscrupulous intentions, they can also have a great potential to accelerate local resource depletion [20]. Our data suggest that some of the middlemen and exporters in both countries offered quite low prices to fishers for some species, relative to the price they sold them for. Others seemed to apply ethical practices and offer relatively high prices (e.g. > 50% of their selling price). Competition among traders appears, at times, to mediate the exploitation of fishers [50], and our findings indicate that it could be one way to promote a larger share of revenue capture by these small-scale fishers.

Further measures such as national pricing standards might also help to achieve more consistent prices to fishers and help to safeguard some fishers from receiving unreasonably low prices from certain traders [32,42,53]. Formal systems for such standards include Fair Trade USA, where fishers are awarded a social price premium for each transaction [9]. Such pricing regulations act as a form of value-chain upgrading to empowering producers. However, trade measures may create feedback dynamics from local fisheries that are difficult to anticipate [54]. At worse, interventions to improve efficiency of value chains could backfire and reduce economic returns to fishers, the so called ‘Jevons’ Paradox’ [55]. For example, better prices to fishers could cause ‘rebound’ (*sensu* [55]) in the form of increased fishing effort or more fishers entering the fishery — with either response leading to a reduction in fishery stocks and per capita fishing incomes in the long term, unless complemented by enforced effort regulations. However, sea cucumber fishers in both Kiribati and Fiji were already fishing, on average, 3–4.5 days per week [35], leaving little leeway for increased fishing effort because of their other weekly activities and obligations. In addition, recent socioeconomic analyses following capacity building of fishers do not lend support to extensive feedback responses of this sort in these fisheries (S. Purcell, unpubl. data).

Governance of these small-scale fishery value chains aligns with the “captive value chain” type proposed by Gereffi and co-authors [56], where small suppliers are transactionally dependent on larger buyers and have low capabilities, leading to relatively high level of power asymmetry. Therefore, we posit that financial returns to such small-scale fishers might be improved by upgrading of value chain governance through the development of fisher cooperatives [see 8] or auction systems [see 11, 57]. Auction systems to enable fishers to sell their products to a wide range of traders bidding on prices has been raised as a potential mechanism to give higher prices to fishers and avoid potentially exploitative behaviour. The non-perishable nature of dried sea cucumbers favours such a system but, on the other hand, fishers often cannot wait long for income from fishing and processing their catch [11]. Logistic and coordination issues of operating such systems would require sound planning and an understanding of the variation in pricing among species in multispecies fisheries.

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