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Examining the Socioeconomic Benefits of Oysters: A Provisioning Ecosystem Service from the Mangroves of Guinea-Bissau, West Africa

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ABSTRACT

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In Guinea-Bissau, West Africa, extensive patches of mangrove provide important resources for the subsistence of local populations. The objective of this work was to assess the relevance of oyster harvesting, consumption, and trade for local communities. For that purpose, a qualitative approach derived from rural diagnostic methodologies was applied in two coastal protected areas where extensive areas of mangrove are present. Ten animal species were found to be collected there by women, both for household consumption and for sale. The oyster, *Crassostrea tulipa* is the only species harvested in all the 12 inquired villages and, by far, the most available in local markets. Three types of oyster products are commercialized—fresh oysters with shell, fresh oysters without shell, and dry oysters—with the latter being the most traded and valued. These products are marketed in the villages, in local markets, and in the capital, Bissau, as well as exported to Senegal. The harvesting of oysters is practised during 20 weeks per year, providing households with an average annual income of 580–595€. This income, which represents a large proportion of the yearly income, is mostly managed by women and is used to cover basic family expenses, namely, to meet the needs of children. This study uncovers the socioeconomic benefits derived from a specific mangrove ecosystem service, which is directly used by coastal human communities, and highlights the importance of oysters for food security, for empowering women, and for securing household incomes.

ADDITIONAL INDEX WORDS: Crassostrea tulipa, *coastal regions, protected areas, shellfish harvest.*

INTRODUCTION

Mangroves are important ecosystems in many tropical countries both for the ecology of coastal zones and for the welfare of coastal populations. Ecologically, mangroves play a crucial role in fertilization, stabilization and protection of the coast, filtration, and climate regulation, while supporting food chains and nurseries for many species of fish and invertebrates. Economically, mangroves provide a wide range of woody and nonwoody products that support rural livelihoods, also having high potential for ecotourism (Ajonina, Diamé, and Kairo, 2008; Basha, 2018). As such, many coastal communities depend on the resources available in this ecosystem for food, shelter, and economic gains (Acharya, 2002).

In West Africa, fishing, salt extraction, mollusc and crustacean harvesting, rice cropping, timber and firewood extraction, and charcoal production, as well as nonwoody forest products such as game, honey and wax, and medicinal plants, are mangrove resources used by the coastal populations (ECC, 1992; UNEP, 2007). In this context, gastropods, crustaceans, and molluscs, such as oysters, represent important ecosystem provisioning services exploited by families for consumption and as a source of income (Ajana, 1980; Diadhiou, 1995; Thiam, Clotilde, and Sy, 2011). As such, and given growing population pressure (Ajana, 1980; Adjei-Boateng and Wilson, 2012, 2013), some of the most commercially important bivalve species are overexploited because of overharvesting of immature individuals.

Oysters from the *Crassostrea* genus have a worldwide distribution and are among the most exploited marine species, being cultivated in several coastal regions of the world. Two species of oysters are cited for Guinea-Bissau: *Crassostrea gasar* (Deshayes, 1830) and *Crassostrea tulipa* (Lamarck, 1819) (PRCM, 2011; Silva *et al*.., 2012). However, currently, *C. gasar* is considered a synonym of *C. tulipa*, which is a species occurring along the West African coast, from Senegal to Angola, and which has been the focus of several studies (Ajani, 2008; Nickles, 1955).

Crassostrea tulipa is a bivalve from hard substrates, generally found attached to the roots of mangrove plants such as *Rhizophora* spp. (Ansa and Bashir, 2007; IBAP and Tiniguena, 2013). In Guinea-Bissau, as in other West African countries, it provides an inexpensive and easily accessible protein source for lower income populations inhabiting coastal towns and villages (Asare, Obodai, and Acheampong, 2019). However, the collection of oysters often entails that the aerial roots of *Rhizophora* spp. are cut to facilitate and speed up harvesting, which leads to mangrove degradation and reduced

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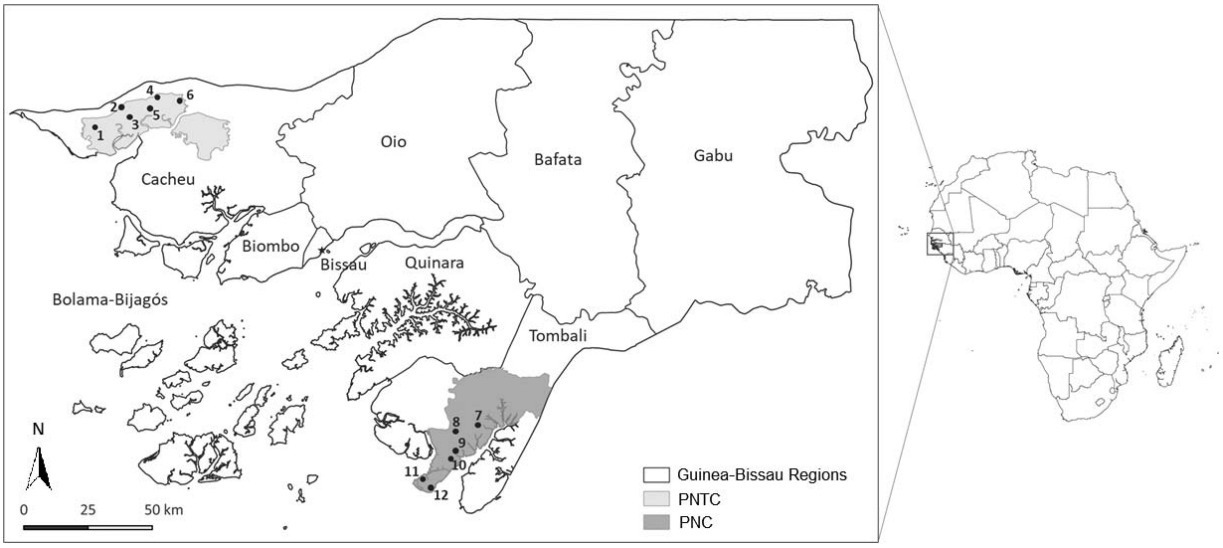

Figure 1. Map of Guinea-Bissau with the location of the study area: Parque Natural dos Tarrafes do Rio Cacheu (PNTC) and Parque Nacional de Cantanhez (PNC) (adapted from Vasconcelos *et al*.. [2015]). The location of the villages sampled in each park is indicated by the numbered stars: 1 - Elia Nhízio; 2 - Colage Oputche; 3 - Causso II; 4 - Badiqué Felupe; 5 - Cacheuzinho; 6 - Poilão Leão; 7 - Gandjatra; 8 - Caiéquene; 9 - Tabanca Bedju; 10 - Cabedú Balanta; 11 – Condiere; and 12 - Djiu de Melo.

substrate availability for spat settlement during the breeding season (Cormier-Salem, 2017).

Given the ecological and socioeconomic importance of mangrove areas in Guinea-Bissau, in Africa, and worldwide (Acharya, 2002), it is relevant to obtain an objective assessment of the value of the services provided by these ecosystems (Peterson and Lubchenco, 1997). Thus, the objective of this work is to assess the importance of one specific mangrove service in Guinea-Bissau, West-Africa: the oyster harvesting, processing, and consumption or trading value chain.

Study Site

This study was conducted in two coastal protected areas of Guinea-Bissau: the Parque Natural dos Tarrafes do Rio Cacheu (PNTC) and the Parque Nacional de Cantanhez (PNC) (Figure 1). Guinea-Bissau is a small country on the west coast of Africa, with a population estimated at 1,874,303 inhabitants (UNdata, 2019) and an area of 36,125 km^2. It encompasses a continental territory and a group of 88 islands and islets, which lie close to the coast and constitute the Bijagós Archipelago (Cardoso, 2017; Fishpool and Evans, 2001). Mangroves, locally known as "tarafe" or "tarrafe," are the most representative vegetation type in the coastal zone and the reason why Guinea-Bissau is considered a mangrove country par excellence. The area of this ecosystem covers more than 8% of the national territory, with an estimated total of 3128 km^2 (Cardoso, 2017; IBAP, 2008).

METHODS

The relevance of oyster collection for local population was assessed using methods adapted from Participatory Rural Appraisals (Walters, Maragos, and White, 1998), with interviews and application of questionnaires in the two parks. These aimed at ascertaining the main animal species harvested in mangroves by local populations.

Households are considered to define the most basic unit for the management and use of resources, but, because they are organized in villages, the first step of the sampling procedure was to select which households in the villages would be questioned. Nevertheless, due to cost constraints, it was decided that a maximum of six medium-size villages would be visited in each park and that five to seven households would be interviewed in each village. The villages were selected according to the following criteria: (1) located not farther than 1000 m from mangrove patches; (2) 50–500 inhabitants; and (3) at least five oyster-collecting households would participate in the survey. To identify the villages that met the defined criteria, georeferenced data from the 2009 population census (INEC, 2009) and a vegetation map (CARBOVEG-GB, 2008; FREL-GB, 2019) were analysed in a geographic information system.

This analysis yielded a set of 26 candidate villages in PNTC and 37 in PNC. These villages were mapped and randomly numbered, and the six villages with the lowest random numbers were selected to be visited in each park. When this criterion could not be applied during fieldwork for logistic reasons, the next lowest numbered village was visited and included in the sample. The location of the villages visited is shown in Figure 1. In each one, and according to the criteria listed previously, five to seven women responsible for a household were interviewed, resulting in a total of 41 and 37 interviews in PNTC and PNC, respectively.

Prior to the interviews and application of the questionnaire, the objectives and purpose of the study were explained to ascertain consent. Then, qualitative and quantitative questions about the collection, consumption, transformation, and

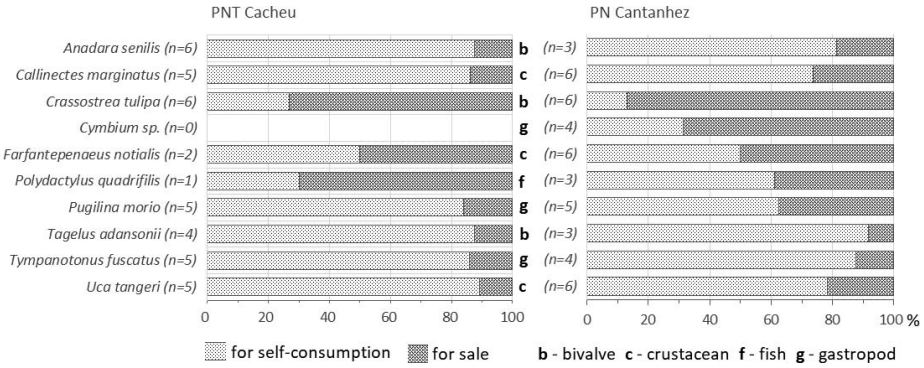

Figure 2. Species of bivalves, other molluscs, crustaceans, and fish extracted from mangroves by women in the two parks, with their associated destination. The number of sampled villages where each species is harvested is presented within brackets.

trade of oysters and other mangrove products were posed. Additionally, samples of oysters' products were weighed with a portable scale and the corresponding monetary value was recorded.

In PNTC, the investigation was performed at the villages of Badiqué Felupe, Cacheuzinho, Causso II, Colage Oputche, Elia Nhízio, and Poilão Leão. In PNC, the selected villages were Cabedú Balanta, Caiéquene, Condiere, Djiu de Melo, Gandjatra, and Tabanca Bedju. The fieldwork was completed from November 2018 to January 2019 in both parks.

RESULTS

In total, 10 animal species are extracted from mangroves (Figure 2), both for household consumption and for sale; however, a large proportion of the harvest is for the former.

The oyster *C. tulipa* is the only species harvested in all the sampled villages of both parks. Also, it is the target species of most captures meant for commercialization, followed by the fish *Polydactylus quadrifilis* and *Farfantepaneus notialis* in PNTC and by *Cymbium* sp. and *F. notialis* in PNC. However, and even though several fish and shrimp species are captured by men in boats in both protected areas, only the women catch *P. quadrifilis* in mangroves.

Oyster Harvest and Trade

The oyster harvest is completed exclusively by adult women, usually in small groups, who move around the mangrove on foot or more often by boat. The harvesting procedure may involve cutting segments of *Rhizophora* spp. roots with a machete or harvesting groups of oysters with a knife or machete. The latter practice is more sustainable and is promoted by the management of the parks. In the PNTC the oysters are harvested by women from the Felupe, Manjaco, and Balanta ethnic groups and in the PNC by women from the Balanta, Nalu, and Tanda ethnic groups.

Three main types of oyster products were identified in both parks: fresh oyster with shell (FOwS)—oysters with shell, directly extracted from the mangrove; fresh oyster without shell (FOwoS)—oyster meat removed from the shell; and dry oyster (DO)—oyster meat after removal, drying and/or smoking (Figure 3). Table 1 summarizes the prices charged and the total income collected in each park. Table 2 summarizes the information about the destination of products and the corresponding revenues.

Socioeconomic Importance of Oyster Harvest

All the households in this study where oysters are collected are led by women. The DO played the most important role in household food security and income, followed by FOwoS, in both parks (Table 1). As illustrated in Table 2, oysters are commercialized in four main types of places: the villages where oysters are harvested; local markets (weekly markets in rural areas, locally called *lumus*); the capital, Bissau (mostly in the Bandim market); and across the border in Senegal, namely the Ziguinchor market in Casamance.

The survey indicated that the collection, processing, and sale of oysters are activities exclusively performed by women. As a result of the sales, women earn up to 30 € per week, or about 595 € (in PNTC) and 580 € (PNC) per harvest season, which lasts 20 weeks.

In PNTC, most of the inquired households sell oysters at local markets, with about one-half also selling at their own villages and one-third exporting to Senegal, namely DO; none of the surveyed families sold oysters in Bissau. In PNC, sales are made only in local villages (fresh and dry oysters) and in Bissau (DO), with most families having sold oyster products at both locations. There is also no reference to selling outside the country, namely to the Republic of Guinea.

DISCUSSION

The distribution of harvested animal species varies from park to park. In general, a greater variety of species is

Table 1. *Average sale price and total household income per park in PNTC* (n = *41 households) and PNC* (n = *37 households). Values obtained in 2019.*

	Prices (€ per kg)			Income Obtained (€)	
	FOwS	FOwoS	DO	Week	Season
PNTC	0.58	3.00	12.80	29.73	594.55
PNC	0.30	1.00	6.11	28.93	579.40

PNTC: Parque Natural dos Tarrafes do Rio Cacheu; PNC: Parque Nacional de Cantanhez; FOwS: fresh oyster with shell; FOwoS: fresh oyster without shell; DO: dry oyster

Figure 3. Oyster products and marketing methods; (a) fresh oyster with shell (FOwS); (b) fresh oyster without shell (FOwoS) and its form of commercialization; (c) dry oyster (DO), air-drying process; (d) DO, previously smoked (with a darker colour) and its marketing format.

harvested in PNC than in PNTC. This finding may be due to the different mangrove functional types found in the two parks (Lugo and Snedaker, 1974). In PNTC, the estuarine mangrove type prevails, whereas in PNC both the estuarine and the coastal mangrove types are found, which may account for the higher diversity of species harvested here.

According to FAO (2013), the prices of DO in Senegal vary between 5.34 and 6.10 € per kg, which are similar to the values recorded at PNC but lower than those found at PNTC. In Nigeria, the country with the largest mangrove area in Africa (UNEP, 2007), the sale price of the FOwS is 0.24 € per kg, whereas that of FOwoS is 1.34 € and of DO is 5.96 € (Ansa and Bashir, 2007). Again, these values are lower than those practiced in PNTC and similar to those found in PNC. Thus, because the sale values are lower in PNC, a greater quantity of oysters would have to be harvested in this park to obtain the same financial return.

Table 2. *Destination of oyster products and of revenues. Values correspond to the percentage of households in each park (PNTC and PNC).*

	Location of Sale				Destination of Revenues			
	Village	Local Market	Bissau	Export	Travel	Children's Clothing	Food	Children's Education
PNTC	51	80	-	33	98	49	39	83
PNC	88	-	83	-	67	60	69	58

PNTC: Parque Natural dos Tarrafes do Rio Cacheu; PNC: Parque Nacional de Cantanhez

Each type of oyster product has a different price, as well as distinct preservation and transportation needs. The FOwS are heavy and difficult to transport and must be consumed or processed within a short period after harvesting (*i.e.* about 48 hours). Typically, most FOwS are consumed, sold, or processed locally, but, even if sold locally, a fraction is also transported to be sold or processed in Bissau if the source is PNC or in Ziguinchor, Senegal, if the source is PNTC.

The FOwoS are easy to transport but present preservation challenges. To improve their preservation, FOwoS are often

boiled and packed in plastic bags, and the sale is made at the site of processing. Typically, DO are the most traded and most valued oyster products. Processing is done locally by drying in the sun or smoking after extraction and boiling; the DO can then be stored for several months and are easily transported.

The money earned by women with the sale of oysters is used to meet a wide range of family needs other than food and shelter. Although oysters are not the only product sold by women in the two parks, according to the survey results, the sale of harvested oysters largely contributes to household income and, consequently, to pay many of the daily expenses of the families, namely, to meet the needs of children. These findings are consistent with surveys in other western Africa countries, which show that oyster harvesting is an activity practiced mainly by women that contributes to improve the livelihood of local families (Adite, Sonon, and Gbedjissi, 2013; Barri, 2008; Carney, 2017; Crow and Carney, 2013).

According to Nije and Drammeh (2011), during the four months of oyster extraction season in Gambia, corresponding to 16 weeks of activity, women obtain $471 (about 431 €) from the subsequent sale. Thus, considering the slightly longer harvesting season in Guinea-Bissau (20 weeks), these figures are very similar to those found in PNTC and PNC. Moreover, it should be noted that the values presented here gain significance when compared with the monthly average salary in Guinea-Bissau. For example, the monthly salary of an unqualified civil servant is about 75 € (General Director of the Budget of Guinea-Bissau, personal communication).

The higher returns consistently obtained by the PNTC households (when compared with PNC) can be explained by the park's geographical proximity to Senegal, where best profits can be obtained. On the other hand, fresh oysters sold in Bissau come from places closer to the city, and only DO will come from farther locations such as the PNC. In this latter park, and given the precarious transportation routes that serve it and its relatively higher isolation from an international market, sales are made exclusively in local villages and in Bissau.

CONCLUSIONS

The present study confirms the importance of mangrove products for coastal communities in Guinea-Bissau and highlights the great importance of oysters for food security, empowerment of women, and improvement of the livelihood of their families. These findings are consistent with surveys in other Western African countries, which show that oyster harvesting is an activity practiced exclusively by women. Even without considering ecological aspects, the results presented indicate the magnitude of the financial impact that a reduction, or loss, of oysters could have for local families. Thus, interventions to replace unsustainable practices of oyster harvesting, such as the cutting of *Rizophora* spp. roots, with alternative and sustainable methods should be encouraged. The facilitation and spreading of alternative nondisruptive procedures to collect oysters, some already employed by certain households, would assist the park management authorities, who often struggle with logistical difficulties and lack of resources, to strive for the sustainable use of natural resources in the protected areas without refraining local populations from the benefits of their ecosystem services.

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□ ABSTRACT IN NATIVE LANGUAGE □

Na Guiné-Bissau, na África Ocidental, extensas manchas de mangal fornecem recursos importantes para a subsistência das populações locais. O objetivo deste trabalho foi avaliar a relevância da colheita, consumo e comercialização de ostras para as comunidades locais. Para tal, foi usada uma abordagem qualitativa derivada de metodologias de diagnóstico rural, em duas áreas protegidas costeiras com extensas áreas de mangal. A partir dos resultados constatou-se que dez espécies animais são extraídas do mangal pelas mulheres, tanto para consumo familiar como para comercialização. A ostra, *Crassostrea tulipa*, é a única espécie colhida nas 12 aldeias investigadas, sendo também a mais disponível nos mercados locais. São comercializados três tipos de produtos de ostras: ostras frescas com casca, ostras frescas sem casca e ostras secas, sendo estas últimas as mais comercializadas e valorizadas. Estes produtos são vendidos nas aldeias, nos mercados locais e na capital, Bissau, bem como exportados para o Senegal. A apanha das ostras é praticada durante vinte semanas por ano, proporcionando às famílias um rendimento médio anual de 580–595 €. Este valor, que representa uma grande parte do rendimento anual das famílias, é maioritariamente gerido pelas mulheres e utilizado para cobrir despesas familiares básicas, nomeadamente para atender às necessidades dos filhos. Este estudo revela os benefícios sociais derivados de um serviço de ecossistema do mangal, que é usado diretamente pelas comunidades costeiras, e destaca a importância das ostras para a segurança alimentar, para o empoderamento das mulheres e para garantir a renda familiar.