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Ariadna Burgos

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Artisanal molluscan fisheries on Atauro Island (Timor-Leste): knowledge, practices and challenges

Ariadna Burgos¹

¹ Laboratory of Local Heritage, Environment and Globalization, UMR 208 IRD-MNHN. Department of Humans and the Environment, French National Museum of Natural History, French National Research Institute for Sustainable Development, ANR Popei-Coll. 57 Rue Cuvier, CP 135, Paris France.

Abstract

In South-East Asia and Oceania as in many other areas of the world, shelled molluscs such as clams, cockles, conchs and snails provide multiple services for coastal livelihoods (*e.g.* food security, water purification, stabilization of the shoreline and habitat structure, etc.). On Atauro Island (Timor-Leste) discarded shells resulting from human activities are found on the coastal shore as well as at the top of Atauro mountains, both at the soil surface and buried in the substrate. Nowadays, shelled molluscs provide a source of nutritious food, income and inspiration to local communities. In total, 67 species of molluscs were found to be used in Atauro Island for multiple purposes. Women and children played an important role gathering, processing and selling molluscs. Indeed, in order to efficiently harvest shells local shellfishers must have accurate knowledge regarding the diversity, habitat and distribution of molluscs, as well as constantly learn new information on the dynamics of local fisheries and the marine environment. In a world where ecosystems and societies are facing major challenges such as climate change and ecological services degradation, the link between local knowledge and academic science is central for sustainable development. Drawing from our research in Atauro Island (Timor-Leste), the aim of this paper is 1) to illustrate the diversity of practices and local knowledge involved in the gathering of molluscs; and 2) to identify socio-cultural and ecological factors that affect the way local people interact with molluscs and the marine environment. We found that the relationship between humans and molluscs in Atauro offers insights to understand long-term socio-ecological changes on the island. Our results allow us to propose lines of action to monitor, assess and manage molluscan fisheries in Timor-Leste while combining traditional and scientific knowledge.

Keywords: shellfish, local knowledge, women, marine heritage, socio-ecological change, conservation, sustainability, environmental justice.

Artisanal molluscan fisheries: importance and resources

Molluscs are the largest marine group including almost a fourth of all known marine species (Bouchet et al. 2016). Bivalves and gastropods, such as oysters, mussels, clams, cockles, snails, abalones, conchs, whelks are shelled molluscs, or more commonly known as “shellfish”. They are found in all habitats of the marine realm and provide essential ecological services such as cycling and storage of carbon and nutrients, habitat structure, water purification, stabilization of the shoreline, and food for other organisms (Gutierrez et al. 2003, Smaal et al. 2019). From a societal point of view, the flesh of shellfish offers not only key nutritious elements and food to coastal societies (Khan and Lieu 2019, Venugopal and Gopakumar 2017), but also the shell itself carries cultural values and provides a source of income (Nijman 2019, Burgos et al. 2019).

Shelled molluscs are relatively sedentary and some are strictly sessile or fixed during their adult stage (e.g. oysters, mussels and some clams). This condition makes that their distribution and habitat are relatively predictable by shellfish foragers (Thomas 2007). Indeed, bivalves and gastropods meld perfectly with their environment and foragers must pay particular attention to different ecological features within coastal ecosystems while they glean in order to maximize harvest outcomes. This requires a deep and up to date knowledge of molluscan habitats, life habits and population dynamics. Additionally, a high awareness of who is fishing where and what, is necessary to avoid selecting sites that have already been exploited, decreasing shellfishers’ chances of finding molluscan species (Burgos 2016).

Research context and study objectives

The research presented in this paper was carried out within the research framework of a larger interdisciplinary project on cultural policies, local heritage and collaborative approaches in Eastern Insulindia (POPEI-Coll 2019-2022). This project carried out by the French National Research Institute for Sustainable Development (IRD) seeks to understand “heritage” as perceived and conceived by the local communities of Atauro Island. POPEI-Coll’s approaches propose a new dialogue between local heritage, applied science and policies. It aims to reveal the social stakes of heritage in non-Western societies by proposing new methodologies and concepts for the assessment of local heritage and the development of cultural policies.

Atauro, located 25 km north of the main land of Timor-Leste, is inhabited by approximately 8,000 habitants (GDS and MAFF 2020). Isolated shells or shell fragments, as well as large shell deposits resulting from human activities can be easily observed along Atauro’s coastlines, as well as on the top of Atauro’s mountains. These archaeological records demonstrate the long-lasting interactions of Atauro people with this resource from ancient times to our days (Galipaud et al. 2016).

Drawing from our research in Atauro Island (Timor-Leste), the aim of this paper is 1) to examine the diversity of practices and local knowledge involved in the gathering and use of molluscs; and 2) to identify the socio-cultural and ecological factors that affect the way local people interact with molluscan resources and the marine environment.

Study site

Atauro is a small oceanic island 22 km long and 5–10 km wide. It has a total area of 140 km² and a maximum elevation of 1000 m at Mount Manucoco which is located in the southeastern

part of the island. Atauro is formed by a volcanic edifice mantled by a succession of uplifted limestone coral reefs (Ely et al. 2011). The island comprises flat to sloping lime-stone terraces, steep hills and deeply dissected valleys cut into the volcanic substrate (*idem.*). The northern part of the island has a lower relief that contrasts strongly with the south part (Figure 1). There is limited development of alluvial plains, and no freshwater wetlands, tidal rivers or extensive mangroves are found on the island. The coastline typically comprises long beaches with relatively narrow (30–200 m wide) fringing reefs and extensive seagrass beds are found near the village of Beloi in the eastern side. In the southern part of the island, the coastline is dominated by cliffs and rocky shores. Atauro is known for its outstanding marine biodiversity and by a well-preserved coral reef system (Brian et al. 2019, Conservation International 2016, Erdmann and Mohan 2013). Furthermore, the island has also a rich linguistic diversity comprising three languages : *Rasua* (spoken in Atekru, Akrema, Bikeli, Beloi, Uaroana), *Ratunglu* (spoken in Berau, Maker and Makadade) and *Hrseuk* (spoken only in Makili) (Guillaud 2019).

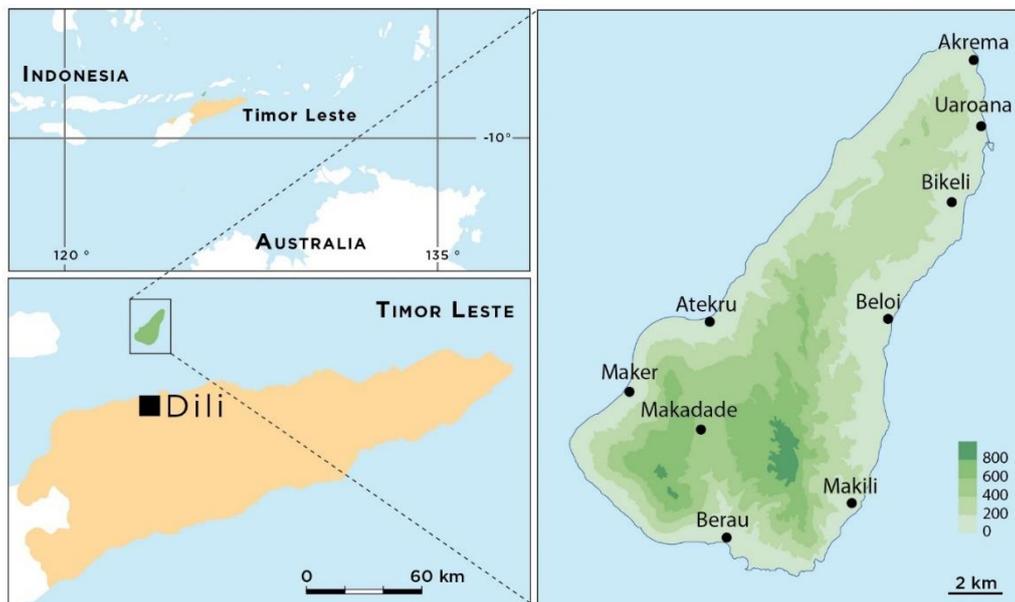


Figure 1 : Map of Atauro Island and villages where research was conducted.

Fieldwork in Atauro was carried out between 2017 and 2019 for a total of 156 days. Interviews with local people and inventories of the molluscan fauna were conducted in nine out of the thirteen villages located in Atauro (Figure 1). Seventy-six interviews were carried out with women (n=46) and men (n=30). Interviews were conducted in Indonesian, Portuguese, Tetun (Timor-Leste official language) and Rasua (one of the three local languages of Atauro). For the latter two, the assistance of a translator was required.

Fishing grounds were located by GPS and described according to local knowledge and ecological observations. Molluscan species were inventoried during follows of shellfish gathering activities and participatory observation of fishing activities. Shells seen along Atauro's trails, or dispersed on the surface of the soil in the hills or caves were registered in order to determine the diversity of shell waste dumps or shell deposits. Market surveys (n=23) were conducted at the Beloi weekly market to survey the diversity of molluscan species sold for food or as souvenirs. The shells of species used by Atauro people were collected, photographed and identified with their local name *in-situ* and with their scientific name at the marine invertebrate collection of the French National Museum of Natural History in Paris.

Social structure and organization of fishing activities

Atauro artisanal molluscan fisheries are part of a larger frame of food production systems which include other forms of fishing, agriculture, wild forest gathering, and livestock such as raising pigs, chickens, and goats. The way Atauro people fish and relate to aquatic resources is highly specific to each locality. In fact, the contrasted topographies of the Island produce a high diversity of ecosystems and coastal habitats that house specific biota and thus different marine resources and exploitation practices. This is particularly notable between the villages of the extreme south (Makili, Berau and Maker) and the other villages of the island.

The social structure and organization of shellfishing activities displays gendered and intergenerational particularities. Women are the main gatherers of shells in the seashore (Figure 2), while men fish mainly in areas that are permanently submerged regardless of the tide, and target large molluscan species such as *Tritonia charonis*, *Tectus niloticus* and *Turbo marmoratus*. These species are sought after mainly for the economic and cultural value of the shell, more than being target for edible purposes. Children can be seen accompanying their mothers during gleaning activities. They also play an important role finding small empty shells washed up on the beach, mainly gastropods, that are turned into necklaces or earrings by their mothers and sold during the Saturday market at Beloi. Women are the main sellers of molluscs, both for food or for ornamentation purposes.



Figure 2: Women play a key role harvesting molluscan species in intertidal environments.

Diversity and uses of bivalves and gastropods

In total, 67 species were found to be used in Atauro 48 of which were gastropods and 19 bivalves. Sixty-three species were used as food, of which nine were also used for ornamental purposes. Four species, consisting only of gastropods, were used for ornamental purposes only. Eleven species were sold at the Saturday market for local consumption and thirteen species were sold as souvenirs or as jewelry. *Asaphis violascens* was the most abundant and recurrent species sold at the Atauro Market. Two handfuls of shells of *A. violascens* were sold for one dollar. These represented more less 20 - 30 shells depending on the size and were bought mainly by other inhabitants of Atauro or by domestic tourists, visiting Atauro on Saturday during the market day.

Names of molluscan species and coastal habitats varied between the different linguistic areas of the island. Indeed, while some names displayed some similarities between Rasua and Ratunglu, names of species and habitats were significantly different in Hresuk. Moreover, in each language certain names of shells have become general terms to designate a group of species. For instance, for the younger generations, the name “kima” can refer to various species of *Tridacna* while for older generations all four species of *Tridacna* found on the island had a specific name. Despite the erosion of knowledge regarding species names, it is important to highlight that young women who glean for shells, were highly aware of molluscan habitats and species behavior. This knowledge was fundamental to enhance the efficiency and productivity of their shellfisheries.

Molluscan habitats and shellfishing techniques

Coastal zonation differed from one village to the other and varied according to topography, quality of the substrate, and exposition to wind and currents. Figure 3 presents a schematic illustration of coastal zonation in Atauro. Five common intertidal environments are represented: rocky shore, gravel beach, seagrass, reef flat and forereef. Harvesting methods varied across these environments and according to the habitat of species. Shellfishing trips could target one species or a group of species, involving the use of one or a combination of techniques.

The rocky shore located at the edge of the upper intertidal zone, is submerged by ocean water during high tides, although the duration of submersion is relatively short compared to the other four zones. In this environment, most of the gleaning concerns small gastropods such as *Nerites* (snails) and *Patella* (true limpets). Harvesting is done by hand and mostly at night when the *Nerites* crawl on the rocks.

The gravel beach is defined here as a compact mix of rubble coral, gravel, sand and coarse sand. *Asaphis violascens* is found buried 10 to 20 cm in the gravel substrate. To collect this bivalve, women displace rocks on the top of the substrate and look for specific small holes that indicate the presence of the *A. violascens*' siphons. They then dig into the substrate with an iron bar or sharp object and remove the shells. In the seagrass area, women walk slowly while digging in the substrate with a long iron bar to detect the presence of *Codakia tigerina*, a large bivalve that is found buried up to 30 cm within the seagrass substrate.

The reef flat has the highest diversity of targeted species and often a combination of harvesting techniques is used for gleaning in this area depending on the life habits of the target species. *Tridacna* spp. as well as *Turbo* spp. are dislodged from the rocks using iron bars. Lastly, the forereef is the zone where spear fishing and diving for shells is carried out mainly (but not exclusively) by men. This zone is always submerged by ocean water. Shellfish

species (e.g. *Charonia tritonis*, *Turbo marmoratus*, *Tectus niloticus*) are collected by hand. These gastropods are often harvested for decoration and handcraft purposes.

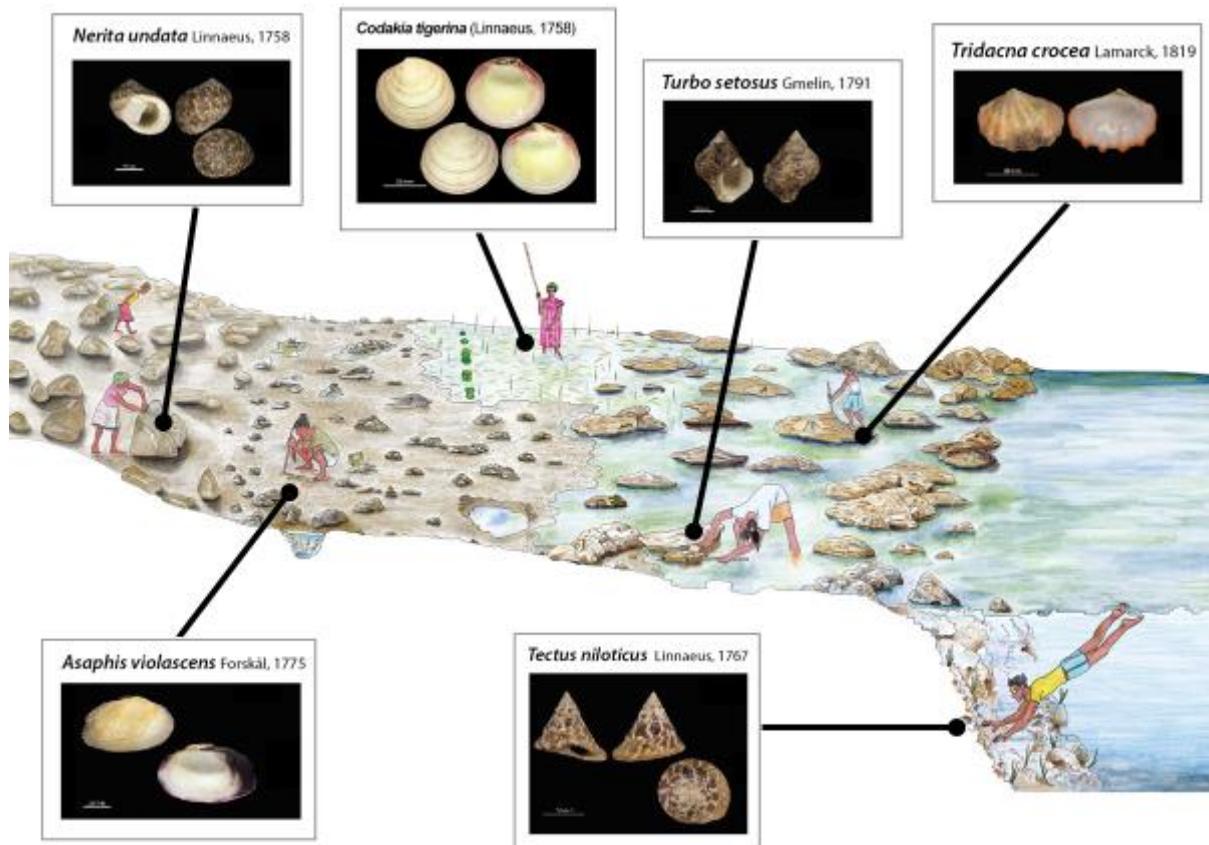


Figure 2: Distribution of shellfishing activities in the shore (adapted from Tilley et al. 2020 © Burgos A. Billault L. – IRD). *Nerita* species are found on the rocky shore, *Asaphis violascens* is buried in the gravel beach, *Codakia tigerina* is specific to seagrass environments, *Turbo setosus* and *Tridacna crocea* are sought after in the reef flat, and *Tectus niloticus* is harvested in the fore reef.

Molluscs were available year-round but were never harvested on a daily basis. The collection of intertidal species was dependent upon the timing of the low tide whether subtidal species were harvested disregarding of the tide. The most popular times to look for shells were during the morning, evening and nighttime (using a torch). If low tide occurred outside these times, shellfishing was more arduous due to high temperatures and sun exposure, and resulted in lower catchability, particularly of gastropods, who sought refuge in reef crevices (Tilley et al. 2020). Indeed, some burying bivalves such as *A. violascens* and *C. tigerina* could be sought any time of day, as their distribution was not affected by the heat.

Current changes in access to the ocean and to resources

In Atauro, there are informal but strictly codified ways of using coastal ecosystems and resources. Since 2015, several temporally restricted no-take zones have been implemented throughout the island as a mechanism to promote environmental conservation and coastal resource management (Mills and Tilley 2017, Kim 2021, Tilley et al. 2019). These no take zones are called “*Tara bandu*” which is a seasonal or periodic resource-harvesting ban used traditionally in Timor-Leste to protect ripening crops, resolve conflicts and restrain

transgressive behavior (Palmer and McWilliam 2019). The development of *Tara bandu* areas has been increasingly adopted by the state and environmental organizations as a mean to promote hybrids modes of resource governance. Nevertheless, the interpretation of the *Tara bandu* concept is not yet clear and varies amongst authors as amongst organizations promoting them (Alonso-Población et al. 2018, De Carvalho and Correia 2011, Palmer 2016, Meitzner Yoder 2005). Today, the support and implementation of *Tara bandu* by state, international development organizations, and non-governmental organizations (NGOs) throughout Timor-Leste have revealed both positive and negative effects (Alonso-Población et al. 2016, Kim 2021, Palmer and McWilliam 2019, Tilley et al. 2019). As a fact, if *Tara bandu* provides unique opportunities to preserve biodiversity in the context of marine settings, their establishment has not come without consequences for local people's lifestyles, cultural practices, and subsistence strategies.

In Atauro, several *Tara bandu* areas have been developed during the last five years. If the first *Tara bandu* established in Atauro was the result of an entire year of negotiations with the local communities of the village of Adara, the rapid subsequent implementation of twelve other *Tara bandu* throughout the island may not have completely achieved the proper consultation and characterization of the biological and social settings specific to each community (Kim 2021). Nowadays, the majority of *Tara bandu* areas are located in front of villages, and they often cover the total expanse of the village coastline, such as is the case in Maker, Berau, Atekru and Uaroana. Two relevant issues affecting lifestyles and molluscan shellfisheries will be highlighted here, but there are many other social and ecological aspects that need to be consider (see Kim 2021). First, while international divers and tourists are allowed to enter *Tara bandu* zones in exchange for a fee of two dollars, the same principles of fees apply to locals - including children. Nevertheless, two dollars represents a significant amount of money in Atauro and this principle entails that children can no longer swim in front of their houses, or easily fish and collect shellfish in localities where they can be supervised by their parents or relatives. This affects children's interaction with the ocean, and puts them at risk as they need to find far distant localities to be in contact with the ocean. Secondly, all fishing practices are prohibited and liable to financial penalties within the boundaries of *Tara bandu*. Women, whose fisheries depend on marine invertebrate species located in intertidal habitats are disproportionately affected by these regulations as they need to walk long distances in order to look for shellfish. This, in addition to the many tasks that women have to accomplish for the functioning of their household, creates an impediment to look for and rapidly harvest animal protein and discourages women from carry out this activity.

It is worth highlighting that in Timor-Leste 50% of children under 5 years of age are subjected to malnutrition, and chronic food insecurity affects 64% of the population during the dry season (Bonis-Profumo et al. 2020). Shellfish and other marine invertebrates represent a rich source of animal protein and provide micronutrients that can foster child development and food security and provide nutrition in Timor-Leste (Lopez-Angarita et al. 2019). The majority of women consulted within the framework of our project affirmed that, with the exception of the most commonly sold species such as *A. violascens* and three large species of gastropods sought after for their shell and primarily harvested by men (see above), there are still plenty of edible molluscs on the island. One elderly woman in Akrema noted that when her husband passed away, she depended significantly on *Nerites* and other shellfish species to feed her four children. Both women and men affirmed that shellfish represent a unique source of food during periods of shortage and in times of rough seas.

Molluscan fisheries and cultural heritage

Molluscan fisheries have a long tradition on Atauro and are part of a system of cultural practices that deserve to be preserved and encouraged with as much emphasis as biodiversity. These fisheries play a crucial role in supporting interconnected food production systems, food security, nutrition and income (Grantham et al. 2021, Lopez-Angarita 2019, Tilley et al. 2020), as well as, in the establishment of social bonds and networks of non-commercial exchange (Grantham et al. 2020). Moreover, the diversity and abundance of shell middens and molluscan archaeological records scattered throughout the island are a testament to the importance that molluscan resources have played for the societies that have inhabited the island since at least 18000 years (Galipaud et al. 2016).

Women in Atauro display a high diversity of shellfishing techniques and traditional ecological knowledge related to molluscs. Whether the effects of their gleaning activities on coastal ecological process and biodiversity remain understudied, the traditional management practices carried in Atauro for millennia might have contributed in a way to support the diversity of marine species and well-preserved coral reefs observed today in the island (Brian et al. 2019, Conservation International 2016, Erdmann 2016). Indeed, marine invertebrates and intertidal habitats are vulnerable today to rapid social and ecological change (Grantham et al. 2021, Kim 2020, Tilley et al. 2020), but also cultural practices and local knowledge are vulnerable to new forms of marine resource management.

Nowadays, the involvement of local communities and their knowledge of natural resource management is fundamental to better understand changes in coastal ecosystems and to favour the sustainable use of wild species. It is now widely accepted that “effective conservation requires context-specific understandings of human interactions with, and conceptions of, nature” (Infield et al. 2018). Transdisciplinary research linking methods and approaches of anthropology, archaeology, ecology and geography are key to understand human-mollusc interactions in the long term and to support the development of alternative conservation models that take in account also the cultural heritage and social settings of each locality (Burgos et al. 2019). In addition, local and scientific knowledge should complement each other to build adaptive strategies in the face of rapid change of coastal socio-ecosystems. To this end, it is crucial to develop coastal management frameworks where local people are included, not only in the collection of data, but also in the development of monitoring approaches and tools, in the analysis of data, and in the elaboration of recommendations and policies. Indeed, achieving this will require shifts towards institutional diversity at all levels of coastal management and governance.

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