


Original Article

King tuna: Indian Ocean trade, offshore fishing, and coral reef resilience in the Maldives archipelago

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The traditional offshore pole-and-line tuna fishery of the Maldives has historically promoted low levels of reef fishing in this archipelago. While the tuna fishery is old and extensive—some evidence suggests it has been in place for over a thousand years—the reasons for its development have not been closely examined. Why did an offshore fishery develop in such small and isolated islands with abundant and easily accessible nearshore reefs? Why is tuna considered the “king of fish” in the Maldives, in contrast to many other islands across the globe where reef fish are prized for a wide variety of cultural and social reasons, often deeply rooted in community histories? In this article, we use a historical approach to uncover some of the drivers of this fishery, and the long-term consequences it has had for the resilience of this island chain. We trace the written accounts of travellers, voyagers, and traders, in addition to more recent research to gain an understanding of how early Indian Ocean trade networks may have shaped the development of this fishery over time. We propose that the early growth of the tuna fishery was likely tied to the trade in money cowries (*Monetaria moneta*), of which the Maldives was a major global supplier. A regional demand and market for dried tuna from the fourteenth century onwards contributed to the income of Maldivians and promoted and supported reef health by encouraging relatively low levels of reef fishing. However, the emergence and substantial growth of the Maldivian tourist industry in the past few decades are resulting in a shift in local consumption preferences and increased exploitation of reef fisheries. Exploring this history is important, not only to help contextualize the modern governance of the offshore tuna fishery, but also for a more nuanced understanding of the social, cultural, and ecological dynamics that have shaped Maldivian coral reefs in the past with implications for those that will do so in the future.

Keywords: coral reef resilience, fisheries, marine historical ecology, trade, tourism

Introduction

Humans have fished for millennia. But in the past six decades, rapid industrialization and overfishing has made achieving sustainable fisheries one of the most challenging global management problems (MacNeil *et al.*, 2010). This governance and management challenge has been complicated by the effects of climate change, especially on coral reefs, where multiple coral bleaching events have degraded and changed these habitats, causing large-scale reductions in

diversity, habitat extent, and system functionality (Perry and Morgan, 2017; Pratchett *et al.*, 2018; Stuart-Smith *et al.*, 2018). It is now predicted that the greatest fisheries losses will occur among reef-based fisheries (MacNeil *et al.*, 2010). In this context, pelagic fisheries have gained attention as a way in which some of the pressures of reef and coastal fishing may be shifted to the open ocean, targeting fish species that are faster growing and better able to sustain the nutritional demands and health of a region's

population (Bell *et al.*, 2015; Birkeland, 2017; Wabnitz *et al.*, 2017). Pelagic fishing is, however, not a recent phenomenon—drivers for and practices of offshore fishing extend into deep antiquity. Evidence for systematic pelagic fishing extends back to 42 000 years before the present from East Timor, when the humans who colonized Wallacea are thought to have developed complex maritime technology to fish in the deep sea for species like tuna (O'Connor *et al.*, 2011). The diverse and expert knowledge and skill of traditional fishers across the globe attests to the variability, age, and importance of reef and pelagic fishing practices (Johannes, 1981). Engaging with the historical ecology of these practices and traditions—why a particular method of fishing began and what local, regional, or global forces sustained it—can help contextualize modern resource management, and provide a framework to better understand the drivers of human influence on the environment. As Braje *et al.* (2017) point out, if conservation is to be successful over the *longue durée*, then deep historical perspectives integrating archaeology, ecology, and anthropology will be essential for a holistic understanding of human-ecosystem change through time. This is especially relevant for fisheries research, where the problem of “shifting baselines” (Pauly, 1995) has exposed how neglecting the past can have disastrous consequences for how we understand and govern marine habitats today.

In the Indian Ocean, the Maldives present an interesting case study on how the historical development of an offshore tuna fishery has enabled reef fishing pressure to stay at subsistence levels for centuries. Rooted in an archipelago of 26 atolls and 1900 islands in the central Indian Ocean (Figure 1), a traditional offshore pole-and-line fishery targeting skipjack tuna has been practiced for over a thousand years. Skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna remain the most important export commodities from the country (FAO, 2012). Of the 0.43 million people who live in the Maldives, the fishery sector employs about 20% of the workforce (MEE, 2016) and contributes to 3% of the country's GDP (Ahusan *et al.*, 2015). As of 2014, skipjack tuna comprised 37.45% of total fish catch, and all fishery products accounted for over 80% of total exports, bringing in over USD 120 million (Simoes and Hidalgo, 2011; FAO, 2012). The cultural value of tuna in these islands, past and present, has contributed greatly to the continued success and sustainability of the tuna fishery over time. From the Maldives, the pole-and-line fishing practice was successfully introduced into the Lakshadweep (the northernmost islands on the Chagos-Laccadive ridge, politically part of India) in the 1960s by local fisheries departments (Arthur, 2008; Jaini *et al.*, 2018). Today, dried skipjack tuna caught using this method forms the main export commodity from the Lakshadweep (Jaini *et al.*, 2018). Importantly, by driving a low level of reef fishing, offshore tuna fishing has helped bolster the resilience of these reef systems to climate change events, ensuring that the abundance of critical, functionally important guilds of reef fish remains high on these reefs (Sluka and Miller, 2001). Healthy populations of herbivores like parrotfishes are known to be especially critical for coral reef recovery, often preventing the proliferation of macroalgae in disturbed reef environments (Mumby *et al.*, 2006).

However, the history of the pole-and-line fishery—when it began to develop, the reasons it grew over time, and its contemporary relationship with coral reefs in the Maldives—has not been very well documented. In particular, we were interested in examining the factors that might have propelled the early development

of this fishery and the reasons why fishing for tuna offshore might have promoted a relatively low level of reef fishing in more easily accessible nearshore waters. We focus on the early history of this island nation and the impact of trade on the growth of its tuna fishery, examining the written accounts of travellers and traders for references to tuna or dried fish through time, and the places where tuna might have been exchanged. We also explore early methods of processing tuna and the factors that contributed to its success as a commodity, both locally and for export. While this study is at times inductive, we use a number of historical sources as well as more recent archaeological and historical research to demonstrate that the growth of this fishery was closely associated with a trade in money cowries, of which the Maldives was a major global supplier. A key insight emerges in this history in the way that social and cultural practices linked to one natural resource (money cowries) serve as a condition of possibility for the emergence of and, then, a driver for, the exploitation of another natural resource (tuna), with significant linkages to the ecological wellbeing of a third natural resource (nearshore reefs and their companion species). Finally, we conclude by drawing on this long historical perspective to call back into view links between the tuna fishery and coral reef resilience in the Maldives archipelago in the contemporary context of the growing impact of tourism on this relationship.

Historical drivers of tuna fishing in the Maldives

Setting the context: Maldives in the Indian Ocean world

The Maldives archipelago is a double chain of atolls situated 700 km southwest of Sri Lanka and about 475 km south of India, extending 7°N to half a degree south of the equator (Figure 1). Geologically, it occupies the central portion of the Chagos-Laccadive submarine ridge, which was formed by the volcanism of the Réunion mantle hotspot about 65 million years ago (Kench, 2012). Only 1.5 m above sea level, it is the lowest country in the world, but its territorial waters are vast (67 000 sq. km) and contain 3% of the world's coral reefs (Stevens and Froman, 2018).

The early history of the Maldives is infamously obscure, complicated by its isolation and lack of written historical records (Mohamed, 2005b; Maloney, 2013). The islands were likely settled around the first to third centuries CE from Sri Lanka and southern India (Litster, 2016; p 14). Several Buddhist relics, monuments, and other artefacts of material culture recovered from this period attest to Buddhism being the dominant religion at that time (Mohamed, 2005a; Litster, 2016). In 1153, the population was converted to Islam by a visiting saint. The state chronicle *Dhivehi Tarikh* credits conversion to Sheikh Yusuf Shams al-Din al-Tabrizi, who, by reciting the Qur'an, was said to have freed the islanders of a sea demon. Over the following eight centuries, the Maldives was ruled by a succession of 93 sultans, until it became a republic in 1965 (Yang, 2019; p 22).

The veil of information that shrouds the early history of these islands has nevertheless been lifted a few times in the past thousand years, by a few key accounts (Bell, 1882; p 30). The Moroccan traveller Ibn Battuta spent 4 years in the Maldives in the fourteenth century and his famous *Rehla of Ibn Battuta* provides some of the earliest details of post-Islamic Maldives (Gibb, 1953, pp 241–253). Francois Pyrard de Laval, a French explorer, was shipwrecked in the Maldives in the early seventeenth century and left an account that is considered to be one of the earliest

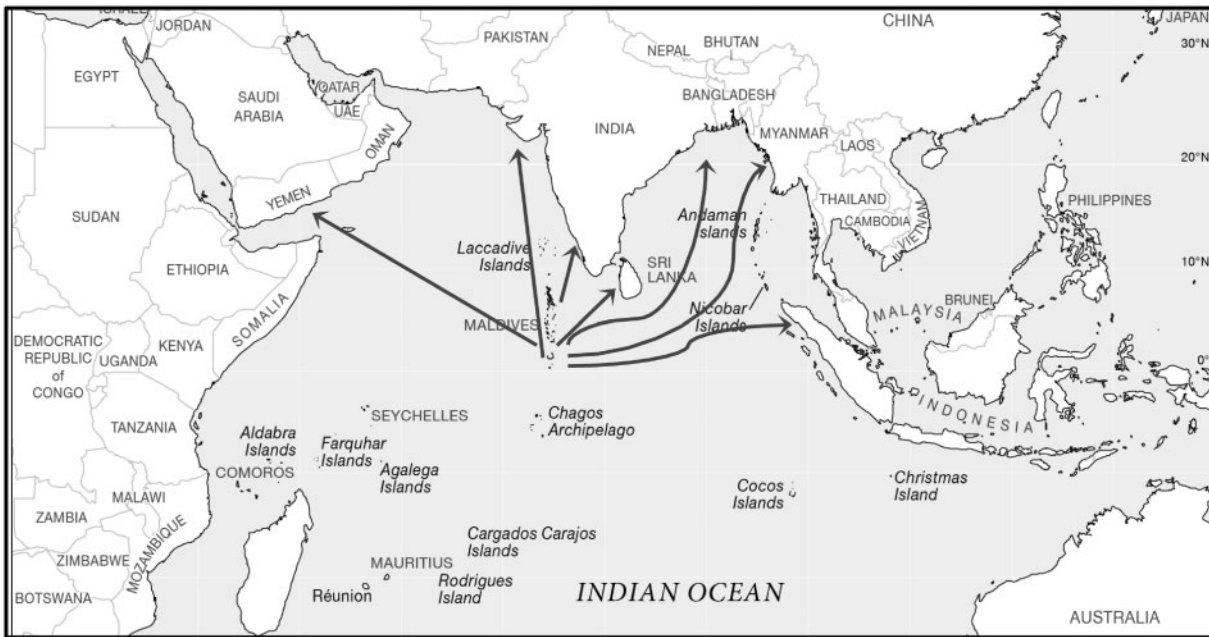


Figure 1. Map of the Maldives in the Indian Ocean, with arrows indicating places where dried tuna and other fish products were being traded between the fourteenth and nineteenth centuries. While it is likely that tuna had a wider reach, especially to parts of east Africa and Southeast Asia, the places marked are only those that had a direct written reference to tuna being shipped here. Map credit: CartoGIS Services, ANU College of Asia and the Pacific, The Australian National University.

ethnographies of the islands (Maloney, 2013). Two British navy lieutenants Young and Christopher visited in the nineteenth century and detailed life on the islands in their memoir, creating some of the first maritime charts of the Maldives (Bell, 1882; p 12). In the eighteenth and nineteenth centuries, two British officials from Sri Lanka—HCP Bell (1882) and TW Hockley (1935)—wrote more comprehensive articles on Maldivian culture and the social history of these islands, which formed the basis for much of the sociological work that came after this period. Between the fourteenth and eighteenth centuries, a few Chinese and European accounts provided glimpses of life in the Maldives, around the time that it was becoming an important trading centre (Yang, 2019; p 29). Much of what is explored in this paper relies on these records for early historical details. An obvious limitation of the present work is its reliance on texts and ethnographic materials that were written primarily by visitors—there is a lack of accessible local writing from this period. Still, this demonstrates both the challenges and opportunities for marine historical ecology to engage with and glean from scant historical evidence (Kittinger et al., 2011, 2015; McClenachan et al., 2012).

By the first millennium CE, trade and movement was widespread in the Indian Ocean, so the Maldives already had some contact with the larger region during their phase of settlement—the famous navigational log *Periplus of the Erythraean Sea* documents the export of tortoise shell from the Maldives in the first century CE (Casson, 1989), and the islands' abundance of coconuts and freshwater was noted as far as Rome in the third to fifth centuries (Litster, 2016). But it was only in the ninth century that references to the Maldives began to appear more regularly in passages and notices from Arab visitors and traders. In particular, the islands were gaining attention for their abundance in cowries. It is this shelled mollusk that would establish the Maldives as a

critical point of exchange for trade and travel in the early Indian Ocean world.

The pull of cowries

The oldest written reference noting the importance of cowries to Maldivians dates to 851 CE, when a Persian merchant Sulaiman wrote that “the wealth of the people [in the Maldives] is constituted by cowries” (Litster, 2016; p 6). Cowries (*Monetaria moneta*) were the standard currency of Indian Ocean trade for almost a thousand years from the ninth to nineteenth century. While the cultural and ritual functions of cowries extend back millennia (Hogendorn, 1981), their primary function by the ninth century CE was as currency. Maldivian cowries were especially sought after because they were small, cheap, and abundant, and large quantities could be transported easily (Hogendorn and Johnson, 1986). They were also not easy to counterfeit and retained their luster for a long duration (Hogendorn and Johnson, 1986; Litster, 2016).

It has been suggested that it was the presence of money cowries that might have provided the impetus for human settlement in the Maldives (Mikkelsen, 2000; Litster, 2016). Whether or not this is true, Maldivian cowries were unquestionably a highly sought-after product that drew traders from the western Indian ocean. In the tenth century, Al-Idrisi, an Arab traveller, was one of the first to note that “commerce [in the Maldives] is carried on by means of (cowry) shells” preserved in the King's treasury (Gray and Bell, 2010; p 432). Several methods of cowrie collection appear to have been employed in the Maldives. Wood floats and coconut branches were placed in the water to provide structure for the animals to attach to, or shells were collected by wading, whereby women, “twice a month, when the tides suit” stood in waist-deep water and detached cowries directly from the

undersides of stones (Bell, 1882; p 87). Shells were processed locally on islands (by sun-drying and burial in the sand) and then shipped to Malé, for storage and export (Hogendorn, 1981).

There is evidence to suggest that trade in cowries, while it grew rapidly, is likely to have first started regionally, with places like Bengal in India, where “kings and great lords [have] houses built expressly to store these shells and treat them as part of their treasure” (Gray and Bell, 2010; p 239). Ibn Battuta also recorded this trade with Bengal in 1327 and wrote that cowries “are sold to the inhabitants of Bengal for rice, because the cowries are also current in Bengal, and also to the inhabitants of Yemen who use these instead of sand as ballast in their ships” (Gibb, 1953; p 243). The shells were also shipped via the Red Sea and across the Sahara to West Africa’s savanna region (Hogendorn, 1981). While Hogendorn (1981) notes that cowries were used as currency within the Maldives, Yang (2011) refers to accounts of Huang Xingceng from the 1520s that suggest that silver rather than cowries served as local money in the Maldives, while the latter were only sold or exported to bring wealth. Nevertheless, by the fifteenth century, the reach of Maldivian cowries had expanded to parts of Arabia and West Africa, and cowries would eventually make their way into European markets, functioning “as a lubricant for the European colonial machine” (Yang, 2011) and fueling the transatlantic slave trade (Hogendorn and Johnson, 1986). Portuguese, Dutch, and British traders were involved in the cowrie trade by this time, either purchasing shells directly from the Maldives, or from ports in Bengal (Hogendorn, 1981). Historically speaking, cowrie money was the first “global money,” existing across an extensive geographical range and used by a variety of people at various periods (Yang, 2019; p 249). It linked the Maldives to markets in East and Central Asia, Southeast Asia, South Asia, coastal Africa and the middle-east, and eventually Europe.

The early trade in cowries, however, was most likely driven by Arabs and Persians, who were the dominant traders in the Indian Ocean in the ninth century (Pearson, 2003). It is these early Arabic connections that resulted in Islam arriving to the Maldives in 1153. In the Indian Ocean of the twelfth century—already increasingly fused by Islamic connections—the conversion of the Maldives to Islam would have further enhanced its position as part of the growing network of trade routes and emporia in existence at the time (Pearson, 2003).

In addition to the cowrie trade, or perhaps because of it, the Maldives’ strategic location between port cities in the Western Indian Ocean and Southeast Asia made these islands a convenient stopover point for travellers and traders in the region. Duarte Barbosa, a Portuguese official who passed through the Maldives in the 1500s, wrote that “many ships of the Moors which pass from China, Maluco [Indonesia], Peegu [Burma], Malaca [Malaysia], Çamatra [Sumatra], Benguela [Bengal] and Ceilam [Sri Lanka] towards the Red Sea touch at these islands to water and take in supplies and other things needful for their voyages” (Dames, 1921; p 108). The Indian Ocean region was connected by a monsoon-driven trade, and the “predictability of a home-ward wind made the Indian ocean the most benign environment in the world for long-range voyaging” (Pearson, 2003; p 19). The southwest monsoon (May–September) and northeast monsoon (November–March) separated the year into two halves, and ships would sail between the Red Sea, Persian Gulf, India, and parts of East Africa when the winds were known to be stable. The geographical location of the Maldives, therefore, was advantageous in other ways to seafarers, who also began to use these islands as

stop-over points for victualling and replenishing supplies on their voyages.

To summarize, constrained by what could be grown on land, Maldivians benefitted from regular and sustained exchange in several commodities with passing groups of traders, merchants, and voyagers across the long arc of their history. Significantly, the Maldives’ abundance in cowries put the islands on the map of Indian Ocean traders, and the establishment of Islam in 1153 further connected them with larger Muslim networks of trade active at the time. While coconuts, coir (the fibrous husk of coconuts), fish, ambergris, and tortoise-shells were exchanged in smaller quantities (Bell, 1882), cowries were almost certainly the most valuable and well-recorded item of export from the Maldives for the better part of a millennium. The presence of cowries in the Maldives supported and may have been a critical driver for the start of a regional, and later, global trade network centred around these islands (Table 1). Certainly, by the fourteenth century, the islands were important waypoints for sailors going both east to Southeast Asia, India and Sri Lanka and west, to Madagascar and parts of the African east coast. This regional-global trade context also served as a condition of possibility for the emergence of another significant trade with striking implications for the long-term dynamics of human engagements with nearshore reefs in the Maldives.

Dried tuna and the trade growth for “Maldivian fish”

The lack of abundant freshwater and arable land, and the size and geography of the low-lying, sandy islands of the Maldives essentially prevented the development of large-scale agriculture in the archipelago (Litster, 2016). Nevertheless, taro, yams, millet, and fruits were cultivated to some extent, especially in the northern islands (Munch-Petersen, 1982; Gray and Bell, 2010). Coconut palms were cultivated throughout and were critically important, with the net worth of islands designated on the basis of their coconut trees that locals used for several different purposes (Maloney, 2013). But rice and wheat had to be regularly imported from Sri Lanka, India, and Burma (Gray and Bell, 2010), and there was frequent exchange between islands for produce. “God had willed that these people should visit each other” and “what is plentiful in one island is rare in another,” wrote de Laval (Gray and Bell, 2010; p 114.). Interestingly, he noted that islands were separated by their craft, with jewelers, potters, toddy-drawers, mat-weavers, blacksmiths, and carpenters all located on different islands and travelling to each other regularly on boats “covered with a little deck, working and dealing in their goods, and it is sometimes more than a year ere they return to the island of their home” (Gray and Bell, 2010; p 115.).

However, like for many other island chains, the principal food in the Maldives was fish. “I believe there is no place throughout India, nor elsewhere, where the fishery is richer and more plentiful” de Laval wrote in 1619 (Gray and Bell, 2010; p 194). Faunal archaeological data indicate a historical reliance on fishing (Munch-Petersen, 1982; Maloney, 2013). Most notably, scombrid (tuna) remains were the major fish taxon recovered during these archaeological studies, both from Buddhist (pre-1153) as well as Islamic times (Litster, 2016). This potentially dates tuna fishing to the ninth century CE. However, the earliest written record is only from Ibn Battuta’s account in 1327. He was the first to note in some detail the local diet, which he said consisted of “a fish like the lyroun, which they call koulb al mâs. Its flesh is red; it has

Table 1. Summary of important sources and accounts documenting the growth of the tuna fishery in the Maldives from the ninth to the twenty-first century.

Time period	Source	Details recorded	References
First to ninth century (pre-Islamic)	Faunal archaeological collections	Scombrid (tuna) remains major fish taxon recovered from this period; more diverse reef fish assemblages recovered post-ninth century	Maloney (2013); Litster (2016) and references therein
Fourteenth century	Ibn Battuta	First (?) written record in post-Islamic Maldives documenting the processing of and trade in skipjack tuna; export to Bengal, Gujarat (India) and Yemen recorded	Gibb (1953)
Sixteenth century	Francois Pyrard de Laval	Second detailed record of skipjack tuna processing in the Maldives and trade expansion	Gray and Bell (2010)
Nineteenth century	Harry Charles Purvis Bell, Thomas William Hockley	First ethnographic accounts of the Maldives; details of cutting and curing skipjack tuna; places of export and uses of tuna	Bell (1882); Hockley (1935)
Fifteenth to nineteenth centuries	Merchant records and notes by traders and visitors (Dutch, Chinese, Arabs, Mappillas, and Bohras)	Places of trade and uses of skipjack tuna; growth of “Maldivian fish” in Sri Lanka	Bell (1882); Dames (1921); Hockley (1935); Pearson and Gupta (1999); Mohamed (2005a); Yang (2019)
Twenty-first century (post-mechanization)	Fish catch records and reconstructions	Tonnage of skipjack tuna and other species fished, management of modern tuna and reef fishery	Adam and Anderson (1998); Adam (1999); Sattar et al. (2011, 2014); Hemmings et al. (2014)

no grease, but its smell resembles that of mutton. When caught at the fishery, each fish is cut up into four pieces, and then slightly cooked. It is then placed in baskets of coco leaves and suspended in the smoke. It is eaten when perfectly dry” (Gibb, 1953; p 242). Further, he mentions that this fish was “exported to India, China, and Yaman [Yemen],” making this the first direct reference to the fact that dried tuna was an item for export by the 1300s. de Laval, in the 1600s, was next to document this fishery noting that “they [cobolly maas] are cooked in sea water, and then dried in the sun upon trays, and so when dry they keep for a long while. . . there is great traffic in them, not only in the country, but throughout the rest of India, where they are in great request” (Gray and Bell, 2010; p 191). In both these passages, Ibn Battuta and de Laval refer to a fish called *kalu-bili-mâs* or *cobolly maas*, which is the local name for skipjack tuna (*Katsuwonus pelamis*; today referred to in Dhivehi as *kalhubilamas*) (Abdulla and O’Shea, 2005).

While these provide early references to how tuna was being fished, Bell’s account of these islands from the late 1800s detailed the nuances of tuna cutting and curing. Elaborating on the process that Ibn Battuta first recorded in 1327, Bell (1882) again noted that once caught, each fish was either sliced longitudinally at the centre in half, making four pieces in all (called *gadu*) or sectioned into several strips, thus creating pieces of different names and values (*gadu mas* or pieces along the back and belly; *medu mas* or pieces along the side; and *kira mas*, or pieces between the head and ends). In this case, *gadu mas* would fetch the highest price, followed by *medu mas* and *kira mas*. He documented, again, how these fish were “thrown into a cauldron of boiling salt water. . . and placed on a wattle loft or shelf above the fire. . . till well blacked and dried” (Bell, 1882; p 94). This process, of smoking and drying the fish, would have allowed it to be preserved in the absence of refrigeration. For the rest of the catch, the largest fish was given to the “king’s kitchen” and the remainder to “the clergy, the poor, and to their friends. . . however small the catch,

this division must always be made” (Gray and Bell, 2010; p 191). Pyrard’s is the only account to suggest that the king required people to pay taxes in local products. The king “imposes on his subjects an ordinary tax. . . consisting of coco-cordage, of shells called *boly* (cowries) and of dried fish,” he wrote (Gray and Bell, 2010; p 228). These were likely sold to traders in Malé, illustrating again the value of dried tuna as an export commodity at the time.

It is also striking that the method of fishing, drying, and processing tuna remained more or less unchanged from when it was first noted in the fourteenth century by Ibn Battuta until the nineteenth century in Bell’s report. In fact, it was only the mechanization of the tuna fishing fleet in the 1970s, and the development of larger scale industry that modernized methods of fishing and processing skipjack tuna (Adam et al. 2003).

Bell also noted that there were several other species being fished by islanders including “sawfish, swordfish, searfish and sharks” but that their “soft, oily nature, unadapted for curing. . . [meant they were] never salted for the foreign market” (Bell, 1882; p 93). On the other hand, tuna, once dried, had the “appearance and consistency of blocks of wood,” which would have made it easy to package and ship. The fact that tuna lent itself to this method of smoking and drying *en masse* unlike other reef fish or pelagic species was critical to its durability, transportability, and marketability. Further, the fact that different cuts of tuna were valued differently, and that there was a well-defined method in place for processing, even in the fourteenth century, suggests that it was more than just a local fishery by this time. “The fishery is of great yield and is the chief employment of the islanders” Pyrard wrote in 1619, “. . . they are daily dispatching ships with cargoes of this [fish] to Achen, in Sumatra, and elsewhere.” Duarte Barbosa also remarked in the 1500s that the islands have “a great store of dried fish” that were carried with cowries to the Kingdom of Cambaia (present-day Gujarat) and Bengal (Dames, 1921; p 105). Ma Huan, a Chinese official who

visited the Maldives in 1425 on Zheng He's treasure fleet from China, noted that dried tuna was used by travellers on ships during their voyages (Yang, 2019). In reconstructing Safi bin Wali Qazwini's account of life on Indian ships in 1669–1670, Qaisar makes a passing reference to “smoked fish from the Maldivian Islands” being part of the dietary staple on board (Pearson and Gupta, 1999). Dried tuna, apart from being exported, might have played a vital role in fulfilling the protein requirements of sailors and travellers in the Indian Ocean who spent long periods of time at sea.

While it is difficult to ascertain exactly how this trade was organized, by the fifteenth century it had diversified to include Mappila merchants from the Malabar coast (modern Kerala) who carried items from the Indian west coast to Sri Lanka, Maldives, Laccadives and Malacca (Subrahmanayam, 1995). By the nineteenth century, Bohra merchants monopolized the fish trade from the Maldives to Sri Lanka using a fleet of *buggalows* and schooners that sailed between the islands (Bell, 1882). The Bohras also carried out a profitable trade in fresh coconut, copra, and tortoiseshell. Even though written references to tuna are not ubiquitous, they appear frequently enough to suggest that by the mid-fifteenth century, trade in “dried fish,” most likely skipjack, was well-established and growing rapidly around the subcontinent. Dried tuna from the Maldives became such a popular commodity in Sri Lanka that by the eighteenth century it had its own local name: “Maldivian fish” (Hockley, 1935). It remains an important ingredient in Sri Lankan cooking today. According to Hockley (1935), the annual worth of “Maldivian fish” to Sri Lanka at this time was “well above £200 000”—over USD 16 million in today's currency (Officer and Williamson, 2019).

While it appears that dried tuna began as a commodity piggy-backing on more valuable cowries, over time, the export of tuna and other fish products appears to have become profitable in itself. By the nineteenth century, the cowrie trade had collapsed, for reasons related both to changing global economies, as well as the introduction of a competitor—the ring cowrie *Monetara annulus*, that resulted in hyperinflation (Litster, 2016; Yang, 2019). Tuna quickly and naturally replaced it as the primary commodity of export from the Maldives.

Why fish for tuna: the advantages of a pelagic fishery

It is not surprising that fishing has been an important part of the Maldives' sociocultural and economic history, as it has for islands around the world. What is striking is the emergence of an early offshore fishery that was so strongly linked to a regional trade. This offshore fishery acted as a driver for local subsistence practices, thereby exerting a negative pressure on the exploitation of nearshore reefs. But offshore fishing requires more time, resources, effort, and risk than fishing in nearshore waters, on reefs or in lagoons. We propose a few reasons why investing in a pelagic fishery might have benefitted Maldivians more than reef fishing.

First, Indian Ocean islands experience a heavy southwest monsoon from June to November, when storms and rough weather prevent reef and offshore fishing for several months in the year. Skipjack tuna, fished in abundance during the dry season, would have been ideal to smoke, dry, and preserve during the monsoon months. In the Maldives, dried tuna maintained its edibility for long periods, allowing it to be stored in bulk without refrigeration. This parallels the ways in which cod was dried as stockfish in Norway, because of its ability to store well for several years

once cured (Nedkvitne, 2016). Smoking and drying would have allowed it to be supplied year-round, as and when outside demand for it arose. Rihakuru, a traditional dish of salty fish paste made by slow-boiling tuna is an example of how fish were and continue to be preserved in the Maldives today. Like colatura from the Mediterranean or prahok from Cambodia, rihakuru can sit on the shelf for long periods of time—over a year if prepared well (Naila *et al.*, 2011). In contrast, reef fish were and are not considered suitable for drying and preservation in this manner. They were likely fished in smaller quantities in nearshore reefs and lagoons for direct consumption, especially during the rainy season when travelling offshore might have been more challenging. Importantly, however, locals seemed to have developed strong cultural values around tuna and a preference for its consumption over time. Tuna appears in several folk tales from the Maldives as the “king of fish,” superior to other fish because of its taste, texture, and firmness of flesh (Romero-Frías, 2012). Today, the majority of all fish-based traditional cuisine is still centred around tuna in some form or another (e.g. recipes in Sattar, 2017).

Second, skipjack tuna, while pelagic, are often found fairly close to islands in the Maldives (“six or seven leagues out” (Gray and Bell, 2010; p 189); or about 40–60 km offshore). This is because clear oceanic waters—prime habitat for tuna—surround the outer atolls. In the Maldives, the geomorphology of the islands enabled easy access to deeper waters, and live bait to chum the water for tuna could have been caught easily on reefs on the way out. Fishing for tuna, while it still required more effort and coordination than fishing in the lagoon or on nearby reefs, might not necessarily have required fishermen to plan multi-day fishing trips; instead, a single day offshore would have yielded substantial catches. The tuna fishery continues to result in high yields—the reconstructed total catch of tuna from 1950 to 2010 was approximately 3.7 million t, 80% of which was skipjack tuna caught using the traditional pole-and-line fishing method (Hemmings *et al.*, 2014).

Lastly, Maldivians were seasoned seafarers and had developed specialized craft for tuna fishing. They were known to make “sewn boats,” a design found throughout the Indian Ocean and one that would have made navigating these reefs easy because of the elasticity of the materials used (Maniku, 1998). Boats were constructed from coconut timber held together by coir and caulked with whale oil, with rigging and sails made of coir. Even today the term used for boat building in the Maldives—*dhoani banun* (“boat tying”) is reflective of the process used in the past. Before the fleet was mechanized, *masdhoanis* (tuna fishing vessels) were traditionally sail and oar driven (Anderson, 1997). *Masdhoanis* were between nine and fourteen meters long, with a platform at the stern (*fenfilaa*) where fishermen could stand and fish with poles. In fact, Maldivian boat building appears to have been well known and unique as it integrated the features of boats from many parts of the Indian Ocean region (Mohamed, 2005a). The earliest schools established in the Maldives are thought to have been navigation oriented (Mohamed, 2005a) and *veshi* or oral poems created “oral maps” that communicated nautical directions of coral reef passages and dangerous currents (Romero-Frías, 2012). All this suggests that Maldivians were not limited in their navigational and seafaring abilities and that boats for tuna fishing were only one among many designed for different types of sea travel. In sum, fishing for tuna might not have been

as logistically or technically challenging as one might imagine an offshore fishery to have been at the time.

From an ecological point of view, perhaps without consciously intending to, Maldivian fishing practices developed to take the best path towards sustainable nearshore fisheries. Skipjack tuna, with its short life span, early age at sexual maturity, and rapid population turnover is a much more reliable resource than many reef fish species for harvest today (Birkeland, 2017). Skipjack grows almost ten times as fast as large coral reef fishes like groupers and snappers, that often live for several decades and are easily over-exploited (Birkeland, 2017).

Contemporary tuna fishing in the Maldives

Today, skipjack tuna is still caught in the Maldives using the pole-and-line fishing method. This occurs in multiple stages. Live bait is first caught in nearshore waters using a net (today made of nylon, earlier of cotton). The reef fish caught—usually planktivores like fusiliers (*Caesio sp.*) and triggerfish (*Odonus sp.*)—or sprats (*Spratelloides gracilis*) are kept in holding tanks on the boat. Once offshore, the water near a potential fishing ground is chummed with baitfish, attracting tuna to the surface. Barbless hooks, attached to a long pole (today made of fiberglass, earlier of bamboo), are then used to pull fish out of the water (Adam and Anderson, 1998; Adam, 1999). Earlier, sea birds guided fishermen to locate schools of skipjack. In particular, the brown noddy (*Anous stolidus*) was an important indicator of where schools of skipjack might be located. Today, fish aggregation devices aid in detecting schools of tuna. Because the pole-and-line method results in little to no bycatch or discards (Miller et al., 2017), the Maldivian pole-and-line fishery was the first in the Indian Ocean to be accredited by the Marine Stewardship Council as a sustainable fishery (Stevens and Froman, 2018). While there has been some concern about the sustainability of the baitfish fishery that the tuna fishing industry relies on, the live bait fishery management plan launched by the Marine Research Centre and the Ministry of Fisheries and Agriculture aims to improve post-harvest mortality rates and monitor catch records in the coming years (Gillett et al., 2013). One of the questions this paper raises is what the effects of historic bait fishing have been on these reefs. Quantifying potential differences in the communities of reef fish species in reefs that have experienced sustained bait fishing and those that have not may help shed some light on whether the long-term removal of species like fusiliers, cardinalfish, and damselfish has impacted reef fish community structure in these coral reef systems.

The processes that govern the modern tuna fishery were first introduced in the mid-1970s, when the Maldivian government mechanized the offshore tuna fishing fleet. Tuna catches (both skipjack and yellowfin) rose rapidly thereafter, from 35 942 t in 1970 to 76 374 t by 1990, peaking at 186 000 t in 2005 (MEE, 2015; p 35). As of 2014, 20 945 t of skipjack tuna and 14 537 t of yellowfin were landed in the Maldives (Hemmings et al., 2014). The earnings on exports from tuna and other fisheries (bêche-de-mer, lobster, etc.) has continued to rise since, even as tourism has become the main driver of the country's economy today, accounting for about 30% of its direct annual GDP (Stevens and Froman, 2018). However, while the tourist sector employs many non-Maldivians, the fisheries sector continues to employ about 20% of the local population (MEE, 2016). Frozen tuna is

exported to foreign markets in Germany, the United Kingdom, Japan, France, and the United States—the fresh tuna supplied from the Maldives, in fact, accounts for over 15% of the fresh tuna imported into the European Union (MEE, 2015; p 32). Yellowfin tuna is an important component of this, representing over 28% of total marine exports from the Maldives (Adam and Jauharee, 2009). Dried “Maldivian fish” (usually skipjack) is still exported to Sri Lanka by smaller cottage industries. Skipjack stocks are generally thought to be high in the Maldives, and while yellowfin tuna catches have fluctuated in the past decade, they seem to have stabilized since 2010 (Hemmings et al., 2014).

However, even as the tuna fishery maintains its economic and cultural importance in these islands, the rapid rise in tourism since the 1970s as well as growing foreign demand for reef fishes for consumption or display have led to the emergence of a reef fishery in recent years (Adam, 2004). The total estimated annual catch of reef fish in 2014 was 10 780 t (Hemmings et al., 2014; Pauly and Zeller, 2015). An export-based grouper fishery (primarily supplying Thailand, Taiwan, and Hong Kong) also took off in 1994. In 2010, over 600 t of grouper species were exported from the country both in fresh/chilled form and live, mainly via air freight in containers or in bins developed for the shipment of live organisms (Sattar et al., 2011). A management plan for this fishery recommended size limits for some species and protected areas to safeguard spawning aggregations (Sattar et al., 2011), programmes that are currently being implemented. An export-driven aquarium trade has also expanded in these islands, and as of 2008, about 140 species of fish and 5 species of invertebrates were being exported from the Maldives, regulated by species-specific quotas (Saleem and Islam, 2008). While these two industries supply external demand and have been subject to some state regulation, reef fishes also have a growing and important local market. Much of this demand comes from resorts, where catches are either landed directly (Sattar et al., 2014) or supplied by local buyers and traders who purchase directly from fishermen (MS, pers. comm.). Jacks (Carangidae), snappers (Lutjanidae), and emperors (Lethrinidae) form the bulk of the catch bought by resorts, with quantity determined primarily by the bed capacity of the resort (Sattar et al., 2014). Hemmings et al. (2014) estimate that reef fishes constitute 83% of tourist consumption.

Within local communities too, reef fishes appear to be becoming more common in diets, with many households consuming between one and five reef fish per week (Sattar et al., 2014). While this is still a low number, guest houses are developing rapidly on islands previously only inhabited by local communities (428 as of 2017), bringing tourists to islands that they might not earlier have visited. This is also driving an increased demand for reef fish (MEE, 2017). Recent studies suggest that there are efforts being made to address this problem and to create management strategies that will help regulate catches of reef species more effectively (MEE, 2017). However, there is still more research needed to understand what is driving the demand for reef fish locally—whether these are more the results of tourist preferences, changing local tastes, or the unavailability or inaccessibility of tuna today to people outside big market centres in the Maldives. Examining how seafood trade today interacts with production (Crona et al., 2016), and the place of reef fish and tuna in both international and local markets in the Maldives, will help to better understand the current drivers of these respective fisheries.

Conclusions

In many ways, the Maldives is confronted by problems and challenges very similar to those faced by other small island states, chief among them being the threat of sea level rise, coastal erosion, and rapid development fueled by an ever-growing tourist industry (UNEP, 1994; Zubair *et al.*, 2011). At the same time the linked ecological, social, and cultural history of the tuna fishery also provides a glimpse into the factors that sustained a biologically robust fishery for centuries, and the implications this has had for long-term social-ecological resilience of these islands' reef system. Over the past 1000 years, the pelagic tuna fishery has kept reef fishing light in the Maldives, promoting the functional resilience of these reefs and buffering them from climate change-related disturbances, like mass coral bleaching events. However, while it was the earlier form of regional trade in money cowries that led to the development of a pelagic fishery that indirectly supported coral reef resilience, it is now ironic that a more recent globalization, in the form of tourism, has the potential to endanger this same system. Just as the centuries-long cowrie trade served as a condition for the emergence and establishment of the tuna fishery with various cultural and ecological outcomes, the health of nearshore reefs is again linked to transnational and regional dynamics driven by market and cultural phenomena in other domains. One and a half million tourists visited the country in 2017, three times its local population (MMT, 2017; Stevens and Froman, 2018). While the efforts made by many resorts to make their practices more sustainable and conservation-oriented must be applauded and encouraged, tourism still exerts a huge ecological strain on the Maldives, and in island societies in general. In coral reefs around the world, demand for top predators like groupers, and herbivores like parrotfish has transformed reef trophic dynamics and, in some cases, pushed benthic communities to less-desirable alternate states (Mumby *et al.*, 2007; McCauley *et al.*, 2010). While there are notable exceptions to this narrative, especially where local management and protection have reversed these trends (Friedlander *et al.*, 2002; Johannes, 2002; Kikiloi *et al.*, 2017), one of the biggest challenges in coral reef management today remains centred around operationalizing concepts of ecological resilience to sustainably manage reef fisheries (Anthony *et al.*, 2015). In the Maldives, the resilience of these reefs is intimately tied to the tuna fishery. Our work suggests that it is going to be increasingly important to not only understand and respond to the drivers and dynamics of ecological wellbeing in the Maldives today, but to also reflect on deep time perspectives for governing and managing reef resilience and seafood sustainability. Complex historical ecologies such as those exemplified in the Maldives in centuries-long linkages between money cowries, pelagic tuna, nearshore reefs, and local communities can be drawn upon to better inform present and future marine resource management, and to better understand how tourist and local consumption as well as international markets are shaping the demand for fisheries products today. For instance, encouraging the consumption of skipjack tuna over reef fish species in resorts may go a long way towards reversing current trends in tourist demand for reef fish. Simultaneously, while tuna still remains an essential component of local diets, there needs to be more effort directed towards examining just how much is being consumed in households, and in tracking the (monetary, social) value of tuna to locals today.

Meanwhile, as the possibility of increased exploitation of pelagic fisheries to meet consumer needs gains attention from conservationists and reef managers in other island ecosystems (Bell *et al.*, 2009, 2015; Birkeland, 2017; Wabnitz *et al.*, 2017), the Maldives provides an interesting case study of an archipelago that has historically sustained this model for centuries. It is true that successful adaptation to increased environmental stress, in many cases, will depend on societies abilities to invest in alternate fisheries or activities (Brander, 2013). However, both the external and intrinsically cultural factors that have contributed to the persistence of the tuna fishery in the Maldives are unique to this island chain—and dietary preferences, in particular, have played a large role in ensuring the success of tuna here, in the same way that preference for reef fish species has shaped fisheries history in many Pacific island contexts (Johannes, 1981). This will have to be taken into consideration when offshore fisheries are promoted in places that do not necessarily share the same social and cultural values for pelagic fish. Finally, integrating historical perspectives into contemporary conservation will be crucial to uncover and better understand the dynamic forces that have shaped and continue to shape island ecologies. As habitats change rapidly in the Anthropocene, long-term historical data will be needed to frame current management practices and create sustainable, practical, and equitable plans for the future.

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